the Melanesian environment
Papers presented at and arising from
the Ninth Waigani Seminar,
Port Moresby, 2–8 May 1975
the Melanesian environment

John H. Winslow, editor
To the Melanesians who still pause by the river,
Stooping to drink its sweet water,
Its still sweet water
Preface

During the first week of May 1975, a six-day long seminar was held on the campus of the University of Papua New Guinea in Waigani, a suburb of Port Moresby. The seminar, the ninth in a series known as the Waigani Seminars, was convened for the purpose of discussing the impact of man upon the environment of Melanesia.

The seminar took place a few months before Papua New Guinea became independent. The country was already self-governing. It was an unsettled period, a time of countervailing currents and undercurrents both on a national-regional level and within the university itself. Like many tertiary institutions throughout the developed and less-developed world, the role of the university was then being redefined to meet more closely the immediate practical needs of the nation as understood by the government and business community. Those Papua New Guineans and expatriates who believed this to be the primary, if not exclusive, function of a university appear to have held some doubts about the value of holding a broad-ranging seminar of the Melanesian environment. Most of the preceding seminars had had a much greater specialist orientation. To this group of individuals the question-and-answer often heard during the seminar: ‘Who needs more academic talk? What we need are practical solutions to our pressing problems’ held a special meaning.

But throughout the nation there are many who believe that the kind of development taking place is not necessarily in the long-term best interest of the people, their traditions, or the environment that has given them material and spiritual sustenance for so long. These individuals divide into two (or more) groups, although they are not mutually exclusive. There are those who believe they know what the government and the university should be doing, and they are largely critical of both. For the most part they stand for village development, the maintenance of Melanesian traditions as far as is compatible with such development, a concern for conserving the natural environment as much as is practicable, and the limiting if not contraction of the urban population and bureaucratic class. The other group, which is represented by fewer individuals, is also concerned with the same things, but it goes further. John Waiko, in one of his contributions to this book (Chapter 40), discusses this additional ingredient in some detail:

In the technological fields we need a much lower and more useful level of competence. The few specialists needed in these fields do not justify an emphasis towards more such graduates. What we in the villages need are people of vision, with a knowledge of historical change and understanding of philosophical issues and social theory, people with a depth of understanding of the basic alternatives that face us. We need people who can understand the implications and the meaning of the choices we must make. We need thinkers, not blind
technical executors of policies made without the depth of knowledge to act in wisdom. Much of this needed wisdom is in our own traditional culture, though some we must get from the thinkers of the west and the east who are more conversant with the problems of a pluralist society.

The seminar, and consequently this book which arose from it, provided a forum for all of these points of view. For those in the audience who may have felt that one point of view was favoured above another, the equivalent of one and one-half days was set aside for audience-contributor discussions and debate.

This book is made up of original seminar contributions, revised seminar contributions, and contributions solicited after the conclusion of the seminar. While the subjects are wide-ranging, they do not begin to cover the whole gamut of topics that could have been included. Current agricultural problems could have been given greater representation, for example. They were not because the fifth Waigani Seminar, Change and Development in Rural Melanesia, explored many aspects of this subject and because it was known that the following 1976 Waigani Seminar would deal exclusively with the topic of agriculture.

It would have been desirable to have had a wider representation of papers dealing with other parts of Melanesia (as it was, three deal with Fiji, two with the Solomons, one with Irian Jaya and one with New Caledonia, plus a number of others that deal in part with Melanesia as a whole). The colonial or near-colonial status of many of the political entities that make up Melanesia makes it difficult to obtain willing and/or qualified individuals who would be encouraged or permitted (without penalty) to present papers that might be construed as being of a critical nature. Hopefully this situation will improve in the future and some Waigani-type seminars will be held in other parts of Melanesia. Irian Jaya, the least known of the Melanesian political entities, would make a most interesting and useful contribution to Melanesian unity if it were to host such a seminar!

John H. Winslow

Trinity College
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1977
Foreword

I feel very strongly that any worthwhile discussion on the Melanesian environment must be related first to the people or peoples who will benefit from this. But even more important than this, it must also be projected against a background of major world problems that affect large sections of the world’s population today. By far the greatest of these is the mounting problem of hunger and famine. We cannot talk of the environment in isolation. Every nation, great and small, must face up to the critical problem of hunger and world food shortage. If we fail to do this we will have to face the prospect of more devastating misery on an unprecedented scale and, ultimately, the revolt of hungry millions. Of what use is it to talk of the environment to a man who has never in his life known what it is to have a full stomach?

We have in Papua New Guinea, as we all know, a comparatively small population and vast areas of unused land—much of it also unusable. Within twenty years we may find we are forced to justify our right to sit on a scarce commodity like land. The world will have doubled its population by the turn of the century. By that time every known food reserve will be threatened. This must be borne in mind in any discussion of the environment, because its consequences do not allow for any feelings of complacency. Can we afford the privilege of holding on to and conserving an urgently needed resource, if we do not use it to share with others what that resource will produce in the way of food?

Coming a bit closer to the topics of this seminar, can we indulge in what may seem to many the luxury of demanding environmental protection and safeguards, when so many millions are desperately short of land? This is why we need to make sure not only that discussions on the Melanesian environment are pitched in terms of global problems but also that they will have validity and relevance in ten years time, or even in twenty years time. Because of Papua New Guinea’s geographic position I feel it is very easy for us to become academic and detached in our outlook. Let us instead be realistic. This year millions of people are expected to die of starvation and malnutrition. Millions more still living have never in their lives had a full stomach. Compared with the prolonged suffering of these starving millions, year after year, what is happening in Indo-China seems hardly worth recording.

It is difficult for us to grasp the meaning of human suffering on this scale. In another ten years it will have reached proportions that may well jeopardise the stability of many nations, especially those in Southeast Asia. This could bring pressures to bear on Papua New Guinea, and these would affect our own stability, and even our survival as a nation.

There is sound reason therefore why I am linking the world problem of hunger with
the Melanesian environment. To put it bluntly, we may live to see everything we are striving for swept away in a massive debacle that will shake the world to its very foundations. That is what some authorities predict. Of course they may be wrong, but we do not want to look back on this Waigani Seminar and say it was like sweeping the bedroom out while the house was burning down.

The problem of hunger is a very complicated one. I say this because the tragedy of starvation is not simply a matter of too little food. It is a problem of the uneven distribution of the food that the world produces. It is a problem of faulty mechanism for food distribution in areas of starvation. It is a problem of the ‘have’ nations, not caring enough about the ‘have nots’, who are born into hunger, and are living and dying in hunger. It is a problem of no technology, or the wrong technology, and above all it is a problem of too many people.

Like any problem with many facets we must look for many answers. Primarily, however, people must be made aware that the earth’s capacity for keeping us all alive is limited. This means that if man does not accept the responsibility for limiting his numbers, then nature will dictate the limits, amidst untold suffering.

The Waigani Seminar must be true to the challenge of man’s environmental problems. Pollution, population, energy, depletion of resources, land shortage, inequitable sharing of necessities, and insensitivity to our fellow human beings—all these are political, social and economic as much as ecological problems. The survival of human life and the creation of conditions for a better way of life depend on many things. Where Papua New Guinea is concerned we have the necessary guide lines and principles in our national strategies and in our eight-point objectives. This is more than many more advanced nations have at the present time. Furthermore, we have the opportunity and I think we are fortunate in being able to tackle these problems while there is still a chance to find the answers.

The big question, however, is this. Do we have the courage and the will to be trenchant and uncompromising with the systems and institutions that we have inherited? These must be moulded and modified to serve the national purpose, as they have been in the University of Papua New Guinea. Any system or institution that is rigid and refuses to acknowledge its subservience to the common good makes it impossible for us to achieve our national goals. This kind of institutionalised superiority is intolerable. In fact anything that jeopardises national survival is something no nation can possibly tolerate. And as we have seen, the problem of environment is also one of national survival in the face of overwhelming world pressures.

We must therefore accept the challenge and apply these principles to our situation in Papua New Guinea. We dare not sidestep the consequences. It is a tremendous challenge because I believe we have it in our power to produce what will one day be Papua New Guinea’s most valuable export: the knowledge we will have developed in solving many world problems on a miniature scale.

I am not an academic—and I do not see myself as one (though I cannot deny the fact that as a teacher I was involved in this field). My business is practical politics, and the business of governing and leading a new nation so as to bring the greatest well being and happiness to the greatest number of people. And that means not only this year, but next year, and the year after, and so on. As a politician, I have to try to look twenty years ahead while making decisions now that will be seen as right decisions, by your children and by my children. If I do not do this I will have failed in the greatest task any man can be called on to undertake. Your help is needed in this by administrators, legislators and policy makers—those of us who try to govern today and plan for tomorrow.
In your deliberations, wherever possible, try to keep one eye on Papua New Guinea and the South Pacific, and one eye on what is happening in Asia and Southeast Asia. Our most dangerous and unpredictable wind, as you know, is the Guba. We all know the direction that comes from.

In sum, I have tried to show that we are all part of a world family. We cannot look for a solution to environmental problems in isolation. Furthermore, solutions are only valid if they take account of what is happening in the world today. We must make decisions in the light of changes that must come to us and our neighbours in the next five to twenty-five years.

Most of what I have said has been looking forward. I would like now to look back. I want to recall some of the things I value greatly, things I hope will be a part of our life for many years to come. Some of these are very practical and very personal—like lessons in homage (I was almost going to say reverence) and lessons in identity, family pride and self-discipline that I learned from my father and his generation. I cannot help feeling that these are things many of our younger generation are in danger of losing, even while they are acquiring other strengths from a different culture.

Some of the things I want to recall are almost intangible, like the sense of appreciation, which I share with my fellow Papua New Guineans and which I believe is a national characteristic. It is like the unspoken sense of wonder I feel when I see daybreak across Wewak Bay. I begin with Wewak because I think Wewak is a very beautiful place. The truth is, of course, our whole country is beautiful. Our contemporary song writers and poets dwell on the beauty of the country. It is more than an appreciation of its physical features. It is a combination of nostalgia, reverence and pride. We have words for this in many of our languages that simply defy translation into English. This pride is part of our makeup and it goes back a long way. We must not forget this when we are talking about the environment.

In the last four weeks I have flown from the extreme east to the extreme west of this country. I can honestly say there is no other country like this and I say this from the bottom of my heart. I am proud of my country and glad to be alive in Papua New Guinea today. I am proud to be a part of the land that has come down to us from our forefathers, and from those who went before. I know I speak for all my people when I say that we do not want to see our country, our heritage, marred or spoilt.

People talk a great deal about cultural heritage these days. Some even seem to think it is a string of dog's teeth or a traditional dance or the way we get married. It is much deeper than this. In spite of our many differences we Papua New Guineans are a people of intense sensitivity and a capacity to respond. We have what I might call spiritual perception and understanding. We have survived through many thousands of years with a strong belief in the supernatural, and a belief in life after death. We are people of hope and faith.

These were qualities our forefathers had. This was their strength and we are proud of it. Many of our young people, I said earlier, are in danger of losing this strength through the materialism of the West, which is quite foreign to us. Perhaps this was inevitable when so many of our children have had to learn from teachers with little understanding of our past. But in spite of this, I believe these great qualities and values can be, and will be, retrieved and become, once more, the strength and real character of our people. It is happening already.

I want to remind you that in the old days there were times when our young men set out to prepare themselves for battle, or for initiation into manhood, or for a sea voyage. They accepted, without question, an almost spartan discipline. They denied themselves all kinds of social activity. They ate no pig or any other kind of meat. They
had no sex. They followed an extremely strict regimen. And they did all this willingly for a definite purpose. By any count these were men of remarkable character; they had courage and determination and beliefs. This and a great deal more is our heritage. This is part of what is in us and it will come back. It is coming back, though not necessarily in the same form.

So when we are talking of physical environment, we must not forget the spiritual environment that is a part of our heritage, and that we value very greatly. I want to make it clear that I am not belittling the profound strengths and insights that have been brought to us from overseas. These have been passed on to us with affection and often with great sacrifice.

My purpose in recalling these things from the past is to show the qualities and strengths that were ours and that have come down to us, from generation to generation: recognition of authority and reverence for old people; tremendous courage and great endurance in the face of hardship; the capacity to appreciate beauty and respond to friendship and affection; and the deep sense of commitment and loyalty we all have to our own group or tribe and, now, to our new nation. This quality of life and character are part of the very texture and fabric of our people and our nation. This is our heritage. This is Papua New Guinea.

1975 The Hon. Michael Somare
Prime Minister of Papua New Guinea
Introduction—A somewhat personal commentary on the Melanesian environment

JOHN H. WINSLOW

To many people outside the western Pacific the name ‘Melanesia’ (see endpaper maps) may conjure up images distilled from the short and tall tales passed on by the occasional traveller or brief resident, such as those who were engaged in a military campaign, a religious crusade, a travel tour, or an economic or cultural mission. To these may be added an overlay of information and misinformation culled from anthropological paperbacks, geographical and adventure magazines, and an occasional news item in the international press—the latter, more often than not, being about tribal skirmishes, cargo cults or other exotic customs pulled out of context to provide a dash of colour for the Western reader, or to help fill a gap in the column of a page.

The substance of most of the images held by the outside world are to be found in one place or another in Melanesia. The area, however, has much more to offer than tropical- and primitive-world clichés. It is a place of cultural richness and diversity and many of its parts are undergoing rapid political, social, economic and environmental change. Many of the Melanesians who hold university degrees from one of the three Melanesian universities, or from Britain, Australia, the United States, or Canada, were born in remote bush villages.

Melanesia is also a place that is still of outstanding beauty. Its landscapes range from the extreme of mountains supporting glaciers (and others that were formerly glaciated and now include cirque lakes and waterfalls characteristic of such regions) to the other extreme of coral atolls, mangrove swamps, palm-fringed white beaches, and deeply indented and precipitous-sided rias or ‘fjords’. All of these environments, as well as those in between, support a distinctive and sometimes unique flora and fauna.

Over the millennia man, too, by means of the cultural equipment and traditions he brought with him when he first arrived on the islands, and by trial and error, innovation and selective borrowing that have since taken place, learned to make a good living from most of the habitats he occupied. In so doing he brought about a modification of his environment, but this appears to be small (a point that will be discussed in the first papers) when compared to the rapidity and extent of changes experienced in many

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1 This includes Irian Jaya (Indonesian New Guinea); Papua New Guinea (including the Bismarck and Admiralty archipelagos, and Bougainville Island); the British Solomon Islands, Fiji (and its archipelago, including the Lau Islands); the New Hebrides; New Caledonia (including the Isle of Pines and the Loyalty Islands); and the Torres Strait Islands.

2 The University of Papua New Guinea located in Port Moresby; the University of Technology located in Lae; and the University of the South Pacific located in Suva. There is also a university in Irian Jaya but it is uncertain how many Melanesians are enrolled there.
areas since the time intensive contact with the outside world was first felt, whether thirty or over one hundred years ago. With the principal exception of New Caledonia, the projects that are presently under way or about to be initiated—especially in mining, hydroelectricity and forestry—are of a different order of magnitude from those that have so far been experienced. What effect they and subsequent large-scale projects will have upon the relatively fragile tropical island ecology and, where it is still viable, upon the Melanesian way of life, are questions that will be explored by a number of the contributors to this volume.

But is the average Melanesian genuinely concerned with what will happen to his lands and waters? Or is this the concoction of some ecologically-inclined outsiders? (Perhaps only a person whose cultural background has forced a dichotomy between himself and the space around him would think up such a question.) Most of the Melanesian speakers and discussants at the Seminar which gave rise to this book possess a very real concern, a concern that is augmented by a growing knowledge of what has all too often gone wrong elsewhere. But are they representative? More properly, are they representative of Melanesians who live in a Western-technological milieu? Does the Melanesian man and woman in the streets of Port Moresby, Honiara or Noumea (where, incidentally, relatively few are to be seen) want cautious development that is selected and paced so as to minimise its disruptive effect upon the Melanesian way and the environment? Probably not, at least at the present time. William C. Clarke, in his essay, 'The Dilemma of Development' (1973), written in 1970, was one of the first to relate the old cake conundrum to Papua New Guinea. His comments probably apply equally well to other parts of the region:

The truth is that if a poll could be taken, the New Guineans—along with most of the world's people—would side with the development economist, not with the worried ecologist, thus adding force to the cry 'You can't just leave them as they are' that is so often the ultimate argument against the view that many forms of deterioration could be avoided by slowing down development or directing energy to other endeavours.

If the same question were to be asked in the villages, however, the answer would not be so clear cut. And in most of Melanesia most of the people still live in villages. Certainly the men and women in the bush want to acquire the accoutrements of Western technology. When villagers are asked if they will trade their forests for a sum of money and, perhaps, some transistor radios (occasionally given to select individuals before the conclusion of the transaction), and the promise of a road and even a village school, their answer is pretty much a foregone conclusion.

If, on the other hand, they were encouraged to meet with villagers who had already had their forests cut they would gain some insight into the kind and degree of social disruption and erosion of traditions to expect. Likewise, if they paid a visit to a cut-over area with its new roads, school house, depleted forest, wildlife and soil resources, its muddied and flood-prone streams, and its probable aesthetic bleakness, they would be in a much better position to judge what they would be trading away. Put in this kind of framework, they might be less willing to give affirmative answers to questions like, 'Do you want economic development?' and 'Do you want an access road and a village school?' (see chapters 38 and 40 by the Routleys and Waiko). Unlike their urban counterparts they have much more of their Melanesian way to lose, and there are indications that some of the bush people, perhaps all of them, have a deep emotional attachment to the land.

In the past, traditional man has sometimes been pictured as either living in ecological and aesthetic harmony with his surroundings, or as a despoiler of nature. There are others who believe his impact may have been limited simply because of the
absence of large numbers of people and modern tools, and not because of any well-developed appreciation of the land and the life it supports. None of these extremes applies to Melanesians (or, probably, to any other people). I once asked some fishermen who had landed on one of the small islands to the north of New Guinea if it wouldn't be a good idea to leave at least a few of the more than one hundred sea turtle eggs they had uncovered on the beach, and they found this humorous and left no eggs for me. It is not done. Melanesians commonly burn off what will readily ignite in the country they live in or are passing through. It is undoubtedly a very old trait. Often there may be a good practical reason, but sometimes it is just something to do to pass the time.

And yet, contrary to what some of the literature states or implies about the origin of the concept of the aesthetic appreciation of nature beginning only two or three centuries ago in Europe, the Melanesians give widespread evidence of having possessed this appreciation well before contact with Western man. This includes such 'romantic' elements as appreciating the beauty of sunsets and landscape views not only for their own sake but for the emotions—nostalgia and others—they may engender (Chowning, 1974).

Poetry exhibiting a love of nature and landscape is a part of the interchange provided by some of the men of the villages (Clarke, 1975). It is also, as Papua New Guinea's Prime Minister Michael Somare points out in his contribution to this book, much in evidence in the works of contemporary song-writers and poets. More prosaically, the siting of villages and houses often appears to include an aesthetic component, the traditional planting of ornaments in the villages and the use of flowers and feathers in personal adornment, the common practice of women carefully sweeping the village grounds each day, the fond reminiscing of old men over the places in the landscape where important or interesting events once took place, and the occurrence of 'sacred groves' and 'sacred rocks' give some insight into the depth of attachment the people have for place and the natural landscape. On an even more subjective level, I frequently observed the pleasure radiated by village people when on a walk in the bush, and I believe others have noticed the same thing. This pleasure appears to me to be of a different type—a more fundamental level—than that which I have observed among the determined hike-on-the-moors or get-back-to-nature-through-your-nature-reserves enthusiasts of the Western world. Michael Somare refers to this ineffable quality as being a special 'sense of appreciation' and a 'sense of unspoken wonder', and he has not been influenced by the Lake Poets to my knowledge.

At the University of Papua New Guinea student initiative helped to bring about the formation of a group calling itself the Environmental Concern Society. It is perhaps the only student organisation which lacks an obvious political raison d'être. There is a growing concern that the quality of life of the country is being threatened. This has been partly brought about by researchers such as John Waiko (see his contribution) and a number of undergraduate and postgraduate students who have been among the first to realise the extent of the potential threat. They have gone back to their home villages and have asked whether there is a real economic advantage for their people to sell off their natural resources to foreign companies, and what such activities will do to the quality and way of life in the villages and the country as a whole. This is one of the themes that threads its way through many of the contributions to this book. It is the 'development for whom?' of Gabriel Gris's opening address and it lies at the base of the section on appropriate technology. Where it is possible, this is the time to ask such questions. The extent of active, proposed and contemplated development of forest, mineral and water resources of a country such as Papua New Guinea is immense, and many of the organisations behind such development (including the multi-nationals
which are touched upon by some of the contributors) come from countries whose land has not always been treated with respect, and whose resources of the kind they now covet from the western Pacific may have been thoughtlessly squandered or destroyed. They are also generally ignorant of the significance of the non-economic side to Melanesian life and, more likely than not, are victims of some of the same journalistic images about Melanesia that are so common throughout the world. But they have money, power, dedication and experience in influencing politicians, and they are dealing increasingly with politicians who may have been immersed in the non-Melanesian aspects of city life to such an extent that, while they talk a great deal about villages, villagers, village land and the Eight Point Plan, are finding it more and more difficult to see the villages for the city.

In the Indonesian colony of Irian Jaya—a land greater in size than Norway or California and one which may soon be the largest colony in the world—the indigenous Melanesians have neither the freedom nor the education to be able to assess properly what is happening to their land or to ask the kind of questions that are being debated by their brethren across the border in Papua New Guinea. The increasing number of Indonesian settlers, the dominance of the military even in the remote areas of the country, the mineral wealth (see the contribution by Mitton) and other natural resources that are being removed under the direction of Jakarta, and the general immunity of the colonisers from criticism by the United Nations suggest this state will not improve, and the local people may go the way of the indigenous peoples of Kalimantan (Indonesian Borneo). In other places, such as the French colony of New Caledonia, the question is pretty well out of date, for a large part of the land outside the Melanesian reservations has been irrevocably altered by past and ongoing French mining interests and related activities. Furthermore, Melanesians on that island who still retain something of the culture of their forebears have had a minimal influence on the decisions or decision-making policies of the governing body of their country.

Of the remaining islands to be mentioned, Fiji has been independent since 1970.

3 The eight points or aims are principles set out by the government as a guide to Papua New Guinea's future. Briefly they are: (1) a rapid increase in the proportion of the economy under the control of Papua New Guineans; (2) more equal distribution of economic benefits; (3) decentralisation of economic activity; (4) an emphasis on small-scale artisan, service and business activity; (5) a more self-reliant economy; (6) government expenses to be met from locally raised revenue; (7) increasing participation of women in all forms of economic and social activity; and (8), government control and involvement in those sectors of the economy where control is necessary to achieve the desired kind of development.

4 Irian Jaya, formerly Irian Barat, West Irian and Netherlands or Dutch New Guinea. If it pleases the reader he may substitute the terms, 'territory', 'possession', or even 'overseas province' when the word 'colony' appears. The recent military takeover of the predominantly non-Indonesian population of eastern Timor by the Indonesians, and the United Nations sanctioned Indonesian occupation of Irian Jaya and the 'Act of Free Choice' puppet play that followed are reminders that colonial expansion is not a thing of the past. In the last case, just as several centuries ago the Dutch and Portuguese believed they were favouring the 'backward' East Indians by imposing upon them an alien political and military system, and some of the other European nations provided similar services to the 'savage' black Africans, now the Indonesians are doing the 'savage' and 'backward' blacks of part of the western Pacific a similar favour. Many of the nineteenth-century techniques to achieve this end appear to have lost little of their appeal. The journalistic image of Melanesia together with the entrenched Third World political status of Indonesia has undoubtedly helped to make the task of the little-known Irian Jaya Government-in-Exile (Organisasi Papua Merdeka) a particularly difficult one.

5 Apart from Greenland, which lacks a viable indigenous population, the only colony to exceed Irian Jaya in size is South Africa's colony, Namibia.
and the British Solomon Islands, which recently dropped the 'Protectorate' from its title, achieved internal self-government in 1976 and will most probably be granted independence some time in 1978. The Anglo-French condominium of the New Hebrides is still a colony and, from the lack of any unified move in the United Nations to change its status, will probably remain so for some time to come. Papua New Guinea became independent in 1975.

In May of 1975 a week-long seminar, the ninth in a series of annual events known as the Waigani Seminars, was held at the University of Papua New Guinea. The topic, 'The Melanesian Environment: Change and Development', had been selected in response to a growing concern among some of the people working in the government of Papua New Guinea, some of the students and faculty at the university, and certain other individuals at changes that had taken place or were about to take place to the land and waters and the way of life of the people of Melanesia. The example of what a large and fairly carefully planned mining operation, such as that conducted by Bougainville Copper Limited (whose parent company is Conzinc-Rio Tinto of Australia) in south-central Bougainville Island, could do to a river and its valley was well known. Other examples to draw upon from the Pacific area were the French mining activities on New Caledonia, the recent mushrooming of tourist resorts on Fiji, and the extraordinary power of developers (a few of whom have expanded their operations into Melanesia) to override groups of people on the Hawaiian Islands who held a set of values different from their own. Some of the problems relating to the Fijians are discussed by Baines (chapter 43), while the extreme and tragic case of Hawaii is examined in detail by Daws and Kelly (chapters 41 and 42).

Because of the extent of its little exploited forest, mineral and hydroelectrical resources, the island of New Guinea has been of particular interest to foreign companies. As a place with an unusual and only partly disturbed flora and fauna it is in a vulnerable position. Its people, most of whom still retain many of their traditional beliefs and who subsist chiefly upon the garden produce they have grown by traditional methods, are equally vulnerable if changes take place too rapidly with too little foresight and planning. Although less well endowed with natural resources, much the same thing applies to the small islands making up the archipelagos of the Solomon Islands and the New Hebrides. Introduced activities and ideas which might have a minor effect or be absorbed and dissipated on larger bodies of land may produce major and sometimes catastrophic effects on islands, especially small ones. Examples of this well-known phenomenon may be observed on some of the islands of Fiji and the New Caledonia-Loyalty Islands-Isle of Pines group. Of course, even the most fully transformed of these island environments can still be further abused.

Information about development projects that are taking place or being proposed is not always easy to obtain. This is particularly true of Irian Jaya. An Indonesian citizen who has openly defended his government's policies on a number of occasions had intended submitting a paper on this subject and visited Irian Jaya with that object in mind. Upon arriving there he reported that he was denied permission to visit any of the places where development projects are occurring. Similar reports have been received from other individuals. Those few foreign researchers who have been given permission to work in that colony are all too often reluctant to express any criticism in print for fear of not being granted a visa to visit there in the future. Bob Mitton's contribution on the development on the Freeport Copper Mine on the Ertzberg of the

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4 A few of the islands making up the northern part of the New Hebrides (including the Banks Islands) have recently petitioned the United Nations for independent status.
Carstensz Range is therefore of particular value. He too has a long standing research interest in the western half of the island.

Much has been said about the right of the people of Papua New Guinea to have access to essential information before the acceptance of any development project. Unfortunately such information is sometimes classified as secret or has a very restricted circulation and is therefore not available to the public or even the group of people who will be most affected. I have received information that an unavailable government study of the chemistry of the waters and the biota of the upper Fly River indicates that both contain in their natural state excessive amounts of mercury. Attempts to investigate the health of the fish-eating population around Lake Murray (which, during flood time, receives water from the upper Fly) to see if they exhibit symptoms of Minamata disease appear not to have been encouraged; but there are indications that some indigenous populations in the Fly drainage basin have unusually high levels of mercury in their hair. If the report of the findings of this preliminary investigation is accurate—and I have reason to believe it is—there is a chance that mining activity at Ok Tedi on the upper Fly will cause the lower Fly River, the largest river in Papua New Guinea, as well as the Gulf of Papua, to become further contaminated. This could pose a threat to the health of the small number of people who live near the mine site and, possibly, to the larger group of villagers who fish along the river, in the estuary of the Fly, and the adjacent region of the Gulf of Papua. It could also have an adverse economic impact upon the barramundi (a large fish) industry there.

In this case, as in every case, the long-term interests of the people of the country are best served when detailed environmental, social and economic impact studies precede commitment to a development project, and the results are made readily available to the public early enough to enable them to discuss and debate the issues. In countries where big business dominates the economy and life-style of the people this kind of precaution has been ignored until recently and even now many impact studies are highly suspect. The government of Papua New Guinea has declared in its Eight Point Plan that it has a different set of priorities. As an independent country little more than two years old, it is in an enviable position to avoid the many irrevocable and self-reinforcing environmental and human mistakes made by so many other governments: first, second and third world.

The emphasis of many of the contributors on the problems associated with development should not obscure the fact that the governments of the various political entities of Melanesia are in favour of developing their natural resources with all due haste (see Prime Minister Somare's contribution) and that the potential for such development, especially on the island of New Guinea, is considerable. During the brief period in which advanced prospecting techniques have been used to search for minerals, three large and relatively high grade or extensive copper ore deposits have been discovered in Papua New Guinea: the Ok Tedi, the Freida River, and the Bougainville Island deposits. The last, the only one presently in production, has turned out to be one of

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7 The contribution of Charles Goldman and Roderick Hoffman on the Purari River scheme represents a distillation of a more extended report written by Goldman and presented to the government of Papua New Guinea. Although the report was printed it obtained a restricted circulation within the government and was generally unknown to exist by the public, including some of the concerned villagers from the Purari area.

8 A booklet, *The Land is Our Life* (Winslow and Gubbay, 1976), attempts to spell out to the villagers some of the things they should first consider before agreeing to sell their natural resources. It arose from some of the ideas expressed at the Waigani Seminar.
the richest single mines in the world. In 1973 it showed a profit on copper, gold and silver sales of $A158,000,000 (equivalent to about $US193,000,000). It provided its Australian shareholders with a greater total return than that received by the shareholders of any company in Australia during that year. Since then the terms of the original contract have been renegotiated with the government of Papua New Guinea.

The subject of the potential for large-scale development in Melanesia has been but briefly touched upon in this book. This is partly because of the belief that the power and persuasiveness of those behind large-scale development are already very great, and because there will never be a time as opportune as the present to discuss questions about the direction development is to take, or to gain from the errors made by others. Furthermore, it is not easy to find people knowledgeable about discoveries of ore, natural gas or petroleum deposits who are willing to discuss these subjects openly, and independent researchers are generally not given access to this type of information. S. Warren Carey’s paper on the hydroelectrical potential of the Gulf of Papua is a notable exception. His observations are of special significance since he was among the first individuals to recognise the potential of the Purari River for hydroelectrical development—an almost Aswan-size project that is now under consideration by the governments of Papua New Guinea, Japan and Australia (see the contribution by Goldman and Hoffman).

In the past several years a small but apparently growing number of people (especially in Papua New Guinea) are asking if large-scale development of any sort is either necessary or desirable. They are concerned that the essential qualities that make up their Melanesian outlook will be undermined and eventually destroyed by the intrusion of big business and foreign capital and all of the attitudes and dependency clauses they engender. Most proponents of Western-style development would probably see this as a reflection of a romantic or even immature approach to the problems facing Melanesia—and would also probably maintain that such development is inevitable (and right) anyway. Others, such as Prime Minister Somare and some of his advisers, appear to place a higher priority upon having the land and its resources used to their fullest extent as quickly as possible so as to deter the masses of the greater Asian continent from considering their country fair game. A cynic might point out that this could well have just the opposite effect.

Those who wish to try to maintain the essential qualities of the Melanesian way of life, even if it means that the people and their government employees will be less well off materially, claim there is another possibility. The lot of the villagers can be significantly improved with much less disruption by selectively applying the kind of technology that has been used with such success in the villages of the Chinas and North Vietnam. In this way the people will tend to participate more in their own material improvement, they will understand the technology, and there will be little

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9 Professor Carey’s early contribution to the development of the theory of continental drift at a time when only a handful of geologists had the knowledge and courage to associate themselves with the concept is well known.

10 There are others who accept in principle the idea of such development but want to wait until dependence upon foreign capital and expertise can be significantly reduced. One of the arguments is that the copper deposits will not deteriorate if they are not mined at this time. By waiting, the country should be in a better position to obtain much greater profits. As high-grade reserves of this ore are depleted around the world the ore will become much more valuable. Once enough local engineers and various technical and management specialists are produced and gain the requisite experience, the government or national companies can open up and direct the mining operations.
dependence upon highly specialised, difficult to maintain, and costly machinery which often requires spare parts that may or may not be available. The kind of changes initiated would be modest and more in keeping with the context of the culture of the villagers instead of cutting across and eroding their beliefs, institutions, and long-accumulated and technical (especially agricultural—see Maenu’u’s contribution) knowledge and expertise. The section on appropriate technology explores some aspects of this subject. John Waiko, in his contribution on the forest industry and in his remarks in the section on appropriate technology (chapters 40 and 48) writes on this subject with the same ‘fierceness of purpose’ he believes characterises the grass roots people of his country.

The section of the book that may be interpreted as standing alone is the one that discusses the prehistory of Melanesia. Some exciting discoveries have been made in recent years by a number of archaeologists, geographers and biogeographers from Australia and New Zealand. Even though their studies suggest that New Guinea might well have been one of the earliest places in the world to adopt agriculture (and that it might well have been an independent centre of plant domestication as well), and even though the information they provide represents the only history of this region before the coming of the white man, few Melanesians have taken an interest in the subject. In a sense, therefore, the subject was included in opposition to what is presently interpreted as being ‘relevant’ and valuable. I make no apology for this. These studies offer a datum point from which to judge and to some extent predict the direction and effect of man-induced environmental changes, and they offer an opportunity to the peoples of Melanesia to begin to see themselves and their land in perspective in the same way that many Mexicans are now able to see themselves. The artificial boundary dividing the island of New Guinea in half becomes invisible when one goes back only fifty years in time.

Monkeys, the trematode causing bilharzia, and many other Southeast Asian and tropical organisms, appear never to have reached the islands of Melanesia. Other creatures such as the giant snail, the tubercle bacillus (keeping in mind Wigley’s qualification—see his contribution), deer, tilapia and trout, the syphilis spirochete, the domestic cat, Homo academicus, the toad, Homo vagans touristicus, cattle and sheep, and Homo missionarius (see Ulufa’alu’s contribution) have been brought in by outsiders. In the absence of effective controls or predators many of these are flourishing, the toad and the tourist being outstanding examples. (So far no one has made a study of the comparative effects of toads and tourists.) Some of these organisms have been largely beneficial, others have been a mixed blessing, but many others have had a decidedly harmful impact. In recent years the introduction of potential pests and weeds has been slowed down by the application of quarantine regulations.

This is briefly discussed in the contribution by Golson. In a more recent paper presented before the Ninth Congress of the International Union of Pre- and Protohistoric Sciences at Nice (September 1976), Jack Golson and P. J. Hughes follow Bulmer’s evidence that there is a case for the presence of the pig in the New Guinea Highlands from 10,000 B.P.—a case that adds support to other field evidence for the practice of bush clearance for agriculture before 9000 B.P. They also cite studies by Douglas Yen (1971, 1973) and Jocelyn Powell (1976) as a basis for suggesting the possibility of independent origins for plant domestication in New Guinea although—given the possible early linkage of pigs and agriculture—they argue that it is likely that the earliest Highlands agriculturalists were using introduced plants.

In 1894 the creator of Sherlock Holmes, Arthur Conan Doyle, wrote in his ‘Stark Munro Letters’ of the most ludicrous example of an archaeological society that could be imagined for the future: The New Guinea Archaeological Society. Since Conan Doyle believed that he would be able to communicate with the world after his death (which took place in 1930) he may have a few surprises still awaiting him.
Introduction

It is probably neither possible nor desirable to attempt to apply heavy-handed quarantine regulations to infiltrating alien technologies and institutions, even though in the long run some may turn out to be more devastating to all aspects of the Melanesian environment and way of life than all the introduced diseases and pests put together. Bart Philemon (1975), in his paper before the Waigani Seminar,13 recognised this kind of problem when he spoke of the tourist industry:

it should be our ultimate goal to strengthen our cultural life. We must do this for a number of reasons, not the least of which is sheer self protection. For unless we can strengthen and fortify our unique way of life, the impact of Western culture will not pollinate our culture but pollute it. A cross-cultural experience can come when two equally stable societies make contact. But if one of them is weaker than the other then what results is not social development but social destruction ...

One of the arguments in favour of world tourism is that it promotes international understanding; but the plain fact is that too many of today's tourists, blinkered and cocooned from reality by their travel agent, promote not mutual understanding but mutual contempt.

I have said that the root of our society is respect. But respect will wither on the vine unless it is mutual. We would not want to have tourists whose requirements stop at a comfortable bed and a comfortable seat in a car. Nor indeed do we want the tourist who wishes only to gape at us and ... our customs. The kind of tourist we do want ... is the one who comes to us with an open mind, who seeks to meet us on equal terms, who is interested in us, ourselves, as people.

Philemon is probably the first Melanesian to express critical remarks about the tourist industry in a public address. The Seminar also gave Bart Ulufa’alu an opportunity to question the benefits of missionaries and other alien institutions in his country; he too is probably one of the first Melanesians to do so in a public address.14

The spokesman of one of the villages on the Purari River came to the lectern and in an impassioned statement criticised the general absence of effective communication between the people of the government, who have tentatively planned to submerge her village land beneath impounded waters, and the people of the place.15 Another villager, Bobby Gaigo, used the Seminar to give vent to the fears held by some traditional fishermen that foreign commercial fishing, expatriate-type sports fishing, and other

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13 From Bart Philemon's printed address, quoted with permission of J. H. Winslow, Convenor of the 1975 Waigani Seminar. Mr Philemon is an executive working for Air Niugini.

14 In 1912, in an article entitled, 'A Native Fijian on the Decline of His Race' (Anonymous, 1912), an unnamed Fijian stated that he believed the introduction of the Christian religion had been in many ways detrimental to his people and he asked that they be permitted once again to turn to their native religion. In the discussion that followed it was stated that 'the Colonial Government will do well to keep a close watch upon our essayist and his friends'. During the public discussion that followed his address Mr Ulufa’alu stated that he did not think he would have been able to have given the same speech in his own country. Since then the Solomon Islands have obtained internal self-governing status.

15 Since it has a bearing on the question of whether or not village people can gain anything from (selectively) attending an academic seminar, such as the 1975 Waigani Seminar, I would like to quote from an unsolicited letter received from this individual some time after the end of the Seminar:

Dear Sir:

It is my pleasure to write to you this morning. I'm very please because during Waigani Seminar most of Feasibility Study has advice me more information about land.

During Waigani Seminar the Feasibility Study people had told me to go and get people's views about land, instead of Government telling them what to do, and this is the report it was enclosed what I get then during my visit in my area. Once again I would like to say thank you ... [From] this Waigani Seminar ... I get more idea to help my own people.

Yours faithfully

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imported practices were believed to have contributed to a decline in their catch. Gabriel Gris discussed his concern that the main beneficiaries of the present form of development may be the developers, and the long-term losers may be the people of his country. Other Melanesian speakers expressed similar but more specific fears: John Waiko on the timber industry; Leonard Maenu'u on the loss of the wisdom of the traditional farmer in the face of modern agriculture; Peter Kavo on the effect of foreign aid on village development; and John To Vue, John Waiko, Jane Cooke, Meg Taylor and Leo Hannet on the inappropriateness of an ever-increasing dependence on Western-style technology—other Melanesian contributors are the Governor-General, Sir John Guise (on agriculture); the Hon. Stephen Tago, Karol Kisakau, and Brown Bai (on conservation); and Leonard Kaupa and Dr Peter Pangkatana (on health).

Even though Papua New Guinea as an independent nation has been in existence so short a period it appears to have already become committed to Western-style development. Much the same thing appears to be true of the other political entities of Melanesia, emerged, emerging, and submerged. During the Seminar the voices of those Melanesians who raised questions about the direction and effects of change taking place, and the voices of outsiders who pointed to the liabilities and benefits of similar types of change and development experienced elsewhere, were heard by few individuals. It is to be hoped that the contributions to this book will not meet with a similar reception.

If Western-style development, technology and institutions continue to root and entwine themselves into the environment and the behaviour and thought patterns of the populace, the Melanesia that is still viable may lose in a very short time many of its distinctive characteristics. Once this occurred, the incentive to hold on to other essentially Melanesian qualities would increase as the chances of being able to do so decreased. What would be left would be little more than the costumes and dances seen during a festival occasion. Gabriel Gris’s ‘development for whom?’ would soon become a meaningless question. Perhaps this is inevitable. Perhaps it is desirable. Perhaps not. It would be sad if the outcome were reached by default.

The Melanesian environment and culture have taken a long time to evolve. They still complement each other. The bird of paradise should serve as a symbol of all the other beautiful things that are being threatened.

Acknowledgments

First and foremost I wish to thank Professor William C. Clarke for his help in so many different ways before, during and after the Waigani Seminar. A special note of appreciation is also due to Professor Harold Brookfield and Mr Douglas Yen who wrote the concluding remarks to both the Seminar and this book, and to Mr Tom Unwin, the Resident Representative of the United Nations in Papua New Guinea, whose cheerful assistance was provided at a time when it was most needed. Thanks are also due to the organising committee and to my assistant at the time, Ms Sharon Gubbay. Ms Gubbay assisted me in organising the Seminar, in helping to write the booklet which arose from some of the ideas presented at that time: The Land is Our Life, and in preparing many of the abstracts that accompany the papers. Appreciation is also extended to the students who helped us so much and to those who chaired the various sessions: Dr Gabriel Gris; Professor William C. Clarke; Dr David Purdy; Dr Ross Garnaut; Mr Michael Hill; Professor David A. M. Lea (who also helped in many other ways); Professor Eugene Ogan; Dr Kerry Pataki-Schweizer; Reverend Theodore Woods (whose assistance during the early planning stages of the Seminar is also gratefully noted); Mrs E. Nahou Rooney; and Professor R. Gerard Ward. Dr Lance
Hill, who was then seconded to the Papua New Guinea Office of Environment, was also of considerable assistance in suggesting topics and speakers. Mr Rabbie Namaliu helped to chair part of the day set aside for questions and debate. Also, Mr Tom Craig, his staff, and Margaret Craig at the Creative Arts Centre kindly gave their professional and personal assistance, including the cover design for the book jacket. The special interest and genial presence of Mr Ron Robertson-Swann of Sydney was also much appreciated.

The day following the last of the sessions of the Seminar the people of Lea Lea opened their village to the participants. Their warmth and friendship will be long remembered by those who experienced their hospitality and excellent food.

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I  Prehistory and the environment
Recent concern about man’s impact on his environment has led to increased study of man induced alterations in biological and physical ecosystems. From the geomorphological point of view the most important change brought about by man in Papua New Guinea has been the acceleration of erosional processes. It must be remembered, however, that man entered the scene very late in geological history, and his impact can therefore not be expected to have been very significant in geological terms. Physical changes in Papua New Guinea are governed by its particular climatic conditions, producing weathering, fluvial processes, and slope wash among others; and by its geotectonic position, giving rise to volcanism and earthquake initiated processes. In Papua New Guinea many important geomorphic processes, volcanic activity for example, cannot be influenced by traditional man’s activities. Consideration of the remainder of important agents of change leaves only slope wash as an area where man’s activity has had a clear impact—usually because of his reduction of the ground cover by burning or intensive gardening. There can be little doubt, however, that in comparison with the impact of industrial man, traditional man’s impact has been very small indeed.

During the last decade we have become increasingly aware of man’s impact on the environment and its often disastrous consequences. Man’s impact is most obvious in its effect on the natural vegetation, which in many parts of the world has been completely changed or removed. The removal of the natural vegetation brought with it other changes of the environment. It severely affected not only the biological ecosystem but also the physical one. Among these effects are alterations in climate, particularly microclimate, changes to soil properties, and to the whole hydrological cycle, and many more. From the geomorphological point of view the most important changes were the acceleration of erosional processes. Man did not usually cause any specifically new processes but, by disturbing the environment, he caused the naturally occurring processes to operate at an accelerated rate; the rate of acceleration often increased dramatically once the first major change to the environment had taken place. This does not apply to all processes or to all environments. To understand the processes of accelerated erosion one first has to gain some insight into the naturally occurring processes and the landforms they create.

In the following paper I will consider the impact of the activities of traditional man on landforms and landforming processes in Papua New Guinea.

Before dealing with traditional man’s impact on the landforms and landforming processes, this chapter gives a brief account of the distribution and development of landforms in Papua New Guinea and the landforming processes acting upon them. A more complete account of this will appear in a monograph on the geomorphology of Papua New Guinea (Löffler 1977). My personal experience is restricted to Papua New
Guinea and I will therefore concentrate my discussion on this country. Since the other parts of Melanesia are situated in very much the same climatic zone and geotectonic region most of the discussion will be of relevance to the other countries of Melanesia.

**Landform development in Papua New Guinea**

The Papua New Guinea landforms are all very young in a geological sense. Much of the country is dominated by ridge and ravine landforms with steep slopes, sharp crests and deeply incised V-shaped valleys, which bear witness of vigorous fluvial incision. In addition there are vast areas of karst country that have been formed by solution processes on limestone. The erosion in the mountains has been matched by an equally active deposition of the eroded material in the mountain foreland where large areas of depositional plains have developed.

The framework of the present landforms, in fact the entire shape of the present land mass, was not established until the late Miocene to early Pliocene some 5-10 million years ago. The tectonic or mountain building activity continued well into the Pliocene and sedimentation from the rising land mass was active well into the Pliocene around the margins of what are now the central mountain ranges. Uplift seems to have come to a halt sometime in the Pliocene and a hilly, in places mountainous, landscape developed. Most of this landscape was still relatively close to sea level and subject to intensive tropical weathering. Remnants of this landscape can be found all along the Owen Stanley Ranges in form of low, hilly summit plateaus. Large areas of the highlands, especially around Kainantu and Goroka, also have the character of relict landscapes with low local relief and river gradients not adjusted to the present base level of erosion.

During the latter part of the Pliocene this landscape was uplifted during a major phase of vertical earth movements. The rate and amount of uplift varied from a few hundred metres in the east around Milne Bay to some 3000 metres at Mt Albert Edward. Accompanying the uplift was intensive erosion, probably favoured by widespread seismic activity. In the Pleistocene a major phase of volcanic activity set in, leading to the formation of most of the volcanoes that dominate so much of Papua New Guinea's landscape. In the highlands the volcanoes erupted on a mountainous landscape with a drainage system very similar to the present one. The drainage system was severely disrupted in places and several intramontane basins were formed by blockage of rivers by lava and ash flows.

The existence of pre-volcanic structural depressions and areas of low relief between the mountain ranges has favoured the development of some of these basins. One example would be the Wahgi valley (or, better, basin), which was formed by blockage of the former westerly flow of the Wahgi by the Mt Hagen volcano. This basin is situated in a structural low between the Kubor anticline to the south and the Bismarck fault zone to the north.

The only significant and so far clearly established break in the landform development besides the volcanic activity has been the glaciation of the high mountains. There is now growing evidence that Papua New Guinea experienced more than one glacial period. It is only the last, however, that we know in any detail. It was also probably during it that man came to Papua New Guinea. During this last glaciation the climate in the highlands was some 5-6°C cooler than at present (Löfler 1972), resulting in a general depression and compression of the vegetation belts. In the lowlands reduction in temperature was probably less (3-4°C) because of the likelihood of an increased lapse rate due to cooler and drier air masses (Nix and Kalma 1972). The amount of depression would therefore have somewhat decreased with decreasing altitude. Ice
caps and mountain glaciers of varying sizes covered all the mountain peaks exceeding 3600 m. Below these glaciers extensive grasslands developed. It is not known how far down these grasslands extended. There is pollen analytical evidence that grassland communities extended down to about 2000 m (Powell and Hope 1976). This would, however, mean a lowering of the forest grassland boundary by nearly twice the amount considered likely for the depression of the snowline. This discrepancy is difficult to understand unless one implies major climatic changes in addition to the temperature depression. It could well be that the pollen data represent a local situation like those that presently occur in some grassland basins well below the general forest boundary.

There is very little geomorphological evidence that the lowering of the vegetation and climatic belts caused significant changes in the landforming processes below the ice caps. From the limited observations available, it seems that there was hardly any periglacial activity below the ice; in fact all the evidence for periglacial activity so far has been found inside the formerly glaciated area and must have occurred shortly after the ice had receded. This is, however, not surprising and is consistent with the present-day situation where genuine periglacial activity is restricted to a very narrow belt below the snowline.

At about 12000 years BP the glaciers receded rather rapidly and by about 9000 years BP all the mountains in Papua New Guinea were ice free. Surprisingly, glacial activity and the recession of the ice do not seem to have resulted in any large-scale transportation and deposition of fluvio-glacial material in basins in the vicinity of glacially covered areas such as the Kaugel basin at the foot of Mt Giluwe (Pain 1973). This could be due to the diurnal regime of melting typical for tropical glaciers where there is a much more gradual release of meltwater than in higher latitudes.

The period from about 8500 to the present is characterised by some minor climatic changes and, more importantly, by the onset of man's impact on the land and widespread destruction of forest by man (Hope 1973). In the high mountains evidence of burning has been found from about 4000 years BP, possibly resulting in temporary slope instability (Blake and Löffler 1971).

In coastal areas of Papua New Guinea an important factor for the landform development during the Pleistocene was the eustatic sea level changes. It is now well established that during the Pleistocene sea level fluctuated from about its present level to some 180–200 m below this level, causing repeated alteration to the coastal environment. In Papua New Guinea the most important event was the repeated closure of Torres Strait and the joining of mainland New Guinea to the Australian continent. This caused significant changes in climatic and environmental conditions of this area, in particular widespread dessication of the exposed shelf and southern Fly Platform (Nix and Kalma 1972).

Along most of the other coastlines of Papua New Guinea the drop in sea level did not result in any significant land gains because of the steep offshore slopes, but coastal streams had to adjust to the much lower base level. Smaller streams with steep gradients were little affected but larger rivers like the Sepik and the rivers flowing in the Gulf of Papua experienced dramatic increases in their gradients. This resulted in incision into older alluvium like that on the Fly Platform or the formation of deeply incised embayments in areas where an extensive shelf was missing. The subsequent rise in sea level led to drowning of most of the coastline and the rapid filling in of the embayments and other low lying areas such as the Sepik basin with sediment and organic matter.

The last glacio-eustatic transgression started at about 15000 years BP and sea level
reached its present level at about 5000 years BP. This implies a mean annual rise of close to 2 cm per year (Galloway and Löffler 1972), an extraordinarily high rate that must have made the coastal fringe a highly unstable environment for the population living there. The sea reached its present level at about 5000 years BP and the present coastal landforms have developed since under relatively stable conditions.

In other areas of Papua New Guinea the geomorphic history during and after the last glaciation is little known. Observations by Mabbutt and Scott (1965) in the Port Moresby area suggest periodicity in soil development with periods of soil formation and slope stability alternating with slope instability. These changes are interpreted by Mabbutt and Scott as results of periodic changes from drier to more humid conditions. An alternative explanation would be that the slope instability was caused by man’s impact on the land.

**Geomorphological processes**

In the Papua New Guinea environment geomorphological processes are governed by its particular climatic conditions and by its geotectonic position in the highly mobile circum-Pacific belt. Among the first set of processes are weathering, fluvial processes, a variety of mass movements, slope wash, solifluction and subsurface erosion; among the second group are volcanism and earthquake initiated processes.

Without doubt the most important single process in Papua New Guinea is that of fluvial erosion. Rivers are choked with coarse bed load that provides them with powerful tools for continuous downcutting. The downcutting is usually accompanied by equally active slope processes on the valley side slopes and, among these, mass movements under the influence of gravity, such as landslides, rotational slumps, debris avalanches and mud and debris flows, play an important role. Also important, though less obvious are slope wash processes, particularly in the lower lying areas where they are responsible for much of the supply of suspended load to the rivers. Subsurface erosion by piping or tunnelling locally contributes to the erosion, in particular the headward extension of gullies where weakly consolidated fine textured sediments occur. In limestone areas, however, subsurface erosion by solution is the dominant process, giving rise to peculiar landform types such as enclosed basins surrounded by steep sided cones and towers known as karst. True solifluction, that is movement of material by repeated freeze and thaw action, is insignificant in Papua New Guinea and is restricted to a few square kilometres on the two highest peaks, Mt Wilhelm and Mt Giluwe.

Earthquake initiated mass movements are at present of great significance in the northern part of Papua New Guinea and on the islands of the Bismark Sea. The seismic activity here totals about 5-10 per cent of the world’s earthquake occurrences (Brooks 1965), which makes Papua New Guinea one of the most active seismic areas in the world. The denudation rates during recent earthquakes have been estimated to amount to an average loss of between 10 and 40 cm of debris over the earthquake affected areas (Simonett 1967; Pain and Bowler 1973).

Like seismic activity volcanic processes are geomorphological accidents that can far outstrip any of the normal geomorphic processes. The impact of volcanic activity has not been restricted to the formation of volcanoes alone, but lava flows, ash flows, lahars, volcano-alluvial fans and, above all, airborne ash falls have extended far beyond the actual volcanic centres. Besides the creation of new landforms, volcanism has severely disrupted existing drainage conditions, disrupted plant life and altered soil properties.
When considering man's impact on landforms and landforming processes one has to realise that man did not create any new erosion processes but simply caused an acceleration of the rate of naturally occurring processes or made land more vulnerable to a specific kind of erosion that previously had little or no significance. In a few rare cases man may even have reduced the rate of a specific process. Many of the geomorphic processes operating in Papua New Guinea are susceptible to very little or no influence by traditional man's activities. Volcanic processes are the most obvious ones; fluvial erosion, solifluction and subsurface erosion are also unlikely to be affected.

The impact on mass movements is more difficult to assess. Simonett et al. (1970) claim from air photo investigations that small landslides, slumps and mud flows are more common under grassland than under forest in some highland areas. This is not the case with larger mass movements. Against this one has to consider that small mass movements are very difficult to identify under densely forested terrain and the difference between forest and grassland may be more apparent than real. During my own field work I have always been impressed by the relatively frequent evidence of small mass movements under forest, which I was unable to detect from the air photographs even after the exact locality was known to me. The direct comparison between forested and non-forested terrain in the highlands is also difficult to make because the forest is usually situated at higher altitudes with different environmental conditions. From a theoretical point of view it also seems unlikely that the removal of the forest increases mass movement activity since the removal results in increased runoff and reduced infiltration.

In the lower Purari area, which can be regarded as relatively aseismic, soft mudstone and marl form large areas of low, homoclinal ridges and here slumps and associated mud flows are very common under primary rain forest conditions. Forest studies suggest that much of this area may experience a mass movement every fifty years (K. White pers. comm.). Pain (1972), on the other hand, claims that during the Madang earthquake in 1972 landsliding of the debris avalanche type was more frequent in forested areas than garden areas and that tree fall triggered off by the earthquake was a major contributor to the initiation of landslides. Tree fall also seems to be an important landslide mechanism during violent rain storms. The movement can also be due merely to the weight of the forest cover once it has reached a critical maturity, height and weight.

The information on mass movements is simply not sufficient to allow conclusive statements on the impact of man on their mechanism. I consider rock type, depth of weathering, seismic activity and the occurrence of violent rain storms as the overriding factors in determining mass movements in Papua New Guinea, against which man's activities have played a negligible role.

The influence of man on soil creep, which is the imperceptible movement of soil under the influence of gravity, is even more difficult to assess. Although soil creep is thought to be operating in most mountainous environments of Papua New Guinea good evidence for its occurrence is lacking. Terraced slopes, curved tree trunks, displaced garden fences and erratic rock fragments are usually cited as evidence for creep, but creep is not the only process to explain these features. Without long-term measurements it is simply impossible to make any assessments on the significance of soil creep and in particular the question whether or not man has accelerated it can not be answered.

The one process where man's activity is clearly shown is in slope wash. Slope wash
The Melanesian environment

consists of two processes: first, rain splash erosion caused by the impact of raindrops on bare ground and, second, un-concentrated wash, which is the removal of fine material by sheet like flows of water. Rain splash erosion is, from the energy point of view, the much more powerful process, but its effect is usually greatly reduced by ground cover of vegetation and organic debris.

In lowland rain forest areas this ground cover is never complete and slope wash is relatively active. The forest canopy does not, as it is often claimed to do, provide a perfect protection against slope wash, since raindrops intercepted by the canopy can still fall with close to terminal velocity—a fall of 7 m is sufficient. The significance of slope wash decreases, however, with increasing altitude. From about 1000–1200 m the ground is covered not only by leaves, twigs and branches but also by a dense and thick mat of surface rootlets and mosses. The sponge like root mat absorbs all the precipitation as soon as it falls to the ground. Clearly rain splash erosion does not operate here and un-concentrated wash is also greatly reduced because the root mat serves as a temporary water storage. Only at very high rates of precipitation is some wash active under the root mat, causing some undermining. The density of the root mat further increases with increasing altitude and in addition heavy rain showers become rarer, being replaced by light showers, mist and cloud and a further reduction in slope wash results.

In the high altitude grasslands above the forest zone, slope wash could be expected to be more active. This is not, however, the case, because the slopes are covered by a layer of dense peat and peaty soil, which serve as a protective cover. Observations during long-lasting showers have shown that surface runoff is in form of shallow overland flow of clear water. The lack of any significant slope wash is also shown by the very low content of suspended material in high altitude creeks and streams even after long periods of rain.

This brief account on the activity of slope wash in the different altitudinal zones shows that the most important factor in determining rate of slope wash is the ground cover. Any disturbance to this will substantially increase its effectiveness. In the lowland forest areas where both rain splash erosion and un-concentrated wash are operative even under primary rain forest, the removal of the forest and ground cover will initially greatly increase slope wash, in particular rain splash erosion. The traditionally applied practice of shifting cultivation, however, ensures a rapid revegetation of the cultivated plots in particular, since the removal of the forest is never complete. The garden plots revert quickly to bush and secondary forest and slope wash conditions are soon similar to if not more favourable than those prevailing under primary rain forest.

In marginal rain forest areas with a pronounced dry season the removal of the forest has been more permanent since, in addition to the slashing of the garden plots, regular burning was practised during the dry season. The rain forest was gradually replaced by grassland and savanna. The burning leads to a nearly complete removal of the protective cover and makes the ground highly susceptible to both rain splash erosion and un-concentrated wash. Evidence of these processes can be seen in the form of earth pillars, lag gravel, undermined root systems and elevated grass tussocks. Slope wash has, for example, been responsible for a near complete removal of the soil cover on most of the slopes in the Port Moresby area, irrespective of rock type.

In the highlands where the agricultural system has been a much more extensive one than in the lowlands the rotation of the garden plots has also resulted in a near complete removal of the forest and its replacement by grassland. In contrast to the lowland grasslands this is probably due not to marginal climatic conditions but to the much
higher population densities and the more intensive use of the land. Here also fires have played an important role. The acceleration of slope wash is locally severe and evidence of this is apparent in old gardens and in unused grassland areas that experience frequent burning. Here irregularly shaped grass covered hummocks are enclosed by a network of deep rills often exposing the weathering zone. The big grass tussocks (mainly miscanthus) with their dense root system firmly enclose the soil and prevent its complete removal. In between the hummocks, however, up to half a metre of soil has been removed. The severity of slope wash depends largely on slope steepness. The activity of marauding pigs is also considered to accelerate slope wash since they are breaking down the soil structure (Blong pers. comm.).

A very similar pattern of grass covered hummocks and intervening rills has been observed in high altitude grassland areas on slopes where frequent burning is evident. Burning of the tussocks not only temporarily removes the thick and dense-grass cover but more importantly at this altitude it destroys much of the protective peat layer. Evidence of this was found on Mt Giliuwe and the Saruwaged Ranges following widespread burning after exceptionally dry spells.

How serious the effect of slope wash has been in the long term is difficult to assess. There is little evidence in the stratigraphy of basin sediments of any exceptionally high rates of sedimentation since man moved into these areas. In the upper Wahgi basin Blong (pers. comm.) has found that the rate of deposition during the last few thousand years has been surprisingly slow; he estimated an average rate of erosion of 1–2 cm per thousand years. Pain (1973) has calculated an average rate of 27 cm per thousand years from accumulations in the Kaugel basin. Although this is more than a magnitude higher it is still a slow rate in geomorphological terms and does not suggest any greatly accelerated rate of soil removal. The problem with these calculations is, however, that they do not take into account the throughgoing drainage, which even in the swampy basins could be considerable.

**Conclusions**

Our lack of precise information on slope processes in this tropical environment in general and on man's impact on these processes in particular is quite apparent. It is particularly difficult to assess man’s impact in its historical or geological dimension, because man entered the scene very late in the geological history of this country. His impact cannot therefore be expected to have been very significant in geological terms. From the limited data available it appears that man has had virtually no influence on major landforming processes. His impact has been largely restricted to an acceleration of slope wash, particularly in areas of marginal rain forest and in densely populated areas where intensive agriculture has been practised. Rain splash erosion appears to be severe where frequent burning is practised and where it is responsible for the removal of large quantities of soil, often rendering the land useless for further agricultural activities.

There can be little doubt, however, that in comparison with industrial man’s impact on erosion processes traditional man’s impact has been very small indeed. For example Pain (pers. comm.) has found that the stripping of overburden and road making for the Bougainville copper project equalled the Madang earthquake as a geomorphic event with an overall denudation rate of about 15 cm over the two catchments involved. The total area affected, however, was much smaller and and seen in its perspective even this high rate of accelerated erosion is easily outstripped by natural events in this unstable tropical landscape.
REFERENCES


Unless he is careful, the modern developer in Papua New Guinea is in danger of destroying not only one of the richest floras of the world but also one of the few remaining centres of diversity for many tropical crops. Throughout the country plant resources form the basis of life; they provide food, medicines and poisons and the raw materials needed to build houses and shelters, canoes and rafts and to make tools and weapons, clothing and containers. A variety of staples, many of which have been introduced from elsewhere, are used in the different regions. Since most staples are predominantly starchy, and since they form 70–90 per cent of the food intake of most people, supplementary crops and animal resources must play a significant part in providing further protein, vitamins and minerals. Archaeological evidence indicates that man has been in the Highlands of Papua New Guinea for well over 12,000 years, in adjacent areas for 26,000 years, and that he probably reached the coastal areas 50,000 years ago or earlier. Interesting questions can be posed, and evidence brought forward to answer them, as to what resources were available to the early immigrant, how and when agriculture began, and what impact man had on the natural vegetation. At present population density in many areas is still below that which the environment might support under a subsistence gardening economy. However, land pressures are increasing owing to rapidly rising population numbers, changing subsistence patterns, development of cash cropping, and the alienation of land for towns, plantations and resettlement schemes. Unfortunately, some traditional foods are being replaced by less nutritious introduced varieties; and clearing of forests causes other wild plant and animal resources to be lost.

The natural flora of New Guinea comprises widespread tropical, Malesian and Australian elements. Little is known of its history, but it is thought that most of the existing families of the mountain areas (of southern affinity) were here by the end of the Tertiary while those of the lowlands came in somewhat later, in early Quaternary times (Walker 1972). Speciation during the Quaternary was probably rapid, in response to the changing environmental conditions.

The vegetation today is extremely diverse but it can be differentiated into distinct types occupying particular habitats: the coastal and estuarine mangrove swamps, sago and *Nypa* palm fresh water swamp forests, dry plain Eucalypt savanna and grassland, lowland and foothill tropical rain forest, and the more temperate montane forests with oaks, laurels, beeches and conifers, and high mountain shrubby and tussock grasslands. As well there are the man induced vegetation types: secondary forests and grasslands, gardens and associated plantings (Paijmans 1976).

Throughout New Guinea plant resources form the basis of life; they provide food, medicines and poisons and the raw materials needed to build houses and shelters, canoes and rafts and to make tools and weapons, clothing and containers. In a recent ethnobotanical review (Powell 1976) I have listed 650 species (representing 378 genera,
TABLE 2.1

Numbers of plant species used for various purposes in New Guinea

<table>
<thead>
<tr>
<th>Use</th>
<th>No. of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>209</td>
</tr>
<tr>
<td>Ash salt</td>
<td>17</td>
</tr>
<tr>
<td>Medicines</td>
<td>252</td>
</tr>
<tr>
<td>Narcotics, stimulants, intoxicants</td>
<td>10</td>
</tr>
<tr>
<td>House and shelter building</td>
<td>100</td>
</tr>
<tr>
<td>Canoes and rafts</td>
<td>43</td>
</tr>
<tr>
<td>Tools and weapons</td>
<td>73</td>
</tr>
<tr>
<td>Hunting and fishing</td>
<td>44</td>
</tr>
<tr>
<td>String and bark cloth</td>
<td>46</td>
</tr>
<tr>
<td>Ropes used in house, fence construction</td>
<td>31</td>
</tr>
<tr>
<td>Personal ornamentation</td>
<td>75</td>
</tr>
<tr>
<td>Ritual and magic</td>
<td>78</td>
</tr>
<tr>
<td>Art and Music</td>
<td>50</td>
</tr>
<tr>
<td>Food preparation</td>
<td>30</td>
</tr>
</tbody>
</table>

TABLE 2.2

Numbers of species and plant parts used as food in New Guinea

<table>
<thead>
<tr>
<th>Plant Part</th>
<th>Cultivated Species</th>
<th>Cultivated + Wild Species</th>
<th>Wild Species</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole plant</td>
<td>5</td>
<td>—</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td>Young shoots</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>‘Cabbage’</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Stems</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Pith</td>
<td>—</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Leaves</td>
<td>17</td>
<td>14</td>
<td>45</td>
<td>76</td>
</tr>
<tr>
<td>Flowers</td>
<td>2</td>
<td>—</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Pods</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Seeds</td>
<td>7</td>
<td>1</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Fruits</td>
<td>13</td>
<td>9</td>
<td>35</td>
<td>57</td>
</tr>
<tr>
<td>Nuts</td>
<td>1</td>
<td>8</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Tubers, corms</td>
<td>9</td>
<td>4</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Roots</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bark</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fern fronds</td>
<td>2</td>
<td>1</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>48</td>
<td>158</td>
<td>271</td>
</tr>
<tr>
<td>Total no. of species</td>
<td>37</td>
<td>43</td>
<td>129</td>
<td>209</td>
</tr>
</tbody>
</table>
Prehistory and the environment

134 families) as being used for these purposes; Table 2.1 summarises that data. Fifty-nine per cent of the species enumerated are used for more than one purpose and some of them provide man with basic sustenance and almost all material needs: coconuts, bananas, sago, Pandanus and perhaps bamboo fall into this category.

STAPLE AND SUPPLEMENTARY FOODS

Table 2.2 provides information on the numbers of cultivated and wild species used for food, Table 2.3 the species used in particular areas and environments. Although these tables are very incomplete they do give us an idea of the availability of resources in the various areas.

1. Coastal and lowland swamp dwellers. Extensive fresh water swamps are present along both the north and south coasts of New Guinea; mangroves occupy coastal mudflats and river estuaries. Population densities are very low in these areas, 2–4 persons per square kilometre. Sago is the staple; it is sometimes cultivated but usually harvested from wild stands. Supplementary foods are often traded in from neighbouring areas but some may be grown in 'hanging gardens' built on piles amongst the mangroves or in small gardens situated on higher ground. At least sixteen flowering plant species are gathered from the strandline and forests, together with ferns, fungi and seaweeds.

2. Savanna and grassland shifting agriculturalists. The southern plains of Irian Jaya and Papua and the broad valleys of the north coast of New Guinea are covered with open forest, savanna and grassland. Population densities are generally low but may reach 16–30 persons per square kilometre in local coastal areas. Yams are the staple in many of the seasonally dry areas; both cultivated and wild species are utilised. In coastal areas near Port Moresby and in the Markham Valley bananas are the staple, while in some other areas cassava, a recent introduction, is most important; it is tolerant of a wide range of environmental conditions and will grow in drier and poorer soils than either yams or bananas. At least fourteen other species are cultivated as supplementary crops and a further nine are available as wild food species.

3. Tropical rainforest shifting agriculturalists. Tropical rain forest dominates the coastal plains, foothills and low mountains where the rainfall is higher and more evenly distributed throughout the year. Population densities vary from 8–16 per square kilometre. Taro is the staple with bananas, sweet potatoes and yams being grown as the main supplements. Sweet potato has replaced taro as the staple in some areas recently following outbreaks of a taro fungus disease (Phytophthora colocasiae). Many other supplementary crops are grown and at least twenty-six wild species provide edible leaves, fruits and nuts. A number of edible ferns are recorded also.

Areas marginal to the central highlands have received little attention. Population densities are low and the people may be more or less nomadic, gathering sago from low elevations at certain times of the year, cultivating small forest gardens at other times. Taro, bananas and sweet potatoes are important crops; wild yams and the fruit of an oil Pandanus are gathered.

4. The highland agriculturalists. The densest populations, locally up to 200 persons per square kilometre and nearly 40 per cent of the total population live at altitudes ranging from 1400 to 2700 m in valleys of the central cordillera. Sweet potato is the staple crop with taro, yams, bananas, beans, sugarcane, edible pitpits and many other green vegetables being grown as supplements; twenty-eight species are listed. Pandanus species are the most important fruit and nut trees planted and gathered. Many other wild foods are available also in the forests, regrowth and grasslands: the 'cabbage' of palms; leaves, fruits and nuts of trees and shrubs; herbs; fern fronds and fungi (fifty-eight species listed altogether).
The staple foods throughout the country are predominantly starchy: yams, sweet potato, taro and related Araceae, sago and bananas. The supplementary crops, on the other hand, both those grown in gardens and those harvested as wild resources, com-

### TABLE 2.3
Main species used as food in various parts of New Guinea

<table>
<thead>
<tr>
<th>Coastal and lowland swamp dwellers</th>
<th>Harvested from wild resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Staple crops:</strong> sago</td>
<td></td>
</tr>
<tr>
<td><strong>Supplementary crops:</strong></td>
<td></td>
</tr>
<tr>
<td>Grown in gardens</td>
<td></td>
</tr>
<tr>
<td>Yams</td>
<td>Myristica sp.</td>
</tr>
<tr>
<td>Bananas</td>
<td>Myristica sp.</td>
</tr>
<tr>
<td>Breadfruit</td>
<td>Araigna sp.</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>Bruguiera sp.</td>
</tr>
<tr>
<td>Cassava</td>
<td>Gnetum gnemon</td>
</tr>
<tr>
<td><em>Amaranthus</em> spp.</td>
<td>Arenga sp.</td>
</tr>
<tr>
<td><em>Hibiscus manihot</em> (Aibika)</td>
<td>Cassia sp.</td>
</tr>
<tr>
<td></td>
<td>Albizia sp.</td>
</tr>
<tr>
<td></td>
<td>Ficus spp.</td>
</tr>
<tr>
<td></td>
<td>Ficus spp.</td>
</tr>
<tr>
<td></td>
<td>Seaweed</td>
</tr>
<tr>
<td></td>
<td>Fungi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lowland and foothill shifting agriculturalists—non-swampy areas</th>
<th>Harvested from wild resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Grassland and savanna areas</td>
<td></td>
</tr>
<tr>
<td><strong>Staple crops:</strong> yams, bananas, cassava</td>
<td></td>
</tr>
<tr>
<td><strong>Supplementary crops:</strong></td>
<td></td>
</tr>
<tr>
<td>Grown in gardens</td>
<td></td>
</tr>
<tr>
<td>Taro</td>
<td>Gingers</td>
</tr>
<tr>
<td>Breadfruit</td>
<td>Gnetum gnemon</td>
</tr>
<tr>
<td><em>Beans</em> (2)</td>
<td>Arenga sp.</td>
</tr>
<tr>
<td><em>Ficus</em> spp.</td>
<td>Vigna sp.</td>
</tr>
<tr>
<td><em>Carica papaya</em></td>
<td>Yams</td>
</tr>
<tr>
<td><em>Saccharum edule</em></td>
<td></td>
</tr>
<tr>
<td><em>Oenanthe javanica</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Rain forest areas</td>
<td></td>
</tr>
<tr>
<td><strong>Staple crops:</strong> taro, sweet potato</td>
<td></td>
</tr>
<tr>
<td><strong>Supplementary crops:</strong></td>
<td></td>
</tr>
<tr>
<td>Grown in gardens</td>
<td></td>
</tr>
<tr>
<td>Yams</td>
<td>Canarium spp. (4)</td>
</tr>
<tr>
<td><em>Beans</em></td>
<td>Terminalia spp. (4)</td>
</tr>
<tr>
<td><em>Coconuts</em></td>
<td>Inocarpus edulis</td>
</tr>
<tr>
<td><em>Sugarcane</em></td>
<td>Barringtonia sp.</td>
</tr>
<tr>
<td><em>Saccharum edule</em></td>
<td>Bassia spp.</td>
</tr>
<tr>
<td><em>Amaranthus</em> spp.</td>
<td>Diospyros spp.</td>
</tr>
<tr>
<td><em>Setaria palmifolia</em></td>
<td>Pandanus spp.</td>
</tr>
<tr>
<td><em>Commelina</em> spp.</td>
<td>Spondias dulcis</td>
</tr>
<tr>
<td><em>Gnetum gnemon</em></td>
<td>Cucurbitaceae</td>
</tr>
<tr>
<td><em>Oenanthe javanica</em></td>
<td></td>
</tr>
</tbody>
</table>
Highland agriculturalists
Staple crop: sweet potato
Supplementary crops:

<table>
<thead>
<tr>
<th>Grown in gardens</th>
<th>Harvested from wild resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taro</td>
<td>Pandanus spp.</td>
</tr>
<tr>
<td>Bananas</td>
<td>Artocarpus sp.</td>
</tr>
<tr>
<td>Beans (3)</td>
<td>Aleurites moluccana</td>
</tr>
<tr>
<td>Xanthosoma sp.</td>
<td>Mangifera sp.</td>
</tr>
<tr>
<td>Saccharum edule</td>
<td>Garcinia sp.</td>
</tr>
<tr>
<td>Gnetum gnemon</td>
<td>Amomum sp.</td>
</tr>
<tr>
<td>Rungia klossii</td>
<td>Rubus spp.</td>
</tr>
<tr>
<td>Hemigraphis sp.</td>
<td>Acalypha sp.</td>
</tr>
<tr>
<td>Lagenaria siceraria</td>
<td>Breadfruit</td>
</tr>
<tr>
<td>Pueraria lobata</td>
<td>Beilschmeidia sp.</td>
</tr>
<tr>
<td>Pandanus conexaeust</td>
<td>Cyrtandra sp.</td>
</tr>
<tr>
<td>Pandanus brosimos</td>
<td>Missiessya sp.</td>
</tr>
<tr>
<td>Commelina spp.</td>
<td>Desmodium sp.</td>
</tr>
<tr>
<td>Solanum nigrum</td>
<td>Laportea sp.</td>
</tr>
<tr>
<td>Pandanus julianettii</td>
<td>Pouzolzia sp.</td>
</tr>
<tr>
<td></td>
<td>Coix lacryma-jobi</td>
</tr>
<tr>
<td></td>
<td>Elaeocarpus spp.</td>
</tr>
<tr>
<td></td>
<td>Finschia sp.</td>
</tr>
<tr>
<td></td>
<td>Pittosporum sp.</td>
</tr>
<tr>
<td></td>
<td>Astronia sp.</td>
</tr>
<tr>
<td></td>
<td>Boerlagiodendron sp.</td>
</tr>
<tr>
<td></td>
<td>Rhodomyrtus sp.</td>
</tr>
<tr>
<td></td>
<td>Pipturus sp.</td>
</tr>
<tr>
<td></td>
<td>Elatostema sp.</td>
</tr>
<tr>
<td></td>
<td>Begonia sp.</td>
</tr>
<tr>
<td></td>
<td>Scleria sp.</td>
</tr>
<tr>
<td></td>
<td>Ferns (8)</td>
</tr>
</tbody>
</table>

prise a wide range of green vegetables, fruits and nuts. While some hunting and gathering groups are known in New Guinea today, the majority of the people are subsistence agriculturalists. The type of gardening practised varies considerably from simple swidden with slash and burn clearance, little if any tillage and abandonment after 1–2 years use, to complex systems involving elaborate ground preparation, water and erosion control measures and more or less continuous cropping with controlled short- or long-term fallowing.

**Population densities and nutrition**

Given the wide range of food plants available and the agricultural systems that have developed it is perhaps surprising that population densities are so low in many areas. Nutritional studies have indicated a wide range of dietary situations from those considered to be quite inadequate (in terms of both calories and protein) to those which are satisfactory and well-balanced (Hipsley and Clements 1950; Oomen and Malcolm 1958; Luyken and Luyken-Koning 1955; Couvé et al. 1962; Bailey and Whiteman 1963). New Guinean average values for calorie and protein intake (1880 calories and 10–30 g protein per day for highlanders, 1470 calories and 10–40 g protein per day for lowland people) fall far short of those considered to be ‘normal’ elsewhere (Oomen
The excellent physique and physical performance displayed by many adults, however, suggests that metabolic pathways may differ also from 'normal' and that New Guineans are well adapted to the food situation (Hipsley and Kirk 1965; Oomen and Corden 1970).

The diet of most people is starchy, with 70–90 per cent of the food intake consisting of one or a few of the staple crops. Few studies of crop production have been undertaken but potential yields of the tubers, the sago palm and bananas are all between 8 and 15 tons per hectare. Sago on its own is a very poor food, comprising starch and perhaps 0.2 per cent crude protein; large quantities must be eaten to satisfy calorie requirements. The tuber crops and bananas are considered to be nutritionally poor also by many authors but others (e.g. Oomen 1971) state that, for adults, they do contribute sufficient ascorbic acid, acceptable amounts of calories and minimal levels of nitrogen and amino acids (except for the sulphur compounds); for growing children and for pregnant and lactating women the protein intake is inadequate. Cultivated and wild supplementary crops, especially green vegetables, fruits and nuts, and animal resources must play a significant part in providing further protein, vitamins and minerals; while detailed production figures are lacking there is no doubt that their importance has been largely underrated.

In some nutritionally marginal areas, such as those based on sago, trading between coastal and inland groups or between one part of the coast and another has resulted in more adequate diets for both parties. In other areas of marginal environment the development of complex gardening techniques generally ensures adequate food production, but this is easily upset by adverse or abnormal weather conditions. In the more favourable environments excess food may be produced for trading and ceremonial exchange.

Areas of origin of the food plants

Considering the food plants as a whole, one is struck by the fact that most of the staples are introduced from elsewhere. Thus the yams are Southeast Asian in origin, the taro of Indian or Indonesian origin and the sweet potato of South American origin. The exceptions are sago and some of the bananas; other bananas are introduced from Southeast Asia. Among the supplementary crops, some, such as the beans and the gourd, have been introduced from Asia (although they did not necessarily originate there), but many more are indigenous, for example, sugarcane, the edible pitpits, aibika, and other green vegetables (Rungia klossii, Oenanthe javanica, Solanum nigrum, Commelina spp. and possibly Amaranthus spp.). Little is known of the origin of either the coconut or the breadfruit but some authorities consider the Melanesian area is their area of domestication (Purseglove 1972).

Archaeological evidence indicates that man has been in the Highlands of Papua New Guinea for well over 12,000 years and in areas marginal to them for 26,000 years (Bulmer 1966, 1974; White 1972; White et al 1970); he probably reached the coastal areas 50,000 years ago or earlier. When man first arrived in New Guinea, then, he must have been a hunter and gatherer, only more recently becoming an agriculturalist. This immediately poses such questions as what resources were available to the early immigrant, how and when agriculture began in New Guinea, and what impact man had on the natural vegetation.

At present we do not have much evidence to answer these questions. Recent studies of the highland's vegetation and its history (Flenley 1967, 1972; Powell 1970a, 1970b; Walker 1970, 1973; Hope 1973; Hope and Petersen 1975) and reconstructions of former climates (and vegetation) in the Torres Strait area (Nix and Kalma 1972);
together with the more direct archaeological evidence of agriculture in the Highlands (Golson 1974; Golson et al. 1967; Powell et al. 1975) provide a basis for speculation.

FORMER VEGETATION, ENVIRONMENTS AND PLANT RESOURCES
Thus at the postulated time of man's entry into New Guinea sea levels were lower and the climate was cooler and possibly drier. Up until 17,000 years ago the coastal strand vegetation was extensive and much of the broad plain south of the central cordillera was probably covered with open forest and savanna, seasonally inundated woodland and fresh water swamps. Inland, tropical rain forest clothed the foothill and mountain slopes up to about 300 m altitude and the more temperate oak, beech and conifer forests were present above this. By 17,000–14,000 years ago (the period of lowest sea levels) there was a further increase in aridity and open sclerophyllous forest (Eucalypt) may have been present in the Markham, Ramu and lower Sepik valleys. During the whole of this period and up until perhaps 10,500 years ago the treeline was probably situated between 2000–2400 m altitude; shrub-rich grasslands and alpine communities occurred above this.

The coastal and lowland vegetation types probably included many of the plants used today: mangrove species, coconuts and other palms, bananas, breadfruit, wild almonds, ‘kanari’ nuts, figs, ‘tulip’, sugarcane and Pandanus. Areas of sago may have been more restricted but were probably present at least in low lying areas of the Arafura shelf and along swampy river mouths. Many of these plants would have been familiar to the early immigrants, assuming the latter came from Malaysia; even if sago and coconut were not known, some of the palms would have been as would some bananas and pandans. Cycad seeds and pith, and ‘tanket’ tubers may have been important early foods also (Barrau 1965). These taxa alone would have been enough to sustain life and, if one adds to them the possibility of a rich fauna (see chapter 3), the immigrants were fairly well provisioned.

The tropical rain forest, although restricted in distribution, offered many edible and otherwise useful plant species also, as did the montane forests. Probably people hunted and gathered over a wide range of ecological zones depending upon access routes and the availability of seasonal plant resources and game. A similar life style is shown today by some of the upper Strickland and Fly River people and by those of the Karimui area.

14,000 to 5000 years BP
After about 14,000 years BP the climate improved, the glaciers melted and sea levels rose. By 8300 years ago the climate was warmer and wetter, probably even milder than today. Swampland and tropical rain forest expanded over areas formerly occupied by the open forests and savanna and at higher altitudes the treeline moved upwards to 4000 m and the subalpine grasslands were replaced by mixed montane and beech forests; at times oak forest became important. Increases in the oak forests are interesting as they can be interpreted in two ways; they may suggest milder or perhaps drier climatic conditions prevailed, but they can also be associated with anthropogenic influences. Thus an increase in oak shown in the Mt Wilhelm pollen diagrams at 6500 years BP could be interpreted as indicating man’s impact on the vegetation there. Certainly by 5200 years ago in the Mt Hagen and upper Wahgi valley area there was considerable forest reduction, associated with an increase in woody regrowth and grassland species, and archaeological evidence indicates drainage of swampland there 4500–6000 years ago, if not before that (this is considered further in chapter 6).

It seems likely that well before this date the lowland people were tending their
swampland and forest plants, clearing around the bases of breadfruit and other fruit and nut trees, thinning out and perhaps transplanting sago palms. Discarded banana stems, apical shoots of sugarcane, stems of aibika, breadfruit and fibre plants may have established themselves in debris near shelters. It is possible, in fact, that by the time the Southeast Asian yams, bananas and taro were transferred to New Guinea some form of subsistence agriculture, based on local semi-domesticated and domesticated species, was being practised.

We do not know when the Asian cultigens arrived, but both taro and bananas are considered to have been transferred at very early times (Yen 1971; Simmonds 1966). Some of the yams may be indigenous to New Guinea and, if so, would have been very important early foods; if not, then some were introduced early, other types later (Purseglove 1972; Burkill 1966). The sweet potato arrived much later than the other staple crops. The establishment of taro, yams and bananas in rain forest communities, widespread by 8000 years BP, would have been relatively simple, especially if some form of subsistence agriculture was already being practised. If an earlier date is assumed for their transfer then the yams and bananas, more tolerant of dry conditions than taro, probably spread more rapidly than the latter. Between 8000 and 5000 years BP the warmer and wetter climate would have favoured the expansion of the tropical tuber crops, the bananas and the sugarcane into highland areas.

5000 years BP to the present
From 5000 years BP until the present there has been some climatic deterioration; this has caused treeline lowering and perhaps affected forest composition. There has also been widespread forest disturbance and clearance for gardens by man. Forest disturbance dates from 4500 years BP at one of the Enga district sites and forest reduction to 2000 years BP and 1600 years BP at others (Sirunki, Birip and Lake Inim respectively). While there is no direct evidence to associate these disturbances with man, such an interpretation would seem reasonable. In the Wahgi valley direct evidence for gardening (digging sticks, ditches) is dated at least 2300 years ago. On Mt Wilhelm forest decline from 1100 years ago is considered due to garden expansion in the Chimbu valley while replacement of subalpine forest by grassland and tree ferns at 3500 m altitude (that is, below the tree line) is attributed to cutting and burning by man. In the lowlands also over the last few thousand years grasslands have been extended by burning and riverine swamps have expanded as rivers aggrade.

The deterioration in climate has limited the upward extension of cultivation of yams, taro and bananas. Sweet potato, being rather more tolerant of cool conditions (although certainly not resistant to frosts) and also tolerant of poorer soils, provided people with a staple that could be grown up to 2700 m altitude or more and thus has enabled them to live at these high altitudes.

Other useful products
Many of the early food plants present in New Guinea (coconuts, sago, bananas, breadfruit, Pandanus) provided other useful products such as fibre, timber, thatch, mats, domestic utensils, medicines, personal clothing and ornamentation, and were probably utilised as multipurpose plants by the early immigrants. Of the narcotics, stimulants and intoxicants used today, the palms (Arenga sp., Areca sp. and Nypa fruticans) may have been present in lowland areas, although both the sugar palm and the betel nut palm are considered to be of Malesian origin by some authorities (Purseglove 1972); kava may have been present also, but was more likely introduced from Polynesia; tobacco, of American origin, probably reached New Guinea from the
Philippines or Indonesia some time in the seventeenth century or earlier (Riesenfeld 1972). At least some of the bamboos would have been present in New Guinea in early times but the large stemmed varieties may have originated in Asia and been transferred from there by man (Burkill 1966). Many of the medicinal plants used are indigeneous but also of widespread tropical distribution; the use of most of them, or of closely related species, in Asia, Malaya, the Philippines and Indonesia is documented (Burkill 1966) and suggests that medicinal plant knowledge has been built up over a long period of time. All of the fibre plants except one (Broussonetia papyifera) are indigeneous also; many of them provide bark cloth as well as fibre.

THE PRESENT SITUATION

Considering 1966 census data Ward (1970) suggests that in many areas the population density is well below what the environment might support under a subsistence gardening economy. Populations are increasing rapidly (about 3 per cent per annum) in many areas today, however, and considerable land pressure is being experienced as the result of changing subsistence patterns, development of cash cropping, and the alienation of land for towns, plantations and resettlement schemes. While many new food crops are being introduced, some traditional foods, such as coconuts, have become more important as cash crops and others, such as taro and yams, have been neglected. Unfortunately the introduced plant foods are more often than not nutritionally inferior to their traditional counterparts. Natural forest resources are also under greater pressure than ever before; by 1970 the right to harvest timber had been acquired over 1.5 million hectares or nearly 12 per cent of the total forest area classed as having economic potential (McIntosh et al. 1973). Today the figure is no doubt higher and many areas have already been cleared; wild plant and animal foods and many other useful products are lost in the process and the local environments are altered considerably. There are also schemes for resettling people into natural forest and faunal reserves such as the Karimui area; in such cases the destructive process may be slower but the effect will be the same. If ‘development’ is inevitable, does it have to proceed along such destructive lines? In the case of New Guinea the modern developer has the chance to destroy not only one of the richest floras of the world but also one of the few remaining centres of diversity for many of the tropical crops.

REFERENCES


The Melanesian environment


The Effect of Prehistoric Man on the Fauna of New Guinea

JEANNETTE HOPE

New Guinea has a rich and varied fauna, which is distinct in many ways from that of the neighbouring islands of Indonesia and Malaya. Wild animals have always formed an important source of protein, and prehistoric man utilised a wide range of species. Coastal utilisation as seen in the archaeological record reflects an economy like that of present day inhabitants; and there is evidence to suggest that trading between the coast and the interior was occurring 10,000 years ago. Hunting in New Guinea by indigenous methods such as bow and arrow, snares, traps and nets has probably had little serious effect on wildlife. However forest clearance must have led to the disappearance of many forest species from areas that are now gardens or grasslands. Any current plans for conserving or managing the animals important to man must be based on an understanding and maintenance of the entire complex ecosystem, including many smaller vertebrates and invertebrates, and depending finally on land or marine plant life. Complete clearance of large areas of forest, for example, leads to a decrease in the number of animal species and possibly also in the number of individuals.

New Guinea, the world's largest tropical island, has a great variety of environments: high mountains, wide swamps, dense rainforests, dry savannas, inland lakes and offshore islands. It has a rich and varied fauna, which is distinct in many ways from that of the neighbouring islands of Indonesia and Malaya. This is due to the geographic position of New Guinea. It lies on the Australian continental plate, and it has been connected to Australia in the past at times of lower sea level. It shares with Australia the basic kinds of animal that make both these lands unique, the marsupials and monotremes and many birds and reptiles, and lacks many animals, particularly larger placental mammals, that are found in Southeast Asia.

In the tropical mountainous environment of New Guinea, the marsupials and birds have diverged from their Australian relatives; though some may be descended from a fauna that inhabited Australia in the past when its climate was like that of the New Guinea mountains today. Other birds and reptiles, as well as rodents and bats, migrated from Southeast Asia into New Guinea (and some into Australia). Many of these have since evolved into species unique to New Guinea.

This brief outline of the fauna of New Guinea is restricted to those species that are of economic importance to man, basically the larger mammals, birds and reptiles, and fish, molluscs and crustacea. These are, however, just a part of a complex network, which includes a great many smaller vertebrates and invertebrates, and which depends finally on the plant life, whether on land or in the ocean. Any plans for conserving or managing the animals important to man must be based on an understanding and maintenance of the entire ecosystem.
New Guinea and its surrounding islands have a rich marine fauna. At least 1392 species of bony fish occur in the waters of New Guinea, the Bismarck Archipelago and Bougainville and this may in fact be an underestimate (Munro 1972). Shellfish are also abundant in species and numbers (McMichael 1972). Marine turtles, dugong, and whales and dolphins also occur in New Guinea waters, and are important in the economy of coastal areas. The richness of the marine environment is mainly due to the position of New Guinea; elements from the faunas of the Indian Ocean, western Pacific and tropical Australia are all found here.

In contrast, the fresh water fauna of New Guinea is relatively poor, with only 207 species of fish found in fresh water; of these only 111 breed there (Munro 1972). These live mainly in the lower and middle reaches of the rivers. Few species of fish occur in many mountain streams, though eels and crayfish are found there. Many of the inland lakes have a very poor fauna of edible species though in the Wissel Lakes of Irian Jaya fresh water crayfish are so abundant that they form the main source of animal protein for the local population.

Birds are the most obvious and spectacular part of the land fauna of New Guinea. There are approximately 670 species in New Guinea itself, a remarkably great number for an island of this size, especially when compared with other parts of the world. In the Papuasian region—New Guinea, its offshore islands, the nearby Bismarck Archipelago and the Solomon Islands—there occur about 860 species (Schodde 1973). For comparison, Australia has 660 species, North America 800, and the whole of Eurasia 1100. Many birds are important as food, especially the largest, the cassowary, and various medium sized game birds, such as jungle fowl, pigeons, cockatoos and hornbills. Some, notably the birds of paradise, are very significant in the cultural life of many New Guinea societies, and their spectacular plumes are an important item in dress and trade.

Unlike most parts of the world, New Guinea has no large, native, game mammals. The entire indigenous mammal fauna consists of monotremes, marsupials, rodents and bats (George 1973; Van Deusen 1972). The largest marsupials are the agile wallaby of the lowland savannas and several species of tree kangaroos. These reach about 20 kg in weight, significantly smaller than the largest Australian kangaroos. Several species of larger, now extinct marsupials lived in both Australia and New Guinea in the past (Plane 1972). At least some of these were still alive when man arrived more than 30,000 years ago, but it is still not clear whether man was responsible for their disappearance.

There are 200 species of mammals in New Guinea, but this number is made up mainly of small, rarely seen rats living in the forests, or small bats. The mammals valuable for food and skins are limited to a small range of two monotremes (the short and long-beaked echidnas, Tachyglossus and Zaglossus), four wallabies (the grassland agile wallaby, *Macropus agilis*, and the smaller forest species *Dorcopsis* sp. and *Thylogale* sp.), tree kangaroos (*Dendrolagus* sp.), cuscus (*Phalanger* spp.), possums (*Pseudocheirus* spp., *Dactylopsila* sp.), bandicoots (*Echymipera* spp., *Peroryctes* spp.), large rats (*Mallomys* sp., *Hyomys* sp.), and several large bats (*Pteropus* spp., *Dobsonia* spp.). In any given area of undisturbed forest, however, only ten or so different species of these larger mammals are likely to occur.

Missing from the native fauna of New Guinea and Australia are the much larger Asian mammals, such as elephants, rhinoceros, monkeys, and tigers and other
predators, but more importantly, a whole range of economically important species, such as cattle and deer. These animals did not reach New Guinea and Australia, because of the deep water channels that have always isolated them from the islands of eastern Indonesia. However two mammals which are now very important in the indigenous economy of New Guinea were introduced prehistorically by man. These are the pig and the dog, and wild and domestic populations of both are now present in New Guinea. More recent introductions include deer, domestic cattle, horses, sheep, cats and rabbits (in Irian Jaya), and new varieties of domestic pigs and dogs. Of these the Rusa deer occurs in wild populations mainly in the western district of Papua and in southwest Irian Jaya (Downes 1972). Domestic cats may also have gone wild in some places.

New Guinea has an extensive reptile fauna, with lizards, snakes, marine turtles and fresh water tortoises, and crocodiles (Cogger 1972). The only amphibians are frogs (Zweifel 1972). Many of these are shared with tropical Australia and have a common origin in Southeast Asia. Snakes and lizards are a supplementary food source in most places, but in some areas are an important protein source. The large goannas (particularly Varanus indicus) provide the best and most commonly used tympanum for drums.

**Prehistoric utilisation**

Hunting in most parts of New Guinea is a subsidiary activity to agriculture as a source of food. Wild animals have always formed an important source of protein, however, probably only now being supplanted by readily available tinned fish and meat. Some species of animals and birds are important in ritual events, and for distribution on ceremonial occasions, and animal products, fur, feathers, bone and teeth, are used in dress and ornaments, or as tools.

It is clear from archaeological evidence that prehistoric people in New Guinea utilised a wide range of animal species. Only very general statements can, however, be made about the way prehistoric man's activities have (or have not) affected the wildlife. This is because of problems in identification of bones, the lack of detailed knowledge of the ecology of most New Guinea species, and the difficulties of using collections of bones from archaeological sites to deduce past environments, because of bias introduced by the actual procedures of collecting, cooking and disposal by the prehistoric hunters, as R.N.H. Bulmer (1974) has recognised.

The faunal resources can be considered in two simple categories, marine and non-marine. Coastal people have access to a great variety of rich protein sources: fish, shellfish, crustacea, dugong, whales and dolphins, turtles and crocodiles. Some of these animals are available also to inhabitants of the lowland swamps, such as those around the Fly and Sepik Rivers, and elsewhere. Aquatic birds, and many land animals are also available in these areas.

Unfortunately the archaeological record of the New Guinea lowlands does not extend back very far into the past. Traces of human occupation 4000 years old have been found at Kukuba Cave, north of Port Moresby, but no bones or shell are preserved there (Vanderwal 1972). Many other coastal and lowland sites have been excavated, and the results have been summarised by S. Bulmer (1974). All are less than 3000 years in age, and most are less than 2000. The faunal remains in them reflect a widely based pattern of use of both maritime and land animals. Fish, shellfish and other marine food animals such as turtle and dugong occur even in sites up to 15 km from the coast, while land animals, most often the agile wallaby, but also bandicoots and other small marsupials and rodents, and cassowary and other birds are also found in many.
Pig bones have been found throughout most coastal archaeological sites, but all are younger than the oldest records of pig in the Highlands. However the oldest dog bones do occur in coastal sites, though they are rare. The earliest records are on Buka, at about 1860 years ago (Specht 1969) and on Yule Island at much the same time (Vanderwal 1972). S. Bulmer (1974) suggests that dog tooth ornaments in lowland sites may be as old as 2500 years. She quotes, for comparison, an age of over 7000 years for dog in Australia (Campbell et al. 1966). However, recent re-excavation of the site in question (Mt Burr, S.A.) suggests that the association of dog remains with the radiocarbon dates cannot be substantiated because of stratigraphic problems (Roger Luebbers, pers. comm.). If this record is shelved, then the oldest confidently dated dog remains in Australia are those from Fromms Landing, S.A., somewhere between 2000 and 3000 years old (Macintosh 1964), and Thylacine Hole, W.A., 2200 years old (Merrilees 1970). Dog in Australia, then, is of the same order of antiquity as in New Guinea.

There have been few detailed studies of the bones and shell found in any of these coastal sites as yet, so only generalisations can be made in most cases. At Rainu, however, in Collingwood Bay (Northern District of Papua), shellfish, wallaby, bandicoot and pig bone, but very little fish bone, was found in archaeological excavations on an old village site (Egloff 1971). Various species of shellfish seem to have fluctuated in importance over the time of occupation of the site. At first, about 1000 years ago, about equal numbers of marine and mangrove species were used; later riverine shellfish became more important and finally there was an increase in the use of mangrove species. These changes may have been due to local environmental changes but could alternatively reflect social factors affecting the use of the middens. The small amount of fish bone may suggest that few fish were caught. Indeed today the people who live at Wanigela do not rely heavily on marine animals for food, although they have fish nets and boats, as the sea is inhospitable along their coast. In this example, the conclusion drawn by the archaeologist is that prehistoric community must have had a very similar economy to that of modern Wanigela people, dependent heavily on taro and sago, hunting in the nearby grassland for wallaby, pig and bandicoot, and collecting riverine, mangrove and marine shellfish.

In general, the use of faunal resources as seen in the archaeological record of coastal Melanesia seems to reflect an economy like that of the present day inhabitants of the region. Yet man has been in New Guinea for more than 26,000 years and must have lived in coastal situations before 4000 years ago, the earliest date for lowland occupation in New Guinea. Very old Pleistocene coastal settlements will now be under water or deltaic silt, as the sea level was much lower in the past and approached its present level only about 8000 years ago. Sites younger than 8000 on the modern coast may yet be found.

The archaeological record for the Highlands of Papua New Guinea covers a much greater time span. The oldest known site at Kosipe, about 2000 m above sea level, and about 135 km north of Port Moresby, was occupied by man at least 26,000 years ago (White et al. 1970). Unfortunately no faunal remains have been found there. Many caves and rock shelters were first occupied 10,000 years ago or more, when the ice and snow on the highest mountains was finally melting, and the climate was becoming warmer. Others have been occupied for only the last 4000–5000 years. Many of these may have been hunting camps, as they contain large amounts of animal bones. The species found in them are mainly mammals; echidnas, wallabies, tree kangaroos, cuscus and other possums, and rats and bats. Few birds have been reported from these sites, but this may be due to the fragility of small birds' bones, and the difficulties in identifying them. Cassowary bones have been found, as well as shell of cassowary
and brush turkey eggs. In even some of the oldest sites, marine shellfish occur, including cowries (such as *Cypraea annulus* and *C. moneta*) now used as currency. This suggests that there were coastal villages trading with the interior as far back as 10,000 years ago, although no excavated archaeological sites on the coast are as old as this.

Pig bones occur in Kafiavana rock shelter from about 5000–6000 years ago (White 1972), and in other Highland sites in more recent levels. Pigs may in fact have been in the Highlands for much longer than this; S. Bulmer (1974) reported that a pig tooth had been found in faunal collection from a level in Kiowa rock shelter dated more than 10,000 years old. In contrast dog bones have been found only in the topmost level at Aibura, less than 800 years old (White 1972). Chicken bones dated to about 800 years ago have been found in Aibura and possibly also Batari.

**Prehistoric Impact of Man on the Fauna**

There is no doubt that local changes in the wildlife of New Guinea have occurred because of man's activities in the past. Forest species no longer survive in areas where extensive clearing has taken place and, in the Highlands, only those people living close to areas of uncleared forest continue to hunt regularly. So far the only archaeological evidence showing a change in fauna that could be due to clearing is from Aibura rock shelter in the Eastern Highlands (White 1972). In the lower levels, which are about 4000 years old, forest animals such as cuscus and other possums predominate. These are less common in the younger levels, where ground living species, mainly wallabies, are abundant. The topmost level contains mainly small rodents. Probably forest was gradually cleared from around the site over the last 4000 years. Today it is surrounded by grassland, in which old garden ditches occur.

Wallabies do not occur today in most of the man-made grasslands of the Highland valleys. This is partly due to overhunting, but the complete removal of forest affects them, as they prefer forest and forest edge environments. The peak of their occurrence at Aibura in the past may be related to a stage in forest clearance which provided them with optimal forest edge conditions. R.N.H. Bulmer (1974) has suggested that the changes seen in the fauna at Aibura could equally be due to a change in the function of the site. These factors are probably interrelated, with changes in local wildlife populations and in site function both following forest clearance.

Apart from the disappearance of populations of forest species because of forest clearance, some species of mammals may have become rare because of hunting pressure. This has occurred recently in areas of the Highlands where human populations are increasing quickly. For example, the long-beaked echidna (*Zaglossus*) apparently no longer survives on the eastern slopes of Mt Wilhelm above the densely populated upper Chimbu valley, though it was hunted there within living memory. Similarly, Bulmer and Menzies (1972–73) record that wallabies (*Dorcopsis* and *Dorcopsulus*) have been almost eliminated in the upper Kaironk valley over the last two generations. In contrast, in the higher forests and on the grasslands of Mt Suckling, in the Owen Stanleys, wallabies are abundant and unafraid of man, probably because they are rarely hunted (Stevens and Veldkamp n.d.).

The bones of two completely extinct mammals have been found in archaeological sites in the Highlands. At Kiowa rock shelter, near Chuave in the Chimbu District, a lower jaw of the thylacine (*Thylacinus cynocephalus*), a carnivorous marsupial about the size of a dog, was excavated from a level between 6000 and 9000 years in age (S. Bulmer 1974). In Nombe (Niobe) rock shelter, about 4 km south of Kiowa, M.-J. Mountain has also found thylacine remains, as well as those of an extinct kangaroo
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(Protemnodon sp.), which was probably a little larger than the agile wallaby. No radiocarbon dates are yet available for the archaeological deposit at Nombi.

The extinct kangaroo is known from other parts of New Guinea; it has been found in Pliocene deposits near Bulolo, in Late Pleistocene peats in the Tari area, and in basal clays beneath the archaeological horizons at Kafiavana rock shelter (Plane 1972; White 1972). The thylacine died out on the Australian mainland about 3000 years ago, probably through competition from the dingo, and the arrival of dog in New Guinea may have been connected with its disappearance here too. Wild dogs are now an important predator in parts of New Guinea, especially on some of the higher mountains, and domestic dogs are widely used by hunters, but the effect of the apparently quite recent introduction of dogs on wildlife populations and on hunting efficiency is not clear.

On the coast, there is no evidence of any impact by man on the marine fauna, though this may be due to the lack of detailed studies of the fauna in archaeological sites. Those animals which are now rare, such as dugong and crocodiles, seem to have been affected by hunting only since the arrival of Europeans, because of the use of guns, and perhaps because of the recent increase in human populations.

In summary, in New Guinea, hunting by indigenous methods such as bow and arrow, snares, traps and nets probably has had little serious effect on the wildlife except locally where human populations are very dense. However forest clearance must have led to the disappearance of many forest species from areas that are now gardens or grasslands. Most of these species probably still survive elsewhere in New Guinea.

In some situations the extension of grasslands can benefit the fauna. Maintenance of the lowland savanna by firing, as a hunting technique, has probably extended the areas available to grassland species, such as the agile wallaby. In the Highlands however, few if any economic species occur solely in the grasslands, though some forest edge species, such as the Raggiana and lesser birds of paradise, and perhaps wallabies and wild pig, may benefit from partial clearing, as long as remaining blocks of forest are large enough to support the species in the face of hunting pressure. Complete clearance of large areas of forest (or simplifying the forest by planting only a few tree species for forestry) leads to a decrease in the number of animal species and possibly also in the numbers of individuals. The speed of change is important too. Clearance in the Highlands took place over many thousands of years, and the Highlands fauna overall does not seem to be seriously affected by it. Rapid, widespread destruction of primary forest for forestry or agriculture would have different results.

References


4 The Use of Resources in Traditional Melanesia

IAN HUGHES

Despite resources permitting self-sufficiency, most Melanesian communities traded vigorously. The exchange patterns were based on unequal access to marine resources and certain minerals and to habitat diversity, but the basic flows were complicated by a variety of cultural and political factors, a number of which are discussed here. Study of past and present resource exploitation, consumption and trade reveals acute environmental knowledge, developed systems of exchange and considerable economic integration periodically interrupted by political hostilities. Introduced cash crops and foreign products have brought benefits but have resulted in a loss of some resources basic to the subsistence economy and upon which village autonomy depends. Part of the traditional exchange economy has been destroyed. Formerly, economic obligations were accepted as contracts between equals. Now these are increasingly being imposed by the trading needs of the industrialised world and the powerful new urban minority in Melanesia, not always to the advantage of the rural majority.

This chapter is written mainly for my Melanesian friends and neighbours. Most of my experience has been in Papua New Guinea and I draw my examples from there, but what I have to say in general applies to Melanesia as a whole. I will speak first about Melanesian resources broadly, then about particular resources, especially mineral resources, then say something of the way in which resources of limited natural occurrence were distributed to other communities by trade.

By traditional Melanesia I mean Melanesian economy and society not substantially altered by the industrial world. Despite three or four generations of contact with foreign cultures, the incorporation of part of their agricultural resources into the world economy, and the rapid social changes of the past two decades, most Melanesians today live in rural settlements and depend for their basic livelihood on the same resources that their parents and grandparents did.

I use the term resources to mean those things used by man. Potential resources are those things that are not seen to be useful, yet may prove to be so. The change in status from unperceived resource to resource depends on discovery, invention or the introduction of new knowledge, either about the needs of the community, or about the properties of the thing itself, be it animal, vegetable or mineral, including knowledge of its location, or about the technology needed to make use of it.

Almost all Melanesian communities can be self-sufficient but the exchange of specialised products raises their economic standards through a more efficient use of resources and enriches their cultural life. Trade in staple foods was exceptional, though it occurred where there were communities specialising in fishing, and a few groups with poorer natural resources, particularly garden land, like the Manus, Siassi, Mailu and Motu of Papua New Guinea, developed trade as a specialised economic activity and acquired basic foodstuffs in these exchanges.
Most outsiders and some of today’s Melanesian young people are ignorant of this capacity for self-sufficiency within the traditional village economy. Even more people, some of whom should know better, have little conception of the scale, the pervasiveness and the economic and social significance of the system of exchange, which, despite the capacity for self-support and frequent periodic political incentives to maintain independence, nevertheless made traditional Melanesian communities economically and socially interdependent. Some of this ignorance is legitimate but some stems from ethnocentrism. Development economists looking at Melanesia conventionally separate the ‘monetary sector’ from the ‘subsistence sector’—they can measure one but not the other. This division has its uses, but it obscures the fact that, long before the introduction of universal modern money, the ‘subsistence sector’, that is the traditional Melanesian economy, produced both necessities and non-essentials, goods for home consumption and goods for export, and that these exchanges were facilitated by items that were both stores of value and media of exchange.

Human use of unequally distributed resources is the underlying basis of trade, as different groups of people find that their own areas have peculiar sets of advantages for the production of certain goods. This pattern of comparative advantages has been profoundly affected by geological structure and erosional history, for these physiographic forces have determined the discontinuous distribution of mineral resources, provided a wide range of altitude and temperature, a variety of drainage patterns, and landscapes of different aspect, internal relief, climate and soil types. The result has been a great diversity of habitats.

Each community in traditional Melanesia has three main natural factors determining its resource base and its potential for distributing resources by trade; these are its altitude of settlement, its proximity to the sea and its proximity to the rarer mineral resources. So constant is the correlation that if one knows the position of a particular community on the map one can predict with a high degree of probability its principal resources, its main foodstuffs and its likely trade goods. Of course, the main pattern is overlaid with complex modifications due to historical and cultural factors but this does not invalidate the general statement. The most significant modification is that not all groups possessing even a very scarce resource utilised it, still less utilised it for trade. Local needs, skills, technological knowledge, competition, trade opportunities, entrepreneurship, and other cultural and political factors all contributed to the pattern of resource use.

As in all societies, the needs of traditional Melanesian communities change constantly, though we know less about some of the agents of past changes than others. We are dependent for information on the memories of old people, on modern observations of traditional practices, on inferential evidence from the environment itself, and on the information provided by archaeology and other specialised techniques for studying man’s past relationship with the land. Supporting evidence comes from the earliest literate observers. Though some discoveries of resource location are remembered or preserved in legend; we know little about the discovery and invention that occurred in Melanesia in the distant past, like the domestication of indigenous plants, though present practices in regard to some semi-wild species strongly suggest how domestication occurred, and data are accumulating about the antiquity of Melanesian agriculture, an antiquity that will surprise the rest of the world.

The spatial distribution of certain garden plants and practices, of products acquired by exchange, of specialised manufacturing techniques and of decorative motifs permits a number of inferences about economic and social linkages between different groups of people and about the diffusion of cultigens, technical knowledge and other...
ideas. When these distribution patterns are given time depth by archaeology, we can even trace some of the ancient contacts and the changes that have since occurred. The direction and mode of the spread of some more recent innovations is well remembered, and of course in regard to new plant varieties and cultivation techniques and the products and methods of the industrial world such diffusion can be observed happening in an accelerated fashion today.

There is also evidence of the way in which Melanesian communities adapted to new environments and, in the course of doing so, changed those environments and the total complex of resources available to them. Though the conditions that initiated these changes in the past are often unclear, migration into a new environment with a new set of resources requiring new exploitative strategies is quite well known and understood, and because of this we know something of the way in which changes in the resource base led to further changes in the way of life of the community. Migration into new land occurred regularly in remembered times and appears to have been a constant periodic factor in prehistoric times.

Today, the peaceful movement and resettlement of expanding rural communities into sparsely populated areas still occurs, but in the immediate past this peaceful means of bringing new resources into production was quantitatively the least important one, for in those days most population movement was accompanied by warfare. Even now, movement of new groups into many parts of Melanesia's apparently unused forests and grasslands is bound to be resisted. It is hard for outsiders, especially foreigners in need of timber, but also Melanesians from densely settled parts, to remember that undestroyed forest is not necessarily unused forest, and that many small forest fringe communities draw a variety of plant and animal resources vital to their economies from primary forest without making significant economic impact on the forest itself. Similarly, much apparently neglected grassland yields a seasonal harvest of animals and birds and provides valuable grazing for feral and domestic pigs. Wet grasslands and swamp forest are no exception.

As government purchasers know, little land is unclaimed. This territoriality is not a modern phenomenon aimed at getting a share of the state's ready money (though that motive is now normal enough and a natural response to requests for land made by obviously wealthy people) for most lightly utilised areas have always been part of the domain of specific communities whose way of life is adapted to the use of those areas. At the furthest remove, they form a valued reserve of resources for present and future generations. The fact that claims to ownership are often disputed by neighbours emphasises the high value placed on these resources.

In the recent past, since most communities had neighbours, population movement was usually into land already claimed by others, and fighting was essential. This fact emphasises better than any other that the most important resource in traditional Melanesia was and still is agricultural land. Certainly, battles have been fought over gathering, hunting and grazing rights in grassland and forest, over the right to fish a particular bay or estuary, or to gather shellfish, and fighting occurred occasionally over mineral resources and over trading rights as well as over those less obvious resources, domestic pigs and the productive labour of women, but by far the most frequent conflicts were over arable land. Groups everywhere and at every level from families up to tribes regarded land as a just cause of war.

Most of the resources of the soil are made available to us by green plants, and we have already had reviews of plant resources and that other important primary resource, animals, which like ourselves ultimately depend on plants to live. But mineral resources used directly by man, unlike soil, plants and animals, are very
limited in their natural distribution. Those of traditional Melanesia are lime, pottery clay, coloured earths useful as paints and dyes, stone of superior tool making quality, and salt.

Lime can be made from limestone, but apart from the occasional use of recent coral, lime was usually made from shells, mainly marine shells, and traded wherever betel nut was chewed. Despite the almost ubiquitous nature of this resource on the coast, not all coastal peoples made lime. Local exchange strategies encouraged some to barter it from specialists.

Clays suitable for pottery manufacture are much more widely distributed than is pottery making. Pot manufacture and distribution illustrate better than most mineral based industries the sometimes dominant role of factors other than the possession of raw material. In a few places there was trade in clay, but this was rare. Along most of the coast of Papua New Guinea, in the islands, along the lower Sepik River and the lower reaches of its tributaries, and along the lower Ramu River, the pottery trade was very prominent in regional exchange. It was little less important in the hinterland of the northeast, that is in the foothills of the Adelbert, Finisterre and Saruwaged Ranges, pots made in hill villages being traded across the Ramu-Markham trough into the eastern and central highlands, though they did not penetrate the highlands far. There was also a pottery industry in the upper Markham valley and in one part of the eastern highlands. Pots made on the coast did not move far inland. Because potsherds are highly durable, the strong association between raw material types, pot shapes and decoration, and specific cultural groups makes pottery one of the most useful indicators of past settlement and trading histories.

Vegetable dyes are prominent in ethnobotanical literature, but coloured earths also provided important paints and dyes. Apart from the ornamental use of lime, mainly on carvings, and the local use of common red and yellow clays, I know little of the place of coloured earths in the economies of the lowlands, but in the highlands the best ochres were significant items in the exchange system. Collecting rights were carefully managed by those claiming the mine area, and red clays coloured by haematite and yellow clays coloured by limonite were carefully collected, graded, treated with heat to complete oxidation of the iron and traded out to neighbours.

Green pigments are rare. No doubt a few more exist, but in an area of some 20,000 sq km that I studied closely, I was told of and saw only two. The less impressive one was coloured by chlorite. The other was brightly coloured by a basic sulphate of copper and aluminium called spangolite. Difficult to get to and laborious to gather, this colour nevertheless was gathered in sufficient quantity to trade to villages 30 km away. Blue colours were traded more widely still. Within that same large area I know of only four sources, one of which is a modern discovery. All consist of vivianite of a beautiful pale but well saturated blue, quite as good as the commercial blue paint now sold in trade stores. Indeed, the same substance was used in ancient Europe and referred to as 'native Prussian Blue'. One product collected and prepared in central Chimbu was traded over an area of 600 sq km.

The most remarkable pigment, most valuable and most widely traded, was a glistening shiny black mineral which early white visitors mistook for graphite but which is specular haematite. Special techniques were used to enhance its lustre. The trade area of this paint was expanding in pre-contact days and, uniquely, it has continued to grow. It has no competitor—nothing like it appears in the range of industrial colours sold in stores; in fact small bamboo containers of this traditional colour can sometimes be seen in village trade stores. During the past forty years its trade area has trebled in size. No doubt such resources seem insignificant in the wider context of Papua New
Stone, especially obsidian for the manufacture of flake tools, was carried by canoe borne trade further than any other good, and in the interior of the largest Melanesian land mass, the main island of Papua New Guinea, in terms of distance travelled and comparative value, trade in stone tools equalled the universal trade in marine shells. Fully finished ground and polished blades of high quality were made from rock quar­ried from deposits of fine grained metamorphic rock in the inland mountains and traded over hundreds of kilometres to the northern and southern coasts. Axe heads and domestic pigs were the main exports of the densely settled valleys of the highlands. Further west, stone axe-adze heads made on the upper Leonard Schultze River, a southern tributary of the middle Sepik, reached the far south of the Southern Highlands District and the inland parts of the Western District of Papua. The principal long-distance imports into axe producing areas were ornaments of sea shell which, with stone axes, functioned as durable stores of wealth. Only the stone axe trade of central Papua New Guinea is known in detail, but it is probable that a large proportion of mainlanders as well as many of the inhabitants of the southeastern archipelagoes used axe-adze heads manufactured in fewer than a dozen main factories.

In a country of such marked ecological and cultural diversity, geographical isolation and political fragmentation, this is a remarkably high degree of specialisation.

Sources of common salt are very limited away from the seashore, yet there is an almost universal demand for it. Some coastal people and a few fortunate possessors of salt springs developed a variety of techniques for producing dry salt, much of which they traded to neighbours. The longest salt trade route that I know of was from the centre of the Enga District to the limits of the Southern Highlands District at Lake Kutubu and Erave. The salt trade provides a unique example of the dominant role of cultural adaptation among humans, for side by side with the production and distribution of common salt made from sodium-rich springs is the production and exchange of potassium salt made from green plants. In the Central Highlands small trade areas for potassium salts exist inside the larger trade areas of sodium salts and, further east as far as the Anga language area, trade in potassium salts predominates even where there are salt springs. In diet and in metabolism these two substances are not inter­changeable; the trade in plant salts is a matter of taste, a matter of custom.

Study of the patterns of distribution of traditional mineral resources, their location, extraction, fabrication, local consumption and barter to others, indicates an extremely high level of knowledge of the local environment, which I am sure applies to Melanesia as a whole. Although the area with which I am most familiar ranges in pop­ulation density from more than 200 persons down to less than one person per sq km and much more of it is forest land than garden and settlement land, the evidence strongly suggests that all salt springs, potential stone quarries with surface indications, all exposures of coloured pigments and, in pottery making areas, all suitable clay sources are known to the inhabitants. My observations are that this high degree of en­vironmental awareness extends to the basic village resources of soil, plants and animals. This is not to say that every member of the community was equally well in­formed but that the distribution of technical and specialist knowledge was such that the community as a whole had access to it and benefited from it.

So, here we have a traditional Melanesia where resource knowledge is acute and most separate communities have the potential for self-sufficient independence; yet substantial natural geographic barriers and the much more significant barriers of
language, culture and political fragmentation were overcome to permit a developed use of the scarcer resources through the production and distribution of a range of goods to improve every aspect of economic, social and religious life—goods for consumption and goods for further production, practical items and luxuries, items for every day, for special ceremonies and for further traffic with neighbours, goods that were both valuables and media of exchange. The fact that unit values varied spatially was no hindrance and the existence of degrees of convertibility was a minor handicap. Pigs converted cheap carbohydrate into expensive protein and were the main means of changing garden produce into valuables. Variations in quality among the most valuable things, together with the divisibility of pork and minor shell, tooth and feather ornaments, salt, pigments, oil, lime and luxury crops like tobacco, meant that somewhere in the process of production and the network of distribution complete convertibility was achieved.

It was a successful, functional, integrated system with its own market forces and regulating mechanisms and it was also a system in constant flux, changing with population movement and expansion, affected by discoveries, absorbing innovations, transmitting knowledge, growing here and waning there with the changing needs and fortunes of different groups of people. The people themselves did not know its extent and its ramifications, especially in inland areas; they saw only what concerned them and their immediate neighbours. Most outsiders, including some in positions of influence in Melanesia today, are also unaware of it, and those that know something of the system continue to underrate its scale, its economic and cultural significance, its value to traditional Melanesian society and its implications for the choices open to the Melanesia of today.

The years of colonial rule have affected traditional Melanesian resource use by changing the status of individual resources within the village economy and by drastically altering the exchange relationships between individuals and between groups. The basic resources which maintain subsistence and upon which rural village autonomy is based—that is, the arable land, stock of garden plants, nearby forest with its plants and animals, and the resources of the edge of the sea—though making some gains and suffering some losses, continue as a reliable and integrated basis for life. The gains have been useful new crops. The greatest loss has been in the reduction in the flexibility of agricultural strategy through the need to devote arable land and time to cash crops, the loss of arable and grazing land to capital intensive enterprises and, in a few areas, a growing shortage of land due to unprecedented growth in numbers of people. In some parts, wild resources have been diminished by commercial timber extraction. Of course, there have been useful cash benefits but they have been spent mainly on consumption and, in terms of resources relevant to the village, there has been a net loss.

The traditional exchange economy was more vulnerable and has suffered most, the changes being caused principally by competition from foreign goods. The stone axe business was the first to go, killed by steel tomahawks, plane blades and hoop iron, a process that started on the coast more than a hundred years ago and finished in the main highland quarries thirty years ago. The stone tools that continue to be used in village technology (sharpeners, drill points, scrapers, hammers and anvils) have been reduced in importance and in any case they are made locally as needed and are outside the exchange economy. In isolated parts, an occasional stone adze acquired in an earlier age continues to be used by craftsmen for hollowing canoes and containers.

Most of the formerly ubiquitous traffic in shell ornaments has been destroyed; it survives only where the use of a single species is supported by great ceremonial
The Melanesian environment

significance, as with dog whelks (*Nassarius* sp.) in northern New Britain, pearl shells (*Pinctada maxima* Jameson) in the Western Highlands and Enga Districts, and cone shells (*Conus leopardus* Röding) in the eastern archipelagoes. The destruction was brought about by new ornaments and cash and, during the first twenty years of white influence in the Highlands, by direct European spending of millions of shells, completely devaluing them. All except one of the traditional mineral pigments have been displaced by factory made colours, and, except where it is still required for ceremony, indigenous salt has yielded to imported salt.

Old resources have been replaced by new ones, in many cases accompanied by obvious technological advantages. Unfortunately, most of the new ones that benefit village life are foreign owned and many are located overseas. The establishment of exchange relationships has always required an acceptance of interdependency and a sacrifice of some freedoms; there is nothing new or inherently bad about that, and it can bring advantages now just as it has in the past. But whether or not a particular relationship is profitable can be judged only from the point of view of individuals and the community of which they are a part; there are no objective universal criteria. In the past, such obligations were entered into cautiously; as part of a general adaptation to the environment and the decisions were made locally, rarely if ever being imposed by others. Competition for advantage notwithstanding, contracts were made between people who were in possession of sufficient facts and who were more or less equal. Contracts between the weak and the powerful result in dependence and loss of control over the resources on which independence is based.

Now that major decisions about resources are made in the city 'in the national interest', in those inevitable cases where the interests of the rural community do not coincide with the interests of the powerful new urban society, it is all too easy to mistake metropolitan interests for national interests, to the detriment of the village society in which more than 90 per cent of Melanesians still live.

References
5 Management of Resources in Prehistoric Coastal Papua

JIM ALLEN

The first large-scale migration of pottery using people to the Papuan coast seems to have taken place about 2000 years ago. For something approaching a one thousand year period these colonisers were able to organise themselves and their environment and maintain the equilibriums they had established with manifest success. The next large-scale movement occurred about 1000 years ago. It would seem that populations along the coast may have increased at that time beyond the capacity of the previous localised and general economic systems to maintain them. The resulting disequilibrium was resolved by a trend towards specialised production in different areas, together with improvements in the systems of distribution and communication. The result was the attainment of highly complex and successful levels of resource utilisation. The end product of these technological and social manoeuvres was a series of culturally distinctive and cohesive units of specialised producers, maintained by essentially egalitarian political and social structures, and connected to each other by formalised exchange systems. In addition there are indications that this system was itself in a state of change. The successful nature of this most recent system has been obliterated by the imposition of a radically different centralised colonial government, which to date has demonstrated no greater success in overall achievement than the prehistoric systems before it, particularly in its failure to replace in any way the personal and group aspirations and satisfactions of earlier systems.

When Captain John Moresby sailed into Fairfax Harbour in 1873 he initiated the beginning of Papua New Guinea’s forced entry into a western industrial world. The European colonisation of the country was not, of itself, a particularly unique event; on the Papuan coast we can now postulate with some confidence at least three prior instances of colonisation. The importance of Papua New Guinea’s most recent colonisation lies in the quality of the changes it has brought to the country: the altered emphases of Papua New Guinea’s new resources, which were not resources in the past, and the technology for their extraction; the altered styles of urban and rural living and their effects upon social organisations adapted to different living patterns; the destruction of systems designed to conserve and utilise the environment in ways no longer relevant. If this chapter has any political purpose it is to elucidate some of the ways in which coastal Papuans exploited and conserved their resources and environment in the past to illustrate their adaptive potential for the future.

From the site of Kosipe, about 2000 m above sea level, we know that man had already gained access to the Papuan Highlands some 25,000 years ago, probably foraging in the area for wild pandanus on a seasonal basis (White et al. 1970). This fact alone indicates man’s early detailed knowledge of the local environment, for the species of pandanus available there were indigenous, and knowledge of the plants needed to be learnt after man reached the country. Coupling this with the evidence forthcoming from Australia (Jones 1973), it is now reasonable to assume that man first
reached Papua New Guinea perhaps 40,000 years ago, but unfortunately direct evidence of man along the Papuan coast extends back only a tenth of this time. At the site of Kukuba Cave, on the mainland almost opposite Yule Island, Vanderwal (1973) obtained two carbon dates of approximately 4000 years ago related to fireplaces and associated stone tools within the cave. Because the soils within the cave are very acidic, it is thought that all other traces of man’s occupation—the bones of the animals he ate, wooden tools, shells and so on—have long since disappeared, but the little evidence that is at that site suggests that Kukuba Cave may have been used only as a refuge during local fights or as a shelter from rain for people gardening in the area; for while we have no evidence of gardening in this region at this time, we do know that quite intensive gardening was being practised elsewhere in New Guinea at least 4000 years ago and beyond.

What can be suggested is that the south coast of Papua was not extensively settled before about 2000 years ago for, despite a number of surveys along the coast, which have produced hundreds of sites younger than this date, Kukuba Cave remains the only earlier site so far discovered. In assessing this state of the evidence it has to be remembered that before about 8000 years ago sea levels were lower and coastline settlements are now presumably submerged. As well, since sea levels reached their present height, many alterations of the coastline have taken place; in some areas the coast is eroding, in others beach sands are accumulating so that what was the shore only a few centuries ago may now be hundreds of metres inland. Tropical jungle also quickly obliterates traces of occupation on the ground surface, and sites may often only be found by accident, while building roads or digging pits for other purposes. Nevertheless the lack of early evidence does appear to be significant, and it may well be that the Papuan coast offered earlier inhabitants fewer year round resources than elsewhere to encourage settlements of sufficiently large size and permanent nature for the remains to be easily recognised.

At about the birth of Christ however the picture altered radically. Right along the southern coast, extending from Amazon Bay in the east to the Papuan Gulf in the west, a distance of some 700 km, sites consistently dated in their earliest levels to about 2000 years ago have been discovered. These sites are located in a variety of places, on offshore islands, beaches, coastal hilltops, and inland up to 12 km on the tops of hills and on valley floors. Everywhere the sites can be related most easily by the distinctive types of pottery that these people used, and by other aspects of their economy that can be reconstructed from the archaeological evidence.

The best expression of this earliest occupation of the coast by pottery using people permanently settled in villages comes from the site of Oposisi, situated on a high ridge top on Yule Island. There, in the levels relating to the initial settlement of the site, Ron Vanderwal recovered a developed and varied pottery industry characterised by plain cooking pots and water jars of good quality, and elaborately decorated bowls, the decoration consisting of complex zones of shell impressed motifs, sometimes with lime rubbed into the surface to heighten the decorative effect. Spatulas, very similar to modern lime spatulas and elaborately carved in bone, were recovered from this part of the site, as were ground and polished stone adzes of distinctive shapes (trapezoidal cross section, front narrower than back, and triangular cross section, apex to the front). Simple flaked stone tools made from local, poor quality cherts were present but not plentiful, and were supplemented by flakes of obsidian derived ultimately from Fergusson Island, 1000 km away to the east. Nut cracking stones and other implements suggesting the preparation of vegetable fibres and wooden tools were also recovered, as were a variety of bone and shell jewellery items, including *trochus* shell
arfbands which, like the obsidian, must have been imported from some distance. Bone remains included wallaby, pig, turtle, dugong, crocodile, cassowary, scale fish and shellfish.

Other early sites along the coast have produced similar pottery to that from the earliest levels of Oposisi, as well as some of the other artefacts, although no site as yet exhibits as wide a range as Oposisi. In the Port Moresby region Sue Bulmer (1974) has excavated a dog burial at the Taurama site, and this together with an early date for a dog tooth necklace from Nebira 4 (Allen 1972) suggests that this animal may be added to the repertoire from Oposisi.

In historical terms what this evidence indicates is that about 2000 years ago a large-scale migration of people took place along the southern Papuan coast. In terms of archaeological time this colonisation was instantaneous, and the apparent ease with which the newcomers established themselves in a number of localities right along the coast adds support to the view that earlier occupation of the area might have been sparse and of an impermanent nature. Several archaeologists working in the region have been tempted to equate this early migration with the arrival of Austronesian languages along this coast (Allen 1972, Vanderwal 1973), an interpretation that fits reasonably well with the postulated time depth for these languages in the area based on linguistic evidence (Pawley 1969). In searching for the original homeland of these colonists we are forced to look eastwards to the western Pacific, for there are some strong similarities between the ornate decorations of the pottery bowls of the earliest Papuan pottery sites and the decoration of the widespread Eastern Melanesian/Western Polynesian ceramic tradition of the first millennium BC called Lapita (Specht 1968); similarly the adzes and some of the ornaments find their closest parallels in that region. Moreover, it is generally accepted that the earliest arrivals into the insular Pacific brought the pig and dog with them, so that the presence of these animals in the sites of these early Papuan colonists is in keeping with this postulated homeland region. The presence of both lime (as evidenced as part of the decoration technique in the pottery) and ornately carved spatulas, together with the fact that the universal word for lime is an Austronesian word (Capell 1943), has led Vanderwal (1973) to conclude that these early colonists may have introduced the chewing of betel nut into Papua. Since this trait is limited in its distribution to the northwest of the Solomon Islands (Riesenfeld 1947), the homeland might be even more closely defined in the area of western island Melanesia.

Both the locations of sites and the bone food remains suggest that the subsistence pattern of these early migrants was orientated much towards the sea and the exploitation of sea resources, but that land hunting also contributed to the diet. As well, the appreciable quantities of pig remains suggest that these animals were probably husbanded rather than hunted in their feral state. If this assumption is accurate it is also likely that some gardening was practised, since pigs kept in villages often require to be fed. Thus the economy appears to be a mixed hunting, farming and fishing one. In addition coastal trade routes were sufficiently maintained to allow the passage of obsidian and shell jewellery (if not other artefacts) from the east, over long distances; whether such links extended back to a home area is as yet unknown.

On the basis of the Oposisi site Vanderwal has postulated a break in the archaeological record after this initial settlement, and it is certain that some of the artefact types represented in the deposits of the early colonists do disappear; these include the lavish bone industry and the trapezoid and triangular adzes and the trochus shell armbands. As well, the succeeding styles of pottery decoration differ from the initial styles. However some pottery shapes and the general high quality of pottery
manufacturing continue; some of the same sites continue to be occupied by these new pottery users, and the continued presence of obsidian attests to the maintenance of the coastal trading links. At the present stage of research it is not possible to say what this change in the archaeological record represents—whether it is the incursion of new groups or the manifestation of closer integration of the early colonists with indigenous groups and a lessening of ties with the colonists’ home area. What does happen is that the material cultural assemblage simplifies and takes on a more ‘Melanesian’ flavour; the wide trochus armshells are replaced by narrow ones fashioned from the conus shell, the adze forms become flatter and broader, and typical New Guinean club heads appear. There is sufficient archaeological evidence therefore to follow Vanderwal and divide the first millennium A.D. appearances of these colonists into an Initial Ceramic Phase and a slightly later Developmental Phase.

The Developmental Phase continued until about 1000 years ago, and can be subdivided during that period on the basis of a sequence of pottery types that may well develop one from the other. Site locations and the general broadly based economy of the Initial Ceramic Phase continued with little change, but already one significant trend in Papuan coastal prehistory was beginning to emerge: while the very diagnostic sequence of pottery styles remains identical between the Yule Island and Port Moresby regions, attesting to continued close relationships between the two areas, further east, in the Amazon Bay region, the sequence appears to have developed differently. The enormous cultural province of the Initial Ceramic Phase stretching right along the Papuan south coast was beginning to fragment.

This is perhaps best seen as the result of the consolidation of the colonial enterprise, as the intruders came to terms with their local environments and the resources within them, and we see intriguing reflections of this in the archaeological record. During this Developmental Phase in the Yule Island sites, the poor quality local chert were replaced with larger supplies of stone of finer quality as access to these new sources was established. In the face of our fragmentary archaeological evidence we must assume that the extractive technology of the people was improved and in some ways altered under this new impetus. We can also recognise economic exploitation changing through time. At the Nebira site 11 km inland from Port Moresby, where a smattering of pottery related to the Initial Ceramic Phase is present in the bottom levels, a very heavy initial dependence on marine fish and shell fish was gradually replaced through time by a greater reliance on hunted land fauna, and presumably, since the site is adjacent to the fertile soils along the Laloki River, an intensification of garden food sources. There is no indication of population crowding on the coastline at this time, and these inland sites seem to be genuine attempts to diversify the exploitation of a wide range of food and other resources.

As far as we can read the archaeological evidence, the establishment, maintenance and development of these earliest pottery communities was as successful a migration and colonisation as that simultaneously spreading man throughout the last major area of the world to be colonised—the island world of the Pacific. For something approaching a thousand years these people were able to organise themselves and their environment and maintain the equilibriums they had established with such manifest success. However, just as their arrival was, in archaeological time, instantaneous, so was their disappearance right along the coast. The cause of this upheaval is unclear, but in the Port Moresby region at least it is thought that inland groups moving towards the coast, themselves perhaps under pressure from the rear, probably contributed to the displacement of the coastal groups. Intriguing reflections of this pressure present themselves in the data; at around 800 A.D. Kukuba Cave again housed
man—this time using pottery similar to the upper levels at Oposisi; at Nebira the
defensive hilltop site was occupied at the same time as the valley floor site fell into dis­
use; and a settlement was made on the offshore island of Daugo (Fisherman’s Island)
during the same period.

The available carbon dates for the demise of these early groups are not particularly
satisfactory and there is a small hiatus that needs to be more clearly defined and ex­
plained. But around 800 years ago new archaeological reflections appear along the
coast at Amazon Bay, Port Moresby and Yule Island (and, we would suspect, elsewhere
as well). At least in the Port Moresby and Yule Island areas the evidence argues strong­
ly for a further migration of people on a large scale; site locations became at this time
highly specified along the coastal strand, and the pottery, the hallmark of
these people, cannot be derived from the ceramic industries that preceded them in
these areas. Obsidian, for a thousand years the most consistent indicator of trade
links into the Massim, disappears from most of the Port Moresby sites from this
time on, although it appears to reach the Marshall Lagoon/Aroma coast region in
plentiful supply. We can presume that more intensive exploitation of the plentiful
finely grained cherts of Port Moresby finally undermined the value of obsidian as a
trade item.

If about one thousand years ago coastwards movements of inland groups and
coastline migrations by sea took place to the extent that is suggested here, then we can
also suggest with some confidence that populations along the coast increased beyond
the capacity of the previous localised and general economic systems to maintain them.
In such a situation of disequilibrium we would expect intensification of the food quest,
either by the development of new technology (including not only tools, but also more
intensive gardening techniques, more specialised production of fewer crops and so
on), or alternatively by a more general intensification in the specialised production of
local areas (made possible by increased population) together with improvements in the
systems of distribution and communication, so that any group’s economic catchment
would extend well beyond the territory it occupies. Although these two alternatives are
not mutually exclusive—indeed we would expect both to operate in most in­
stances—the last millennium of Papuan prehistory is a clear demonstration of the se­
cond alternative in predominant use.

Intensification of this nature requires greater organised co-operation than would be
previously required by more economically autonomous population units at the village
or hamlet cluster level. There would appear to be many alternative methods for im­
posing such organisation, ranging from the development of tighter, more cohesive
groups whose cultural identity in part is determined by their specialised economic ac­
tivities, and whose relationships with other groups, while maintained warily, expand
on a formalised basis, to an extreme centralised bureaucracy such as the former
Australian administration in Papua New Guinea. On evolutionary principles one
would assume that the former always precedes the latter, and in the prehistory of
Papua this seems to be no exception.

It has long been remarked that it is unusual to find population clusters of the size
that exist in Papua New Guinea without greater internal hierarchical structures
developing, but this very situation seems to be one very good method of maintaining
the equilibrium of such an intensified system. Moves towards more complex and more
centralised systems seem likely to be accelerated by the accumulation of power in in­
dividuals or groups. Thus, while we can point to the big man as part of a developed
clan or village hierarchy, the big man syndrome may itself be maintaining
egalitarianism at the village level and thus maintaining some sort of equality between
villages in any economic catchment, by strictly controlling the absolute power of the big man, and preventing the build-up of wealth and power of any individual by inheritance, since an individual’s wealth is dissipated at his death.

In the archaeological record of the last thousand years we are able to document this intensification in action. The fragmentation of the wide cultural province during the Initial Ceramic Phase, already alluded to, accelerated the formation of more local provinces, which at the time of European arrival equated more or less with language distributions along the coast. It appears more than coincidental that these provinces, with the exceptions of the area west of Yule Island and Hula, each maintained pottery industries that were closely associated with central villages of significantly greater populations than others in each province, for example Hanuabada in Port Moresby, Maopa on the Aroma Coast, and Mailu Island, offshore from Amazon Bay. In an elegant application of connectivity theory Geoff Irwin has demonstrated that in the Amazon Bay region during the first millennium A.D. the most central place in the area was not Mailu Island, but a mainland site; however during the second millennium A.D. Mailu grew increasingly more important and more centrally located in relationship to other existing villages. A house count in villages within the province in 1889 revealed a range of houses per village of 6–36, excluding the Mailu Island village, which contained eighty houses (Irwin 1973, 1974). An equally elegant corollary to this piece of research has been Irwin’s investigation into the clays used in the manufacture of the ceramics recovered from his sites. Two thousand years ago pottery in the area was manufactured from at least five discrete sources of clay, suggesting that a number of villages were making pottery. By several hundred years ago at least, pottery appears to have been made exclusively on Mailu Island and distributed throughout the province, and perhaps further afield.¹

Because Port Moresby became the first permanent British settlement in Papua, the records of early missionaries, administrators and anthropologists enable a reasonably complete reconstruction of the Motu cultural province before it became disrupted by the new intruders, and it provides an excellent example of the levels of resource manipulation achieved by a cohesive unit of specialised traders who were remarkable as organisers and entrepreneurs. Seen through European eyes the Motu domain has always been regarded as harsh, infertile and inhospitable, incapable of itself of supporting the Motu people. For most of the year it is remarkably dry, with annual evaporation rates exceeding annual rainfall, which, for the most part, falls in three months of the year. Gardens are of necessity strictly seasonal, being planted before the rains and cropped after them, and in ordinary circumstances garden produce would not support the population beyond the first few months of the dry season.

The Motu are however first and foremost seafarers. As far as we know over the past 800 years they rarely settled out of sight of the sea, preferring instead the beaches, offshore islets and the sea itself in which to build their villages. Their prime resource seems always to have been the sea and the resources associated with it—the fish, shellfish, turtle and dugong, and the salt from the water itself, the reliable coastal southeast trade and northwest monsoon winds to be harnessed for their power; and the barrier reef. It appears to be no accident that seafarers settled this particular stretch of coast, with its several excellent harbours and a barrier reef running 4–5 km offshore for the length of the Motu occupied area, since this provided not only marine resources but also a reliable year round corridor between their villages. Wherever the Motu came from originally, archaeological evidence, particularly from the site of Motupore Island

¹ I am extremely grateful to Geoff Irwin for allowing me to refer to his unpublished data at this point.
in Bootless Bay and the Taurama Beach site, indicates that they arrived sufficiently specialised to be able straightaway to occupy the demanding ecological niche of the immediate coast. That is to say they brought with them their extremely specialised technology of fish nets and dugong nets and watercraft and the knowledge and confidence to exploit their narrow environment in a manifestly successful fashion.

Despite this achievement it does appear on available evidence that the Motu could not provide sufficient food for themselves from their own environment, and were always dependent upon maintaining an economic catchment that extended inland into more fertile garden areas and along the coast into sago producing regions. To understand this manipulation it is easiest to look at its most recent and fully developed manifestations. Elsewhere (Allen in press), I have attempted the description and explanation of the system in detail. Here lack of space demands a simplified outline.

At the time of European contact the Austronesian speaking Motu shared some of their villages with the non-Austronesian speaking Koita who traditionally owned the inland plains as far as the Laloki River. Beyond the Laloki and into the mountains of the Owen Stanley range dwelt the Koiari, related by language to the Koita but regarded both by the Koita and themselves as their adversaries.

Despite sharing the same villages, and despite evidence suggesting that intermarriage had taken place between the two groups for some time past, cultural differentiation between the Koita and the Motu was maintained: the Motu fished, made pots and promoted a flourishing sea trade; the Koita maintained their own language and clan units, hunted and gardened on the inland plains. Both inland groups traded with the Motu, the products of each group being shown in Table 5.1.

<table>
<thead>
<tr>
<th>Motu</th>
<th>Koita</th>
<th>Koiai</th>
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</thead>
<tbody>
<tr>
<td>pottery</td>
<td>vegetables</td>
<td>vegetables</td>
</tr>
<tr>
<td>net bags</td>
<td>wallaby meat</td>
<td>stone axes,</td>
</tr>
<tr>
<td>coconuts</td>
<td>(and pig?)</td>
<td>bird of paradise</td>
</tr>
<tr>
<td>fish</td>
<td>cassowary and</td>
<td>and other plumes</td>
</tr>
<tr>
<td>salt</td>
<td>parrot feathers</td>
<td>bark cloth</td>
</tr>
<tr>
<td>armshells</td>
<td>matting</td>
<td>tobacco</td>
</tr>
<tr>
<td>dogs’ teeth</td>
<td>netting fibre</td>
<td>betel nut</td>
</tr>
<tr>
<td>necklaces</td>
<td>bark cloth</td>
<td>ginger</td>
</tr>
<tr>
<td>woven rope</td>
<td>rattan cane</td>
<td>lime</td>
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<tr>
<td>other shell</td>
<td>betel pepper</td>
<td></td>
</tr>
<tr>
<td>and ornaments</td>
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As well as this inland trade, and internal trade which exchanged local products between Motu villages, the Motu engaged in long distance, highly organised annual trading voyages to the Papuan Gulf, known as hiri. Hiri voyages were primarily pottery trading expeditions which might involve twenty lagatois or large trading canoes and 500–600 men exporting up to 30,000 clay pots to be exchanged for sago. As well the hiri traders carried a variety of shell valuables, both locally made and imported from further east, boars’ tusks and Koiari axes, to be used as ‘gifts’ to trading partners and
to purchase large tree trunks for canoe hulls—a vital resource absent in the Motu area. The *hiri* fleet would sail on the waning southeast trade wind in September or October, staying in the west until perhaps January when, with the new canoe hulls fashioned and attached to the *lagatois*, and loaded with perhaps 600 tons of sago the fleet would return on the northwest monsoonal winds. While the *hiri* was absent from Port Moresby groups from further east would arrive at the Motu villages to fish the Motu grounds and trade armshells and coconuts for pots with the remaining villagers. Upon the return of the fleet these visitors would receive a share of the sago, and perhaps some of the canoe hulls. The sago would last the Motu until the gardens began to bear at the end of the wet season.

This highly simplified account has glossed over a number of fundamental and extremely important aspects of the system—such questions as warfare, sorcery, ritual, social organisation and status acquisition, which are completely intertwined with the economic pattern, and which are vital for a complete understanding of the sophistication of the social and economic stability achieved by the Motu and their neighbours. It does, however, indicate the complex nature of resource manipulation and utilisation within social systems designed for, and achieving a management that helped obviate the overexploitation of valuable resources (for example not all coastal villages had or needed to have ocean going canoes, so that large trees for hulls were not obliterated), and which operated in such a fashion that no group became too powerful.

On Motupore Island the archaeology of the site indicates that the Motu entered into such trading alliances with their inland neighbours very soon after their arrival. Apart from fish and marine animals, the animal bone remains in the site consist largely of wallaby bones, but few, if any, other land animals, which we would expect if the Motu had hunted on the mainland themselves. Instead what this evidence reflects is almost certainly trade with the Koita or Koiai, who in the ethnography are reported to have taken enormous numbers of these animals by fire driving towards the end of the dry season, and who then smoked and traded the meat. Koiai axes also appear in the earliest levels. Later in time there is evidence to suggest some joint Koita (or Koiai) occupation of the site, as well as evidence of early adoption by the Motu of inland forms of ceremonial platform which indicate alterations to Motu social organisation. The history of development of the large scale *hiri* voyages is less clear, but the increasingly simplified decorations on Motu pottery through time are consistent with the limitations expected of mass production, which the developed *hiri* would have demanded.

As has already been noted, the pottery manufacturing centres along the Papuan coast appear to coincide with the largest population centres, and with the possession of large ocean going canoes. In one sense these centres appear to have been developed trading monopolies, and the pottery itself, at one level being of distinct utilitarian value, also provided the basis of an exchange mechanism—a material lubricant that facilitated the long-distance movement of other goods and valuables, and that also provided the opportunity of status acquisition for the traders themselves. It is in this fashion that these monopolistic trading and manufacturing centres grew in size and status. Thus Mailu Island, no less than the majority of the Motu villages situated in what might be called marginal ecological niches in terms of local food production, achieved high levels of population and prosperity basically as nodal points connecting otherwise discrete trading systems. In other words the mechanism of trade appears to have created amongst groups such as the Motu a level of prosperity that denies earlier commentaries which too simplistically suggested that the struggle for life forced the Motu to trade for sago in the west. Indeed it seems equally likely that access to inland
resources alone, allowing that they could be tapped, would have been sufficient to allow the Motu to survive without the hiri, and that the Motu choice of trading as an occupation goes well beyond the question of food procurement, to the wider implications of life style.

It should also be recognised that the Motu trading systems described here were not static, and the emphasis on the ways in which equilibriums may have been maintained is an overemphasis on my part for explanatory purposes. On the contrary, the emergence of centrally-placed, large villages entices me to suggest that we may have in front of us an instance of cultural development involving a fundamental alteration of political and economic organisation—a social evolutionary step frozen in mid-stride by the arrival of the European colonists with their more complex centrally organised system. There are remarkable similarities between the Papuan situation of a hundred years ago and a recent model of Early Bronze Age urbanisation in the Aegean proposed by Renfrew (1969). In part he argues that the formation of urban communities or townships arose from neither significant external influences, nor the development of a centralised autocracy, but rather from a marked increase in trade, which resulted in the very rapid transformation of village subsistence economies into urban societies. More centralised political structures would be expected to emerge under such a fundamental economic change, but they would be clearly results rather than causes. In the Papuan case the forms in which such structures might have emerged remain forever now only speculation, but their possibility stands as testimony to the progress and inventiveness of resource management in the prehistory of Papua.

This chapter has attempted to demonstrate that in the prehistoric past colonists arriving on the Papuan coast were able to achieve highly complex and successful levels of resource utilisation by a variety of adaptive technological and social manoeuvres. The end product of these manoeuvres was a series of culturally distinctive and cohesive units of specialised producers, maintained by essentially egalitarian political and social structures, and connected to each other by formalised exchange systems, which expanded the economic catchments of all the units. In addition there are tantalising indications that this system was itself in a state of change, manifested in the emergence of 'urban' communities deriving their position and prosperity from their trading abilities. The successful nature of this most recent system has been largely obliterated by the imposition of a radically different centralised colonial government, which in my view has demonstrated no greater success in overall achievement than the prehistoric systems before it, particularly in its failure to replace in any way the personal and group aspirations and satisfactions of earlier systems. Instead the political system at present being inherited by an independent Papua New Guinea demands that achievement should be gained within a centralised hierarchy of western values that will exclude most of the population, and which, while paying lip service to cultural heritage, may be forced in the development of the new resources of the country to cut the cultural ground from under the feet of its people. To judge from the past, this problem is not beyond the adaptive capacities of the future nation to solve.

References

——— 1976. Fishing for wallabies: trade as a mechanism for social interaction, integration and

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2 I am grateful to Jack Golson for drawing my attention to this reference, and for his comments on an earlier draft of this chapter.


The landscape of the Papua New Guinea Highlands has been drastically changed by human activity. Through pollen analysis and archaeology, it is possible to reconstruct and date these changes. Shifting cultivation associated with pig pasturing in the area probably dates back to about 9000 years ago, when climatic conditions ameliorated and made it possible. Around 3000 years later cultivation extended from dry land into drained swampland and swamp management was a form of intensive agriculture intermittently practised thereafter. The successive phases of swamp drainage and its abandonment at a site near Mount Hagen are interpreted in terms of complex interaction between deteriorating conditions in the swamp itself necessitating increasing labour input for its management and changing conditions in agriculture and settlement in the region as a whole: ecological deterioration following prolonged shifting cultivation at high altitude, changes in agricultural techniques and cultivated crops and growth of population. A particularly important role in the making of the Highlands is ascribed to the sweet potato, more tolerant of poor soils and altitude than other crops, whose entry into New Guinea is argued to be 1200 years ago, not fewer than 500 as generally accepted.

In only two areas of New Guinea has there been sufficient archaeological work to allow detailed consideration of the history of the various economic systems whereby the resources of the island were traditionally managed by its inhabitants. Chapter 5 has dealt with one of these, the south Papuan coast. This chapter deals with the other, the Central Highlands.

Less than two decades of research has shown that the Highlands landscape between 1500 m and 2500 m is an artifact and represents the most complete and widespread transformation of any New Guinea ecosystem by man. Its vast grasslands have

I make acknowledgment to the Papua New Guinea Government for permission to carry on the research described here; to the Department of Agriculture, Stock and Fisheries for allowing the work to be carried out at one of its research stations; and to the successive managers of Kuk, the late John Morgan and Douglas Grace, and their staff, for their every help and co-operation. Besides my archaeological colleagues, to whom appropriate acknowledgment will be made elsewhere, I owe a great debt to my specialist co-workers, past and present, in the project—Philip Hughes (swamp stratigraphy); Russell Blong (volcanic ash and swamp stratigraphy); Jocelyn Powell (pollen analysis and swamp stratigraphy); Laurie Lucking (wood and seed identification); Ian Hughes (traditional land use). In the preparation of the present chapter I am grateful for discussions with P.J. Hughes and J.R. Flenley. The work described was funded in the main by the Australian National University, but grateful acknowledgment is made also to the support given by Macquarie University to allow the continuing participation of R.J. Blong and to the Wenner-Gren Foundation for Anthropological Research for contributing to the cost of labour during the 1974 season. In this chapter I use New Guinea for the island as a whole and Papua New Guinea and Irian Jaya for the two political entities that occupy it.
replaced an original environment of mid-montane rain forest under the impact of shifting agriculture. Its complex agricultural systems, combining well ordered plantations of sweet potato and other food crops with planted groves of bamboo and Casuarina in the midst of grass or conserved bush fallow, are responses to the spread of grassland that renders the normal procedures of shifting agriculture insufficient and reduces access to the natural products of the bush. The large populations of people and of pigs which the complex agricultural technology supports serve to maintain the environmental transformation that has called them into existence and in certain circumstances to push it further.

Detailed research over the past decade or so, principally in the Western Highlands Province of Papua New Guinea in the vicinity of Mount Hagen, allows us to reconstruct and date the stages by which the transformation was achieved and to hazard some explanations for them. The research in question has two arms. One is the reconstruction of vegetation history through pollen analysis, which provides a method by which human impact on plant environment can be monitored over time. The other is archaeology, which aims to discover and investigate the direct evidences for man’s past activities, however these have been fossilised. An ongoing research project in swampland at the Kuk Tea Research Station near Mount Hagen, on which subsequent discussion relies heavily, combines both types of investigation and adds another, the geomorphological study of the sediments deposited in the swamp and assessment of the extent to which variations in the character and rate of deposition are due to man’s activities in the catchment. Preceding chapters in this book supply the framework within which discussion of the Kuk data can proceed.

The beginnings of Highlands agriculture
It is possible to argue that shifting cultivation was being practised in the Highlands from about 9000 years ago in association with pig pasturing, early dates by world standards on both counts (see Golson and Hughes 1976). The evidence for shifting cultivation is a fan of inwashed sediments in the swamp stratigraphy at Kuk, composed of a grey clay lacking the organic content of older deposits. This grey clay represents an increase in the rate of accumulation from 4 cm to 10 cm per 1000 years and of soil loss in the catchment from 0.2–0.5 cm to 2.0 cm per 1000 years. It is thought to be the product of increased soil erosion following bush clearance for agriculture on the low tephra-mantled hills of the catchment to the south of the swamp. It continued to accumulate over a period of 3000 years. Such sustained forest clearance ought to be registered in pollen diagrams as a decrease in forest values in favour of non forest vegetation. Unfortunately the regional diagrams available (Powell et al. 1975) do not cover the critical millennia.

The evidence for pig at Kuk comes in the form of shallow basins filled and sealed by the grey clay, which are interpreted as wallows. Susan Bulmer (1975 and this volume) has reported pig teeth from 10,000 years old levels at two Highlands rock shelters. Pig is, of course, not an animal native to New Guinea and it is difficult to see how independently of man it could have crossed the considerable water barriers separating the eastern Indonesian islands from New Guinea in sufficient numbers to establish viable populations.1 If man deliberately introduced pig into New Guinea as a domesticated animal, it seems not unlikely that he introduced domesticated plants as well. The close association of pig and agriculture in the 9000 years old levels at Kuk, as

1 The question of the ability of terrestrial animals to cross water barriers independently of man is an important one in our region. For a somewhat fuller discussion of the present case see Golson and Hughes 1976.
the evidence is interpreted, would support this proposition. In other words, the earliest agriculture of the New Guinea Highlands could have been based on introduced cultigens of Southeast Asian ancestry of the type which are prominent in many New Guinea agricultural systems at the present time, such as *alata* and *esculenta* yams, taro and bananas of the Eumusa section.

Several scholars (e.g. Powell this volume) have pointed to the economic richness of the New Guinea flora and its contribution to the repertoire of domesticated plants not only in indigenous agriculture but in that of Oceania as a whole. Some have suggested that given the time scale of its human occupation, back beyond 25,000 years ago, New Guinea could have been a centre of plant domestication independent of and prior to the plant introductions from Southeast Asia. Jocelyn Powell (1976) has recently documented this case in great detail. The suggestion that from the beginning Highlands agriculture was based on extra-New Guinea plants does not contradict this proposition. It simply implies that when climatic conditions ameliorated sufficiently at the end of the Pleistocene for shifting agriculture to become possible in the Highlands, Southeast Asian cultigens had already arrived in New Guinea.

Vegetation studies from a wide area of the Highlands show that under the depressed temperatures of the late Pleistocene when the high mountain peaks carried ice caps, the tree line stood around 2200 m, 1600 m or so lower than at present, with wide expanses of shrub rich alpine grassland above (J.H. and G.S. Hope 1976); the vegetation around Kuk at 1500 m would have been forest dominated by *Nothofagus*, actual stumps of which have indeed been found preserved in the lower swamp deposits. Highlands communities at this period are seen as exploiting the resources of the forest-grassland ecotone. Prominent among these is the mountain pandanus, ranging now from about 1700 to 2900 m altitude, whose seasonal harvest, important still today, is a factor in the archaeological evidence for both Pleistocene and post-Pleistocene sites (Christensen 1975; Golson 1976b). Though pandanus—and indeed other high altitude plants of economic importance—may have been fostered, tended, perhaps even planted, it is hard to see that their manipulation would have involved, or could have developed to involve, the sustained forest clearance implied by Kuk.

Between 10,500 and 8000 years ago the tree line rose rapidly and vegetation zones adjusted themselves accordingly. At 1500 m *Nothofagus* would have been joined by other tree species to create the mixed forest from which agricultural man subsequently carved out his habitat. Indeed there is some indication that from 8000 years ago the tree line stood higher than at present and that the milder climate implied by this persisted for 3000 years. These conditions would have proved advantageous for the entry and establishment at high altitudes of subsistence system depending on tropical food plants. The agency could have been two-fold: the upward expansion of low land cultivators as the climatic frontier receded; and the ready acceptance of new plants by resident populations for whom the forest-grassland ecotone had become a much reduced resource zone with the dramatic shrinkage of the alpine grasslands before the advancing forest and whose use of plants in subsistence had intensified as a result.

The conditions of Highlands agriculture

The conditions that governed the course of New Guinea Highlands agricultural history were the crops that were grown, the methods by which they were cultivated and the environment in which the cultivation took place. The large intermontane basins of the New Guinea Highlands between 1500 and 1800 m were highly favourable environ-

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2 See Golson 1976b.
ments for agriculture. However, they occupied a narrow perch between continuous slopes to the lowlands, on the whole steep, cloudy, wet, thin-soiled and malarial, and with a low ceiling, or ceilings, on productive crop growth. At the present time yam is prominent only below 1700 m, plantings of banana and sugarcane are small above 2000 m and though taro is grown to 2500 m, its yields are small and period of maturation long. These are amongst the crops that we have proposed were basic to Highlands agriculture from the start. It has been suggested that the tuber of the now unimportant legume *Pueraria lobata* may have been a major food in former times (e.g. Powell 1976), but this plant too is not much found above 2000 m. If the period between 8000 and 5000 years ago were milder than at present, as indicated, the ceilings on productive growth would have lifted slightly and temporarily. Effectively, however, the New Guinea Highlands are at the outer limits for tropical agriculture.

The practice of simple shifting agriculture, widespread throughout the tropics and one which forms a component of even the most developed of New Guinea cultivation systems today, can be safely assumed for the early millennia of Highlands agriculture. It involves the clearance of bush, the burning of the debris, the use of the cleared ground for one or two plantings and the move to new clearings while forest regrowth restores the fertility of the recently cultivated ground. Characteristically the land is followed for longer than it is cropped and the area under crops is only a small proportion of the total area required in the agricultural cycle. A number of factors leading to too frequent clearing of regenerating bush can deflect the succession to the point where abandoned plots are colonised only by shrubs and grasses difficult to clear and supplying insufficient nutrients when burned to sustain productive cultivation with the established techniques. These factors include growth of population, which requires more land under cultivation; edaphic conditions, which limit the renewal of soil fertility; and climates, where seasonal drought or coolness of temperature slows the rate of forest regeneration.

In the New Guinea Highlands, where two of these limiting factors certainly apply—cool temperatures universally and seasonal droughts locally—there are additional considerations. They concern the soil requirements of the cultivated plants. These are best known for taro, thanks to the work of Clarke (1973), who shows that it yields poorly on second planting and is today preferentially grown as a first crop in ground newly cleared of bush or in spots of high natural fertility. These circumstances in combination may account for certain features of Highlands botanical and archaeological evidence without the need to appeal too greatly to the unassessable factor of population growth.

When the post-Pleistocene vegetation record for the upper Wahgi begins at around 5000 years ago, the proportion of non-forest to forest vegetation in the pollen diagrams suggests that the clearance of bush for agriculture was already significant (Powell 1970; Powell et al. 1975:Ch.6). Forest values continue to decline and in all diagrams from the two study sites reach a low point, after which they rise sharply and significantly at the Manton site (c.1600 m), minimally at Draepi-Minjigina (c.1900 m), before levelling off. This low point is not precisely dated and could indeed vary between the valley bottom site of Manton's and Draepi-Minjigina at the base of Mt Hagen. However, a central date of about 4000 years ago seems not unreasonable on the evidence.

At Kuk the grey clay fan which is interpreted as representing the clearance of bush for agriculture in the catchment ceased to form around 6000 years ago, when the digging of large channels across the swamp radically altered the character of sediment deposition in it. These channels represent the first management of the swamp itself for
agriculture and they are of surprising size, all of them well over a kilometre long and some of them in excess of 2 m deep and wide. Their function was not only to channel and dispose of the incident water coming from the southern catchment but also to service field systems in the swamp. These systems consist of a close network of small basins linked by gutters, the arrangement being such as to suggest that the purpose was to retain water in the basins but dispose of its excess. They seem suited to the cultivation of taro and may represent the specialised use of an environment both favourable to this plant and at this stage not too difficult to manage. The systems are extensive over the 140 ha under investigation but it is clear that they were not all in use at the same time. However, the entire episode that they represent does not appear to have lasted very long. Though conditions in the swamp were much less difficult for management than they subsequently became, the maintenance of the large disposal drains once dug may have proved too labour demanding a task at a time when extrapolated values for forest compared to non-forest types in the pollen diagrams would suggest a favourable balance of available land to population.

A next phase of swamp management begins at Kuk around 4000 years ago. Man’s previous interference seems to have increased the swampiness of the area and the new systems, large disposal channels and open dendritic networks of tributaries, were designed for drainage. As in the previous system, the disposal channels traversed the whole swamp. Each unit of dendritic drainage served by them presumably represented an area of contemporary cultivation. How many of these units were in use at the same time would be a mammoth task to discover. It is obvious, however, from the chronology of the disposal drains that different areas of the swamp were in use at different times and from the chronology of the dendritic units that the same areas of the swamp underwent periodic use, involving rehabilitation of the major channels on which their drainage was dependent. Restudy in the light of the Kuk evidence of unpublished data from the Manton site 8 km away (Golson et al. 1967) suggests that the earliest swamp management there belongs to this period.

The pollen evidence supplies the context for these extensive undertakings. Their beginnings are roughly contemporary with the low point of forest values in the pollen diagrams and they span the period during which those values recover and/or stabilise. It could be argued that the long-term effects of shifting cultivation using crops, one at least with exacting soil requirements, close to their limits of cultivation, in conditions of slow natural regeneration and possibly accompanied by population growth, however slight, had so reduced the forest in the cultivable zone that the agricultural system was undergoing stress. The pollen diagrams at Manton’s suggest degraded forest and locally cleared areas within it at this period, with no wide expanses of grassland; those at Draepi-Minjigina a mixture of forest, regrowth shrubs and grassland vegetation (Powell et al. 1975:43). At Kuk, at one point in the phase of swamp drainage we are discussing, a fan deposit of grey clay similar to if less extensive than the grey clay of 9000–6000 BP suggests extensive removal of the plant cover in the catchment and is consistent with the proposition of severe pressures on the environment. These conditions would explain the need to reclaim land by drainage at Kuk, Manton’s and presumably elsewhere in the upper Wahgi. The sharp rise in forest values in the Manton pollen diagrams would be a measure of the success of this policy.

By perhaps two and a half thousand years ago, however—the event has not yet been precisely dated—this phase of swamp management had come to an end at Kuk. Its demise coincides with what is perhaps the most marked change in the Kuk stratigraphy, the end of sediment deposition in the form of clay and the appearance of sediments in the form of soil. This could reflect the appearance of a major innovation
in agricultural technology in the dry land cultivations of the Kuk catchment, the replacement of simple dibbling with no soil preparation by soil preparation through tillage.

According to the argument developed here, some such agricultural innovation as tillage would be required to account for the failure of the environmental crisis to arrive in areas with no great reserves of reclaimable land. Thus in one such area, the Lai valley near Wabag in Enga Province, the pollen at Lake Birip at 1900 m altitude shows a dramatic increase in forest values at the suggestive date of 2000–2500 BP, though at the time the investigator interpreted the evidence in terms of a local succession in the Birip crater (Flenley 1967: Ch. 7). The practice of tillage could also provide an acceptable explanation for the tanged slate blades found at a few Highlands localities and present in numbers at the Highlands fringe site of Wanlek where they belong to levels dated centrally at 3000 years ago and are interpreted as earth-working tools (S. Bulmer 1975:40–1 and Ch. 8 of this book; see also Golson 1976a).

Presumably tillage would have supported a wide range of crops, but it is more difficult to say whether the drained gardens at Kuk which preceded it were for mixed or specialised cropping. The next phase of swamp management at Kuk, however, is without doubt one of specialised planting. After an abandonment of as yet unknown but possibly short duration, the swamp was again drained for cultivation but to a new pattern, a grid of gutter-like field drains associated with an extensive articulating pattern of major disposal channels. These features represent an intensification of drainage effort to cope with the effects of deteriorated natural drainage and suggest that the plant at home in these conditions would have been taro. The systematic pattern of the field drains implies equally systematic agricultural organisation and is very similar to the situation described by Yen (1971) for the western Polynesian island of Uvea, where permanent swamp cultivation of taro in raised rectangular plots in checker-board style is combined with shifting cultivation of yams, bananas, taro and Alocasia on hillsides and plateaus.

As in previous phases of swamp management, cultivation shifted over the area served by the disposal drains and these were periodically renewed throughout the period of use. When the system ended about 1200 years ago, it was still in full working order; washed-in and in situ deposits of air-fall volcanic ash from an as yet unlocalised eruption of this date lie as c. 10 cm thick lenses low in the fill of major disposal channels and at the base of the field drains of the last cultivations. The case now briefly made and argued in detail elsewhere (Golson 1976c) is that swamp cultivation ended around 1200 years ago because the sweet potato entered New Guinea Highlands agriculture at this time, not within the last 400 years as generally believed.

The transformation of highlands agriculture

The sweet potato, a plant of ultimately tropical American ancestry, is a late arrival in New Guinea by many lines of evidence. There are sound reasons why it is likely to have recommended itself immediately to Highlands agriculturalists in the limiting conditions of existing agriculture that have been described. Its propagation is similar to, indeed somewhat easier than, that of the existing root crops. In comparison with these, its yields are higher and maturation swifter at the altitude of the great Highlands basins, it will grow productively at higher elevations and it is more tolerant of poor soils (Clarke 1973). As some scholars have argued (Brookfield with Hart 1971:124; Waddell 1972:219; Yen 1971:7, 1973:80), the effects of these properties, once the plant

3 See Golson 1976c.
was incorporated into Highlands systems of cultivation, would have been expected to be the dispersal of settlement and agriculture over poor and degraded soils, their upwards expansion beyond the limits of previous millennia towards the new ceiling at 2500–2750 m (which has now in some places been attained (Brookfield 1964)) and the abandonment of whatever labour intensive agricultural regimes had developed on the basis of the older crops. The recent arrival of the sweet potato in New Guinea, which the orthodox theory proposes, requires, however, that despite the sensitivity of its tubers to water, the plant was immediately incorporated into a renewed phase of swamp agriculture at Kuk which began around 300–400 years ago.

There seems little reason to doubt that these recent systems had the sweet potato as their major crop. Drainage is more intensive than anything that had gone before, as would be required were sweet potato included in the plantings: the disposal drains are more numerous, though not necessarily larger, and the grid of field drains is more finely meshed. The field drains themselves are different in size and shape from those of the previous phase: flat bottomed and relatively wide for their depth, they are similar to the grid-iron ditches of modern dry land sweet potato agriculture in the upper Wahgi. Moreover, for the first time in its history, there are house sites scattered across the Kuk swamp, indicating that the swamp gardens were the focus of agricultural labour. Charred sweet potato has been found during excavations at two of these houses, though they are late structures in the habitation sequence.

The pollen record indicates what was happening in the vegetation of the upper Wahgi during the period after 1200 years ago when the penultimate phase of swamp cultivation ceased at Kuk. The picture it gives agrees well with the proposition that this abandonment is connected with the appearance of the sweet potato in Highlands agriculture. The significant evidence is contained in two diagrams from the Draepi-Minjigina site (Powell et al. 1975: Figs 7 and 11), at 1885 m close to the long-established frontier of pre-sweet potato agriculture. After some thousands of years of stability in forest to non-forest values, presumably reflecting the early attainment of this frontier, forest values begin to decline, consistent with the capacity of the sweet potato to advance the frontier upwards. The decline begins around 1200 years ago by the evidence of a radio-carbon date for one diagram (Fig. 7) and the presence at the critical level in both sequences of the same volcanic ash which is found at that date in the Kuk swamp.

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Two pollen sites west of Wabag, Lake Inim and Kayamanda Swamp, are important because, at 2550 m and 2500 m altitude respectively, they are well above the agricultural ceiling of pre-sweet potato agriculture. Flenley (1972) has published diagrams from the two sites in a discussion of late Pleistocene climates and vegetation
change in New Guinea. Comments on more recent millennia in the diagrams are to be found elsewhere. At Inim Flenley (1967:302–5) sees the first indications of forest disturbance due to clearance at an inferred date of only 1600 BP, considered to be a maximum age because of the lesser consolidation of the detritus of the pollen core above this level than below. There is an increase of *Trema* pollen at this stage, but not of *Casuarina*. The indications of disturbance are not really sustained and may well relate to activities some distance away from and below the pollen collection site (Flenley pers. comm., 1976). Evidence for marked and sustained clearance in the region of the site does not appear until the top metre of the pollen core and is associated with substantial increases in *Casuarina* and *Trema* values. Flenley (1967:305–6) infers a date of 260 years for the beginning of this development.

The Kayamanda diagram is more difficult to interpret, partly because the top metre is not present, partly because, according to its investigator (Walker 1970:219), it is, of the upper Wahgi and Enga sites under discussion, the one most likely to incorporate pollen blown up from lower levels. Walker (1970:219–20) sees the forest opening up from about 4500 BP to 2000 BP but considers human activity as only one of a number of alternative explanations.

At Kuk itself the drainage phase that ends 1200 years ago is followed by considerable erosion on the steep thin soiled slopes of the high ridge that forms the northern margin of the swamp. It is not possible yet to quantify its degree but it is associated with movement of scree as well as of clay and represents a great increase over the previous rates. Perhaps originally the steep slopes were not extensively worked for agriculture and on the arrival of the sweet potato with its tolerance of poorer soils the bush was systematically cleared for the first time, leading to the slope instability reflected in the stratigraphy.

The situation at Kuk allows us to frame a hypothesis that it was the cultivation of the sweet potato, with its tolerance of naturally poor and agriculturally degraded soils, that was responsible for the widespread clearances that have created the open grassland landscape of the Highlands today. In addition, as the sweet potato took agricultural operations to higher levels, the capacity of cleared forest to regenerate would be progressively reduced. Unfortunately there is little evidence against which to test these propositions. The pollen diagrams which theoretically should monitor the growing dominance of grassland are equivocal because they cannot separate the contribution of the grasses growing in swampy basins in the immediate vicinity of the pollen cores from that of the regional grasslands. Once established, however, grassland is likely to be maintained by the use of fire in hunting the animals for which man has created a habitat there (R. Bulmer 1968:312, 314).

Ecological considerations of the type suggested here, however, might in part account for the fact that some 800 years after the postulated introduction of the sweet potato a new phase of drainage and cultivation began at Kuk; the characteristics of this phase have been described. Aerial photographs show that this swamp drainage for sweet potato cultivation was widespread in the upper Wahgi. The intensive nature of the drainage and its extent argue a real need to undertake it. Doubtless the growth of population towards the modern level was a contributory factor, as well as the restricted access of valley bottom communities to the newly opening frontier lands at higher altitudes.

Yet the new systems were of relatively short duration. By the time Europeans entered the Wahgi valley in the 1930s they had totally disappeared and, according to the researches of Ian Hughes (pers. comm.), only the rump of a once extensive regime is remembered by a handful of old Hagen tribesmen today. The progressive abandon-
ment of areas of drained swamp was a feature of this regime at Kuk from shortly after its inception. The intensive drainage network required for sweet potato cultivation must have required constant attention to keep it operative and been highly susceptible to events affecting the somewhat remote outfalls of the system. Difficulties of this sort, however, will hardly explain why swamplands which within recent centuries were the focus of drainage schemes as elaborate as those still operating in the Baliem valley of Irian Jaya should have become so unimportant in the strategy of upper Wahgi land use that they were almost totally alienated to the Australian administration during the decade or so following the end of World War II.

I can only suggest that answers were found outside the swamps to whatever problems had dictated their reclamation. The experience of Highlands communities without access to reclaimable land of this sort suggests what those answers were. All such communities have developed a variety of locally adapted techniques for the cultivation of the sweet potato staple designed to allow frequent reuse of the same ground in a predominantly grassland environment that demands tillage to eradicate grass roots and aerate the soil if cultivation is to be productive (e.g. Brookfield with Hart 1971:96–115). These agricultural practices and the grassland environment in which they operate are what give specific character to the modern Highlands landscape and support its equally characteristic high densities of people and of pigs. They include complete tillage to pulverise the soil and conserve moisture in drier regions, like the Eastern Highlands Province, with planting in small mounds or in ridged beds formed between groove drains; control of fallow by conservation and planting of trees and of erosion by the use of logs, fences or walls; and large moundings with mulching as in Enga agriculture, whereby not only is the soil enriched but temperatures are raised both on top of and inside the mounds, so facilitating cultivation at high altitudes. The equivalent techniques employed in Wahgi and lower Chimbu agriculture give rise to the checker-board garden pattern so distinctive of those areas. Flat bottomed ditches, ranging around 25 cm wide and deep, control the water table; the spoil from their digging, spread over the surface of the intervening plots to serve as tilth, serves to raise the tubers further above the water table and to supply—and, when the ditches are redug, to renew—nutrients from the subsoil.

It is possible that the practices of modern Wahgi agriculture were learned in the course of sweet potato cultivation in the swamps. Here closely gridded ditches were essential for water table control and raised garden beds an inevitable result of the disposal of the spoil. The re-fertilising potentialities of the system may well have been appreciated through the constant requirement to keep the ditches clear, thereby continually renewing the garden soil.

HIGHLANDS AGRICULTURE IN TRANSITION

This generalising review of agricultural man and environment in the New Guinea Highlands is based on a few vegetation studies in one region and one archaeological site where a long and complex series of developments can be used to tie various strands of past evidence together and link them with the contemporary situation. The local story cannot be extrapolated in detail to other Highlands areas. Thus the conclusion regarding the upper Wahgi populations, that they had made satisfactory adjustments at the time of European discovery to problems raised by many millennia of agricultural activity—the maintenance of substantial populations in a radically altered environment—is not applicable to areas like Chimbu and central Enga, which were almost certainly under stress in the traditional situation.

The forty years of non-traditional history that the Highlands have experienced since
Europeans first walked through them have not been discussed here, but they have seen a larger number of fundamental changes in a shorter period than any previous epoch of Highlands history. Medical care has allowed a significant increase in population; the end of warfare has channelled male activities into more frequent and more competitive exchanges; the steel axe and the bush knife have immeasurably facilitated the clearance of land to support the extra production required. At the same time cash crops have been added to or compete with subsistence planting and labour is recruited to work elsewhere, while alienations have removed to other than subsistence purposes so-called waste lands which the archaeological record for the upper Wahgi shows provided essential support for prehistoric populations on past occasions of stress and dislocation. All these developments have increased the demands made of Highlands agricultural systems, while the limiting factors of crops, techniques and environment remain. These systems are now supporting populations as consistently high as in any area of tropical shifting agriculture anywhere in the world and the techniques used are remarkably similar to those adopted elsewhere in the tropics where soil fertility and yield must be maintained in environments degraded to grassland (Denevan and Turner 1974). In these circumstances the capacity of Highlands systems to adjust to the new requirements may be limited without radical departures in the broader field of socio-economic organisation.

Addendum

The essay on the history of the sweet potato in the Highlands, cited as Golson 1976c in the foregoing, has proved unwratable, because the argument it was to develop for the arrival of the sweet potato in New Guinea by 1200 years ago, rather than by 400 years ago as generally accepted, cannot be sustained on available evidence. The penultimate section of the present article, for which Golson 1976c was designed as the definitive reference, must therefore be modified in the light of the following considerations.

It is impossible to say, no matter what type of pollen sum is used as the basis of calculation, whether the decline in forest values in the pollen diagrams from 1200 years ago is real or relative. The real change may be the concomitant rise in importance of trees like Casuarina and Trema, which, as noted, are today planted or conserved in garden fallow, with the effect of controlling and accelerating the processes of natural regeneration, and indeed of supplying them where long used land reverts to grass fallow. It is possible that the practice began simply as a device to provide for supplies of timber where deforestation was well advanced, but that recognition of its agronomic benefits led to its incorporation in the agricultural system. Its adoption in the agricultural context might have accounted for two aspects of the Kuk evidence that were used above in support of the new sweet potato hypothesis: the abandonment of cultivation of the swamp by 1200 years ago and, shortly after, the increased rate of sediment deposition at the northern margins of the swamp, interpreted as the product of erosion following intensified agricultural use of the steep, thin-soiled northern slopes.

These are plausible arguments, but to accept in consequence the orthodox argument that dates the arrival of the sweet potato in New Guinea subsequent to its European introduction into Southeast Asia raises other problems. In particular it fails to explain why a plant with manifest advantages in maturation, yield and tolerances should have been introduced into swamp cultivation at Kuk at a date, 300–350 years ago, so close to the maximum possible for its arrival by the route proposed, especially since special efforts were necessary to render the swamp fit for it. It is true that the
earliest most direct evidence for sweet potato cultivation in the swamp—charred pieces of sweet potato—and the house sites there with which the tuber fragments are associated do not date earlier than 250 years ago. It is also the case that drainage is more intensive after this date than before and that the lower, wetter part of the swamp falls out of cultivation at this time. It could be argued that these are indications of the sweet potato entering the swamp systems. On the other hand the typology of the drainage system is the same before 250 years ago as after and the intensification of drainage works and shrinkage of the area drained after that date might be explained by the degree which the progressive deterioration of conditions within the swamp had attained.

These are important questions to which subsequent fieldwork at Kuk will be addressed. On the answers to them depends any realistic assessment of the role of the sweet potato in the making of the Highlands.

References


The Melanesian environment


Lake Sediments and Human Activities in Prehistoric Papua New Guinea

FRANK OLDIELD

The lake and its total drainage basin can form a powerful unit of study in attempts to reconstruct the changing role of man in terrestrial ecosystems. Chemical and magnetic properties can be used along with the more familiar techniques of pollen analysis to measure the kinds and rates of change brought about by human activities. A range of stratigraphic, biological, chemical and geophysical data has been obtained from the near surface sediments in three lakes in the Highlands of Papua New Guinea. Chronological information from C14 dates and a 210Pb profile show that the sediments studied span, with one possible interruption over 2000 years ago, much of the last five millennia. At least four volcanic ash layers can be detected visually, chemically and magnetically and used to correlate all the cores from each lake. The results partially reflect changes in the output of minerals from the terrestrial ecosystems studied and they suggest that a fuller and more systematic application of the techniques employed could give more insight into the recent ecological history and possible long-term impact of subsistence activities in the area.

At present, I can report briefly on what is just a feasibility study designed to test the extent to which the application of a combination of biological, chemical and geophysical techniques to lake sediments might add to our understanding of recent ecological history in the Highlands of Papua New Guinea. Previous workers have concentrated on pollen and plant macrofossil analysis and on archaeological excavation. This account places greater emphasis on analysis of the chemical content and magnetic properties of lake sediments; in addition, the possibility has also been explored of dating more accurately the most recent lake deposits and the events they record.

Any changes in the nature and degree of human activity within an ecosystem inevitably affect all three basic interacting components—information, energy and materials. The direct concern of pollen analysis is to reconstruct changing biotic patterns that reflect variations in the information component; inferences from pollen analytical evidence about changing nutrient status or productivity are secondary and inevitably more speculative. Archaeology too is most often concerned with material remains usually more significant for their information implications than for the nature of the material preserved; for within an ecosystem that comprehends and reflects human activity, the information component includes the cultural and technological information supplied and used by man as well as the population gene pools of all the organisms present.

Neither pollen analysis nor archaeology can offer much direct retrospective insight into either the energy flux through the ecosystem or those processes such as mineral cycling, leaching and erosion that affect the supply and balance of essential materials. In the case of energy, more or less direct historical evidence is available only in those rare cases where the fossil remains of organisms sufficiently representative of one or
other trophic level are preserved in situations where their quantitative analysis may give some indication of former levels of productivity. In practice, such possibilities have been explored only in relation to aquatic communities, for example through the study of diatom frustules and chironomid or cladoceran remains. There seems no prospect of gaining any comparable insight into the past energy flux of terrestrial ecosystems.

Where lake sediments are available for analysis, some broader study of past vegetation and soils is possible, since the sediments preserve a partial and somewhat distorted record of mineral output from the drainage basin of the lake. Moreover, we may expect such a study to yield information about changes in man’s role, activities and impact. Two sorts of work encourage this idea. Studies of contemporary mineral cycling and of the rates and regulation of mineral loss from soils and vegetation through erosion and leaching show how clearly these processes reflect human interference. Furthermore, studies of the chemical content of lake sediments in temperate latitudes have shown how changing rates and patterns of deposition are related in part to man’s activities in the drainage basin of the lake. Thus, recent work both on contemporary watershed ecosystems and on lake sediment chemistry suggests that, under favourable circumstances, the lake and its total drainage basin may form a powerful unit of study in any attempt to reconstruct the changing role of man in terrestrial ecosystems.

There are theoretical reasons for supposing at the outset that such an approach might be at least as rewarding in humid tropical and subtropical situations as in the higher latitude temperate areas more frequently studied. In undisturbed humid tropical terrestrial ecosystems, the regulation of mineral loss by vegetation is strong and sustained, and the cycling systems for many mineral nutrients almost closed. Thus we may expect the effect of man’s activities on the mineral output from a tropical catchment to be at least detectable and perhaps at times dramatic. Moreover, whereas in information terms humid tropical terrestrial ecosystems are often much more complex than their temperate counterparts, they are not necessarily more complex in biogeochemical terms.

The particular historical and ecological problems of the New Guinea Highlands add to a study of recent palaeoecology dimensions of continuity and relevance unfamiliar to the European worker. Ecological and cultural history are much more intimately related to each other in Papua New Guinea than they are in recent western societies; thus ecological reconstruction becomes a central element in the history of the Highlands and their peoples. There is an additional, perhaps more significant, difference. In contemporary western society the inputs of energy and materials to capital intensive productive ecosystems by way of artificial fuels, fertilisers, etc. create a situation in which political and socioeconomic factors dominate, mask and at times to a degree override the more fundamental ecological realities. Under such circumstances, the contemporary and future relevance of developing any continuity of ecological insight from the past through to the present day becomes limited to special situations—nature reserves or overenriched fresh water bodies for example. By contrast, in a partly or wholly subsistence based economy, the value of historically derived insight into the long-term ecological processes associated with more or less self contained productive ecosystems is increased. It may relate not only to the past but also to the future insofar as an understanding of the long-term impact of recent trends is important in population and land use planning, especially where there is any possibility that human settlement may be limited by the eventual impact of subsistence activities on mineral balance and soil quality.
This, however, calls for a shift of attitude and approach away from the reconstruction of historical events for their own sake and towards the measurement of processes still operative and the estimation both of rates of change and of cumulative effects. This in turn focuses attention on the accurate dating of recent events, on situations where there is continuity of data accumulation and preservation from past to present, and on techniques that allow quantitative estimates of both previous and contemporary processes on a comparable basis. In all these respects, the sediments of existing lakes are uniquely favourable. Figure 7.1 summarises in a very simplified way the kind of material available for study in lake sediments, the sources of this material, some ways in which man affects its supply and the pathways taken by materials as they pass from sources within the drainage basin to the sediments of a lake. This forms a crude conceptual framework for the present chapter.

![Diagram](https://example.com/diagram.png)

Fig. 7.1  Simplified partial model of lacustrine sedimentation

Short sediment cores from three lakes form the subject of this study. Lake Ipea, near Sirunki, lies in the Enga district; Lakes Egari and Pipiak are less than 2 km apart and lie about 14 km north of Mendi in the Southern Highlands. Working out a chronology of sedimentation for the last 1800 years or so in each lake is greatly facilitated by a sequence of volcanic ash layers found in each core and dated not only as a result of the present study but by other workers at the Australian National University and Macquarie University. These ashes can be readily recognised by sight and touch in every extruded core and rapid non-destructive measurement of magnetic intensity and susceptibility allows their detection in undisturbed whole cores before extrusion. Estimates of the rate of accumulation at each site have been made using C\(^{14}\) dates and correlations from lake to lake on the basis of the ash layers. A date for the uppermost ash of 60–110 years ago has been obtained from \(^{210}\)Pb analysis of the topmost material in a core from Egari.

At Egari, a crater lake with a very small, steep, largely gardened drainage basin, the most notable feature of the evidence so far is the change between samples above and below this latest ash layer. The sediments below have a chemical composition indicating constant and minimal supply of minerals from the steep surrounding slopes;
this points to a long period of very strong biotic regulation during which mineral loss was reduced by retention in forests and soils. The magnetic susceptibility measurements indicate little or no mineral erosion and the pollen diagram has relatively few indicators of disturbance and deforestation. The rate of sediment accumulation is relatively slow. Above the top ash, all four parameters—chemical composition, magnetic susceptibility, pollen content and total accumulation rate—change in ways that can be most readily interpreted as indicating accelerated erosion and mineral input as a result of locally more intensive recent human activity.

Pipiak, a similar small crater lake close by has much less gardening in the drainage basin, which appeared almost completely forested in 1973. Although pollen and chemical data are not yet available, the magnetic susceptibility record confirms the total absence of mineral erosion from the drainage basin until very recent times and the deposition rate appears to have been roughly the same above and below the top ash once allowance is made for increased water content in the top few centimetres.

By contrast, in cores from Lake Ipea, the acceleration in sedimentation rate in recent times is even more dramatic than in those from Lake Egari and is also associated with increased mineral concentrations and higher frequencies of non-forest pollen types. There are, however variations in both mineral concentrations and magnetic susceptibility below the top ash, which are suggestive of a longer period of reduced biotic regulation. Lake Ipea lies in the middle of a large valley now mostly deforested.

From the preliminary evidence obtained so far, it seems quite likely that the present range of techniques does hold out some promise of adding to our understanding of the ecological history and long-term ecological dynamics of parts of Papua New Guinea. In particular, the provision of a more detailed chronology of recent times and the addition of chemical and magnetic evidence to the growing range of pollen and analytical and archaeological studies, open up the possibility of placing post-contact and contemporary subsistence in a continuous time perspective, which will include quantitative estimates of some of the ecological changes resulting from human activity.
8 Between the Mountain and the Plain: Prehistoric Settlement and Environment in the Kaironk Valley

SUSAN BULMER

Wanlek is a site at 1675 m altitude in the upper Kaironk valley, near Simbai in the Madang District in Papua New Guinea. It is intermediate between the mountains and the plain in the environmental sense, physically closer to the lowlands than the Central Highlands and offering its inhabitants much more direct access to lowlands resources. It is also intermediate in respect to trade and communication, having trade contacts with both the lowlands and the Highlands. Wanlek is a notable archaeological site in its evidence of an early hunting and collecting settlement, including post holes dating to between 15,000 and 12,000 years ago. More recently, between about 5500 and 3000 years ago, Wanlek was a settlement of intensive cultivators, who were possibly recultivating grassland resulting from earlier forest clearance by swidden cultivators. They brought a new stone technology to the valley, including sophisticated polished axes and woodcarving chisels, drill points, and tanged cultivating tools. Other stone tanged cultivating tools have so far been found only in the Wahgi valley, the Eastern Highlands District, and the Trobriand Islands, but these tools are similar to cultivating implements of wood, bone and turtle shell used throughout the Pacific. On the basis of their stone technology and a few distinctive trade sherds of red slipped and sand tempered pottery, it is suggested that this community at Wanlek reflects contact with early Austronesian speaking communities on the northern coast.

The interaction of man and environment in Papua New Guinea is as ancient as the earliest human occupation at least 25,000 years ago. On the other hand, humans have had their greatest impact on their environment in the relatively recent prehistoric and historic past. In a country where historical records have only begun so recently, an understanding of this process depends upon the archaeological record. In this chapter I want to look at one general aspect of man’s relationship with his environment in Papua New Guinea, the different uses of the resources of the mountains and the lowland plains. My discussion will be based on preliminary information from an archaeological site on the northern fringes of the highlands where I excavated during 1972 and 1973 (S. Bulmer 1973). The site is called Wanlek (Wa-nye-lek), and is in the valley of the Kaironk River, a tributary of the Jimi, in the Madang District. This site reflects communities intermediate, in both the ecological and cultural senses, between the mountains and the plain.

My research at Wanlek was supported by grants from the University of Papua New Guinea while I was an Honorary Research Fellow in the Department of Anthropology and Sociology. I would like to thank the many people of the upper Kaironk valley who helped me in countless ways. Particularly, I am grateful to Simon Peter Gi and Bysky, of Kaironk Village, for first noticing the site and for sending me a collection of artefacts they made while road work was proceeding there. I am also grateful to Ian Saem Manjenep and John Kiyas Kas, Prehistory Laboratory, Department of Anthropology and Sociology, University of Papua New Guinea. Without their able technical assistance in the field and laboratory this work would not have been possible. They and their families also gave generous hospitality in the field.
Wanlek is of particular interest as an archaeological site because it contains:
(a) the reflection of dwellings and other structures relating both to the late glacial period, as early as 15,000 years ago, and to more recent post-glacial times;
(b) information about the stone technology of the period between about 5500 and 3000 years ago, which suggests the presence of agriculture during this period;
(c) trade goods from lowland communities, also relating to this period, which, together with the stone technology suggest the presence of Austronesian speaking communities in the lowlands.

Fortunately there has been a great deal of scientific study done in the Kaironk valley and its vicinity (R. Bulmer 1974), which makes it possible to understand local human ecology in some detail. The archaeological record then can provide a perspective of time and change.

**THE KAIRONK VALLEY AND ITS ECOLOGY**

Wanlek is in the centre of the small valley of the Kaironk River, over the mountain crest from the Simbai, Asai and Aunjang valleys and the Ramu fall. In spite of its small size, only about 15 km from Wanlek to the head of the valley, it is part of one of three corridors of continuous grassland and cultivation between the northern lowlands and the Highlands. The Ramu-Markham system to the east, and the Jimi-Yuat system to the west, are similar bands of particularly intensive past and present human occupation.

The upper Kaironk valley and the adjacent upper Aunjang valley at present support a population of about 1500 people, speakers of the Kalam language. On the basis of local oral history this population density is probably very recent (Riebe 1974), based on a small local population and a few immigrant families; before this century there may have been only a hundred or so people living in this area. The oral histories, in fact, make it possible to reconstruct a record of a 'proto-historic' period in the past few centuries, for which there is practically no archaeological evidence. Local histories in general only refer to the most recent four or five generations of ancestors, although some traditions refer to people and events up to nine generations earlier (Riebe 1974:548). Some families have traditions of always having lived in the valley, but others recall ancestors who lived on the northern fringes of the Schrader range, where the mountains meet the plains. Some families originated in the upper Simbai and Asai valley within the past few generations.

The present people of the upper valley live in dispersed homesteads, cultivating the sweet potato as their main staple crop, with taro as the crop of greatest ritual significance (R. Bulmer 1960). Even without the record of oral history, the present population densities of the upper valley can be expected to be relatively recent, because they are based on the intensive cultivation of the sweet potato, a crop thought to have been brought to Papua New Guinea during the historic period, that is, probably within the past 400 years. Although the Kalam possessed this crop before the recent build-up of population in the upper valley, they now depend upon it very heavily and cultivate gardens well above altitudes where other staple crops grow well.

Oral history indicates that the present Kalam ecological condition is not only relatively recent but is changing. The local histories include matter of fact accounts of the progressive clearance of the forest of the upper valley and the changing ecology resulting from this. Within the proto-historic period the valley was forested down to about 1700 m on the northern side and in grassland on the southern slopes (Bulmer and Tyler 1968:387). Within the past few generations the forest has been cut back to about 2400 m and the Kalam have intensified their use of the land with the use of
casuarina fallow. The grasslands are only sparsely gardened, mainly for sweet potato, offering much poorer soils. The grasslands are probably the result of earlier forest clearance for hunting and/or cultivations, not being the natural vegetation of the valley.

The local hunting and collecting domain has been greatly reduced through the forest clearance and intensive cultivation in the upper valley, although Kalam still make fairly intensive use of wild flora and fauna for food and technological purposes. Particularly, nuts and fruits from forest and semi-cultivated trees at both higher and lower altitudes are still collected. Hunting in the valley has greatly reduced with a smaller forested area and increasing numbers of hunters, although there has been some recovery in wild game in the past decade while many young men have gone to work on plantations in the lowlands. Pig keeping is, on the evidence of oral history, quite recent; the pig has replaced wild game in local ritual presentations only within the past century.

Aside from the products of the forests and garden land in the upper valley, the Kaironk valley contains other natural resources important to prehistoric communities. Among these are the salty mineral springs used to make salt through evaporation on stone and clay ovens. Salt was consumed locally and used as an important trade item. The valley also contains several sources of chert, used in prehistoric and proto-historic times for implements. Other kinds of rock, presumably local in origin, were used by the occupants of Wanlek for implements, including axe-adzes, chisels, and tanged cultivating tools, but the sources of these rocks have not yet been located. The proto-historic Kalam did not make their own axe-adzes, but obtained them from the Jimi valley via Simbai, from which they were also traded to the Ayome of the lowlands. The upper Kaironk also contains a variety of rock and clay used for pigments, at least some of which were used in earlier prehistoric times.

The position of the Wanlek site is not only central to these resources, next to the salt springs at Womk and on the edge of the forest of pre-sweet potato times, and near several rock and pigment sources. It is a natural settlement site, on a headland overlooking the main ford in the river and the road leading over the mountains to the west to the Sal and Jimi valleys. It is also not far from the traditional path down the north side of the valley and over the crest to the north to the trading 'stations' with the lowland Rao.

THE KALAM DOMAIN

The upper Kaironk valley has to be seen in its wider context, because its inhabitants have probably always been dependent also upon resources from outside the valley. Speakers of the Kalam language at present occupy a territory of about 40 km along and up to perhaps 15–20 km wide, stretching from the edge of the Ramu plains at about 300 m altitude, over the mountain crests of up to 2750 m, and down to the banks of the Jimi River at about 600 m. This domain contrasts with the territories of many Highlands groups in that it contains a full range of mountain ecological zones (Brookfield and Hart 1971), from the lower mountain tropical forest (up to about 1000 m), through the mid-mountain subtropical forest (between about 1000 and 2000 m), into the upper mountain temperate forest (above about 2000 m). It also contrasts markedly with zones occupied by lowland groups of the middle Ramu River valley, who live on the river plains and swamps, and only one of whom, the Rao, live at all in the foothills of the ranges (Kasprus 1973).

Although they occupy such a wide range of ecological zones, the Kalam live in and use most intensively the upper half of the mid-mountain forest zone. The highest any
of them actually dwell is at about 2400 m in the upper Aunjang valley, but the great majority live between about 1500 and 2250 m (R. Bulmer, pers. comm. 1975). This contrasts with the distribution of their neighbours to the southeast, the Maring, who occupy mainly the altitudes between about 1000 and 1600 m (Rappaport 1967; Clarke 1971; Buchbinder 1973), as well as with the Kopon of the lower Kaironk valley, who occupy primarily altitudes between about 600 and 1500 m, although their total territory, like that of the Kalam, stretches from about 500 to about 2400 m (G. Jackson, pers. comm. 1975).

The lowland boundary of the Kalam domain is a marked ecological and linguistic boundary. The Kalam cultivate down to the edge of the Ramu plains, which are occupied by linguistically unrelated groups, the Ayome and Wamen, with whom they fought and traded. On the other hand, two of the mountain neighbours of the Kalam are closely related language groups, the Kopon and Gainj. These three languages have been grouped into the smallest family of the huge East New Guinea Highlands Stock. Other adjacent languages in the lower Simbai and Jimi valleys are all members of other Highlands language families, distantly related to the Kalam Family (Wurm 1971). Estimates of the time scale involved in the divergence within the Highlands Stock are of up to 5000 years (summarised in S. and R. Bulmer 1964:41). This suggests there have possibly been some thousands of years involved in the separation of the Kalam languages from other Highlands languages. The marked lowland boundary between Highlands and other languages and the general positioning of the Kalam Family between the other Highlands groups and the lowlands languages suggest that the language ancestral to Kalam was probably spoken by people living somewhere in the Bismarck–Schrader ranges, although not necessarily in their present location. It is possible, then, that the prehistoric residents of Wanlek were speakers of a language ancestral to one of the Kalam family, although, of course, it is likely to be difficult to demonstrate this through archaeological evidence.

Excavations at Wanlek

The archaeological site was first noticed by local residents who were making repairs to the government road that cuts through the site. Local Government Councillor Simon Peter Gi and Bysky, a community leader, both of Kaironk village, collected artefacts and drew them to my attention, leading to my work there. This is a very good example of the way sites are discovered in the course of their disturbance, as well as the way local interest can lead to very important archaeological discoveries.

The evidence so far suggests that at least one part of the site was cleared, down to bare subsoil, as a house site about 15,000 years ago. Houses and other structures have been built on various parts of the sites periodically since then, and most recently at least part of the site was cultivated. There is no disturbance of the earliest deposits or other indications of tree roots, so it appears that the forest never grew again on the immediate site. The patterns of post holes have not yet been studied in detail, but most are from pointed poles 5–10 cm in diameter set directly into the subsoil without separate post holes or packing. Some alignments show curved sided buildings; one small one in the deepest deposits would have been similar to traditional Kalam hunting shelters, and other later ones are larger like traditional Kalam houses. In the earliest soil there is also a small number of very large post holes for which there are no Kalam parallels; one of these is dated by its charcoal contents to about 15,000 years ago.

An area of burnt pink soil over 4 m in diameter has been interpreted as a fireplace similar to those used in the large initiation houses of the Kopon. Other fireplaces in
the excavations at Wanlek include oval shallow pits, fireplaces encircled with stones, and large areas of charcoal with broken oven stones similar to contemporary Kalam fires for heating cooking stones. Oven pits so far found are deep oval steep sided pits similar to traditional Kalam domestic ovens.

The stratigraphic sequence and radiocarbon dates (listed in Table 8.1) suggest at least five phases of occupation at Wanlek. This is, it must be emphasised, a very preliminary summary of the evidence, and will be revised when the detailed study of the excavations is completed.

**TABLE 8.1**

*Radiocarbon Dates from Wanlek Excavations*

<table>
<thead>
<tr>
<th>Years before 1950</th>
<th>Age Range</th>
<th>Laboratory Number</th>
<th>Excavation Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2840 ± 90</td>
<td>3020–2660</td>
<td>I–6861</td>
<td>Trench 1, fire area in Layer 4</td>
</tr>
<tr>
<td>2865 ± 90</td>
<td>3045–2685</td>
<td>I–6859</td>
<td>Trench 1, deepest fill of east pit</td>
</tr>
<tr>
<td>3170 ± 210</td>
<td>3590–2750</td>
<td>GX–3332</td>
<td>Sq. 17–18B(II), fill of pit in top of Layer 7</td>
</tr>
<tr>
<td>3225 ± 180</td>
<td>3585–2865</td>
<td>GX–3330</td>
<td>Sq. 16B, fill of fireplace in top of Layer 6</td>
</tr>
<tr>
<td>3280 ± 230</td>
<td>3690–2770</td>
<td>GX–3227B</td>
<td>Sq. 17–18B(1), Layer 5</td>
</tr>
<tr>
<td>3480 ± 175</td>
<td>3780–3080</td>
<td>GX–3326</td>
<td>Sq. 17–18B(1), fireplace in top of Layer 7</td>
</tr>
<tr>
<td>3840 ± 175</td>
<td>4190–3490</td>
<td>GX–3333B</td>
<td>Sq. 11B, Layer 9</td>
</tr>
<tr>
<td>5455 ± 105</td>
<td>5865–5245</td>
<td>I–6860</td>
<td>Sq. 10A, Layer 10</td>
</tr>
<tr>
<td>11995 ± 425</td>
<td>12805–11105</td>
<td>GX–3328</td>
<td>Sq. 17–18B(1), Layer 9</td>
</tr>
<tr>
<td>14100 ± 400</td>
<td>14900–13800</td>
<td>GX–3329</td>
<td>Sq. 1Z, Layer 13</td>
</tr>
<tr>
<td>15100 ± 450</td>
<td>16000–14200</td>
<td>GX–3331</td>
<td>Sq. 101Y, fill of post hole in Layer 9</td>
</tr>
</tbody>
</table>

*Note:* I quote these dates in round figures in the text, and give here the age range of two standard deviations. All dates are from large lumps of wood charcoal.

1. A number of structures, including a small curved sided pole house and a few very large post holes, dated to between about 15,000 and 12,000 years ago. Aside from the dated post hole, scattered charcoal, derived from fireplaces, from two opposite ends of the excavations in the deepest layer, is dated to 14,000 and 12,000 years ago respectively.

2. Pole structures, fireplaces, and ovens and associated stone artefacts indicate that the site was settled between about 5500 and 3000 years ago. Eight radiocarbon dates come from three fireplaces, two oven pits, and scattered charcoal from three different squares. This indicates the same general habitation during this period over most of the site, reflected in a layer stratigraphically more recent than 1.

3. A truncated garden soil on the top of the above layers indicates the site was later cultivated, that is since 3000 years ago.

4. A consolidated surface on the top of the garden soil suggests a period, following its cultivation, when the site was unoccupied.

5. The present topsoil is another eroded garden soil of two generations ago. It is probably related to the first cultivation of the site by its present owners.
Artefacts from Wanlek

A few undistinguished stone flakes are present in the layer relating to the earliest occupation of Wanlek, between about 15,000 and 12,000 years ago. However, it is possibly safe to guess that the residents used a stone artefact assemblage similar to that used in the same period at Yuku, near Baiyer River (S. Bulmer 1976) and at Kosipe, in the mountains of Central Papua (White et al. 1970). These two assemblages, found at sites some 350 km apart, are markedly similar. They include ‘waisted blades’ (axe-adze like tools with side reductions), large ‘backed’ flake knives or scrapers, and a variety of other large stone tools with convex or pointed working edges, both unifacially and bifacially flaked. Yuku contained also a range of smaller stone implements, probably for working fibre and wood artefacts.

Nearly all of the stone artefacts from Wanlek come from the deposits relating to the occupation between about 5500 and 3000 years ago. They include the remains of the manufacture at this site of polished axe-adzes and wood carving chisels, flake scrapers, drill points and tanged cultivating tools. These artefacts comprise assemblages that should be interpreted as coming from a general habitation site; they reflect a range of activities typical of an agricultural settlement, although not similar to proto-historic Highlands stone technology.

Axe-adzes. One axe making floor has so far been excavated in association with post holes and an oven pit dated to about 3000 years ago. This evidence suggests the stone worker was probably sitting outside his house or on his porch to make his axe-adzes. A number of roughouts were left around the ground, and some waste flakes were swept into the disused oven pit, but the general impression is one of the axe maker having left in the middle of his work. Other axe making floors are present in the site, for at least one was disturbed in the road making leading to the recognition of the site. The finds include a range of manufacturing equipment and waste—roughouts broken in manufacture, uncompleted roughouts, waste flakes, finished polished tools, and chert hammer stones used for percussion flaking. These axe-adzes were made by bifacial primary flaking and delicate bifacial retouch, creating a lenticular sectioned symmetrically bevelled tool. At least some of these axe-adzes were made on a large blade flake, and blade flaking is also apparent among the waste flakes and on smaller chert tools and cores.

The Wanlek axe-adzes are made by different stone working techniques and in a different style from the proto-historic planilaterial axe-adzes imported from the Jimi valley. They also contrast with the axe-adzes made from unquarried river pebbles in the eastern mountains of the Highlands (for instance, those described by Blackwood 1950:15–27), which were shaped by hammering and finished by grinding rather than retouch. The Wanlek axe-adzes are, on the other hand, similar in both technique and style to those made on Woodlark Island (Malinowski 1934), and to one variety of axe-adze made on many Pacific Islands. On these grounds, and on the general sophistication of the stone working at Wanlek, I am inclined to interpret these finds as reflecting the introduction to the mountains of a new stone technology, probably imported to Papua New Guinea. This can be taken together with the presence at Wanlek of drill points, of little wood carving chisels made in the same style as the axe-adzes, and the tanged digging tools, none of which are known from earlier assemblages in the mountains, but all of which are known from lowland contexts.

Tanged cultivating tools. These are perhaps the most remarkable finds at Wanlek. Only a few similar artefacts have so far been found elsewhere in Papua New Guinea. These include two from the upper Wahgi valley (Allen 1970, 1972:187, Fig. 3; O. Christensen 1975) and a few from the Eastern Highlands (S. Bulmer 1973) and the Trobriand
Islands (R. Bulmer, pers. comm.; Queensland Museum 1973). The small numbers of finds are, at this stage in research, just as likely to reflect our ignorance as the real rarity of this kind of artefact. On the other hand, tanged tools may normally have been made of wood in the Highlands, rather than of stone. The slate used in the Wanlek tanged tools was obviously used because it broke into thin flat slabs that could be easily shaped around the edges, not because of its hardness or toughness. It may be that in areas of the country lacking in slate, tanged tools were made of wood. In other Pacific countries, similar cultivating tools were normally made of wood, shell, or turtle shell, rather than stone (Barrau 1958).

The tanged tools from Wanlek and elsewhere can be interpreted as cultivating tools on several grounds. First, taken as a group they have two shapes of cutting edge; either a very broad convex edge or a wide point. These are also characteristic of cultivating tools elsewhere in the world, in both stone and other materials (Kramer 1966; Barrau 1958). Only the convex working edge has so far been found at Wanlek, but so many of the tools are broken across the blade that the pointed variant may also have been used there. Although there are some percussion breaks on the working edges, most were broken under some sort of levering pressure, snapping either across the blade or at the base of the tang.

The Wanlek tanged tools that still are complete and the unstratified examples I have seen from other areas have heavy use smoothing along their cutting edges. This kind of wear is characteristic of tools used in digging in the ground (Semenov 1964:133), and could have been caused, for example, by tilling, ditching, or digging for roots. For this reason I would still avoid the use of the term 'hoe' for these tools, which may have served a variety of functions. One common use of stone tools in Highlands gardening is the cutting of shrub and grass roots, for which the polished axe is sometimes now used (Golson 1974:11). However, it is likely that such use would have heavily worn a tool's cutting edge, rendering it useless for wood cutting until resharpened.

The carefully retouched and smoothed tangs of the tanged tools are also distinctive, and this feature has led to the suggestion that the tools were hafted. On the other hand, the carefully smoothed tangs could have been made in aid of comfort to the user of a hand held stone implement. Two wooden tools from the Eastern Highlands District in the Goroka Museum (S. Bulmer 1973: Fig. 6) have been interpreted as wooden replicas of tanged tools plus wood haft; if this is an accurate interpretation the tanged tools may have been hafted as a spade on the end of a stick.

Stone digging tools have been recorded in the historic period in two parts of the Highlands, at Chuave (S. Bulmer 1966:50) and near Kainantu (R. Giddings, pers. comm. 1975; S. Bulmer 1973: Fig. 6). These tools have the same heavy use smoothing as do the unstratified tools. On the other hand, the Chuave tools were not tanged, although they were wide bladed implements. Both records report the tools used in gardening, the former in clearing grass and the latter as a predecessor of the steel spade. These are only brief records, but are important in light of doubts cast on the validity of stone cultivating implements (Kramer 1966).

Similar tools with similar wear have been found elsewhere in the world in many contexts and have been interpreted as hoes or digging tools. On the other hand, none of the glacial period end edged tools from Papua New Guinea has the distinctive digging wear, although a small proportion are tanged, rather than waisted. It seems likely then, in light of the presence of tanged digging tools in the lowlands and elsewhere in the Pacific, that the tanged digging tool was introduced to the mountains of Papua New Guinea. This was no doubt as a part of the same stone tool kit as the Wanlek axe-adzes and other tools.
To interpret the tanged tools from Wanlek as cultivating tools fits well with the evidence of pollen sequences from the valleys of the Highlands. Forest clearance and cultivation was widespread by at least 5000 years ago (Powell 1970), and there is now evidence of agricultural ditching that had already gone out of use by over 6000 years ago (Powell et al. 1975:42–3). It is therefore possible that there was even earlier cultivation in the upper Kaironk than is suggested by the deposits at Wanlek in which the tanged tools were found. On the other hand, if the site and its vicinity were already in grasslands, the tanged tools could have been employed to assist in their recultivation.

Pottery. A small number of potsherds of at least three different ‘wares’ can be interpreted as direct evidence of trade with lowland potting communities. One tiny red slipped sherd with a body angle would fit into the pottery style made at present by Austronesian speaking communities near Madang, 150 km to the east. This pottery was in proto-historic times traded as far as the upper Ramu plains (Hughes 1971). The second ware is a sand tempered red pottery similar to that made at present near the mouth of the Sepik River at Kaup, a village of Austronesian speakers 175 km to the northwest of the site. The third style is river clay, untempered, coiled ware, similar to that made by the Rao to the north of Kalam territory, and by a number of other communities on the north side of the Ramu River (Hughes 1971) and Madang plains.

All but one of these sherds come from the layers dated to between 5500 and 3000 years ago. One Ramu plains style sherd comes from an earlier layer. One sherd is not sufficient evidence to argue an early date for the non-Austronesian style of pottery, but I have argued, on the basis of its wide distribution along the northern coast and plains of Papua New Guinea and its similarity to early pottery from eastern Asia, that this should be the earliest pottery style in the Pacific islands (S. Bulmer 1971). As no non-Austronesian community in Papua New Guinea made red slipped pottery, and only one non-Austronesian community, the Mailu (a maritime trading community), in southern Papua, tempered their pottery, it is highly probable that these trade sherds reflect Austronesian speaking pottery communities in the northern lowlands.

**PREHISTORY IN THE UPPER KAIRONK VALLEY**

To summarise the archaeological evidence and the ecological context of the site, five phases of human occupation can be suggested for the valley:

A. Seasonal camp sites for hunting and collecting between 15,000 and 12,000 years ago, and possibly more recently. Period settlements may have been made by groups visiting the valley to collect mountain pandanus nuts and other products of the upper mountain forest, and possibly to hunt above the forest line. These people most likely lived much of the year at lower, warmer, altitudes, and could even have exploited a domain that covered the territory down to the river plains below.

B. Residential sites of swidden agriculturalists may have left little evidence in the ground, but it is possible that the valley was first cultivated between 9000 and 6000 years ago. This hypothesis is based on the presence of agriculture in the Wahgi valley before 6000 years ago at similar altitudes, not on direct evidence from the upper Kaironk. The site at Wanlek was possibly under grass or fern during this period, perhaps maintained as grassland for hunting purposes through grass fires.

C. Agricultural settlement between 5500 and 3000 years ago, perhaps on the part of groups moving into the valley to obtain salt, rock, and pigments for trade with the lowlands. There is no evidence for trade with the Highlands during this period, but the Kaironk people may have been middlemen in at least the marine shell trade, between lowlands and Highlands.

D. There is little evidence at Wanlek for occupation from about 3000 to perhaps 100
years ago. This, from a single site, cannot be taken as evidence that the valley was not inhabited. Rather, it is likely there were always at least a few families living in the valley or that it was at least used for hunting and collecting by people cultivating at lower altitudes.

E. A thin garden topsoil is the only archaeological evidence at Wanlek for the period of dramatic change in the past few generations, recorded in oral histories of the present inhabitants. During this period the upper valley was cleared and intensively cultivated with the use of the sweet potato, and the residents were middlemen in a multidimensional trade system between the Highlands and the lowlands.

Prehistoric human ecology in the Bismarck-Schrader range

Having first looked at the human ecology of the upper Kaironk valley in the recent past through the means of oral history, we now need to consider earlier general environmental changes to understand the cultural changes recorded by archaeology. This is, of course, too large a topic to cover in any detail here (see S. Bulmer 1974) but I want briefly to discuss five general points.

1. The original settlement of the mountains was by hunter-collector groups in the glacial period, extending their range of resources to include the mountain forest and/or moving into the intermontane valleys to specialise in the use of the resources of the mid and upper mountain zones.

2. The natural processes of environmental change at the end of the glaciation and in early post-glacial times were of importance in changing the size and distribution of different vegetation zones and in introducing a new major human habitat in the tropical forest. During this period men also introduced a new major environmental force, the clearing of forest for cultivation.

3. Mountain groups were probably never isolated from lowland influence, and were engaged in trade with lowlanders by at least 9000 years ago. In the absence of early lowland evidence, we can guess that early trade was largely motivated by the lowlanders' lack of suitable rock for artefacts.

4. One general trend of mountain settlement was towards a distinct break between mountain and lowlands settlement; this could have begun toward the end of the glacial period when the mountain forests shifted to higher altitudes. The mid-mountain cultivators tended to use the upper margins of the tropical forest for hunting and tree cultivation.

5. Another general trend in mountain settlement was toward movement into higher areas; this is particularly related to the introduction of new crops in the proto-historic period and to the introduction of lowland diseases into the mountains.

The mountain forests. During the colder glacial climate between about 33,000 and 9000 years ago the mountain forest zones moved to lower warmer altitudes, probably down to within a few hundred metres of sea level (G. Hope 1973). The mid-mountain forest zone would particularly have attracted hunting and collecting groups; its comfortable subtropical climate, open oak forests, varied if small sized animal life and abundant edible plants, fruits, and nuts (R. Bulmer 1964) would have encouraged its early exploitation. Early archaeological evidence from the lowlands is so far lacking, but human groups ventured far into the mountains by about 25,000 years ago. This may have been largely in pursuit of the nuts of the mountain pandanus, but they may also have sought now extinct species of large animals in the upper mountains scrubland (J. and G. Hope 1976).

Groups moving into the intermontane valleys and central ranges put considerable distance between themselves and the resources of the lowlands. Yuku, for instance, is
some 40–50 km from the lowlands. Mountain specialisation due to geographical distance may have been a prime motive in the mountain trade established before the end of the glacial period. In contrast, hunting-collecting groups on the fringes of the mountain ranges could have maintained domains with a wider range of resources. Wanlek is only about 20 km from the edge of the plains and both the upper Kaironk and the plains could have been included in a reasonably sized hunting-collecting domain.

Post-glacial adaptations. With the melting of the glaciers between about 14,000 and 9000 years ago, the distribution of ecological zones changes. Mountain forests expanded and generally moved to higher altitudes and alpine grasslands shrunk almost to the point of disappearing as the upper limit of the mountain forest moved uphill. Human groups dependent upon the alpine zones would have found their resources nearly gone, but mid-mountain groups could have gradually moved to higher altitudes, occupying new territory in the process.

Perhaps the most important change in terms of human ecology at the end of the glacial period was in the lowlands rather than the mountains. With a generally warmer, wetter post-glacial climate, the tropical rain forest expanded over the lowland plains and foothills. In terms of its resources, the tropical rain forest of Papua New Guinea is a generally favourable environment for hunter-collectors as well as cultivators (see, for example, Lea 1975). A wide range of edible and useful native plants, and native and self-introduced fruit and nut trees, together with the sago palm, provides a wealth of plant food. The bounty of the fish, shellfish, and animals of the rivers and sea, and good lowland forest game (such as the pigeon, flying fox, and possibly the self-introduced pig) offered an abundance of animal life for hunting. On the other hand, there are some factors discouraging settlement within the lowland rain forest by hunter-collectors. These include difficulty of travel through the dense tropical forest, other than on navigable rivers, lack of rock for implements, and generally less healthy conditions for humans. These factors probably encouraged early populations in the lowlands to live mainly near the rivers and coasts.

On the other hand, forest clearance and cultivation in the tropical rain forest in Papua New Guinea may have begun relatively early. Mountain groups were cultivating by over 6000 years ago, and the lowland groups may have done so even earlier, as the repertoire of food plants introduced from Indonesia and Southeast Asia is adapted to lowland forests and coasts. Many of these crops also grow well in the mountains up to about 1500 m. The establishment of gardens at even higher altitudes, such as the Wahgi valley and the upper Kaironk, may have been aided by the rather warmer, wetter climate thought to have prevailed from about 9000 to 5000 years ago (G. Hope 1973). We do not have a clear idea what the role of the local domestication of native plants played in early cultivations, but the earliest of all may have been the lowland cultivation of nut and fruit trees. On the other hand, some locally domesticated species do better at higher altitudes than the introduced crops, other than the sweet potato. As the climate cooled slightly about 5000 years ago, mountain gardeners may have come to depend more heavily on some of these local crops at higher altitudes.

Forest clearance for gardens over wide areas, and erosion and sedimentation caused by this, have complicated the relationship of man and environment in both mountains and lowlands. Once cleared of forest, large areas have been maintained as grasslands by further human interference in the form of fire. This has rendered some areas virtually unusable for gardening and has encouraged population movements and the adoption of new gardening techniques. The extent to which hunters of the glacial period cleared the forest and created grasslands for hunting is not yet known, but some of this activity is likely to date back into the glacial period.
Lowlands contacts. As far as can be told on the limited evidence available, the peoples of the mountains and the lowlands have never been isolated from each other. The earliest evidence for trade is from a mountain site that contains marine shell in a layer over 9000 years old (White 1972: 96). By the period 6000–5000 years ago, rock was being quarried in a number of mountain localities and traded between mountain groups; it was probably also traded to the lowlands. The nature of contact between the mountains and the lowlands can be guessed on the basis of proto-historic trade. Goods were exchanged through ritual and informal person to person gifts, through formal and informal barter at trading ‘stations’, such as the market places maintained by the Rao in the foothills of the Schraders, or by trading parties travelling over inhabited or uninhabited territory with goods to sell.

In the proto-historic period the Kalam were the middlemen in the trading between the mountains and the plains, particularly in respect to the stone axe-adzes from the Jimi valley. A wide variety of other goods changed hands, however, including salt made by the Kalam themselves, wooden bowls, weapons, medicines, and many other commodities. Two lowland groups were positioned in respect to this trade. The Ayome gardened on the plains some distance from the river to maintain trade contacts with the Kalam (Kasprus 1973). Another group, the Rao of the middle river and headwaters of the Keram River, moved partly into the foothills for trade purposes. The Rao occupy sago swamps among a number of other language groups, making pots and salt to use in their role as professional traders, to supplement their restricted resources. They have a variety of cultural traits thought to have been acquired through contacts with Austronesian speaking groups, although they are probably basically non-Austronesian in origin (Kasprus 1973:17). It is not surprising, therefore, that the Kaironk valley contains evidence of prehistoric trade with lowland communities, or that some of the evidence can be interpreted as reflecting Austronesian contacts.

Trade goods can be interpreted as indicating indirect contact, but the presence of the ‘foreign’ stone technology in the upper Kaironk is another matter. It is perhaps necessary to hypothesise that individuals or small parties of lowlanders possessing the relevant technological knowledge ventured into the mountains and settled into existing communities. On the other hand, we may eventually find lowland stone working sites where mountain rock was worked or where rock of lowland origin was used and where mountain people could have learned the techniques. Kasprus (1973:34) noted both the use of river pebbles in the vicinity of Atemble on the Ramu River and the general lack of rock on the river plains. Clearly the desire for stone artefacts was one of the main motives for trade by the Ramu River people with the mountain groups.

Highlands versus lowlands. Human populations in Papua New Guinea did not distribute themselves evenly up into the various mountain zones, but there was a distinct division between mountain and lowlands settlement. Brookfield reviewed this general pattern of a zone of grassland or tropical forest between Highlands and lowlands settlement, but pointed to its complex causes. The lower limit of close mountain settlement is related to a variety of factors, including the depletion of soils through gardening, local variations in rainfall, and the incidence of disease, particularly malaria. Probably the division between Highlands and lowlands has been exaggerated by the proto-historic shift to higher altitudes with the assistance of the sweet potato. This, however, seems to be a shift from the lower mid-mountain zone to the upper mid-mountain zone, rather than from the forest zone below 1000 m. It seems in the Bismarck-Schrader ranges that the lower mountain forest is a much less healthy place for human habitation (Buchbinder 1973; G. Jackson, pers. comm. 1975). On the other hand, it seems that the lower mountain zone is useful for hunting and collecting and
that some groups maintain groves of cultivated trees between about 1000 and 1200 m, while preferring to dwell and garden at higher altitudes.

**High mountain settlement.** Considerable discussion has surrounded the antiquity of settlement in the high mountains, particularly above 1700 m. It has even been suggested that cultivators could not have lived above this altitude before the introduction of the sweet potato (for example by Sorenson and Kenmore 1974). The archaeological evidence is to the contrary; pollen analysis from sites in the upper Wahgi valley indicates that the mountain slopes above the valley were extensively cleared and cultivated earlier than 5000 years ago, and possibly earlier still (Powell et al. 1975). I think the evidence from Wanlek also supports this.

The general tendency in the mountains during the protohistoric period to move into higher areas and to clear back the upper mountain forest to 2400 m or more is undoubtedly related to the use of the sweet potato. The dense human and pig populations in high altitude areas would not have been possible without the support of this crop. This does not mean that no one previously cultivated at all in the high altitude areas, but rather than many fewer people did so and with a much greater dependence upon collecting and hunting and on resources from lower mountain zones.

The reasons for people moving into higher areas in the mountains are complex, but the desire to avoid lower altitude diseases, particularly malaria, must count high among the causes. The causes of population increase are a different matter, but the correlation between the introduction of new crops and population increases and cultural changes is known from other areas of the world, such as the introduction of New World crops to Europe (reviewed in Crosby 1972). Located in direct contact with the lowlands on two fronts, the protohistoric Kalam must have been vulnerable to lowland diseases. Their general shift to a higher altitude distribution can possibly be seen as a withdrawal from lowland contacts. On the other hand, their apparent population explosion in the upper Kaironk needs to be interpreted in terms of a marked change in ecological base.

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9 Environment, Migration and Site Selection in the Port Moresby Coastal Area

NIGEL ORAM

There are a number of challenges involved in looking at the prehistory of the Port Moresby area, and in trying to determine why social groups migrated, and why they stopped moving when and where they did. The tools available include genetic, language and archaeological analysis, post-contact written records, and, while the opportunity is still present, oral traditions. Certain assumptions can also be made: people have hierarchies of needs of which some (defence, access to water) must be satisfied primarily or solely by their immediate environments, and others may be satisfied by trade and ritual. It may also be assumed that people will not move from a more to a less favourable environment without powerful reasons for doing so. Thus the movement of Motu and Koiari speaking groups from Bootless Bay demands explanation. Using all the evidence available, including valuable oral material, new light is shed on this particular migration. It appears that the movement westward of Motu speakers from the Bootless Inlet area was due to warfare rather than population pressure, and that further westward movement was due to the nature of the social structure and a search for a better environment. Additional hypotheses concerning the migrations of the Motu and Koiata speaking groups and the factors determining their movements are also advanced in the light of a new synthesis of evidence.

The coastal area between Galley Reach and Round Head is occupied by speakers of Motu, an Austronesian language, and by speakers of Koita and Koiari, which are both members of the non-Austronesian Koiarian language family described by Dutton (1969). In this chapter I discuss the origins and migrations of these peoples, basing my work on available evidence of all kinds but especially on the oral traditions that I have been collecting since 1962. In 1969 I advanced the thesis that the ancestors of present Motu speaking populations were an amalgam of people who had migrated from the east and from inland to the Bootless Bay area. Warfare was the main reason that the Western Motu settled further to the west and the Koita also migrated to the coast from inland as a result of Koiarian pressure. The area between Round Head and Galley Reach is not to be regarded as a single environment but as a series of microenvironments, and the differences between them play a part in determining patterns of settlement and trade. I differ from Allen (1976) who has advanced the theory that when the 'Motu', that is the Western Motu, who were already skilled sailors and traders, migrated into

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an unfavourable environment, they moved into an 'ideal rather than marginal' ecological niche.

The weaknesses and strengths of oral tradition as a historical source will be discussed elsewhere, but if a number of traditions interlock and are supported by other kinds of evidence, a high degree of probability may be accorded to them. In the area under discussion, genealogies are valuable as a means of dating only when they ascend to some six or seven generations, but they provide valuable supporting evidence when they extend further into the past. The varied origins of different village populations must be remembered, but it is still possible to trace major migration paths. The term 'tribe' is used here in the sense defined by Groves (1963:15) as a population that claims descent from a single ancestral village, intermarries and does not make war within itself.

A number of traditions recorded in different villages agree that in the past the coast between Round Head and Galley Reach was unoccupied except for four villages:

![Diagram of Western Motu migrations according to available evidence](image)
The Melanesian environment

Gavera Maka
Koiari

Motu Hanua

From southeast

Badihagwa

Hanuabada

Manumanu

Pari

Rea Rea

Porebada

Boera
(1 section)

Fig. 9.2 Western Motu migrations

Inland village

Koiari

From southeast

Inland village

Tubusereia

Gaba Gaba

Gaire

Barakau

Fig. 9.3 Eastern Motu migrations
Fig. 9.4 Marehau–Apau migrations (in part based on maps by Vanderwal 1973 and Chatterton 1969)
The Melanesian environment

Tubusereia, Taurama, Vabukori and Boera. The coastal areas to Keapara, some 120 km to the east, and to Cape Possession, 160 km to the west, were also largely uninhabited. The migrations discussed here were achieved not through conquest but by movement into empty areas.

The Motu speakers are divided into two tribes (see Figures 9.1, 9.2 and 9.3). The Western Motu tribes live in seven villages, if Hanuabada is counted as three villages, extending from Pari to Manumanu. Western Motu elements are also found in Boera. Further research supports my account (1969) of an eastern origin for the Western Motu. Traditions say that they originated from a migration along the coast to the east and from Gavera Makana on the coastal edge of the Sogeri plateau. They settled on Motupore Island and at Taurama Village but were driven away from Bootless Bay by Lakwaharu (Tubusereia) attacks to settle at Badihagwa, which was 400 m inland of the present Hanuabada. From there four new villages, and a section in a fifth, Boera, were established. Fourteen generations are recorded to the founder of Taurama, who is considered to be a god, but the genealogy is likely to have been telescoped. Rea Rea and Pari were founded from Badihagwa-Hanuabada seven or eight generations ago and Porebada was established a few years before the first Europeans arrived in the 1870s.

Vabukori and Tatana shared in the past a similar dialect and consider themselves to be apart from the Western Motu. Little is known of Vabukori origins except that it is an ancient village and is of mixed origins. One of Tatana’s main descent groups was a Western Motu group that ventured to the west of Galley Reach and was driven back by the Lala (Nara); another appears to have been of Koita origin.

Tubusereia was the ancestral village of the Eastern Motu and traditionally regarded as an ancient village, but the longest genealogy records only some seven generations. Sixteen out of twenty-five descent groups are of Koiari origin. Gaire and Gaba Gaba were founded as a result of a conjunction of Tubusereia and inland migrants shortly before the arrival of Europeans and Barakau was founded from Tubusereia late in the nineteenth or early in the twentieth century.

There are three former Motu speaking populations living on the mainland near Yule Island. Originating from either Taurama or Vabukori, a group settled at Marehau Poena near the present Waima or, some say, they settled first on a hill called

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**Fig. 9.5  Marehau–Apau migrations**
Fig. 9.6 Koita and Koiari settlements (based on Map 5 in Dutton 1969)
Aria Ororo or Kariku inside the present Gulf District. From Marehau Poena they moved to Araha and then the majority went to Yule Island while some settled at Tarova close to Marehau Poena. From Yule Island one group was driven to (Davage) Boera, while another crossed to Delena about the time the first Europeans arrived. One small group went to Mou Village (see Figures 9.4 and 9.5).

The Koita speak a language that is part of the Koiarian Family. Their traditions say that they separated from the Koiai in the Sogeri area some nineteen generations ago. They moved through Rouna to Nebira and Gubinimu and a division occurred in the Seven-mile area. Some descent groups stayed in the area of the present Port Moresby while the remainder moved inland to the west as far as Galley Reach. The Koita began to join the Motu on the coast from about seven generations ago and the movement continued until the present century (see Figures 9.6 and 9.7).

There are several divisions among the Koiai but the grass Koiai (see Williams 1932) have long been in contact with Motu speakers on the coast. Some Koiai came down from the Soger area and joined the Eastern Motu and others founded villages in the foothills behind the Eastern Motu villages. Other grass Koiai moved westward and drove the Koita to the coast while some descent groups settled in Western Motu villages (Figure 9.6).

**Traditional Economies**

The Port Moresby coastal region is dominated by the Owen Stanley Range of the main New Guinea cordillera. From Boera to Gaba Gaba, the coast is hilly, with patches of coastal plain between Tubusereia and Gaba Gaba. The coastal hills run from southeast to northwest, parallel to the coast, and the escarpment of the Astrolabe Range rises some 8 km inland from Bootless Bay to Gaba Gaba. North of Boera the coastal plain extends some kilometres inland and includes large areas of swamp, which lead to the Galley Reach estuary. The Laloki and Goldie Rivers flow parallel to the coast after they descend from the ranges and are joined by the Brown and Vanapa Rivers in Galley Reach.

By no conquest do the Motuans live here, but simply because the Koitapuans allow them, saying 'yours is the sea, the canoes and the nets; ours the land and the wallaby. Give us fish for our flesh and pottery for our yams and bananas'. (Chalmers 1887: 14–15)

This statement, which has been quoted by a number of writers (e.g. Groves et al. 1957-8:223; Allen 1976), serves as a myth validating the symbiotic relationship between Motu and Koita, although today Western Motu groups dispute Koita claims to all coastal land. While the statement expresses a basic truth, it oversimplifies a complex situation.

Previous writers have seen the area occupied by Motu speakers as a single ecosystem, but there are significant differences in the environment between Gaba Gaba and Manumanu. These differences have not been adequately studied, although some distinctions have been made by Groves (1960:5–8).

There are marked climatic differences within the area. The central coastal area from Pari to Rea Rea is very dry with a mean annual rainfall of 995 mm at Port Moresby Harbour. The rainfall gradient increases rapidly approximately at right angles to the coast. According to rainfall figures recently provided by the Department of Agriculture, Stock and Fisheries, it is 1175 mm in the Boroko airport area, 1413 mm at Mount Lawes some 24 km from the coast, and 1867 mm in the Rouna Falls area. From Bautama on Bootless Bay to Gaba Gaba the rainfall gradient rises as steeply as 254 mm within 3–4 km of the coast. Rainfall is higher in the estuarine area of Manumanu and mean rainfall at Kanosea, 14 km inland from Manumanu, is 1515 mm per annum.
Compared to the central area, the eastern sector is well watered. While there is no all-weather stream between Bootless Bay and Rea Rea, a number of considerable all-weather streams flow through the coastal plain to the east of Bootless Bay. Figure 9.8, which is based on Mabbutt et al. (1965), clearly shows the low rainfall in the harbour.
Fig. 9.8 Annual mean rainfall of the Port Moresby-Kairuku area, 1954–60 (from Mabbutt et al. 1965, reproduced by permission)
area but, owing to the uneven distribution of rainfall stations, not that of the coastal area immediately to the west. As Figure 9.8 indicates, great variations are experienced in monthly (and also annual) rainfall and the uncertain beginning of the wet season is a major cause of food shortage.

Much of the western area is clear of trees and scrub, especially in the coastal plain in the area behind Boera and Rea Rea, probably as a result of human occupation. There was a shortage of timber for building houses and canoes and one tradition describes how grass was imported by Kila Kila people from Boera to construct a particularly large building.

The eastern area is correspondingly more fertile than the central area. Evidence is provided by extensive areas of sirih (Saccharum spontaneum) and by the abundance of uncultivated foods. To a lesser extent the inhabitants of the area from Rea Rea westward to beyond Galley Reach, with the possible exception of Kido, also enjoy a more favourable environment. As Groves (1960:7) points out, people of Manumanu ‘own and cultivate rain forest clearings on the banks of the Vanapa and Veimauri rivers’. The areas inland, including those in the vicinity of the Laloki and other rivers and of the Waigani Swamps, are well watered and fertile. These were the areas occupied by Koita groups before they moved to the coast and they still retain land rights on the seaward side of the Laloki. The areas to the east of the Laloki, the foothills below the Astrolabe escarpment and the Sogeri plateau, are highly fertile and are occupied by the Koiai.

A large reef runs some 6 km from the shore from Redscar Head past Gaba Gaba to Table Bay far to the south. There is also a fringing reef, which extends as far as Yule Island. As Allen (1976) points out, this is an important resource in terms both of fishing and trading, but it was of value for trading only within the Motu speaking area and to the southeast. Canoes trading in the Gulf of Papua were faced with open and dangerous seas beyond Redscar Head.

Environmental differences within the Motu speaking area have been accompanied by and are related to differences in the economies of village populations, especially in the economies of Eastern and Western Motu. Broadly there were three types of economic organisation in the Port Moresby coastal region: that of the Western Motu and the three other Motu speaking villages in the same area; that of the Eastern Motu and that of the Koiai and Koita. There were also significant differences within these groups and changes took place over time which cannot fully be discussed here.

The Western Motu fished, gardened and hunted and exchanged goods with the Koita inland. Gardening was important to the Western Motu and, as Groves (1960:7) makes clear, their main crops were yams and bananas. Coconuts were also important to the east and west while few coconuts were planted between Pari and Rea Rea. Yams could not be kept through the wet season and coastal villages were under constant threat of famine. Hunting and gathering were important means of obtaining food. Local resources were not enough and, to maintain themselves between harvests, the Western Motu undertook trading expeditions to the Gulf of Papua. An important source of food, fruit and tubers gathered in the bush, has been mentioned only in passing by previous writers (e.g. S. Bulmer 1971:39 and Allen 1976). I have made a list of thirty-five edible plants described by people from different villages. Much further research is needed into this source of food. Plants need to be found and identified, further study of the plants available to different villages is needed and the nutritional value of plants should be examined.

The fruits of edible mangroves including gavera were prepared and eaten in all coastal villages and bags of gavera are still sold by Manumanu people in Koke market.
The work of preparation is laborious; the fruit has to be boiled three times, soaked in water, peeled and mashed. While mangroves are to be found all along the coast, they were a major resource at Manumanu, where their importance in determining the village site has been noted. It was an important famine crop at Hanuabada Village: 'The people are all very hungry now, living almost entirely on mangrove fruit and the bottom of banana trees' (Lawes, Diary for 13 February 1876). Also eaten in many villages is hatoro (Cycas media). There are a wide range of tubers including taitu kava, a wild yam.

Some of these plants, such as gavera, batu, hodava, and hatoa (Amorphophallus companulatus), are ready for eating towards the end of the year in the month called Manu maure, when the time of hunger used to begin. While many wild plants are appreciated as sources of food, some, because of their ill effects, are eaten only under pressure of hunger. Matoa, for example, are described by Pari informants as causing dysentery.

Stimulants were buatau (Areca catechu) chewed with popo (Piper betel), vaga (catkin of betel pepper), the leaves of the betel pepper, and siomu, tobacco. Buatau was obtained by Western Motu villagers during gaura and hiri expeditions and by the Eastern Motu from the Koiaari living inland of them. Pari people claim that the only stand in the Western Motu area was at Ranubada near Taurama barracks, where there was also a small stand of sago. Informants describe traditional use of tobacco, the introduction of which has been described by Riesenfeld (1951:69–102).

Children were expected to gather bush foods, as they still are today (Ian Maddocks, pers. comm.) and this appears in legends (e.g. Moi Higo 1974:247). Sir William MacGregor, then Lieutenant-Governor, observed that children were often away from school gathering food (Further Correspondence 1891:167).

Other trees and plants were used for house and canoe building and for making weapons, and these were not always available in the vicinity of the villages concerned. The bark of vanea was used for making matagara (dugong and turtle nets), mainly at Redscar Head and in the hinterland of Rea Rea. Rea Rea informants still tell the story of Pari vanea collectors finding in a cave a woman and child from the former Koita village of Buria, near Rea Rea, and, instead of killing her, taking her to Pari where her descendants live today. Biri, the fronds of the nipa palm, were used for walling of houses and are found in the rivers near Gorohu and Manumanu.

Fishing played an important part in the economy of the Western Motu. Fish were used as food and for exchange. Heavy seas limited fishing at some seasons, especially towards the end of the year when the harvest was exhausted. I have recorded at least eight traditional methods of fishing, nearly all of which have disappeared. Different methods were practised for catching different kinds of fish, and various fish were caught at different seasons. There was specialisation in fishing between villages, and between descent groups within villages. The Motu made three kinds of net: matagara for dugong and turtle; ole, also with a big mesh, for larger fish; and reke for smaller fish. The great nets were made by groups of men to the accompaniment of extensive rituals. Special fishing techniques were developed by different villages; Pari people had their own method of fishing for tuna during their seasonal runs in Bootless Inlet (Papuan Villager 1930, 2(12):7; Pulsford 1975).

Pigs and dogs were domesticated. While the pig population was small by Highland standards, oral tradition shows that pigs were an important element in Motu culture and each iduhu had its own pig name (see e.g. Revo Pita et al. 1975). Pigs were fed on food scraps and scavenged near their villages. In his diary for 22 January 1876, Lawes observed that Hanuabadans paid for Keapara armshells with pig and other commodities and that 2 January 1881 was a day 'sacred to feasting and the worship of pig'.
The present absence of pigs from the villages is due to the actions of the colonial administration and local government councils in the 1950s. The number of dogs kept in pre-contact times is not known, but traditions say that in some villages at least only chiefs owned them. They were used for hunting and as guard dogs. They are frequently mentioned in traditions and, like pigs, they were fed on village scraps.

The annual trading expedition of the Motu called hiri involved transporting pots, armshells and other valuables to the Gulf of Papua in huge canoes to exchange them for sago and often additional canoe hulls to carry it away (e.g. Barton 1910:96–120; Wedgwood 1955). Tradition ascribes the founding of the hiri to a culture hero of the Boera people called Edai Siabo. This tradition is inherently probable because a section at least of the Boera people, Apau, migrated from places close to sago making areas (cf. Chatterton 1969:95). As a result of these expeditions a form of exchange called abirakwa developed, in which Motu exchanged sago for vegetables grown by the Koita.

Available evidence suggests that the hiri in the form observed by the first Europeans to go to Papua developed during the last two to three hundred years, although some form of trade with the Gulf may have occurred earlier. Both Motu and Koita genealogies independently state that Edai Siabo lived ten generations ago. The development of the hiri is likely to have coincided with the movement of the Western Motu into an unfavourable environment, which began at about the same time; as Allen (1976) points out, the type of Motu pottery first appearing at that time suggests mass production.

Descriptions can be found in the sources quoted and elsewhere (Groves 1960, 1972) of the exchange relations involved in hiri expeditions, but the earliest, brief, mention of the two kinds of hiri distinguished by villages making these expeditions is in Dutton and Brown (1973). Hiri lata or daiva expeditions went across the Gulf of Papua as far as the Purari Delta and involved the dismantling of lagatot and the addition of many new hulls, making a total of up to sixteen hulls. Where villages were in danger of famine, hiri lou, or ‘return’ expeditions, went as far as Kivori, Oiapu and other areas near the borders of the present Gulf District to obtain urgent supplies of food. They either did not add more hulls or added two or three. A number of informants say that Manumanu people made only short expeditions, possibly as far as Keuru, and added no more or only a few extra hulls because supplies of gavera (mangrove) were available to them at home. While there were broad economic factors, relating to the need to maintain the trading network that ensured that hiri lata expeditions were undertaken, flexibility in meeting immediate needs was obtained through the more easily mounted hiri lou expeditions. Pottery was an essential element in the hiri trade (Groves 1960). From west of Aroma (Allen and Littlewood 1974:17) to the Gulf of Papua and beyond, the Motu were the only potters.1 Traditions describe how the Marehau migrants jealously guarded their potting skills and evidence (Chatterton 1969:93; D’Albertis 1880:419; Haddon 1900:275) makes it clear that the Roro did not begin to make pots until the time of first European contact.

Environmental differences within the Western Motu area were an important factor determining patterns of trade. Rea Rea informants state that they did not make the expeditions called gaura to Gabadi for yams because, unlike their Boera and Porebada neighbours, their own good gardens made it unnecessary. The mangrove in the Manumanu area was collected by a number of Western Motu villages in times of

1 There is one reference (British New Guinea Annual Report 1883/84:24–36) for which I am grateful to Margaret Tuckson, to a ‘Bush tribe called Hakeko in the area of the Gulf of Papua who made some rude clay dishes’.
famine. A comparison can be made between the economies of Tatana and Manumanu. W.Y. Turner, the LMS missionary, wrote ‘the people of Tatana, a small village near Port Moresby have no plantations and so they live by plunder’ (1878:492).

Turner spent only a few months in New Guinea and his observations are suspect. The village was certainly small (see Appendix), but in an age when the strong plundered the weak, oral tradition suggests that they raided smaller Koita settlements on the mainland. They may have held rights to land, because in August 1908 the Central District Monthly Report recorded that they refused to sell their rights to land on the mainland to the Government. They, with the Vabukori people, specialised in the making of shell beads called ageva (see Seligman 1910:93) but it seems probable that they did not make pots. They claim that they were the only people to produce headbands made of shell called gema, which they traded to the southeast. They were more dependent on fishing and trading than the Manumanu, who had the edible mangrove as a staple food and also fertile gardening land and easy access to the productive Gabadi area.

The Eastern Motu were also involved in fishing, gardening, hunting and trade. Seligman (1910:14,n.2) observes, and oral accounts confirm, that in pre-contact time the Eastern Motu did not undertake hiri expeditions, although they began to do so after the British administration had established peaceful conditions. As informants point out, their unwieldy trading canoes would not have been able to pass the Western Motu villages for fear of attack. Owing to their more favourable environment, they did not have the same need to trade in sago, which grows in the Eastern Motu area. According to A.C. English, government agent at Rigo, at Tubusereia ‘the sago trees belong to the man who plants them’ (British New Guinea Annual Report 1893/94:xxi) and it was planted at least until the 1930s. When they needed more sago, they obtained it from the Hood Peninsula. According to Seligman (1910:114, n.1), they traded pots for food with the Koiai, although it is not known when they first began to make pots. Traditionally many, if not all, were obtained from the Western Motu. Tubusereia informants say that they provided the Koiai with pots, lime and fish and received in return feathers of various birds and hornbill beaks for decoration and areca nut with accessories.

Bush foods were much more plentiful in the Eastern Motu area than in the Western Motu area. When Pari people were asked to identify such foods, they led straight to the area behind Tubusereia. Hatoro was until recently an important food among the Eastern Motu and with hodava (Terminalia complanata), which is found only in the Eastern Motu area, was eaten at feasts.

While the Eastern Motu shared a common culture with the Western Motu, they were also associated with the Hula to the east with whom they had ties of kinship and trade. They shared a common house design (which differed from that of the Western Motu), the use of bereavement terms as a form of address and names for fishing techniques.

The Koita expanded their economic activities when they settled with or near the Western Motu on the coast, while retaining their own language and continuing their traditional gardening and hunting. Fishing became an important part of the Koita economy. Seligman (1910:45) contradicted himself by saying that even in the Port Moresby area, ‘no Koita possesses the strong large meshed net with which these animals (turtles and dugong) are caught’ and (p.91) that a Koita man owned a net although ‘it is quite unusual for a Koita to possess such a net’. The Koita also became involved in hiri expeditions.

The Koiai who lived inland practised an agricultural, hunting, gathering and exchange economy. Those who joined the Eastern Motu were completely absorbed into
the Motuan culture and adopted the Motu language; but they had joined the Eastern Motu much earlier than the Koita joined the Western Motu.

The Motuan need for food and the desire of other peoples for pots was the basis of the exchange network. Long-distance trading primarily for food was rare in Papua New Guinea. In spite of the sago trade, food shortages sometimes amounting to famine were endemic in coastal areas, at least from Manumanu to Marshall Lagoon, which is the area of which I have knowledge. Famine extended inland: there was, for example, famine in the inland areas of the Rigo Subdistrict as late as 1964. Western Motu informants say that the people of Hanuabada suffered most from famine. Accounts of the founding of the hiri specifically say that the institution of abirakwa, the exchange relationship between Western Motu and Koita, arose because of food shortages among the latter (see e.g. London Missionary Society 1956:69). In return, the people in the sago producing areas obtained a much prized commodity, pots. The Vulaa and Keapara obtained both food and pots in exchange for their fish and armshells. The Koita also sought pots and traditions say that the Koita intermarried with Western Motu because of them.

Quoting Chalmers (in Lindt 1887:124–5) Allen (1976) refers to ‘the profit motive on which Motu exchange was based’. He later says that:

in short it is a simple matter to see how the system worked to the advantage of Motu but less clear to see why it should work. How were the Motu able to impose these trading systems on groups which appear to have been previously economically self-sufficient?

It is not possible to draw up a profit and loss account because there is no common unit of value by which the values of different commodities can be compared. Allen cites as an example of profit or middleman surplus Chalmers’s discussion of the armshell exchanges traded from the east ‘again to the Motu natives for sago, and the Motuans to the Elemaiites for sago in bulk …’. Allen suggests (pers. comm.) that the middleman surplus is clear (as far as the reference is accurate). The Motu gave x sago for one armshell from the east, and gave the same armshell westwards for x + n sago. In this sense the n surplus is a profit, but of course one would have to determine expenditure of time and effort in making canoes, undergoing ritual, and actually trading to determine real profit, especially as the exchanges did not involve a direct exchange by the Western Motu of armshells for sago. As noted above, they sometimes exchanged their pigs for armshells and on hiri expeditions they generally exchanged their armshells for additional hulls and their pots for sago. While in the small eastern Gulf villages they received tallies in exchange for their pots, in the west they received as much sago as they could carry away. Vulaa informants say that the amount of sago given to them by the Western Motu as a return for their fishing services was not measured and they were sometimes given lagatos hulls to transport it.

In support of his contention that the Motu imposed or induced these trading systems on others, Allen argues (pers. comm.) that

even from a weak economic base (and perhaps often motivated by it) one group might impose on another, by warfare or sorcery (vide Koita controls of Motu) or … by blocking supply of something (such as Motu control of armshells from the east going west). Not only the Western Motu but any of the groups involved in the armshell chain of exchanges could have blocked supplies. In doing so they would deprive themselves of a valuable commodity on which the very existence of some Motu speakers depended.

Discussion of concepts of ‘profit’ or ‘middleman surplus’ and of imposition or inducement of trade has more than a technical significance. Allen’s claims are Motucentric, a bias shared with other writers, and help to build up a picture of the Western Motu as skilled seamen and traders who had moved into ‘an ideal rather than
marginal ecological niche'. My own view is that, as refugees, they were forced to undertake expeditions at great cost in effort and lives to survive. Among the Western Motu loss of life and goods was frequently caused by canoes being wrecked during hiri. There are a number of accounts of such wrecks: in 1889 Vabukori lost both lagatoi (British New Guinea Annual Report 1889/90:102). While those who managed to reach the shore might hope to return home, there are several accounts of crews being slaughtered. Chalmers (1887:272–3) records that 177 members of Boera lagatoi crews were killed by Roro people and those whose lagatoi were blown past the Western Motu village to the southeast were particularly in danger. When it is considered that a single lagatoi carried some thirty people, the impact of their deaths on small village populations was considerable (cf. S. Bulmer 1971:41).

A high degree of probability can be accorded to the tradition, widespread among Motu speaking groups, that the hiri originated with the Apau people of Boera. Their history shows that they had lived near, and possibly in, the sago producing areas to the east of the Gulf of Papua. The existence of this trade may have made Western Motu migration to the west possible.

The peoples of the whole coastal area had to struggle to meet their need for food, shelter and other commodities. Rainfall was low and uncertain throughout the central coastal area but less so in the area east of Bootless Bay and west of Rea Rea. In all respects these areas, especially the Eastern Motu area, provided a more favourable environment than the area west of Bootless Bay to Rea Rea. This area lacked permanent water supplies and timber (probably as a result of forest clearance). While bush foods were found throughout the area, they were particularly plentiful in the Eastern Motu area and the people in the area of Galley Reach had plentiful supplies of edible mangrove. The immediate hinterland was better watered and more fertile than the coastal areas but it also suffered from periods of drought. The Western Motu moving into the central area overcame their lack of food and other resources by introducing or developing new techniques: hiri expeditions, pot making, and the big nets that Boera informants say they learnt to make from the Lala during their migration southeast from Yule Island. According to oral tradition these developments may have occurred during the last two or three hundred years.

Causes of migration and settlement patterns

Migrations occur either because the people concerned are forced to move as a result of deterioration of their environment through overpopulation or other causes; or as the result of the hostilities of other tribal groups. In seeking the causes of migration and settlement in the Port Moresby area, all available evidence must be taken into account. Research in the Port Moresby region has been the most detailed archaeological study of any coastal or lowland area, but most of the results of this work are not yet available. The state of current knowledge was reviewed by S. Bulmer (1971, 1975); her account includes preliminary information on five excavations and over a hundred surface sites and collections. The earliest known style of pottery first called Redslip by Bulmer (1971), has been found from Aird Hill in the Gulf District to Mailu in the east. In both the Yule Island area (Vanderwal 1973) and the Port Moresby area (Allen 1976; Bulmer 1975) this has been shown to comprise a series of several subsequent styles of pottery, dating from 2000–1000 years ago.

The ceramic sequence for the period subsequent to 1000 AD consists of three distinct styles in stratigraphic sequence, although the precise dating of these is in dispute. The earliest style, called ‘Massim’ by Bulmer, is subsequent to the final Redslip pottery, but earlier than the Boera-Taurama style at two sites, and therefore probably dates to
about 1000 years ago or slightly less. This was a short-lived ceramic style, soon to be replaced by the Boera-Taurama style, that continued as a developing ceramic style from about 1200 AD to perhaps the seventeenth or eighteenth century. This is the same or similar style to the earliest pottery at the site on Motupore Island (Allen 1976).

The final, most recent ceramic style is stratigraphically later than Boera-Taurama, and dated by one radiocarbon date to about 300 years ago or less (280±80 years BP). The decoration of this pottery is identical to that described in the early historic period for the local Motu pottery industry. It may conceivably have developed out of the earlier Boera-Taurama style.

The implications of this pottery sequence are not yet clear. In some sites there is no change of occupation or settlement coinciding with change in pottery style, but in others there is clear stratigraphic discontinuity together with pottery style change. Unstratified site collections show that early Redslip style and later ‘Massim’ pottery was widespread, being left on inland as well as coastal sites, although always in what appears to have been nucleated settlements. Boera-Taurama style pottery is distributed almost exclusively on coastal sites, although there is a nucleated settlement at inland Nebira using this pottery. ‘Motu’ style pottery, on the other hand, is found in thin scatters on almost every site known, particularly in the coastal hills and on the beaches, suggesting perhaps more dispersed settlement.

If my assessment of the value of genealogical evidence as a guide to dating is accepted, oral tradition does not in general conflict with archaeological evidence. While oral tradition is silent on the history of the makers and users of Redslip and Massim pottery styles, it provides much information about the other sites which have been studied. As noted above the fourteen generations of the longest Taurama genealogy are likely to have been telescoped. According to Allen (1976) Motupore is seen as having been continuously occupied by the same group of people for around 500 years from about 1200 AD; the inhabitants are thought to have been ancestral to the present day Motu. While archaeological evidence alone has not yet fully demonstrated that the first users of Boera-Taurama pottery at Taurama and Motupore were ancestors of the present Western Motu, oral tradition supports this hypothesis.

The greatest discrepancy between archaeology and oral sources arises from lack of traditions relating to a village on Motupore. Archaeological evidence suggests that Motupore was occupied between 1200 and 1700 AD, with possible later occupation; a number of traditions state that ancestors of the Western Motu lived on the island. While there are large quantities of cultural debris at the Motupore site, there is no evidence that indicates the size of settlement at any given time. Traditions for Taurama, which was possibly destroyed a little after Motupore was abandoned, are extremely clear and detailed down to individual descent groups. While there are traditions that ancestors of present Motu speaking groups passed through Motupore, no tradition has been recorded of the existence there of the village suggested by later archaeological data. There is oral evidence, however, relating to short periods of settlement up to the time of first contact with Europeans.

A second problem, relating to the Apau-Marehau migration, arises over differences between oral tradition, linguistic evidence, and archaeological findings. While no full assessment has been made of pottery at the huge Davage-Boera site some Redslip and considerable quantities of Massim and Boera-Taurama pottery have been found. According to Vanderwal (1973), the Urorina settlement is dated to 700 BP and part of the Davage complex may be shown to have been founded at the same time. Interlocking traditions suggest that the Apau people first settled in the Boera area within the last three hundred years. Some support is given to this view by the similarity which, ac-
The Melanesian environment

cording to earlier missionaries, existed between the Motu spoken at Boera and that spoken at Delena. If the migration had occurred much earlier, the languages would have been likely to have diverged considerably. We do not know whether the ancestors of the present Apau-Maréhau people settled in the Yule Island and Boera areas a very long time ago or whether they exterminated or absorbed populations, possibly Motu speaking, already settled in the area or whether they entered an unpopulated area.

While direct contradictions between limited evidence or different kinds of evidence are few, disagreements can arise over the interpretation of the limited evidence available. Opposing the view that the Motu arrived by sea as a separate late migration, I suggested (1969:89) that ‘It seems possible, however, as a shot in the dark, that both Motu and Vulaa were not descended from late sea-borne migrants, but instead were descended from Austronesian agricultural peoples already established in Central Papua.’ Allen (1976) takes a somewhat different view. His main conclusion is that ‘... the Motu arrived as developed pottery makers and marine traders along the coast, and represent a sufficiently different population to argue against them being merely a local group developing internally towards a higher level of adaptation’. Further, he says, ‘... the model would appear to require a migration and specialisation of people in spearhead fashion along the coast, with open lines of communication behind them’. He implies a large-scale migration because he says that they ‘arrived in sufficient numbers to create the initial equilibrium posited above, and to implement at least in embryonic form the exchange systems documented ethnographically’.

There is common ground that some of the people who settled at Motupore, not necessarily all, and some of those who formed other settlements on the shores of Bootless Bay practised a marine type economy and are likely to have done so before they arrived there. It also seems probable that they brought pot making skills. This tells us nothing, however, about where they come from or in what numbers. Oral tradition and our knowledge of other migrations in this area suggest that Motu speakers originated from the westward movement of small, independent groups. From many examples of settlement along this coast, it is possible to discern a pattern in which, after an initial settlement has been made, the first settlers are joined either by members of their own tribal or village groups or by members of other groups who later adopt their language and culture. I have elsewhere cited the Vulaa, whose small beginnings can be traced (1968:244–5). A few migrants, possibly originating inland of Marshall Lagoon, settled in the sea below Keapara where they depended entirely on exchanging their fish for other goods. By 1900, the tribe lived in six discrete coastal settlements spread along some forty miles of coast.

Available evidence, which is limited, suggests that Motu speakers came from the east. Motupore type pottery has been found in the Hood Peninsula (Johnston 1971:27) and there are similarities between Motupore pottery and prehistoric pottery found in the Mailu area (Allen 1976). The linguistic evidence appears to support a local origin for Motu speaking groups. The most striking aspect of Motu is its homogeneity. The same Motu is spoken with little variation between Gaba Gaba and Manumanu and only minor differences of dialect are found among Koita speaking groups. This suggests that the period of separation between different Motu or Koita speaking groups is not great. Sharing of language and similar origin traditions suggests that some elements within the Eastern and Western Motu shared a common origin even though they have since developed the minor cultural differences discussed.

Earlier linguists, such as Capell (1943:20, 276) saw the original Motu speakers coming with their language from outside the central coastal area. Pawley (1974:81) takes a different view. He sees the development of a proto-Central District stage after a period
of isolation following the movement of speakers of a Milne Bay language into the area. After resuming ‘a fairly close knit unity for several centuries’, it diverged into three dialect groups, ancestral to Motu, the western languages, and the eastern languages. He considers that ‘Mutual intelligibility between Motu and its immediate neighbours may have been maintained until at least A.D. 500, though the extremes of the dialect chain were probably quite divergent by this date’.

So far, there seems little conflict between Allen and myself. The nub of his argument lies in his conclusion. He points out: ‘Almost universally in the literature one implication has been that the Motu were forced to trade for sago in the west to supplement the poor food producing potential of a region with low rainfall and infertile soils’. Disagreeing with this view, he concludes:

Allowing that they arrived with specialist coastal exploitation skills as well as being experienced canoe builders and traders, both the local marine environment and the central position in relationship to the wider coast, coupled with the diversity of inland resources and the existing position and skills of the owners of the land at that time would have made the ecological niche an ideal rather than marginal one.

This hypothesis deserves careful examination, especially in the light of evidence not available to Allen. The Eastern Motu enjoyed all the advantages and none of the disadvantages of the environment into which the Western Motu migrated. They enjoyed equally good fishing conditions and a much better agricultural environment. The main benefit enjoyed by the Western Motu when they moved to an inferior environment at Badihagwa was a more easily defendable position. A number of reasons can be put forward for the initial migration of ancestors of the Western Motu to the west—one is population growth.

When population figures at first European contact are examined, it will be seen that population of the coast and its immediate hinterland was extremely small. Allen (1976) quotes figures, but it may be desirable to take the figures as near the time of first contact as possible, before such external factors as the measles introduced by the LMS steamer Ellengowan in 1875 (Lawes 1875) intervened. I calculate that, in 1873, the total population of Motu speaking villages was approximately 4000. The population of the Western Motu tribe was about 1700 and that of the Koita tribe was 1500 (see Appendix). Allen suggests

That unless the few earlier period sites were of an immense size in comparison to those that followed (and the surface evidence does not suggest it) then during the last 1,000 years there was a significant population build-up on the inland sites.

If their own account of their migration is accepted, the Koita population increased after they dispersed into the plains inland. The existence of a large number of Koita sites does not necessarily indicate a large population, although a very large number of Koita inland sites have been located and many others will probably be discovered in the future. Traditions say that many Koita village sites, like those of the Koiari, were occupied for a very short time: according to a Tubusereia source, one reason for leaving a site was that visitors to a feast might plant harmful magic in the village area. Sir William MacGregor reported that ‘... certain tribes frequently shift the place of their abode from one part of their land to another’ (British New Guinea Annual Report 1888/89:70). Inspection of a number of sites also suggests that occupation was for a short time. The evidence suggests that two other factors, rather than population pressure, drove them to settle on the coast.

Population growth was restricted by cultural factors including post partum taboos on sexual intercourse (see R.N.H. Bulmer 1971:145), disease and warfare. Frequent ritual abstinences, including those in preparation for warfare, and possibly prolonged
absences on trading expeditions, may also have had some impact on population growth.

Little is known about the health of pre-contact populations. According to Maddocks (1970:120): 'We may guess that malaria and filariasis were present from early times. Malaria would have been a potent force in determining population size and distribution. Yaws was probably universal in the pre-contact period.' He adds (p.121) that, with increasing density, internal parasites, such as hookworm, roundworm, shipworm and amoebic diseases, which are all widespread today, would have assumed greater importance. Frequent famines must have reduced the population but are likely to have affected mostly young children and old people.

One epidemic, almost certainly introduced from the outside some years before European contact, swept the southern Papuan coast and considerably affected the population picture. Chalmers (1887:318) called the disease smallpox. According to another European 'sixteen years ago smallpox was introduced via the Torres Straits, and decimated the coast and inland tribes. Old men still speak, with tears in their eyes, of the frightful disease that carried away their children and friends' (Chester 1883:7). Stone (1880:92) saw pockmarks on a Hanuabada ‘chief’. Williams (1933:3,9) carrying out an inquiry into depopulation of the Suau District, recorded a dramatic account by an old man of the symptoms of the disease and the devastation it caused. Maddocks (pers. comm.), however, suggests that this disease may have been chickenpox.

While a number of early European travellers observed that the disease had appeared in several areas, its extent has not yet been examined. Mention of the disease in the literature suggests that it extended from north of Yule Island to Woodlark Island (Stone 1880; Seligman and Strong 1906:350; Seligman 1910:35; Chester 1883:7; Dupeyrat 1935:118; Williams 1933). Stone says that it had occurred ten years before the time of writing, which was 1880; Chester, writing in 1883, said that it had occurred sixteen years before, in 1867. The Hula, perched on Hood Point, were able to acquire land inland because so many of the previous rightholders died of an epidemic at this time (British New Guinea Annual Report 1892/93:74; Oram 1962-75). It also caused the dispersal of the Roro from Araha to Yule Island and elsewhere (Seligman 1919:196; Oram 1962-75).

One clue provided by contemporary observers may determine the date for this outbreak. According to Seligman and Strong (1906:350), on Murua (Woodlark) Island ‘about thirty years ago an epidemic swept the village nearly clean, and with the dead died the art of making stone implements’. This accords closely with the account provided by the French Roman Catholic missionaries who lived on the island from 1847 to 1855: 'In 1852, the islanders were struck by a disease that in less than three months swept across the island wiping out a quarter of the population. A frightful illness which would in a matter of three days kill two, three or even six members of one family.' (Laracy 1969:55). If this was the same epidemic as that mentioned in other early sources (and this is not certain) it occurred somewhat earlier than they estimated.

Allen notes that, despite the population build up of Koita, 'by the time of European contact the inland between the coast and the Laloki river was almost entirely depopulated'. Koita traditions cite the inland villages that were abandoned as a result of disease about this time. They included Taurama (Porebada), Daeroto and Darebo, and other villages also suffered. Oral traditions state that disease rather than war as stated by Seligman (1910:41), wiped out the Namura section settled at Keiva. A weakened population found it difficult to withstand Koiai raids and retreated to the coast.

Wars were an important factor in reducing populations. Among unrelated groups
the goal of much warfare was annihilation. Keapara chiefs told Chalmers (1887:97) that, if women and children were allowed to live, their enemies would eventually recover sufficiently to take their revenge. Besides, Tubusereia, Taurama and Buria, many villages, including Gaba Gaba, Roku and Kila Kila by the Hula are recorded as having been destroyed. The evidence of early Europeans shows that these accounts are not exaggerated. As late as 1893, A.C. English said in his report on the Rigo District that he was going to ‘wind up this list of disastrous slaughter’ (British New Guinea Annual Report 1893/94:App.M).

The Western Motu did not fight each other; conflict between Western Motu and Koita was rare, though it sometimes occurred, for example in the destruction of Buria village by Gunina iduhu of Hanuabada. Different Koita groups fought bitterly among themselves (cf. Seligman 1910:41). At least one major attack was made by Hanuabada and by the new village of Porebada against Boera. Traditions suggest that warfare between the Eastern and Western Motu was incessant until the arrival of the first Europeans.

When the first Europeans reached the Port Moresby area in the 1870s, the region was sparsely inhabited. Many factors combined to keep the population small, including famine, disease and warfare. Before the expansion of various Motu speaking groups and the Koita move to the coast during the last two or three centuries, the coastal population, limited to the few ancient settlements recorded by local traditions, must have been very small indeed. Both the Koita and Motu speaking populations had slowly grown separately from one or two village groups inhabiting several scattered hamlets, into tribes with a number of discrete nucleated settlements. Is there any evidence to suggest that conflict for scarce resources led to warfare and thence to migration? Population pressure is very difficult to measure. Those coastal societies who practised mixed economies—agriculture and gathering with hunting and/or fishing—were not in the category of populations whose soil is exhausted, who have no alternative means of subsistence and who are forced to migrate or starve.

Widespread and specific traditions indicate that the ancestors of the Western Motu living in the Bootless Bay area were driven by Lakwaharu attacks to settle further to the west. The hamlets along the shores of the Bay were the first to be abandoned; later the settlement at Taurama itself was destroyed. Careful examination of the available full genealogies suggests that the destruction of Taurama occurred during, and possibly in the middle of, the eighteenth century. The way to settlement towards the east was blocked by the hostile settlement of Tubusereia towards Gaba Gaba; aggressive tribes to the east once destroyed Tubusereia itself and forced the Eastern Motu villages, founded about the time of European contact, to build their villages on the fringing reef and at times to go ashore only in armed parties. The Western Motu could only move westward. While defeat in war explains why the Western Motu moved into a less favourable environment, the causes of the warfare must be sought.

Wars can occur for a variety of reasons and in Papua New Guinea, as a number of writers have pointed out (Langness 1972:925; Berndt 1972:1053; de Lepervance 1972:1070; Wedgwood 1930–1; Steadman 1971:229–37) the major causes of war may not be economic. Other factors are security, prestige and the struggle for leadership. Once hostilities broke out between two village or tribal groups, they were likely to continue, as treacherous attacks often brought to an end peace that had been concluded. Even though there were a number of settlements in the Bootless Bay area, the population was small, and it seems unlikely that population pressure in the sense that resources were inadequate was the basic cause of conflict. Situated in an empty coast, the nearest western settlement was Vabukori 6.4 km away and Keapara was the major
settlement to the east, a distance of some 110 km. Lakwaharu and Taurama were situated on the fringe of the Bootless Bay area. Comparisons can be made with the Hood Peninsula when by 1900 there were eight settlements within a triangle 11 by 11 by 8 km. Although Thomson’s estimate (1892:57) of a population of nearly 4000 for that area may be too high, the population was considerable. Another example of a dense population is the three discrete settlements situated within 400 m of each other at Keapara Point. They consisted of the large agricultural village of Keapara, a smaller agricultural village called Karawa, and Alukuni, which, as noted above, held no land at all. While population pressure did not exist in terms of absolute scarcity of resources, already hostile groups fishing in the Bay had ample opportunity for conflict.

Oral tradition says that the Koita population has been much larger and it appears to have been greatly reduced by the epidemic already discussed and by warfare. Even so, the Koita population would not have been very great. It is difficult to explain their move to the coast on economic grounds. By doing so they gained few benefits which they did not already enjoy through exchange and they left a more fertile and better watered environment for a less satisfactory one. Defence against Koiai attacks when their population was reduced appears to have been the main reason for the move, as their own traditions state.

Pressure on resources may have been a more important factor leading to migration westward from Hanuabada, which provided the least satisfactory environment in the whole Western Motu area. The large size of the village, as Susan Bulmer (pers. comm.) suggests, was possibly due to dependence on fishing and sago rather than on gardening. Those who moved to Rea Rea and Manumanu enjoyed a more favourable environment, while the people of Porebada had ready access to ample and well stocked fishing grounds in the Idiha and Bava area. Population increase may also have led to the development of the sago trade to the Gulf. These were stateless societies and there was no form of political organisation at the village level in Motu speaking villages, let alone for the whole Hanuabada complex. The immediate cause of migration was often a quarrel within a descent group, as Rea Rea traditions illustrate, coupled with the discovery of a good fishing and gardening area.

Conclusion

The coastal area under discussion should be seen as embracing a number of micro-environments and not as a single macro-environment. The environment was least favourable in the neighbourhood of the present Port Moresby but more so from Bootless Bay to the east and Rea Rea to the west. Any population will seek to meet its needs in the most economical and least dangerous manner possible when an existing economic balance is disturbed. Until such disturbance tradition may inhibit the adoption of new techniques: agricultural villages situated near the coast may not take up fishing, and those who do not make pots may be content not to do so. Populations that are always struggling for survival will not risk adopting new techniques, unless they have compelling reasons for doing so. The ancestors of the Boera people may have gradually developed the *hiri* as an institution as a result of their contacts with the Gulf of Papua, although an increase in population or other cause may have hastened its development.

The factors that have determined migration and settlement patterns have changed over time. While no one knows the state of the environment 700 years ago when Motupore was first settled, the area west of Bootless Bay may have been much more heavily forested. The almost total lack of trees in the Boera area may indicate long settlement there. The economies of peoples settled in the area will also have changed.
Susan Bulmer (pers. comm.) suggests that sago may have been widespread in the area before the area was cleared of forest. Certainly the exchange relationships between Koita and Western Motu when the former lived inland differed from those of a later period when the Koita had joined the Western Motu on the coast. As a result of the coastward move, the Koita became involved in fishing and sea trading and their economies became more alike.

In searching for origins, therefore, too much stress should not be placed on continuity of economic activity of a given population over time. Many central Austronesian speaking populations practised the same type of economy as that of Koiai and Koita. The considerable evidence I have collected suggests that many of the Austronesian speaking peoples settled on the coast, for example a number of descent groups among Velerupu and Aroma villages and Kapari came from inland. They either pushed their way inland and then returned to the coast or some, as Kolia (pers. comm.) suggests, crossed the mountains from the present Milne Bay District. When they moved to the coast they adopted a mixed marine-agricultural economy. All known groups settled along the southern Papuan coast practised some forms of exchange but the patterns varied greatly. The immediate causes of the foundation of the majority of coastal villages were warfare, quarrels within the group and fear of sorcery. Small bands of refugees or adventurers—Tarova people say that Marehau means 'wanderer'—settled often at considerable distance from their village of origin. Both Motu and Koita speakers can be included within these categories.

The combination of several descent groups into large nucleated villages appears to have been a late development among Motu and Koita speakers and many populations lived in small scattered settlements until European contact. Many examples of such scattered settlements can be found among Kivori, Koita, Marehau, Vulaa, Waima and other tribal groups. Defence may have been the main factor leading to larger villages. These conclusions are based on all available evidence, including oral tradition; when such tradition is detailed, extensive and interlocking, as it is here, it should be accorded a high degree of probability unless there is convincing evidence to the contrary. According to this evidence part of the small Motu speaking population established in and around Bootless Bay was driven by warfare first to settle on the shores of Port Moresby Harbour and later to spread further westward. The environment into which they moved was the poorest along the southern Papuan Coast and in no way constituted an 'ideal ecological niche'. There is no evidence that the Motu speaking populations practised long-distance trading before they moved from Bootless Bay and there is evidence that the hiri expeditions, as developed by the time of first European contact, were of recent origin. In areas where food shortages were less severe, hiri expeditions were either not undertaken or were reduced in scale.

The Motu speaking settlers in the Bootless Bay area were in contact with inland peoples, but traditions and the present system of land rights suggest that they were Koiai rather than Koita and some descent groups were absorbed by Motu speakers at Tubusereia. The Koita, after settling on the coastal plains, were driven as a result of Koiai pressure to settle among or near the Western Motu on the coast. Their coastward movement was accelerated by an epidemic that reduced their population in the middle of the nineteenth century and continued into the present century.

Appendix

Population of the Port Moresby Area

Allen calculates, from an LMS census taken in 1888–9, that the Western Motu population was 3178 and the Eastern Motu population was 1389. This figure includes a guessed population of
200 for Barakau because it was not mentioned, but Barakau was not established until after contact. If the estimated 200 people for Barakau which did not then exist are removed, the two totals are not greatly different. The later figures show a marked increase for Hanuabada while other villages declined. Allen’s figures relate to all western villages and he does not distinguish between Western Motu and other western villages. If, however, we are considering the migration of the Western Motu, a very different figure is arrived at.

<table>
<thead>
<tr>
<th>Population Figures</th>
<th>Motu-speaking Villages</th>
<th>Allen’s Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Western Motu</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hanuabada</td>
<td>800(^a) (800(^b))(800(^c))</td>
<td>1310(^e)</td>
</tr>
<tr>
<td>Manumanu</td>
<td>300(^d)</td>
<td>300(^d)</td>
</tr>
<tr>
<td>Porebada</td>
<td>250(^a) (200(^c))</td>
<td>349(^e)</td>
</tr>
<tr>
<td>Rea Rea</td>
<td>450</td>
<td>209(^e)</td>
</tr>
<tr>
<td>Pari</td>
<td>300(^c) (400(^b))(400(^d))</td>
<td>306(^e)</td>
</tr>
<tr>
<td>Total</td>
<td>2100</td>
<td>2474</td>
</tr>
<tr>
<td><strong>Other Western Villages</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boera</td>
<td>450(^a) (300(^c))</td>
<td>315(^e)</td>
</tr>
<tr>
<td>Tatana</td>
<td>250(^a) (60(^b))(200(^d))</td>
<td>205(^e)</td>
</tr>
<tr>
<td>Vabukori</td>
<td>200(^a) (200(^b))(200(^c))</td>
<td>184(^e)</td>
</tr>
<tr>
<td>Total</td>
<td>900</td>
<td>704</td>
</tr>
<tr>
<td><strong>Eastern Motu</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaba Gaba</td>
<td>450(^d)</td>
<td>450(^d)</td>
</tr>
<tr>
<td>Gaire</td>
<td>350(^c)</td>
<td>263(^e)</td>
</tr>
<tr>
<td>Tubusereia</td>
<td>350(^c)</td>
<td>476(^e)</td>
</tr>
<tr>
<td>Barakau</td>
<td>—</td>
<td>200(^e)</td>
</tr>
<tr>
<td>Total</td>
<td>1150</td>
<td>1889</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4150</td>
<td>4567</td>
</tr>
</tbody>
</table>

\(^a\) Laws 1876  
\(^b\) Stone 1880  
\(^c\) Chalmers 1883  
\(^d\) Chalmers and Gill 1885 (Manumanu 1880; Gaba Gaba 1884; Tatana 1885)  
\(^e\) LMS Annual Report 1890 (Rosenstiel 1958:145)

The figures above are based mainly on the present number of Koita descent groups in the village concerned and are therefore speculative. They possibly represent underestimates of the Koita components of coastal villages. The villages concerned are Pari less the Koita component (say subtract 15 per cent), Porebada less the Koita component (say subtract 10 per cent), the Western Motu component of Boera (say 20 per cent), Rea Rea less the Koita component (say subtract 15 per cent) and Manumanu with no Koita component. As Allen points out (pers. comm.) Chalmers (1887:1) estimated the Koita population of Hanuabada to be 300, so I have subtracted 40 per cent. On this basis the Western Motu element in the population according to Allen’s figures would have been 2033 and according to my figures it was 1662.

Only part of the Koita population shared villages with the Western Motu. Koita in Pari, Vabukori, Porebada, Boera and Rea Rea formed only a small proportion of the total populations of these villages. Writing in 1876, Lawes said that the population of Baruni was 250 and Chalmers (1883:64) estimated the Kila Kila population to be 300. There were at least five other discrete Koita villages. While no reliable estimates are possible, a total Koita population of about 1500 people seems reasonable. As noted in the text, the Koita population appears to have been reduced by an epidemic shortly before European contact.
**Prehistory and the environment**

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The Melanesian environment

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Papuan Villager 1929–41. Port Moresby.


The Pacific area houses about 1500 languages, which can be divided into Austronesian and Non-Austronesian groups. The Austronesian languages have a common proto-language, which appears to have been spoken by a people on the Southeast Asian mainland, whose descendants took versions of it to New Guinea and ultimately Polynesia. The Non-Austronesian languages fall into several unrelated groups. Although their distribution is still a matter for conjecture, it seems likely that it is best explained by a series of migrations to and from the New Guinea area.

The Pacific region is linguistically one of the most, if not the most, diverse areas in the world. Excluding Southeast Asia and Australia, there are about 1500 languages spoken in the area.1

These languages are generally referred to as belonging to one of two distinct and unrelated groups—Austronesian and Non-Austronesian. The Austronesian languages are all related to one another and are all descended from one proto-language, Proto-Austronesian, although, as we shall see, there are a number of divisions, or branches, within this broad grouping. The Non-Austronesian languages are not all related to one another but fall into a number of separate groups of different sizes as distinct from one another as English and Arabic. They are not descended from one common ancestor (at least they do not seem to be on present evidence) or single proto-language, but from a number of them. That is, there is no such thing as Proto-Non-Austronesian corresponding to Proto-Austronesian. However, for descriptive convenience linguists traditionally talk about them as though they were all related by referring to them collectively as 'Non-Austronesian'. Some also use the term 'Papuan' to refer to these languages but here we shall not use this term (except when quoting from another author’s work). We do this to avoid confusion with the present political division of Papua and to avoid the suggestion that these languages are all related to one another as the Austronesian languages are.2 Our purpose is to outline the present classifications of these languages and review briefly the cultural-historical implications of their distribution and relationship to one another.

1 The exact number of languages is not known because some areas are not freely open to linguists (e.g., parts of the interior of Irian Jaya) and there are also many dialect chains which make the definition of languages quite arbitrary. Although the identification and classification of these languages is not complete, linguists are fairly certain that the linguistic picture that is described here will not be significantly changed by the recording of the remaining languages (estimated to number no more than 50–100). It is highly probable that these languages will be found to belong to the large groups and subgroups of languages that have already been established.

2 In fact the term 'Papuan' could usefully be reserved for the largest group of related languages described later, viz. the Trans-New Guinea Phylum languages.
Before doing that, however, we should point out that the validity of the cultural-historical conclusions drawn from the linguistic pictures presented depends very much on the validity of the genetic classifications that are put forward. In a brief outline such as this it will not, of course, be possible to go into the finer points of the methods (and the assumptions underlying them) that have been used for these classifications, nor into controversial issues and problems associated with them (see McElhanon 1970 and Wurm 1972), although we feel we should outline briefly the principal features of the techniques that have been used for the benefit of the non-specialist.

These techniques are of two types—the classical one of comparing languages in detail and of reconstructing earlier stages in their history, and a more recent one of comparing only certain parts of languages. The former is known as comparative or historical linguistics. The subgroups that result from the application of this method are the most reliable that can be achieved with any method, and the reconstructed parts (especially the vocabulary) can also be used for cultural-historical suggestion. However, in areas like New Guinea, where the language situation is so complex and diverse, linguists have had to be content with using the second method to try and obtain a quicker insight into the relationship between the large number of languages. The method most commonly used is one of counting what is known as ‘basic’ vocabulary items (that is, selected sets of items that are thought to be common, or basic, to all known human societies and that are thought to change only very slowly and at a fixed rate). Hymes (1960) provides an early review of this technique, the different varieties of which are known collectively as lexicostatistics (but where the results are used to suggest a time-depth of separation of two or more languages it is known as glottochronology). The results of the application of these vocabulary counting methods can be regarded only as preliminary and subject to confirmation by more detailed comparison. Furthermore, they do not allow of the reconstruction of earlier stages in the history of the languages, so they do not provide that extra information for making observations about the culture of a particular era.

Finally one should also distinguish between linguistic (pre)history and the actual (pre)history of populations—the two do not necessarily coincide. It is possible, for example, for cultures to change without peoples and languages changing, and vice versa, and the traces left behind, if there are any, become more difficult to identify the further one goes back in time. In what follows then we shall attempt as far as possible to keep the reader informed of the reliability of the classifications and their interpretation in cultural-historical terms as well as making the simplifying assumption in many cases that linguistic history coincides with actual history.

The Austronesian Languages

Distribution and Classification
Linguists today recognise about seven or eight hundred languages of the Pacific area as belonging to a single large language family, known as Austronesian (AN). In the western region, AN languages occur in Indonesia, Malaysia, the Philippines, Taiwan and Madagascar, and a few are found in Vietnam and south China. In the Oceanic region, all the languages of Polynesia, Micronesia, Fiji, New Caledonia, and the New Hebrides are AN, as are almost all the languages of the Solomon Islands. AN languages are found in the Admiralty and Western Islands, in most areas of New Ireland, and in coastal areas and offshore islands in New Britain and Bougainville. They also occur on the New Guinea mainland itself, thinly scattered from the Bird's
Fig. 10.1 Distribution of languages in Melanesia
Head in Irian Jaya along the north coast of the island to the border between the Central and Gulf Districts in Papua (see Figure 10.1).

In this section we will examine what has been achieved by the comparative study of these languages. We will pay particular attention to attempts at subgrouping these languages, for the nature and composition of linguistic subgroups can give considerable historical information. In doing so, we will examine in particular the problems involved in classifying the languages of Melanesia, the most complex area within the AN region. We will also pay attention to the cultural-historical information provided by the reconstruction of the vocabulary of earlier stages on the AN languages.

The Melanesian Problem

It was recognised very early that there were considerable similarities in vocabulary between Malay and other languages of the Indonesian area on the one hand, and the languages of Fiji and the Polynesian Triangle on the other. As early as 1784, Lorenzo Hervas y Panduro had recognised the existence of a genetic grouping of these languages, although it was not till 1836 that von Humboldt used the term 'Malayo-Polynesian' to refer to it (Dyen 1971:5). Both the physical differences and the linguistic diversity of the Melanesians and Micronesians, however, seemed sufficient to exclude them from this grouping, and it was only a fortunate historical accident that the first Melanesian languages studied in any detail (Fijian, Motu, Mota) were those that were most closely related to the languages of Polynesia and Indonesia. Even so, it was only late in the last century that linguists like Kern, Codrington and Ray began to find that many of the languages of these regions did belong to this grouping, and only in 1899 that Schmidt coined the term 'Austronesian', which is now used in preference to the regionally biased term 'Malayo-Polynesian'.

The linguistic complexity of Melanesia has been the major cause of disagreement among linguists attempting to discover the nature and degrees of relationships obtaining among the AN languages and the probable historical development of the modern situation. Part of this complexity involves sheer numbers: there are about eleven hundred languages spoken in the Melanesian area, and of these four hundred or more are AN—that is, at least half the family is found in a region occupied by fewer than four million people.3

More important than the mere number of AN languages in Melanesia, however, is their incredible heterogeneity. Observers have been impressed with a certain amount of commonality among Melanesian (MN) languages and between MN and other AN languages,4 but they have been even more aware of often extreme differences in phonology, grammar and vocabulary both among MN languages and between MN and other AN languages. Grace (1968:67), for example, speaks of both 'a characteristic uniformity and ... a remarkable diversity among the Melanesian languages'; while Dyen (1965:53) notes 'a concentration of relatively remotely related languages in the

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5 Pawley (1973) gives the distribution of Austronesian languages in: Fiji 2; Rotuma 1; New Hebrides 110; New Caledonia and Loyalty Is. 26; Solomon Is. 85; New Britain 25; New Ireland and adjacent islands 26; Admiralty and Western Is. 25; Milne Bay District PNG 40; Central District PNG 10; Northern and Morobe Districts PNG 21; Madang and Sepik Districts PNG 16; Sarni Coast and Jayapura area (Irian Jaya) 18. Of these, about ten are Polynesian outliers, but at least another ten are found in areas west of the Sarmi coast (Capell 1962b). This gives a total of at least 405 Austronesian languages in Melanesia.

4 By the term 'Melanesian' (Melanesian) we mean those Austronesian languages of Melanesia that are not Polynesian outliers.
New Guinea and Melanesia areas' as opposed to concentrations of relatively closely related languages in areas like the Philippines and western Indonesia, or the eastern Carolines and eastern Polynesia. Linguists have thus been careful to attempt to explain both the uniformity and the diversity, but different emphases have led to different classifications with, obviously, different cultural-historical explanations. We will explore these classifications and their implications below.

Before doing so, however, it is important to clarify the MN linguistic situation. Excluding the eight or so Polynesian outlier languages (PN) in Melanesia, there appear to be three basic 'types' of MN languages. Two of these have been specifically identified by Grace (1962:409):

- there are many languages in Melanesia which show many recognizable cognates with most Austronesian languages everywhere, while there are other languages which are generally accepted as Austronesian but which show very few recognizable cognates with other Austronesian languages.

Languages of the first type belong to the generally recognised Eastern Oceanic subgroup discussed below, and are found in Fiji, the northeast and central New Hebrides, and the southeast Solomons. Languages of the second type are found elsewhere in Melanesia, with the exception of New Caledonia and the Loyalties, the southern New Hebrides, and parts of the New Guinea north coast, where a third type of MN language is found—languages that not only show few cognates with other AN languages but whose phonological history is so complex that many of these cognates are extremely difficult to recognise. These three types are illustrated in Table 10.1, with Fijian representing the first type, Suau (Milne Bay, Papua) the second, and Lenakel (Tanna, New Hebrides) the third. Proto-Austronesian (PAN) reconstructions are also given, and forms or parts of forms in each language cognate with these PAN forms are in bold type.5

<table>
<thead>
<tr>
<th>WORD</th>
<th>PAN</th>
<th>FIJIAN</th>
<th>SUAU</th>
<th>LENAKEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>eye</td>
<td>*maCa</td>
<td>mata</td>
<td>mata</td>
<td>nimir-</td>
</tr>
<tr>
<td>four</td>
<td>*empat</td>
<td>vaa</td>
<td>hasi</td>
<td>kuvir</td>
</tr>
<tr>
<td>liver</td>
<td>*qatay</td>
<td>yate</td>
<td>ate</td>
<td>nakanmop-</td>
</tr>
<tr>
<td>three</td>
<td>*telu</td>
<td>tolu</td>
<td>haiona</td>
<td>kisil</td>
</tr>
<tr>
<td>road</td>
<td>*zalan</td>
<td>sala</td>
<td>dobila</td>
<td>suatu</td>
</tr>
<tr>
<td>hear</td>
<td>*dejer</td>
<td>rojo</td>
<td>atai</td>
<td>arou</td>
</tr>
</tbody>
</table>

*Reconstructed forms

**Table 10.1**

*PAN and MN cognates*

The Oceanic Hypothesis

While there is no generally accepted classification of all the AN languages, there is a significant body of opinion that all the languages of Polynesia, Micronesia (except Palauan and Chamorro) and Melanesia (except those west of Geelvink Bay in Irian

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5 A form is reconstructible in a proto-language if cognate forms are found in at least one language in each of at least two first order subgroups, and if the relationship between the forms cannot be explained by borrowing. Such reconstructed forms are preceded by an asterisk to indicate their hypothetical status.
Jaya) belong to a single large subgroup of the AN family, now known as Oceanic. The exact position of the Oceanic subgroup relative to the languages of the western AN area, however, is not known; whether these western languages form a single subgroup co-ordinate with Oceanic or more than one such subgroup, or whether Oceanic should be grouped in a larger subgroup with some western languages is a question still being debated and researched.

Crucial to the Oceanic hypothesis is the fact that, despite the heterogeneity of the MN languages, there are sufficient phonological, grammatical, and lexical similarities shared by the MN, PN, and Micronesian (MC) languages over against the languages of the west that suggest that they all derive ultimately from a single ancestor language, Proto-Oceanic (POC), which itself is one of the descendants of PAN. Examples of the evidence cited are the merger in all Oceanic languages of certain PAN proto-pho nemes kept apart in all western languages; grammatical features like the alienable/inalienable possessive distinction found in Oceanic but not in the west; and a significant number of vocabulary items that appear in one region but not the other. Proponents of the Oceanic theory (Dempwolf, Milke, Grace, Biggs, and Pawley, inter alia) argue, on the grounds of economy, that these innovations occurred only once, and in only one language (POC), and that the presence of these diagnostic features in Oceanic languages is due to common inheritance from this ancestor language (and thus to membership of the same subgroup) rather than to a number of identical but independent innovations in a number of languages.

Research into the lower order subgroups of Oceanic is still proceeding, and although certain postulated low level groupings appear secure, the general picture is still unclear. A secure subgroup of importance to the present discussion, however, is Eastern Oceanic (EO) to which belong the languages of Polynesia, Fiji and Rotuma, northeast and central New Hebrides, and the southeast Solomons (Pawley 1972). The Oceanic hypothesis rests largely on the ‘characteristic uniformity’ of the MN languages. Not a great deal of effort has been expended in attempting to explain the ‘remarkable diversity’, although Pawley’s (1972:4) statement probably represents the general view:

The lexical disparities between the languages of Melanesia have long been notorious, and were one of the reasons for Ray’s hypothesis of Papuan substrata (discussed below). An alternative explanation ... is an uneven rate of change among Austronesian languages, with some (not all) of the languages of Melanesia changing a good deal faster than the bulk of Austronesian languages. Reasons for faster rates of lexical replacement in the area have not been systematically investigated but word taboos and the influence of Papuan languages on small enclave AN languages have been mentioned as possible factors in some cases.

The Oceanic hypothesis also implies a general west to east movement of peoples from an Asian mainland homeland, where the more conservative AN languages are found, to the Oceanic area, where more simplified languages occur, Polynesia being the last major area settled. Much of this general assumption has been confirmed by archaeological evidence.

Other Hypotheses
A number of other hypotheses as to the classification of the AN languages have been

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6 There is a certain amount of evidence (Blust 1974) that certain languages of eastern Indonesia may in fact belong to the Oceanic subgroup.

7 Motu and its relatives on the central Papuan coast are quite closely related to the EO subgroup, and may eventually be shown to belong to it.
proposed. Two of these, which would have important cultural-historical implications, are examined here.

Ray and Capell classify the AN languages into four co-ordinate first order subgroups: IN, MN, MC, and PN. While noting that 'the position of MC is so vague that no challenge [to its status in this classification] as yet touches it' (Capell 1962a:388), both Capell and Ray feel that there are sufficient differences between MN and PN to support their theory that they are co-ordinate groups of equal antiquity, and to contradict the view that MN and PN languages belong to a single Oceanic group, and that within this group PN languages subgroup (as members of EO) with some but not all MN languages.

In support of this view, Capell (1962a:389–90) notes that the presence of the ‘compound consonants’ kp and ym and of closed syllables in MN but not in PN is sufficient phonological evidence; that the MN SOV or SVO order and the subclassification of alienable possession-types as opposed to PN VSO and the absence of this subclassification is sufficient grammatical evidence; and that the fact that some words are ‘typically’ MN and others ‘typically’ PN is sufficient lexical evidence to postulate the separate status of MN and PN.

The ‘remarkable diversity’ of the MN languages is explained as being due to the individual mixing of the (IN) language of each immigrant group with the non-Austronesian (NAN) language or languages spoken by the indigenous inhabitants of the area settled by the Austronesians. The resultant pidgin languages retained largely AN grammar but also a considerable amount of vocabulary from NAN substrata.

On the first point, most linguists feel that Capell’s arguments for distinguishing MN from PN as separate groups, while sufficient to distinguish PN as a closed subgroup, do not take into account the many similarities shared by all MN, MC, and PN languages as members of a single subgroup. They also feel that there is a very considerable body of evidence pointing to the existence of the EO subgroup, which includes all PN languages and some but by no means all MN languages (cf. Pawley 1972).

On the second point, some linguists feel that the pidginisation thesis may explain some aspects of the MN linguistic picture; e.g., the fact that certain MN languages show many more, and many more recognisable, AN cognates than others, the general simplification of the MN and PN languages as compared with those of Indonesia, and the physical differences between speakers of MN languages and speakers of other AN languages (Grace 1962). We might also point to languages like those of central Papua, where SOV order and postpositions occur—features rare in AN languages but common among the neighbouring NAN languages. On the other hand, Grace (1962:409) has also raised two points very important to the thesis as presented by Capell:

I find it hard to overcome a conviction that the contact between one Indonesian and one non-Austronesian language would have led to very different results from the contact between another Indonesian language and a quite different non-Austronesian language. However, proponents of the pidginization hypothesis acknowledge a tendency to uniformity in the “Indonesian” vocabulary found in Melanesian languages as well as a phonological and morphological similarity among Melanesian languages in general as opposed to Indonesian languages ... Another reason why I am skeptical of the pidginization hypothesis in its present form is the failure of investigators so far to show any connection between the presumed “non-Austronesian” vocabulary of the Austronesian languages in Melanesia and any known Papuan (=NAN) language.

While the Oceanic hypothesis rests largely on the ‘characteristic uniformity’ of the MN languages, and the pidginisation hypothesis, while acknowledging this, attempts
to explain the 'remarkable diversity' by pidginisation or substratum influence, a lexicostatistical classification of the AN languages carried out by Dyen (1965) is very much concerned with the lexical diversity of the MN languages. Dyen's classification shows that PAN originally split into forty first order subgroups. One of these, the Malayopolynesian Linkage, comprises most of the languages of the IN area and virtually all those of the Oceanic area recognised by Grace, Biggs, and Pawley as belonging to the EO subgroup. Of the other thirty-nine subgroups, thirty-three are found solely in Melanesia and four (Yapese, Nauruan, Carolinian, and Enggano) on its borders. On the basis of the age-area hypothesis—that the area of greatest linguistic diversity is probably the area of earliest settlement—Dyen (1965:54) notes that the lexicostatistical evidence points to the east New Guinea/Melanesia area as the homeland of the AN languages. He does recognise, however, that non-lexicostatistical evidence (like the merger of certain PAN phonemes mentioned before) militates against this theory and, finding that Taiwan is the most linguistically diverse region west of Melanesia, he proposes this as an alternative candidate for the AN homeland.

Dyen's particular classification has been strongly attacked by Grace (1966), partly in terms of his general procedure and partly in terms of the underlying theory. Grace notes that a number of the percentages may be inaccurate, and that a minor restatement of the method of subgrouping would lead to quite different results. With a number of linguists, he believes that shared innovations in phonology and grammar are at least as important as vocabulary retentions in deciding questions of subgrouping.

On demographic grounds, too, it seems difficult to justify the settlement of the populous IN area and parts of the Asian mainland from a relatively sparsely populated area like Melanesia, while most modern culture historians accept the archaeological evidence of a general west to east movement of man and his material culture from the Asian mainland into Oceania. Perhaps the most useful aspect of Dyen's classification is its highlighting of the lexical diversity among the MN languages. Dyen himself notes that there is considerable evidence of a non-lexicostatistical kind supporting the Oceanic hypothesis; 'what is remarkable is that there is no lexicostatistical evidence for [this grouping] in the present classification' (Dyen 1965:55).

Cultural-Historical Implications

Comparative linguistics provides various kinds of evidence about the past, some corroborating archaeological data and some complementing it. Two aspects in particular are important. The subgrouping of languages indicates that these languages, and thus their speakers, underwent a period of common development apart from all other languages (and their communities) not belonging to the subgroups. Basing our argument on subgrouping hypotheses, we can in many cases determine patterns of settle-

8 Many of Dyen's first order subgroups contain only a single language. However, it should be remembered that Dyen surveyed just over 200 (no more than 30 per cent) of the Austronesian languages. If a fuller survey had been done, many of these subgroups may have been shown to be composed of a number of languages.

9 For example, Dyen (1965:42) notes that Tanna—specifically the Lenakel language (George Grace, pers. comm.)—has its highest relationship with Fijian, the figure being 11.2 per cent. One of us has shown that this figure should in fact be of the order of 20–24 per cent and that Lenakel has an even higher percentage (around 29 per cent) with Anetityum, another language used in Dyen's survey.

10 Dyen (1965:55) himself notes that the merger of certain PAN phonemes in Oceanic languages is important, since 'a merger is evidence for grouping together the languages showing the merger'.

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Prehistory and the environment

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ment and migration, and can in some cases date relatively accurately the various splits in proto-languages. In addition, the reconstruction of vocabulary in the various proto-languages can give us considerable information about the culture and environment of the speakers of the original proto-language and the cultural and environmental changes that occurred at various periods in its development.

The Oceanic hypothesis implies, on the basis of subgrouping evidence, a general west to east movement of the Austronesians from a PAN homeland on the Southeast Asian mainland to a POC homeland probably somewhere in the east New Guinea area, and thence into the Pacific, with Polynesia being the last major region to be settled. Grace (1968:73) summarises Milke’s views on the breakup of Oceanic as follows:

The speakers of Proto-Oceanic lived for an extended period in contact with speakers of earlier stages of Philippine, Celebes, and eastern Indonesian languages ... After the breakup of Proto-Oceanic, the languages ancestral to present-day New Guinea languages remained in contact with languages ancestral to present-day eastern Indonesian languages.

More detail on the actual time-depths involved are given by Pawley and Green (1973):

If Oceanic languages were present in Southern Melanesia by 3,000 B.C. and in Fiji and Tonga by 1,300–1,100 B.C., the disintegration of Proto-Oceanic cannot have occurred later than 3,000 B.C. and may well have occurred earlier ... The disintegration of Proto-Austronesian must have preceded that of Proto-Oceanic by at least a few centuries. The innovations characterizing the Oceanic subgroup indicate a reasonably lengthy Pre-Oceanic period, i.e. the period of unified development between separation from Western Austronesian language and the breakup of Proto-Oceanic. A date of 4,000 B.C. or earlier for the initial dispersal of Austronesian languages begins to look reasonable.

Attempts at reconstructing the vocabulary relating to the environment of the AN homeland and the culture of the speakers of PAN were made as far back as 1889, by Hendrik Kern. Blust (1976) notes that PAN speakers were settled people, occupied villages which contained both some kind of public building and dwelling units, raised on posts (and thus entered by ladders), with thatched gabled roofs, internal hearths, and a number of storage shelves and wooden headrests. They possessed domesticated pigs, fowls, and dogs. They hunted, potted, wove (both mats and baskets and also true fabrics), used needle and thread, tattooed themselves, chewed betel and drank some kind of intoxicating drink. Iron was known, as was writing. They had a well developed maritime technology, but also cultivated root crops, as well as rice and millet, which were ground in wooden mortars. They hunted heads, and used the bow and bamboo stakes in their hunting. Blust (1976) notes that

the somewhat mixed picture that emerges from these interpretations (with stone tools next to iron, probable bark cloth next to textiles, root crops next to grain) suggests a polymorphous economic base incompatible with the somewhat rigid notion of ‘progress’ from one exclusive level to the next.

Obviously, while a much more complete cultural-historical picture can be reconstructed for the lowest order proto-languages, little more can be said for proto-Oceanic, apart from the loss of grain crops, iron, writing, and probably the loom.

A number of minor east to west migrations have also taken place—we might note specifically the settlement of certain islands in Melanesia by Polynesians moving west—but the major direction of population movement seems to have been eastwards.
Fig. 10.2 Phylum level Non-Austronesian language groups in New Guinea
The Non-Austronesian Languages

Distribution and Classification

As already noted Non-Austronesian languages constitute a separate category from Austronesian. They belong, not to a single large group as the Austronesian languages, but instead to a number of unrelated groups of different sizes concentrated in the New Guinea area—see Figures 10.1 and 10.2. Most of these languages are to be found on the New Guinea mainland (except in those areas where Austronesian languages are now located) with scattered members in Indonesia on the islands of Timor, Alor, and Pantar in the southwest, and on the northern half of Halmahera in the northwest. Some are also to be found scattered across the larger islands to the east of New Guinea from Rossel Island through New Britain and New Ireland down through the Solomon Islands chain as far east as the Reef and Santa Cruz Islands. Approximately 700 languages are crowded into this small area—or about as many as there are Austronesian languages spoken in the whole Pacific region. It is little wonder then that most of these languages are small, with numbers of speakers ranging from a few dozen to several thousand. A very few languages do have speakers in excess of 50,000 but these are rare. The largest language is Enga, spoken in the district of the same name in the Western Highlands of Papua New Guinea. This has speakers numbering approximately 150,000. The total number of speakers of Non-Austronesian languages is estimated to be only about two and three-quarter million.

Given the large number of languages and the relatively small number of speakers of each it is easy to understand how early linguists and others gained the impression that the island was inhabited by a seemingly endless number of different and unrelated languages and small groups. And this impression persisted until after World War II, when civil administration was re-established and linguists began to study the languages in more detail. This work was begun by Dr A. Capell of the University of Sydney, and has subsequently been carried on by staff and students of the Australian National University as well as by members of the New Guinea branch of the Summer Institute of Linguistics. The results of this research have been continually assessed, summarised, and publicised by Professor S. A. Wurm (1960, 1964, 1971, 1972, 1975) of the Australian National University.

In these accounts languages have been assigned to groups of different size depending on the degree of similarity of vocabulary, grammar and sound systems. Generally speaking, and except for considerations outlined below, languages are assigned to the same family if they share 28-81 per cent of basic vocabulary and have similar grammars. They are assigned to the same stock if they share about 12-28 per cent basic vocabulary and some grammatical features, and to the same phylum if they share between 5-12 per cent basic vocabulary and have a few grammatical features in common. Where families, stocks, and/or phyla are found to consist of only a single language these are described as family, stock, and phylum level isolates. On the other hand where stocks and phyla are found to consist of single stocks these are referred to as phylum level stocks.

Now while these percentages and other similarities provide general guidelines for the classification of Non-Austronesian languages, there are other considerations that have to be taken into account in making final decisions about the relationship between languages, families, and stocks. These considerations are dependent on a growing awareness amongst linguists interested in these languages that they contain many aberrant features that mask the true origin of the languages. Thus, for example, Austronesian loan words have been found in Non-Austronesian languages far from
the coast, and most Non-Austronesian languages contain pronouns that belong to a small number of different sets and that generally co-occur with certain other features in the same languages (see the Appendix to this chapter). The probable reason for this situation is that these pronoun sets and other associated features represent the remnants of former languages that once came into contact with the ancestors of present day languages, influencing and mixing with them. This mixing of language features seems to reach such a degree in some cases that it becomes difficult to make other than arbitrary decisions about including particular languages in one or another language group. This is further complicated by the fact that all present day languages show influences upon one another also. Thus decisions as to whether the resulting similarities between present day languages are due to borrowing and mixing or are the reflexes of former common parental features are sometimes difficult or even impossible to make. Different classifications therefore can result from emphasising one set of features over another. In other words any classification of Non-Austronesian languages reflects both genetically inherited features and borrowed ones.

These points have gradually come into more prominence as more evidence has been collected and Professor Wurm has taken them into consideration in drawing up his latest classification. In this classification Professor Wurm suggests that all but eight of the so far identified Non-Austronesian languages belong to five major and six minor phyla as follows:

Major Phyla

The five major phyla are:

1. The Trans-New Guinea Phylum. This is the largest of all the phyla and covers the greater part of the New Guinea mainland except for areas around Geelvink Bay and the northern half of the Bird’s Head in Irian Jaya, and the Sepik and lower Ramu basins in Papua New Guinea. Non-Austronesian languages in Alor, Pantar and Timor also belong to this phylum. In his account Wurm estimates that 491 languages (or 67.9 per cent of all Non-Austronesian languages) belong to this phylum.

2. The Sepik-Ramu Phylum. This is the second largest phylum. It contains ninety-seven languages (or 13.4 per cent of all Non-Austronesian languages). These languages occupy the Sepik Districts and a west coast section of the Madang District of Papua New Guinea around the lower Ramu River.

3. The Torricelli Phylum. This contains only forty-seven languages (or 6.5 per cent of all Non-Austronesian languages), which are spoken in a small northern section of the Sepik Districts of Papua New Guinea, but mostly just inland of the coast to the west of Wewak.

4. The East Papuan Phylum. Languages in this phylum are located entirely within the islands to the east and south of Papua New Guinea including Rossel Island off the southeast tip of the mainland. There are twenty-eight East Papuan Phylum languages (or 3.9 per cent of all Non-Austronesian languages).

5. The West Papuan Phylum. This is the smallest of all the major phyla and contains only twenty-four languages (or 3.3 per cent of all Non-Austronesian languages). These are spoken in the northern half of Halmahera and in the northern part of the Bird’s Head of Irian Jaya.

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12 See Wurm (1972:145-9) for a list of criteria that he uses for the classification of Non-Austronesian languages, and pp. 149-51 for some illustrations of how these criteria are applied.
Minor Phyla
The six minor phyla are:

1. The Sko Phylum Level Stock. Eight languages belong to this stock. These are to be found in the northern border coastal area between Papua New Guinea and Irian Jaya. The total number of speakers approximates six and a half thousand.

2. The Kwomtari Phylum Level Stock. This stock contains five languages which are spoken in the northwest of the West Sepik District of Papua New Guinea inland of the Sko Stock with one of its members separated from the others by several isolates. This language is to be found just across the Irian Jaya border west of the last Sepik-Ramu Phylum languages. There are about 3300 speakers of Kwomtari languages.

3. The Arai or Left May Phylum Level Family. This family is located in the West Sepik District on the southern side of the Sepik-Ramu Phylum and contains six very small languages whose combined population is estimated to be no more than 1600.

4. The Amot-Musian Phylum Level Stock. This is a very small stock of approximately 300 speakers situated in the area between the Kwomtari Phylum Level Stock and the Arai or Left May Phylum Level Family. It contains only two languages.

5. The Geelvink Bay Phylum. Four Geelvink Bay Phylum languages, with a total of about 8000 speakers, are spoken in the eastern coastal area of the bay of the same name in Irian Jaya as far east as the Mamberamo River and on Yapen Island in the same bay.

6. The East Bird's Head Phylum Level Stock. This stock is to be found in the eastern portion of the Bird's Head Peninsula. It is represented by only three languages. There are estimated to be 16,000 speakers of these languages.

Isolates
The eight other languages, which are referred to above and which do not (on present—rather sketchy—evidence at least) seem to be related to one another nor to any of the member languages of the phyla just discussed are regarded as isolates pending further investigation. These isolates are scattered across the mainland with two in Irian Jaya (along the Mamberamo River), three in the West Sepik District of Papua New Guinea, and one each in the Morobe, Gulf, and Northern Districts of Papua New Guinea.

Cultural-Historical Implications
Assuming then that the above classification is a reasonable one which roughly (if not accurately) reflects historical processes, what cultural-historical conclusions can be drawn from it?

To begin with there are two sorts of evidence to be considered—one is the distribution of the languages in relation to themselves and to Austronesian languages, and the other the distribution of so-called substratum features that seem to reflect contact between these languages and others at different times.

As far as the first kind of evidence is concerned we have already seen that Non-Austronesian languages are found only in the Indonesian-Melanesian area in a more or less continuous band and are surrounded on all sides (except the southern side where Australian languages are to be found) by Austronesian languages. Thus it seems fairly safe to conclude that the Non-Austronesian languages represent earlier languages than the Austronesian ones. It is not possible to date the antiquity of these languages, but the fact that they (excluding the eight isolates) belong to five major and six minor phyla suggests that they have been there a very long time—perhaps as much as 50–60,000 years, or as long as man has been in New Guinea, which archaeologists
say is upwards of that figure. Unfortunately this is well beyond the range at which any sort of comparative linguistics can hope to provide reliable hypotheses about the history of these languages. Yet if we look at the distribution of these languages in their various phyla we note that this is very uneven. Indeed about 75 percent of the total mainland area is occupied by languages of one large phylum, the Trans-New Guinea Phylum, while most of the remaining languages are crowded together in a relatively small area in the north around the Sepik-Ramu Rivers in Papua New Guinea and around Geelvink Bay and the Bird’s Head in Irian Jaya. Other phyllic groups occupy islands east and west of this, excluding Timor, Alor and Pantar where Trans-New Guinea Phylum languages are found.

This distribution alone is enough to suggest that the Trans-New Guinea Phylum languages represent either a relatively recent intrusion into New Guinea, which has forced the other more diverse languages into their present positions, or that they represent a relatively recent expansion of a group of languages that once existed side by side with these other languages. If the first is true then it is evident that the Trans-New Guinea Phylum languages represent younger languages than those in the fringe areas and that they must have absorbed, if not obliterated, other languages that once probably occupied much, if not all, the area now occupied by the Trans-New Guinea Phylum languages. In this case it is interesting to ask where these languages might have come from? An obvious suggestion is that they came from the west, perhaps somewhere in the Timor area or even further east around the Andaman Islands, since at least one linguist has suggested that these languages are distantly related to the majority of those in New Guinea. It would seem unlikely that they came from the east because no members are to be found beyond the mainland in that direction.

On the other hand if the second situation outlined above is true (or more nearly true) then it is likely that these languages spread from a centre of distribution somewhere in the Sepik-Ramu-Central Highlands area since this area is the area of greatest diversity. In this case we would explain the occurrence of languages on Timor, Alor and Pantar as the result of migrations from the mainland westwards.

There is really no way of deciding between these two possibilities. But neither can be entirely adequate because neither takes into account the various substratum features that have been mentioned and that have been taken into account in establishing the classification. Evidently the picture is much more complicated than the distributional evidence alone indicates.

Professor Wurm, who has studied these languages most as a group and has given a good deal of thought to this situation, has developed an elaborate hypothesis of migrations and counter-migrations to account for all the differences and similarities that have so far been encountered. Briefly his view of the linguistic prehistory of Non-Austronesian languages in the New Guinea area runs as follows.

Between ten and sixty thousand years ago the New Guinea area was occupied by peoples speaking languages that are today probably represented by some, if not all, of the isolates and minor and major phyllic groups so far identified, and/or by some of the features of these and other languages in the Trans-New Guinea and Sepik-Ramu

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13 See Greenberg (1971) whose hypothesis is that, excluding the indigenous languages of the Australian mainland, “the bulk of non-Austronesian languages of Oceania from the Andaman Islands on the west in the Bay of Bengal to Tasmania in the southeast form a single group of genetically related languages for which the name Indo-Pacific is proposed” (p. 807).

14 This account borrows heavily from Wurm (1972) and Wurm et al. (1975). Interested readers should consult these sources for more detailed statements.
Phyla where they occur as substrata. The origin of these languages is unknown but it is probable that they began somewhere in the island world to the west. Perhaps further study of the Andaman languages and languages spoken by so-called Negritos in Southeast Asia may help clarify this. Much later (but pre-5000) two language migrations entered New Guinea from the west—one via Timor, Alor and Pantar Islands, and the other via Halmahera and the Bird’s Head.

These two migrations brought with them different pronoun forms. They seem to have come into contact both in the ‘neck’ portion of Irian Jaya and again in the Central Highlands region around the Irian Jaya-Papua New Guinea border area, where they left behind sets of fused pronoun forms. The first movement continued on into the highlands and other areas of Papua New Guinea now occupied by Trans-New Guinea Phylum languages, and into New Britain and the islands to the east to some extent. This migration, which Wurm calls the First Trans-New Guinea Phylum migration may have been responsible for obliterating older languages (now represented by East Papua Phylum languages or similarities in them) in eastern Papua New Guinea and/or for pushing them out into the islands to the east. It also apparently spread both north and south into Irian Jaya and into the northeast of Papua New Guinea where it has left traces in the pronoun system of Sepik-Ramu Phylum languages.

The other migration, which Wurm calls the Second Trans-New Guinea Phylum migration (though it probably preceded the first migration because typological features and pronominal forms associated with it are met with in many instances as substratum features in language groups attributable to the first), spread mainly into the southern lowlands of present day Irian Jaya as far east as the Trans-Fly area of Papua New Guinea. Certain features are also strongly present in the Central Highlands of the mainland and in the northern central coastal and Sepik-Ramu Phylum areas. Wurm notes that too little is known about most of the languages of northern Irian Jaya to make a suggestion as to whether this stratum reached the northern central coastal and Sepik-Ramu areas via a route from the neck portion through what is today northern Irian Jaya or whether it came from the centre of the mainland. The former is perhaps the more likely. From the centre of the mainland second basic set pronoun forms have to a limited extent, moved east through what is today the highlands of Papua New Guinea into the southeastern tail end and further east into the islands.

The pronouns of the remaining basic set that Wurm identified seem to have moved from the Bird’s Head area along the northern coastal and near coastal areas all the way across to the present day Madang District area of Papua New Guinea. From here they appear to have moved southwards through the central part of the highlands down into the Papuan Gulf region and to a limited extent into the southeastern tail of the mainland and islands.

Following these main migratory movements a major disturbing influence appears to have affected the linguistic picture of the New Guinea mainland in the form of an Austronesian migration centring on the Markham valley. That area appears at that time to have been occupied by a later form of the original Trans-New Guinea Phylum languages, which were characterised by certain sets of subject and object person markers with verbs and certain typological features. These languages appear to have started migrating quite extensively some time after the Austronesian contact which left behind a number of Austronesian basic vocabulary loan words. These migrations spread these features into the Huon Peninsula-Madang District areas nearby, the Central Highlands as far as the Kukukuku (or Angan) area and eventually reached the neck portion of the mainland and Bomberai Peninsula.
Quite independently from the Trans-New Guinea Phylum language migration into the New Guinea area, and probably preceding it by a comparatively short span of time, another language migration, carrying the ancestral form of the Sepik-Ramu Phylum languages, appears to have entered the New Guinea mainland on the north coast approximately in the present day Irian Jaya-Papua New Guinea border area, and penetrated south, and then to the east and northeast as far as the country between the lower Sepik and the Ramu. These languages appear to have been of a comparatively simple kind and this type is still largely preserved in the east where only little if any influence of the Torricelli Phylum languages is discernible in them. In the west the languages have been subject to a succession of multiple influences from various sources.

Finally amongst the small groups in the Western Sepik District, the languages of the Sko Phylum Level Stock are probably relatively late arrivals on the New Guinea scene. They are coastal languages with a tonal morphology which is unique in the New Guinea area, though they also show quite strong Trans-New Guinea Phylum pronominal and lexical influences. The speakers of these languages use tacking sailing canoes which again are unique in the New Guinea area and have their closest occurrences in present day Indonesia. Thus it seems not improbable that these languages, or at least elements in them, originated in the west.

This then is how one authority sees the linguistic prehistory of the Non-Austronesian languages in Papua New Guinea and the surrounding area. It cannot of course be taken as the final answer, nor does it say anything about the culture of the peoples speaking those languages—it cannot, until more intensive comparative work has been carried out and attempts have been made to reconstruct the vocabulary of the various stages of this history. One pilot study along this line has been carried out by one of the authors of the present review but the problems associated with interpreting the results militate against its being used on a wide scale for some time to come (see Dutton 1973). The general impression seems to be, however, that peoples and languages in the New Guinea area have been in contact with one another for a long time and that linguistic features are borrowed and loaned more freely than perhaps has been previously realised. This field is still very much open to speculation and more detailed work.

Appendix

Loan-words in Non-Austronesian Languages

There are two types—Austronesian and Non-Austronesian. As regards the former Wurm (1972:151-2) notes that ‘over a dozen Austronesian loan words—some of them in Eastern Oceanic form’ have been found in Non-Austronesian (or Papuan) languages in the west and far interior of the New Guinea mainland a long distance from the nearest Eastern Oceanic Austronesian language. Some of these are so-called culture items such as ‘pig’ and ‘dog’ but some are basic vocabulary elements such as ‘tooth’, ‘breast’, etc. These words seem to indicate that:

in comparatively recent times in terms of Papuan linguistic prehistory an east-to-west language migration took place through a large portion of the central part of the mainland, with this language migration originating in the Markham Valley area under an Austronesian, probably Eastern Oceanic, impetus. There is additional linguistic evidence available on the structural level to support the assumption of such a language migration which can be mapped out in some detail, and there is also interdisciplinary evidence in its favour such as the recent discovery by prehistorians (J. Golson, pers. comm.) that the presence of the pig in the New Guinea mainland may date back to only 5000 years or less which is approximately the date at which the Austronesians are believed to have entered the New Guinea area. (See Golson, this volume.)
Non-Austronesian loan words in Non-Austronesian languages are not as easily identified and no one has yet attempted to investigate these systematically in these languages. However, in the early seventies Wurm collected together and analysed the original forms for personal pronouns from over four hundred and fifty languages. This study suggested that these could be divided into three main sets, and a fourth minor set, of which the third set seems to be derived from the other two. These sets are regionally distributed in such a way that the first main set 'shows strong correlations with the presence of languages of the large Trans-New Guinea Phylum and seems to be closely associated with it' (Wurm et al. 1975:935–6). They also occur, however, in the western half of the Sepik-Ramu Phylum and in the New Britain-Bougainville area of the East Papuan Phylum.

Pronouns of the second set are mainly encountered in the west Papuan Phylum and in small areas of the southeast part of West Irian, the Trans-Fly area, the central north of the mainland and a few other scattered areas where Trans-New Guinea Phylum languages are spoken in the Torricelli Phylum, and finally in the Solomon Islands of the East Papuan Phylum.

The third set belongs predominantly in the West Papuan Phylum in the Madang-East Sepik District areas, in the central New Guinea Highlands and in northern New Britain. Weaker occurrences are met with along the northern coastal areas of the mainland up to Irian Jaya. As has already been indicated this set seems to be derived from the first two.

Finally the limited fourth set appears to be an old substratum feature found only in unrelated isolates and two highly aberrant sub-phylic members of the Sepik-Ramu Phylum. It seems to appear largely in conjunction with the typological feature of multiple class systems, though multiple class systems are, to a limited extent, also encountered in other parts of the New Guinea area.

Wurm finds that in many languages whose pronouns belong to the first set the following features prevail:

(a) presence of sentence-medial verb forms as distinct from sentence final verb forms;
(b) complex verb morphology including references to aspect, tense, mode and varied sets of persons (subject, object, beneficiary, etc.);
(c) general tendency towards suffixing (though prefixes may be used for marking objects);
(d) absence of overtly marked number in nouns;
(e) absence of gender and noun classes though nouns may be classified by special classificatory verbs;

Languages whose pronouns belong largely to the second set tend to display the following features:

(a) absence of sentence-medial verbal forms;
(b) complex verb morphology but this associated more with verb stem changes and supplementation related to changes in the number of objects;
(c) general tendency towards prefixing;
(d) presence of overtly marked number in nouns.

Languages whose pronouns are largely members of the third set show characteristics which are either those associated with the pronoun forms of the first or second sets though with the first generally predominating.

References


II  Agriculture and the environment
11 Commercial Agriculture in Papua New Guinea

JOHN GUISE

Papua New Guinea is still wasting scarce overseas funds buying from its erstwhile colonial tutors foodstuffs that it could easily produce itself. It must not only become self-reliant in the production of food, but must also produce marketable surpluses so that the small village farmers can share in the cash profits from selling these surpluses on domestic and external markets. This, unlike any other direction in which the economy can develop, will provide cash without destroying the traditional lifestyle and will provide employment for many young people.

Recently Panguna copper mine took over as the number one earner of foreign exchange for Papua New Guinea. Until then the few export plantation crops established by expatriates had been responsible for almost all our export earnings. Unfortunately a lot of people came to believe that these few plantation crops were all that was meant by agriculture in Papua New Guinea.

It is true that we have no real secondary industries as yet, and that we are dependent on overseas manufacturers for such things as saucepans, or axes, or pressure lamps. It is fortunate that we have copra, coffee, tea, cocoa, timber and such things that we can sell to get the money for our imports. Our former metropolitan tutors, who enjoyed their modern comforts, were eager to build up this foreign trade, but it has been taken too far. The nonsense starts when we begin to exchange our scarce foreign earnings for things like foodstuffs, which we can produce perfectly well ourselves. The convenience of established colonial shipping arrangements and sources of supply must not take precedence over our own internal food marketing. It certainly has been doing so, and it must stop.

I say this, with determination, for two main reasons. First, it is necessary for us to break our dependency relationship with our former metropolitan parent, and to be self-reliant. We have the resources, we have the labour. What we need now is that magic word, co-ordination. We need to co-ordinate our efforts if we are to achieve self-reliance in internal food production and marketing. Second, not only are we wasting our scarce foreign earnings buying things that we should be producing ourselves, but we are denying to our village people the opportunity to participate in the cash economy and to share in the dignity and security of earning for themselves what they want and of putting away some cash reserves.

I have mentioned the value of the export crops—well over a hundred million kina each year now—and we have all heard the kinds of sums earned by Bougainville Copper (although, alas, copper prices seem now to be as unpredictable as those of coffee, copra, cocoa, etc.). But I wonder if the world appreciates our internal agricultural production, the people’s own village subsistence farming. If we allocated a mere 20 toea per day as the value of feeding each Papua New Guinean, then I am talking of the
daily provision of half a million kina worth of food, or K180 million worth each year. (The kina is presently on a par with the Australian dollar, the toea is equivalent to the Australian cent.)

Moreover, from many parts of this land surplus production can be obtained with ease. Our task, as I see it, is to provide the market outlets for such surpluses and the skills in storing, marketing, transporting and disposal of them to those areas and institutions which, by their nature, depend on food purchases. The rapidly increasing food imports of the last few years must be halted. Although world food supplies fluctuate, the trend in prices is upwards. The money outlaid by Papua New Guinea in buying the 50,000 tons of rice and 30,000 tons of sugar that it imports each year is money wasted, gone. Other countries with many fewer needs than ours take our money from us most readily. Meanwhile our people are unemployed!

Our fresh food marketing organisation does not have to be an instant commercial success to be worthwhile: the money we outlay to the village grower, to the drivers and to the storemen and clerks remains here. As our organisation stabilises, as our suppliers become more accustomed to producing a steady supply that our consumers can rely on, this venture will strengthen and mature.

Similarly the potential for growing rice and sugar, both of which have advantages of convenience and storability, must be utilised. We must utilise this capacity to grow rice, not necessarily by deploying large capital and mechanical input, but by encouraging smallholder family farming. The aim of this is obvious, to enable growers to be both producers and consumers. Surplus can be marketed, both internally and ultimately on the overseas market by the Government.

In the matter of livestock produce we have had to be very firm with the Australian suppliers of poultry and beef. The dumping of their glut production on our markets can only threaten the achievement of our own self-reliance. Hopefully we might be self-sufficient for poultry and eggs in Papua New Guinea within eighteen months. But that self-sufficiency will be more apparent than real unless the production of adequate supplies of stock feed is achieved. Here we are initially in a more difficult area than with human foodstuffs. For the stock feed must be produced very cheaply, have adequate protein, and be storable. Nevertheless, the very diversity of Papua New Guinea’s areas suggests that grain growing will be successful in some, and work is well advanced with a number of grains. Our most likely source of protein is from the ocean. Indeed Papua New Guinea’s waters offer food for both man and beast. But it is not easy in a humid tropical environment to store and transport fish; it is possible, but expensive. Nevertheless, the need to develop internal sources of supply and marketing arrangements is clear.

I have spoken of my concern with and concentration on building up an internal agricultural development, with emphasis on involving village people in increasing firstly their village subsistence agriculture and secondly production of a surplus that may be sold through the Government for cash income. I have placed this emphasis on increasing the output and quality in the village subsistence sector because we cannot expect internal agricultural commerce to develop until the subsistence sector, on which people depend, is developed first. I believe this for several reasons:

1. Because the village subsistence farming pattern has been neglected by so-called experts who seem to be flooding our country for their own academic benefit.
2. Because I see it as spreading the benefits of a small cash surplus to many village people. Our eight point philosophy is concerned with spreading whatever benefits we can achieve to even the most distant villages. The days when time, money and effort are concentrated in areas where greater economic results are expected are gone. We
are dealing with human beings and their social and economic welfare. Wherever there are people, it is our responsibility to spread the benefits.

3. The Government, through plant research stations of the Department of Agriculture, Stock and Fisheries, must now begin plant breeding of staple foods grown and eaten by the people of this country, in order to promote greater and healthier produce for village subsistence farmers in their village gardens. Still, we have to be realistic. And we have to be imaginative. The five-year road development plan announced by our Government will be of immediate and very great value for our commercial agriculture. But there will still be areas that we can reach only by canoe, or by light aircraft. For those we will have to develop the production of high value, low bulk goods that can be preserved and will stand transporting. Crocodile farming for the lowland areas is already receiving attention and the results are most encouraging. But there are other things like butterflies and beetles, which are sought after by collectors throughout the world, and for which good prices are paid. A study of the potential for these has been initiated, and I am hopeful that they will play their part in winning a little cash for the remote villages, so that villagers may have their share of the trade items that can make life more pleasant. In winning them they will also be contributing to the growth in commerce and to the strengthening in self-reliance of our country.

I now turn to employment or unemployment of human and material resources in this country and their relationship within the meaning of the eight point philosophy. As a result of rapid growth of other sectors of the economy, the relative share of agriculture is bound to decline after a certain stage of development. It is therefore imperative that in order to keep our increasing rate of unemployment at a minimum we must foster a more rapid growth in agriculture, and intensify it. This is necessary for two reasons.

1. To improve the present level of locally produced foodstuffs, not only in quantity, but in quality; the nutritional level must be raised.

2. To develop the production of raw materials for local industries (fibres, oil seeds, timber and timber products, natural rubber, etc.). These two trends would, as I see them, permit the strengthening of the internal market and provide employment for an increasing number of young people who are coming out of primary and secondary schools every year. There are two important consequences: one is that only this intensification of agriculture can provide a very significant and rapidly increasing body of jobs to reduce or even obviate unemployment; the second is that such intensification provides for rural populations the purchasing power and productivity that are essential for the development of local industries. Agriculture belongs to the people. Papua New Guinea has survived for thousands of years on agriculture through her subsistence farming and will continue to survive, regardless of what ‘experts’ may want to say to the contrary.

For this reason agriculture, to my mind, is the base of our economy; agricultural industries are the machinery of our development. The majority of our people are and will long remain dependent on agriculture for subsistence living and agricultural industries for cash income. Agricultural development poses implicitly the problem of mechanisation, tractors, harvesters, etc., but I have always maintained that mechanisation is not indispensible to increasing the output of the internal agricultural economy. I am aware that mechanisation of basic industries would increase production to an extent, but it would also reduce the supply of the basic food items that people would otherwise obtain through traditional means, in ways complementary with their life style and with seasonal changes. Mechanisation would also increase unemployment hand in hand with production.
Before concluding, I would like to pose a couple of questions on what I have said so far. How are we going to meet the people's aspirations in agro-economic development and increase production for internal and external markets without destroying the people's basic lifestyle, and without mechanising production of basic foodstuff? How are we going to increase the employment opportunities for our up and coming young people without following developed countries, where industrialisation is the main source of employment? We certainly cannot depend on copper mines, nor wait for factories to provide employment. This is our biggest challenge today and for years to come. Our unemployed youth, most of whom later will be leaders in their own right, will pose a very serious political, social and economic challenge to the Government and to those citizens who will want to enjoy a decent peaceful living.

My opinion is that we should return to our lands and use them for mixed farming, which would in some small degree provide self-employment. In spite of the problems that I have made mention of, I am absolutely certain that we shall survive by having confidence in our own natural ability and common sense and by co-operating with one another in our respective areas and districts.
Although some change in patterns of subsistence agriculture in Papua New Guinea will certainly come, it is not necessary to see any change as the first step in an inevitable progression from subsistence through cash cropping to complex industrialised forms. The demonstrated flexibility of native systems, combined with the variety of ecological situations and potentials for cultivation, provide the basis from which a range of alternatives can be evolved without destroying the viability of social or natural systems. Past successes with horticultural adaptation include the sweet potato, tobacco, and maize; while the good results obtained from the introduction of cocoa in the Gazelle peninsula show how subsistence farming can form the foundation for development. Suggestions with potential for the future include exploitation for industrial and other uses of the natural starch of sago; investigation of the cash value of the highland pandanus nut species; the production of relatively disease free seed of some western crops; further cultivation of the yam species that provides the ingredient for chemical birth control; and growing of sugarcane. The efficiency and economy of the large-scale operation must be considered where environment allows. In this, the role of national planning is vital, as it is the only means whereby an environmental overview can be combined with the kind of capital needed. Now that Papua New Guinea has an educational system evolved to tertiary level, with agriculture as one of the important subjects, there is a rich source of innovative solutions and alternatives to be developed by people who know the special needs and resources of the country.

The commercialisation of agriculture among emergent nations requires intensification and extension of land use and a transition from subsistence patterns for the majority of people to a mercantile economy whose ends or objectives are trade and cash involvement—measures of production that cannot be duplicated under traditional systems. Neither trading nor cash (or equivalents) are unknown in pre-European societies, but the change of emphasis in values, in which vehicle becomes objective in incessant rather than in cyclic ways, is perhaps as drastic an effect of transition as more material results. Thus, at local levels, marketing of produce is initiated or, where it already exists, is generally expanded to include formidable capital expenditures on transport and communication. The pursuit of even wider horizons of exchange through overseas trade with the hope of profit requires capital adjustments of even greater magnitude, capital more often than not provided from overseas and a consequent profit outflow.

**The Role of National Planning**

With production aimed towards surplus, the scale of the agricultural enterprise is enlarged so that any equation of production is componentially altered; indeed, maintenance aspects of food production may be neglected prematurely for the
promises that surplus might produce. Subsistence systems are inevitably changed in cultigen pattern and agricultural methods when they attempt new adaptations, and such qualitative modification may be enjoined by the adoption of ‘plantation’ techniques, the quantitative expression of which is the requirement of bulk and even production promoted by the extension of land area under cultivation. The usual effects of this have been the loss of control in planning, production and distribution, and the relegation of people who formerly exercised such control in subsistence contexts to providers of labour as a cash commodity.

In considering the prospects for agricultural development in Papua New Guinea, we are looking at an ongoing transition, whose modulations of technology are represented by a range extending from purely subsistence systems evolved internally in a long prehistory; the internal modifications of these systems to varying degrees, maintaining some subsistence components while converting some indigenous cultigens to commerce and adapting European introduced plants; and the foreign capitalised enterprise. At this momentous stage in a new nation’s history, the prospects of adoption of an agricultural policy, whether it is directed to intensification of production or to innovation, puts a different cast on rates of progress or even direction of an evolutionary process. With independence, economic development becomes more urgent, the human resources for such development in terms of technical levels less available, and the capital with which to finance it scarce. The levels of accomplishment, the training of personnel and the effects of earlier capitalisation all seem inadequate.

These factors form some of the background, the climate in which decisions about agricultural production on commercial scales are to be developed. The shift from colonial status is translated into the area of national politics, and the choice between retention or discarding of earlier developmental courses accompanies the need to search for innovative means to increase the capital base. Since natural products, as always, hold out the best prospects for economic expansion, the ecological consequences of intensive and extensive development of terrestrial resources require the most serious and constant consideration. The integration of agricultural planning with that of communication, transport, mineral resources, timber exploitation, water power, etc., in an ecosystematic way is an ideal often expressed and just as often neglected in compartmentalised and departmentalised ways. For the purposes of this chapter, I have tried to open with the most obvious theme, the role of national planning in the prevention of the most vexing problem of all, the degradation of the environment. Papua New Guinea has in its opportunity to plan an advantage very often not shared by the more developed countries. At a recent symposium in Sydney (Anon. 1974), on environmental protection, the leading roles in discussions on planning and the political/legal aspects were taken by delegates from countries of the western Pacific at varying stages of development. The summaries of these contributions from economies ‘more advanced’ than Papua New Guinea’s give a pervading impression of the necessity for salvage, the restitution of at least some of the natural order of land, air and water. I would submit that the earliest stages of environmental degradation are concerned with agricultural development. For whether the final objectives are commercial agriculture or industrialisation with trading for food, the basic initial decisions determine the fate of traditional means of food production, the balance achieved with the natural environment and the economic and political climates at pre-national and pre-international levels.
Subsistence Agriculture

Subsistence agriculture is the ultimate expression of independence. It supports not only populations but all social institutions as well. Appeals for further understanding of subsistence in this social role, a tradition in the ethnographic studies of Melanesia since Malinowski, produced in the golden era of the 1950s and 1960s a corpus of information from anthropology and cultural geography that must be considered one of the most impressive in the third world. Thus the end points for environmental analyses in prehistory and the explanatory bases for the contemporary workings of pre-literate societies become the data base for colonial economic development and, particularly, for the succeeding regime of independence. Much as one might like to see the application of a museum attitude toward the preservation of cultures, and thus agricultures, the impracticability of such a course is obvious, and the preservation of native subsistence as a means of feeding a nation, in the purest sense, cannot be considered. The philosophy of self-sufficiency, however, does require examination in any transitional society, and there may be justification for wondering whether the courses of economic progress to date have emphasised too greatly the cash aspect of production, and whether only the most easily employable yardsticks have been used. The calculable $300 per annum, and the comparison of this income with x decades ago, are apparently more impressive than the efficiency and labour that have gone into the maintenance of the local food supply. The low social status of the subsistence farmer in European eyes appears to have hardened into an indigenous political view, at least in Fiji. There the Senate Select Committee on Food Production (1973) considers that 'the traditional subsistence pattern of agriculture has impeded progress in agriculture'. The report goes on, in the next sentence, to say that agriculture involves hard work and inadequate return—as sophisticated and pragmatic a set of reasons for neglect of a weak enterprise as it is possible to find. But if the $25 million import of food in 1972 is serious, it would be staggering to add the figure for imported substitutes for indigenous foods under subsistence regimes. I can do no better than quote the summary of problems to which the failure to produce enough food in Fiji is attributed by the Senate Committee (p. 5) following a tabulation of imports that includes rice, meat, flour, lettuce, mushrooms and radishes:

(a) lack of motivation among the farmers;
(b) unproductive and inefficient methods of farming;
(c) uncertainty of land tenure;
(d) lack of good husbandry and farm management;
(e) uncertainty of available markets at remunerative prices;
(f) lack of suitable storage facilities;
(g) lack of suitable roads and sea transport;
(h) lack of proper and adequate credit facilities.

The significance of this summary is not that any part of it is untrue, but that its implication of acceptance of an agricultural structure long established under a colonial regime and dependent on two export crops, a monopolistic processing and marketing system and a peasant mode of production. All of the factors in the list have a familiar ring to those concerned with development in Papua New Guinea and, indeed, the studies of the New Guinea Research Unit of Australian National University have long focused on most of them. Before looking forward, however, it is as well to balance the view of failure a little, with the kinds of successes that have been achieved by the internal adjustments of individual social systems to external economic influences. In Fiji itself, Belshaw (1964) has pointed to such cases in which subsistence has not given way, but has been incorporated into the quest towards foreign goals, while retaining basic
cultural values. The most striking and well-documented case of which the writer is aware, however, is the Tolai village study of Richard Salisbury (1970), in which capitalisation of the cultivation and processing of cacao has blended in with native institutions which transcend economic and indigenous organisational forms as political entities. One of the most valuable conclusions of Salisbury’s study, however, is the convincing proof of the flexibility of native systems; ‘traditional’ social structures are accommodative and evolutionary in nature. Cacao, with coconut and copra production, provided the villagers with one impetus for development and internal change in a rationalising process of adaptation. This is a most optimistic example of an original subsistence system as a basis for change rather than as a conservative, resistant and immutable handicap—an attitude too prevalent among academics. There is no doubt of the role that traditional patterns can play in the extension and intensification of cash cropping.

The potential for self-sufficiency in the subsistence sector, however, needs encouragement, since the expression of this ability on a nationwide basis must be considered one of the bases of development in other areas. The maintenance of the traditional status for the family provider is probably the most difficult single problem in the face of changing values resulting in the exclusive quest for cash and resultant population moves from rural settings. Much valuable work has been accomplished in research and extension in some subsistence crops (see, for example, Department of Agriculture, Stock and Forestry 1972; Department of Agriculture 1973), but until recently (Powell, pers. comm.) research designs have had the characteristics of

(a) aiming towards commercial production;
(b) failing of testing of materials and methods under systems of subsistence;
(c) failing to incorporate native methods of production as experimental control comparisons;
(d) ignoring a wide range of indigenous cultigens, food and industrial, and the conservation of valuable germ plasms;
(e) difficulties in ‘translating’ positive experimental results to use because of the failure to provide for running costs in developing cash systems.

Perhaps the most successful result of research on subsistence crops has been the introduction of new food species, but this has not led to the production of cash crops. Papua New Guineans have, of course, demonstrated their abilities for horticultural adaptation in their history with the American plants, sweet potato, tobacco, maize and Xanthosoma, which have made changes ranging from the quite drastic to simple enrichment of the food range. The present, geographically variable introduction of Asiatic and European cabbages, American beans, peanuts and Solanum potato is effectively enriching local diets and the cash potential of gardening for largely European markets. Most of these plants pose no threat environmentally, but in the Highlands, the cost of successfully introducing cold resistant tubers, such as the Solanum potato, could be greater cutting of the native high forests, which, on any substantial scale, could contribute towards endangering the watershed areas and the flora and fauna.

The balance of elements of subsistence and adoption of cash cropping within agricultural systems is of major concern to planning, and bimodal rates of change have to be recognised in the conversion of that subsistence element to cash market gardening. In both forms of cash acquisition, the limits of available land to any given group may be the final determinant of expansion.

In considering the subsistence base as one of the most practical foundations for development, it is necessary to question the general applicability of such a course. The fortuitous introduction of cacao in the Gazelle Peninsula may not be duplicated by
other crops in other areas. As Salisbury has pointed out, the agronomy, processing and marketing of cacao is peculiarly suited to adaptation that begins on the basis of individual action. The equivalent requirements of other possible economic crops like rice and sugar may not prove so suitable. And, just as the dynamic nature of social adjustments and political action may be positive for internal adaptation of introduced ideas and economic gain, there may be negative and unpredictable changes in attitudes to such results, in what Bennett (1973) has called the 'high-want' aspect of human behaviour in contexts of economic change. It is perhaps a universal of the labour force that the great initial progress to a level of a $1–2 per day income cannot be held to in the face of changing costs and changing aspirations in material requirements and business. And we thus must question whether the cursory prospective glance of the people of Vunamami at the possibility of buying a plantation, turned aside by the financial magnitude of the enterprise, is not a persistent trend that will point up dissatisfaction with local development in an atmosphere of enlarging objectives. Indeed, this may be the first step in the adaptation of a further new idea, the efficiency of the large-scale operation and the nascent readiness of a society for further change. Finney (1969) has illustrated a further growth in native ‘capitalism’ in the Goroka area, in which the acquisition of cash through agriculture has resulted less in the expansion of consumption requirements and more in the accumulation of capital. Nevertheless, this trend in business leadership is unable to cope with worker demands for wages rather than the unpaid status of traditional help in agricultural activity. The expansion of cash getting development will intensify this trend with the tendency for the desire for expansion of consumption by workers.

**Commercial Agriculture**

Brookfield and Hart (1971) have comprehensively reviewed the changing scene in Melanesia, with considerable emphasis on agricultural development under colonial rule to the present. Without neglecting the subsistence sector of production, they have described the dual nature of the cash economies in terms of the intermeshed peasant and commercial systems. It is proposed not to elaborate on their work, but to apply some of their information to the Papua New Guinea situation in terms of potential.

Of all the island groups in Oceania, Papua New Guinea presents one of the greatest potentials for the development of tropical agriculture. With its vast area and its variety of ecological situations—and reasonably large population—it is capable of cultivating not only tropical plants, but almost a full range of temperate cultigens that are not limited by short day length. With varying degrees of success, this has already been demonstrated, and it is to be expected that further concentration on research and the breeding of adapted varieties will reinforce the ability to produce a well diversified agricultural industry. It is noticeable that the greatest progress has been achieved from the perennial crops, coconut, rubber, coffee, cacao, and the newer pyrethrum, tea and oil palm show promise. The natural adaptation of these genera alone represents a sampling of the total range of the continental island, and with the addition of rice, sugar, vegetable species and the traditional crops, as well as livestock production and the conservation farming of timber, the basic prospects of primary industry seem assured. Brookfield and Hart tacitly acknowledge the positive environmental adaptations of these crops by emphasising the managerial or organisational reasons for failure or marginal success in Papua New Guinea.

It is to be hoped that the levels of agronomic research may be maintained and expanded conceptually to cover a greater emphasis not only on subsistence crops, but also on the industrial uses of such plants, some of which could conceivably become ex-
tinct. Some ideas along these lines are listed here. In the economic uncertainty of today, the shortage of energy and/or the cost of energy producing materials may portend some retrospective evaluations of energy and its industrial products. To my knowledge, no applied research has been conducted on the starch rich sago species, for example, and it is a reasonable guess that there has been a steady decline in the use of this resource; it is generally located in swamplike regions from which people tend to emigrate. The value of natural starch for industrial and other uses has declined in favour of artificial starches, and the idea of revival might have been greeted with scepticism a few years ago. It should be remembered, however, that industries were supported in southern Japan before World War II by the production of industrial alcohols from extensive plantings of sweet potato. It seems at least worthwhile to explore the possibilities of sago for this purpose, as an exploitation not only of native species, but also of areas that are of little use without extensive reclamation. The maintenance of sago stands in indigenous subsistence contexts, at least, has been shown to be relatively simple. Research into processing and utilisation of native foods may produce solutions to the effects of frost and drought on fresh food supplies in the highlands.

Luxury products in world markets often find their origins in subsistence contexts; the Hawaiian million dollar industry of the Australian macadamia nut, for example, arose from a marginal object of Aboriginal gathering. The cash value of the highland pandanus nut species should be investigated; the export of the nut would be easier than its adaptation! My observations in the highlands indicate that areas from 3000–5000 feet can produce large crops of relatively disease-free seed of some western crops. The modern prices and shortage of seeds make this another possible alternative cash avenue. We know also of large areas of Papua New Guinea suited to the growing of yams. The *Dioscorea* species still provide the ingredient for chemical birth control, and may provide a further adaptation for such areas.

Experimentation with sugarcane (Department of Agriculture, Stock and Fisheries, Papua New Guinea, 1972) has shown promise, not surprising at the probable centre of domestication of the species. Adaptability to valleys and slopes of riverine areas, especially those now in grassland, combined with high prices for the product and the default of some producing areas in the world, make the prospects of a new industry a distinct possibility. To examine something of the economics for such development, we can make some comparisons with the viable industry of Fiji and the marginal of some years standing in Hawaii.

**Production level.** In Fiji, present yields vary between 10 and 11 tons per hectare (with the plantation yields being approximately 2 tons heavier), while in Hawaii, *averages* of paying crops vary between 20 and 23 tons per hectare. Marginal crops in Hawaii range from 14 to 17 tons per hectare. While this discrepancy in production may be simply explained in terms of adaptation, research in genetic and agronomic factors, disease control and the plantation mode of production with full agronomic control are other factors. In a word, management may be responsible in its roles, not only as businessmen, but also as innovators in the direct and large-scale application of the benefits of research.

**Prices.** World commodity prices have been thought to be a matter of supply and demand, but the story of manipulation of such goods as sugar has yet to be told. A serious aspect of research is the question of whether such manipulations are inevitable, and whether new producing countries can get into the act.

**Labour costs.** These, of course, are among the most universally recognised of cost differentials between developed and emergent nations, and little needs to be said if we compare the Hawaiian basic wage level at $2 per hour with the Fijian $2 per day.
Capital costs. The capital costs that revolve around interest charges and profit requirements of investors are universal, and are one of the aspects of development that has had considerable attention, with erstwhile solutions of charitable aid and low interest loans (low in the western sense).

The mathematics of production development involving these factors are perhaps the great stumbling block, for in considering commercialisation in the agricultural field, we are compelled to think of efficiency and economy of the large-scale operation where environment allows. Thus the plantation concept has to be transformed, and one approach must be in terms of national planning and action, for this is the one possible source of capital for extensive development plans. The sponsorship of labour exploitation (in which the differentials with the 'advanced' nations are exploited) is justifiable only in the national interest, and under conditions of striving for socioeconomic equality. In this view, the extension of agricultural development and its research foundations become just as much a part of public works as roads and utilities.

Social Responsibility

I have tried to avoid consideration of planned development of agricultural systems as a unilinear evolution from subsistence through intermediate stages of cash cropping to complex industrialised forms. Eventual co-existence of several supportive systems may not be impractical, and such, indeed, has been the case to varying degrees in prehistoric and colonial times. The shifting of the financial base for larger-scale operations is one of the major responsibilities for independence. Another is the already established trend to population redistribution towards urbanised living; this may relieve population pressure in some areas, but poses problems of employment in towns while threatening the subsistence base in some rural areas, since it is the young and able bodied males who are inclined to migrate. The establishment of rural centres of specialised production—agronomic, processing, management, with health and social amenities, may reverse this trend.

At this juncture, reference should be made to Clunies Ross's consideration (1973) of Tanzanian socialism and its possible application to social planning in Papua New Guinea, for it is obvious that the preceding statements are leading to suggestions of the type of controlled planning that might be called socialism. Although Clunies Ross's work was not available to me in arriving at this point, many of my suggestions coincide with his 'areas of restraint and initiative' as they apply to agricultural commercialisation, especially concepts of economic ideology and rural development (Clunies Ross 1973: 250). We know, from example, that 'rural economic development is something that rural people do for themselves', although in some socialist forms this is not a rule. Restriction of the government's role to ideas, demonstrations, training and finance, however, hardly fits one of the objectives of social planning—to provide income earning opportunities to unskilled (presumably in the urban sense) workers. Nor does it work in the direction of maximising incomes of Papua New Guineans. Demonstrations of the efficacy of extensive plantation type operations are now the experience of many for nearly a century, and their non-adoption seems to be not a cultural limitation but, as we have said, a financial one. Many of the new crops are not well adapted or adaptable to the indigenous, essentially horticulturally based production systems of Papua New Guinea. Capitalisation of agricultural industries is too formidable for individual or group resources, while marketing requires the intercession of brokers in overseas markets. Perhaps it is here that efforts in national planning will help regional operations with subsistence support and equitable wage earning capacities in all labour sectors. The eventual disposition of such enterprises could be
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for future decision, but it is to be hoped that they would serve as the steel axe and the coffee bush did in Papua New Guinea's history, with greater initial investments but on a greater scale of gain. To some, the risk that the success of such schemes might usher in social changes, modifications to traditional patterns of social organisation and group identity, are too great. Be that as it may, change is inevitable, and this course may be preferable to urbanisation with illusory economic bases, or the hasty creation of quasi-industrial societies. Policies of enforced restriction on internal immigration may work towards the preservation of social institutions, but would probably accentuate inequalities between urban and rural populations. Agricultural commercialisation should present alternative opportunities, and it is the alternative pathways that must not only be demonstrated in models, but exemplified.

Further, in connection with agricultural opportunity and choice, the role of education and research in agronomy has had an adequate initiation; management is a recognised curricular theme. These are the operational aspects of agriculture. The preparation for policy decision making, however, has relied more on external expert advice. With the education system of Papua New Guinea now firmly established to the tertiary level and with agriculture as one of the important subjects, it seems that systematic modes of production should be one of the principal concerns. The basis is local—the understanding of the production modes of the Papua New Guinea subsistence systems in their variation, environmental and social roles, the historic changes and additions; the workings of the capitalist mode in its ultimate development, corporation farming; the co-operative organisations of Israel; the socialist forms of Russia and China. Enlargement of the range is not aimed at the transplant of any one, but at providing materials for new adaptations that are bound to come in an emergent country of great potential.

The philosophy of social responsibility overriding urgent maximising of income, so eloquently put by Clunies Ross, and apparently adopted by the government of Papua New Guinea, endows the situation for development and its related decisions with a great asset—time.

A Typology for Papua New Guinea

Thus in terms of commercialised agriculture in its intensive and extensive modes, we arrive at a point that may be relatable with the concept of 'intermediate technology' recently defined by Schumacher (1975). The commitment to gradualism is in common, but there is contrast in the necessity to view development in obligatory evolutionary steps of technology—low level to high level through an intermediate stage. A sequential typology of this sort may be made to fit the Papua New Guinea scene, if 'low level' may be equated with the simple and complex agricultural technologies whose efficiencies have been demonstrated repeatedly. 'Intermediate' levels have been attained in New Britain, the Eastern Highlands and the Western Highlands with cacao, coconut and coffee; but from the analyses of Brookfield and Brown (1963), Salisbury (1970) and Finney (1973), there may be derived rather consistent limits to such development that involve the factors of the social circumscription of indigenous group territories, population increase, the competitive element between commercial and subsistence cropping, capital availability, etc. The paternalistic subsidy of trial and error operations on individual farmer bases seems to be a wasteful option, to say the least, under such circumstances. Accepting that Papua New Guinea possesses 'large areas of habitable yet uninhabited land' (J. Winslow, pers. comm.) that belie the local pressures on land in areas of population concentration and generally 'advanced' technology, it is easy, in theory, to come up with schemes of land and population redistribution. At
this time, we do not know whether such schemes would be greeted with pioneering responses—the transplantation of social environments into new adaptive surroundings. We are, however, aware of some of the social problems that are the consequences of compulsory schemes of resettlement in recent African experience (Scudder 1973). It seems to me then, that nationalised agricultural enterprises in areas largely uninhabited but suited to particular crop complexes, with their appropriate processing installations, is a proposition that bears consideration. Certainly it is one way of giving entity to the innovative suggestion of Clunies Ross (1973) of rural centres as an alternative to the kind of port town urbanisation that typified population distribution changes in Pacific history. While again, we cannot predict group responses to such a scheme of planned and gradual development, the model would be one in which rural centres act as safety valves for upward population changes in subsistence and internally developing areas, with an ebb and flow of excess people to such centres to avail themselves of the opportunities of labour in the primary field of their familiarity—agriculture, albeit with new but understandable forms. There are some Pacific examples of such phenomena, even if they are unplanned. We may refer to the Ifugao of Luzon in the Philippines, who, under a succession of political regimes, have used the mines of Bontoc as a source of cash for generations; few have stayed, preferring to return to stable cultural settings in which their complex agricultural systems provide the constant economic background, and the acquired cash satisfying the 'high-want' factor of modern contact as well as conferring some flexibility on less privileged members of a somewhat capitalistic society. The Futunans and Uveans under French rule in Polynesia are able to handle the mines of New Caledonia in somewhat similar fashion, while the Anutans of the British Solomons have preserved their old ways of life and intensive economy by their young people working for periods on coconut plantations on the other islands in the colony. In such examples, there may be some parallels for Papua New Guinea of the past, for they may all have one feature in common—the exploitation of labour. The difference for the proposition for commercialisation along socialised lines is obviously in the distribution of the proceeds ... on distribution in the national interest, as the only justification for the 'exploitation' of labour.

CONCLUSION

In this discussion of possible considerations for commercialisation of agriculture in Papua New Guinea, I have tried to view as components of a single system the conservation of subsistence agriculture and that of natural resources, the encouragement of local development and recognition of its economic and social limits, and the national responsibility for research and development of technology and, even more, capitalisation programs. This is not to suggest a commitment to a single pathway to a static end. All planning is short-range in terms of human history, and the choices that will arise through the changing vision of successive decision makers may alter radically the political and economic bases of commercial production. It is to be hoped, however, that, regardless of inevitable change, the potential for self-sufficiency will be the one realised constant at any given point in a future of promise.

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Most existing models of agrarian change seem to be insufficient to explain the actual behaviour of farmers. This may be because there has not been enough awareness of the motives and means available to farmers as people in a changing context. In Fiji, evidence suggests that farmers are not incapable of responding to incentive. Rather, people have access to more options, including notable wage labour in the larger centres; and that continued effort on the farm simply appears a less reliable prospect for ensuring personal and family security. The low-technology high labour structure of much of Melanesian industry should be re-examined as it imposes harsh working conditions and is often unrewarding for the individual. This structure may be the only factor that can be changed with good and widespread effect. In today's context, the notion of 'primitive affluence', while it may have been valid in the past, does not seem especially relevant to the low-productivity rural slums that are spreading over the more 'developed' parts of Melanesia, and from which farmers and their children flee in search of something better to the growing cities.

Fred Fisk’s ‘primitive chieftain’ (Fisk 1962) concluded that it is better to lie down and do nothing at home, rather than walk a whole day into town with a bag of sweet potatoes, get just enough for a beer, and fall flat on his ear there. He faced a real problem. A.V. Chayanov’s (1966:92) peasant farmer faced another:

Given freedom to acquire the necessary area of land for use and the possibility of having available the necessary means of production, peasant farms are structured to conform to the optimal degree of self-exploitation of the family labor force and in a technically optimal system of production factors as regards their size and the relationship of the parts. Any excess of production means available to labor or of land above the technically optimal level will be an excessive burden on the undertaking. It will not lead to an increased volume of activity, since further intensity of labor beyond the level established for its self-exploitation is unacceptable to the family.

Broadly agreeing with Stalin’s police, who put Chayanov firmly away, J.W. Mellor (1966:244–8) regarded this mould as essentially static. Given three desiderata: a desire for material welfare, an expectation that change will increase wealth, and expectation on the part of the innovator that he will participate in increased wealth—Mellor envisaged a ‘technologically dynamic agriculture’ in which the risks of innovation diminish and the capacity to absorb failures increases, so that institutions that will provide incentive to change arise and make change a ‘normal’ condition.

Farmers in eastern Fiji do not seem to see things in the light of any of these models. An administration questionnaire survey into population, production and income among the rural population, to which the author is currently adviser, has completed a
large part of its work in the Eastern Division and is now starting work in the Northern Division. The survey is very revealing, and much of the ‘hard’ data in this paper are drawn from it. At the end of the questionnaire form is an open ended question asking respondents to state their problems. The responses can be classified into four groups:

(a) internal difficulties of society and community;
(b) external difficulties of general application;
(c) external difficulties affecting the community;
(d) personal difficulties of the individual.

From the smaller islands of Lau the general and particular external difficulties dominate the responses. Prices are inadequate; freight rates are high and shipping infrequent; there is no market for craft goods. There is also shortage of land for coconuts; some islanders complain of poor soil. One respondent, on Komo, puts it all very succinctly: ‘Little land; few coconuts; no money; nothing to spend it on; wish to migrate.’

On Taveuni and Qamea some very interesting patterns emerge. Here per capita incomes range upward from the values obtained in Lau, and though there are communities with a per capita household annual income as low as $29, there are a number receiving over $150, and Somosomo village had a per capita household income of $230 in 1974. In the poorer communities the pattern of complaints is much the same as that encountered in Lau: ‘We can sell only copra; prices are down and costs are up; we get insufficient shipping; government neglects us.’ Closer to the centre of things in Taveuni—if Somosomo-Waiyevo can be regarded as such—the predominant complaints concern the internal difficulties of society and economy; ‘People do not cooperate; ‘leadership is bad’; or—from a leader—‘people will not support me’. We also get: ‘too much time is wasted on useless things like drinking yaqona and other Fijian way of life’; ‘the young people behave badly and will not work’; ‘too many people are not tending their gardens, and simply getting drunk’.

The difficulties of the individual run like an undercurrent through the whole. ‘I am old, or crippled, or often sick, and cannot work; there is none to help me’; ‘I am sixty-seven, have only one leg, and live alone, and if only I could be admitted to the “Home of Compassion” in Suva!’—this last from a Fijian villager, a member of one of the landholding mataqali. Society is most certainly not increasing ‘its capacity to absorb failures’.

But there is also much else of interest in the Taveuni survey. Data are far from perfect, but they do at least make possible some analysis of income distribution, and the broad pattern shows quite remarkable similarity across communities—including some Indian communities—of very different earning capacity. The poorest 25 per cent of the population receives pretty consistently only between 2 and 6 per cent of cash incomes; the top 10 per cent receive between 35 and 55 per cent of the whole.

Something else also emerges. Taveuni has a strongly commercialised economy, in which, taking village, subdivision and estate settlement together, it seems from data analyses so far that at least half the total income of the inhabitants will be generated by wages. The proportion of what may be described—following my project colleague Bayliss-Smith—as ‘environmental income’, derived directly from the environment by the Chayanovian self-employed, is only 64 per cent of the income of the villagers, though almost 70 per cent of the income of those villagers who are members of the landholding mataqali. Income from wages, remittances and business is 35 per cent of village incomes, 48 per cent of that of the ‘stranger’ households in the villages. Wage labour involves the individual in little planning and decision making; it is reliable and less subject to risk than environmental income; the time lag between input and reward
is enormously shorter. It may be added that the year to which these data refer is 1974, a year of quite exceptional received prices for copra. The share of environmental income is thus presented at its most favourable.

This is Taveuni, where a fair amount of employment is available, though at rates universally regarded as insufficient. What do we find in islands where employment opportunities are minimal? Essentially, the answer is a massive emigration to Suva and elsewhere. The registered population of the landholding mataqali of Batiki, in the Lomaiviti group, is just over 1000; this would yield something like half a hectare per head of the registered population. In fact the resident population is under 300, and probably declining. In August 1974 Bayliss-Smith found forty-six households on Batiki; Joan Macpherson’s nutrition survey in January 1975 reported that three of these had meanwhile shifted, holus bolus, to Suva. The age-sex structure of these smaller islands reflects the emigration of potential parents. Children in the 0-4 age group are so few on some islands, especially in Lau, that the replacement of population is in doubt even if emigration comes to a stop tomorrow. One might ask if this is not due to the family planning program rather than to emigration, but an examination of the family planning records for Batiki removes this possibility from question, and the same is probably true elsewhere.

To return to theory. Empirical evidence is always hard on theory, and Mellor’s rosy picture at least falls to the ground with an audible crash. What of Fisk’s ‘primitive affluence’, and the structure he builds on this? Fisk accords with Chayanov that farmers will suffer the disutility of work only up to the point where their utilities are satisfied. He goes on to suggest that a farmer with adequate resources, who can make do on little input, will be less inclined to adopt innovations than a farmer with lean resources, who must already work more intensively in order to achieve a comparable level of satisfactions. Fisk is perhaps subconsciously seeking to explain the distinctive role of the Kelantanese in the Malaysia of his earlier experience: this model would fit their situation well. By the same token we would expect to find notably more enterprise among the ‘strangers’ of Fijian villages, but we do not. All we find is that because they have less access to land, they obtain a slightly lower mean income including greater reliance on wages. And in general, we find notably higher incomes gleaned from the rich soils of Taveuni than from the leaner soils of Qamea, or Lau. But even on Taveuni the environmental income of the whole village population is only about $100 per head in a good year.

Are we perhaps looking at the whole question the wrong way round? We are seeking to explain agrarian change, or lack of it, but we are failing to place it in a context of total change. We are asking why farmers do not, or cannot, respond to incentive, or do not have incentive, but we are doing so in a context of thinking that assumes that they are only and inevitably farmers, and can be nothing else. Our Fijian farmers have at least two alternatives: some can find employment, remaining where they are; all can go in search of work and opportunity in Suva. If what they are seeking is not only a larger income, but also a more reliable income, then the wage earning alternatives have very obvious attractions. Even in Taveuni, the mean individual wage is $910; the mean household income from copra in a good year—and this is gross income—is only $652. In Suva, the mean wage in the same year for an industrial worker was $1404. There is nothing irrational about their observed behaviour in this context.

I would suggest, therefore, that in looking at the question of change, and its constraints, we should adopt a paradigm constructed on these lines. Let us assume our farmer wishes to maximise his welfare in the realistic context of known possibilities—we may have ‘many dreams,’ said one, ‘but there is no way to realise them’.
The welfare goal involves the attainment of an adequate income, with a surplus over needs, without working every hour God gave, and with as much certainty and regularity as possible. In short, we are supposing that he would like to replace the securities of a subsistence farm planned according to well tried rule of thumb, with comparable certainties in a modern world that includes money and the things money will buy.

Let us assume also that he is prepared to put certainty, or perceived certainty, above potential income maximisation if this latter entails greater risk. In the context of traditional farming practices, Kirkby (1973) had some interesting things to say on this subject. Seeking to explain the decision making behaviour of farmers in the Valle de Oaxaca, Mexico, where production levels are far below those potentially feasible, she argues (p.153) that:

the strength of agricultural tradition in Oaxaca can be understood as a means of reducing dissonance resulting from having to make an important and difficult choice with little information by distorting reality to give an appearance of minimal freedom of choice. In the face of extreme uncertainty, traditional answers serve instead of social security and information services to reduce the sheer work and anxiety of computation and assessment involved in, for example, corn planting decisions.

Fijians are, notwithstanding numerous apologists for the 'Fijian Way of Life', much less beset by tradition than the Oaxacan peasant. The sort of institutionalised redistribution and reciprocity that are designed to reduce inequalities in the Mexican peasantry, as they were also designed to reduce inequalities among Fijians, seem to be breaking down in Fiji in a way that has no parallel in southern Mexico. This may be the product of colonialism on a small society, and of the impact of a great number of learned reporters who have felt traditional ways to be the anathema of progress. But while this may be so, progress also increases both inequality and risk. And the rural Fijians now suffer plenty of both.

There is little that is less certain than the reward to be gained from a newly planted coconut grove. Many men told us, with sorrow, how their coconuts are just about to come into bearing and now—down goes the price. Planter and villager alike lamented the violent swings of the price of copra in the last twenty years, and the steep fall of received prices at Somosomo from over $500 per ton a few months before to less than $150 per ton in March. The prices for yaqona (kava) and dalo (taro) remain good, but the press already warns of a coming glut of dalo on the Suva market, and even the yaqona price reflects capacity to consume, and will be affected adversely by a general depression.

We may therefore go on to assume that in the absence of 'traditional answers' which will reduce uncertainty—or the breakdown of such answers—farmers will seek whatever alternatives are open to them that will seemingly ensure an adequate income combined with reasonable certainty. They will not be inclined to respond to price incentive unless they can be fairly sure that the price incentive will be durable. They might instead prefer the longer hours and less leisure of wage employment, and will go where they can get it.

This is then the first element in a paradigm; it concerns motive. The second element concerns means. The present structure of the east Fijian economy, like that of so many parts of Melanesia, is governed by the almost mediaeval structure of the copra industry, with its low capitalisation, high labour coefficient, ancient technology, minimal R&D input, and archaic systems of marketing and transportation. The astonishing persistence of this industry is one of the major unexplained phenomena of the region. This is the context within which most cash agriculture in the region has to
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operate. Alternatives—for east Fiji—are to market dalo through the National Marketing Authority or yaqona through Indian and Chinese middlemen, who claim the business to be very unrewarding. The problem of means also includes that of transportation, involving much manual effort in the initial stages, high costs in the second stage—that of getting copra to the buyer—and pretty high costs in the third, from buyer to market, for copra is a bulky product. To watch the handling of copra bags or other cargo by workboat onto an interisland or overseas vessel is to go back two centuries in the history of cargo handling.

It is not very different elsewhere in Melanesia. I recall well the very similar structure imposed on the infant coffee industry in Chimbu, New Guinea: very low technology, very high labour input at all stages up to sale of the partly dried beans, very costly transport, high labour coefficient even in the factory stage, where something like modern technology overlapped with the primitivism of the earlier production stages. Essentially mediaevalism was imposed at the outset, because this was the 'right thing to do'. One should perhaps draw a veil of silence over the disastrous cocoa project in Malaita, Solomon Islands, or the primitive early stages of the Tolai Cocoa Project, but the pattern was much the same. It was assumed that low capital coefficients and high labour coefficients were right, given the existing factor endowment, but there was failure to comprehend that this factor endowment belongs to the past, not to an early future of which the new industry formed a part, and which also contained other opportunities. There was also a failure to comprehend that an industry with a high labour coefficient is very susceptible to variation in the marginal return per unit of input of labour. Yet the fact that it was the undercapitalised village production of copra that diminished faster than the plantation production during the depression of the 1930s was surely there as example.

The means to increase environmental income are therefore very demanding of labour, very uncertain in return, and in particular very susceptible to changes in marginal return for unit of labour input. But it is the uncertainty that is perhaps most significant. Twice now, in Chimbu in the later 1960s, and in Fiji in 1974/75, I have seen the effect of this uncertainty on confidence, and on response. In between, I have also seen its effect on the banana growers of St Vincent in the West Indies, but that is another—though similar—story.

And what of environment? Environment is at once the underlying constraint, but also the last constraint in the threefold order. Environment, including distance, determines what sort of return can be obtained for equal units of input, or alternatively what sort of input is required to obtain equal units of return. Copra producers on Qamea get lower yields than their fellows on the richer soils of Taveuni, and they also have to pay more to get their copra to market. But copra is their only significant resource, given the structure of the economy. The proportion of copra income to total income is therefore much higher than on Taveuni, though the mean return per household is much lower. Given the motive, and given the structure, it is environment that determines that life should seem so unrewarding on many small islands in Lau—or in the higher altitude areas of the New Guinea highlands, and other areas which are thus 'marginalised' in the context of the whole economy. Migration is, we hypothesise, therefore greater because the potential gain of migrating even reduced by its disadvantages, is further removed from the potential return of agrarian effort at home.

Fundamentally, there are two things wrong with most of the theories of agrarian change. First, they fail to take account of alternative opportunities open to the farmer; second, they are far too static. Agrarian change takes place in a context of total change, and total change both affects the motives and demands of the farmer and also widens
his range of alternative means. An individual island, or regional, economy may become more specialised as a result of change, but the individual himself gains access to wider choice, through migration.

This chapter arises from the rethinking we are all undergoing in the UNESCO/UNFPA project in Fiji, and in a wider sense in the Man and the Biosphere Programme as a whole. We are striving to get away from static notions of the man/environment relationship, and to replace them with notions that are at once more realistic, and theoretically more productive. We argue that the central fact of change, insofar as it affects man/environment systems, is the incorporation of formerly autarkic systems into larger and worldwide systems. Hence it follows that there is a reduction in autonomy, and simultaneously an increase in risk. Behind this, however, there lie also changes in motive, or perhaps the translation of the search for security from old modes to new. It lastly follows, in this wider context, that what has been wrong with man/environment theory in the past is that we have paid too much attention to environment and not enough to man.

Finally, then, what of a way forward on the practical issues? We can do little about environment, or about motive in the short term, but there is a lot that can be done about means. The persistence, or adoption, de novo, of mediaeval structures in the cash economy of rural Melanesia has, in my view, been a severe constraint on progress. Adoption of production and marketing technology involving high labour coefficients is all very much in line with dual economy theory, from the days of W.A. Lewis (1954) on. But in a situation in which the farmer has the choice between alternative money making strategies, it has exposed behaviour in rural industry to a very elastic response to changes in the expected marginal return for labour input. It has furthermore led, as several of us have tried to show, to levels of production that are very unrewarding to the individual. And, most especially, the rural producer has little security in expectation of income. This runs across all environments, as does the behaviour I am seeking to explain.

Pacific specialists might find this conclusion unduly biased in a structural direction: this can perhaps be attributed to my re-education in the Caribbean since 1970, though some of the same arguments were already present in my writing before I left Australia (Brookfield with Hart 1971). But I go much further and urge that—pace my good friend Fred Fisk—‘primitive affluence’ needs to be treated as an historical concept, not especially relevant to the low productivity rural slums that are spreading over the more ‘developed’ parts of Melanesia, and from which farmers and their children in search of something better are fleeing in droves to the growing cities.

References


The traditional Solomon Islander had patterns of land use, tools, and rhythms of planting that allowed him to meet his needs without significantly changing soil productivity or ecological balances. There is some danger that the introduction of modern tools, costly fertilisers, and changing settlement patterns will upset this long established balance of man and nature irreversibly, and that the practical and ecologically sound wisdom of the older methods will be lost. This paper documents some traditional practices observed over the past twenty years, most particularly on the island of Malaita. Specifically, the seral phases noted by the traditional farmer are described, along with the decisions he made on the basis of these phases. The contrast between the impact of the traditional farmer on his environment and that of the modern agriculturalist is shown schematically using a ‘balance of forces’ model.

This chapter is an attempt to put on record the practices and observations of the traditional Solomon Island farmers. Before contact with the outside world was made, they were more or less independent. The experiences that they accumulated over the years are dying away, with only memories of them lingering on in the minds of the few elders who are still alive today; they are themselves not aware of the enormous and valuable knowledge they possess, knowledge that almost certainly will silently be lost with them.

The accounts here refer mainly to the island of Malaita, rather than to the whole country. But as conditions throughout the area were similar (for example, tribal warfare existed throughout), we can assume that the farming and gardening practices noted here were also widespread. It is also useful to mention that the traditional farmer himself was at that time part of the overall ecological pattern. This is because, as a result of his various interactions and integrations with the environment, certain vegetational types have been brought about. His observations of the plant successions were a key factor upon which he made great and accurate decisions. These successions indicated soil conditions and the decision on the point at which to re-enter and recultivate a piece of land was based on them.

Even today’s shifting cultivation practices differ considerably from those of pre-contact days—more so since the introduction of intensive farming practices. It is not the intention here to promote traditional farming and discredit the sophisticated, intensive farming methods that are being introduced to the Solomons, but rather to show how one tended to be part of the natural cycles, while the other intrudes upon them.

Traditional Farmer and His Society
In pre-contact days, Solomon Islanders lived almost always in smaller communities than those of today. These small communities were, of course, located in the interior
of the islands and rarely on sea coasts, because any settlement on the sea coast would have been an easy prey for enemy attacks. People normally lived on land that belonged to their own tribe and in several settlements located throughout that particular piece of land. These settlements, on the whole, were temporary. There was frequent movement from place to place (but, of course, within the same piece of tribal land). The traditional farmer was a man of all trades. Besides being a farmer, he was also an ecologist, a botanist, a zoologist, a physician, a geologist and a builder, etc.

Gardening Practices and Tools
The only tools available to the farmer in pre-contact days were stone axes and knives. His use of these was therefore limited, in many respects. He found it difficult if not almost impossible, for example, to cut down any sizeable trees. Whenever there were large trees to be removed, this was effectively done by burning them and leaving them to die in situ. Leaf drop from such trees served exactly the same purposes as mulching. The interesting thing about this is that it was not done mechanically or manually; the traditional farmer took advantage of the processes of leaf fall, with help from the wind. A lot of the organic wooden material was also burned when preparing sites for cultivation. The remains were spread over the fields as potash in the form of wood ashes.

The practice of burning off debris by traditional farmers needs clarification here, as it has been the subject of heavy criticisms by modern agriculturalists who themselves are new to the islands and therefore not familiar with them. These authorities argue that the burning kills and destroys microorganisms in the soil. This is rather a sweeping statement without any actual research results to show just how much of the assumption holds true. One thing, however, is certain, and that is that for the many hundreds of years that debris burning was employed, any negligible adverse effects on environmental conditions were overcome in nature’s normal course of recovery. On the other hand, the burning process is only short circuiting what would have taken several years under natural conditions through bacterial activities of decaying. The wood ash resulting from burning is in a form readily incorporated into mother soil; this would have happened anyway, had the rubbish been left to rot away, but which may have required a considerably longer period.

Traditional farming used land for a relatively short period; about one and a half years at a maximum. Crops were annual, and land was used for only a single crop harvest at any one time. After harvesting the land was left under fallow. Farming was not concentrated on one area, but spread out in accordance with settlements and the movement of the people. As these settlements were temporary so, on the whole, were the effects of farming on land. In other words, the disturbances caused to a particular piece of land by the farmer were only temporary, and were spread out over the land.

Shifting cultivations of the traditional farmer are also being looked upon by modern agriculturalists as uneconomical and energy wasting, especially if one considers the fact that the only gardening tools were stone axes and stone knives. Largely, this is a view based on economy, and not ecology. It should be noted that economy played or occupied a very small role in the traditional farmer’s mentality. When the traditional farmer was establishing a new garden his first thought in doing so was for his own family consumption, and the money aspects came in only unconsciously. The farmer did not have to go around advertising to interested buyers that his garden was now ready for harvesting. Rather the reverse took place; the buyer went out inquiring of anyone who would wish to sell out produce from their gardens and when he found someone they would then negotiate an appropriate deal.
The traditional farmer was very much concerned with the ecological aspects, and once he had decided to abide by them nothing would then alter that decision. Weeding was done only once for the entire cropping period, although a final weeding would have been done at harvesting time. When the traditional farmer finally left the area after harvesting, the soil was still in almost a perfect condition.

Observations of Plant Successions
In reality, the plant successional stages are much more complex than the traditional farmer’s practically recognised four phases, upon which he then could tell the fertility of the soil. If gardening was abandoned, a fifth sere or phase was reached. This can be regarded as the climax forest; that is, a phase that is fairly permanent. The four phases could be labelled herbaceous, euphorbiaceous, leguminocoeous and guttiferaceous. Table 14.1 shows the common species by seral phase. In nature, as we have said, the seral stages are much more complex and the number of plant species occurring at each one very numerous. Table 14.1 gives only the commonly occurring species for each sere, which would have probably conditioned the physiognomy of the plant community at those various seral stages. Whether or not these plants have any effect on soil is not certain. However their appearance at a particular time in the succession accurately indicated to the traditional farmer conditions of the soil at that time, including soil fertility.

The herbaceous phase is characterised by communities and associations comprising largely herbaceous plants. Practically, these form the first recognisable group of plants. The expected life time of this phase is about six months to one year.

The euphorbiaceous phase is the next recognisable sere after the herbaceo us phase. Species of the family euphorbiaceae are common, which gives this phase a certain distinctiveness from other seres. The ground floor is cleaner than during the previous phase, as many short lived herbaceous plants will have died away, and the canopy appears to form a single stratal layer. The average height may not be more than 6 m. This sere has an average expected lifetime of about five years.

The leguminocoeous phase is the third recognisable plant community in the succession, which the traditional farmer adopts for his observation. Again the name denotes the fact that leguminosae appear quite frequently here. This of course also gives it certain characteristics that make it almost unique among the other seres. In a number of cases, Albizia may appear as the dominant species. Epiphytes appear conspicuously towards the middle of this sere and continue into the next one. Selaginella spp., pteridophyta, also start occurring here to form a carpet on the forest floor. This also continues into the next sere. The expected life time of the leguminocoeous phase is about ten years.

The guttiferaceous phase is the fourth recognisable association or community of plants observed by the traditional farmer. It is characterised by the appearance of guttiferae and its associates. Epiphytes are numerous; woody climbers also appear in a fair proportion; and the Selaginella spp. sometimes form a complete ground cover. Pos-

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1 The observations on which this paper were based have been made firsthand over a period of many years, mostly on the island of Malaita, and particularly in the Kwara’al Sub-district. There the traditional farmer uses terms in the Kwara’al dialect that would have little meaning for people outside the Solomon Islands, and the naming of species and phases thus presents something of a problem. Botanical names have therefore been used for the species and families. The phase names refer to the family seen to give a characteristic appearance to the phase in question. These names are chosen for convenience, and comply more with the traditional farmer’s observations than with any strict formal analysis.
TABLE 14.1
Common species by seral phases

<table>
<thead>
<tr>
<th>Genus and Species</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbaceous phase</strong></td>
<td></td>
</tr>
<tr>
<td>Wedelia biflora</td>
<td>Compositae</td>
</tr>
<tr>
<td>Coleus spp.</td>
<td>Labaceae</td>
</tr>
<tr>
<td>Cyrtandra spp.</td>
<td>Gesnericaceae</td>
</tr>
<tr>
<td><strong>Euphorbiaceous phase</strong></td>
<td></td>
</tr>
<tr>
<td>Macaranga urophylla</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Macaranga aleouritoides</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Macaranga polyandra</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Homalanthus trivalis</td>
<td>Euphorbiaceae</td>
</tr>
<tr>
<td>Commersonia batramia</td>
<td>Sterculiaceae</td>
</tr>
<tr>
<td>Melochio umbellata</td>
<td>Sterculiaceae</td>
</tr>
<tr>
<td>Trichospermum peekeli</td>
<td>Sterculiaceae</td>
</tr>
<tr>
<td>Prosopis insularis</td>
<td>Leguminosae</td>
</tr>
<tr>
<td><strong>Leguminaceous phase</strong></td>
<td></td>
</tr>
<tr>
<td>Albizia falcatia</td>
<td>Leguminosae</td>
</tr>
<tr>
<td>Albizia manihassae</td>
<td>Leguminosae</td>
</tr>
<tr>
<td>Elaeocarpus sphaericus</td>
<td>Elaeocarpaceae</td>
</tr>
<tr>
<td>Rhus taitenses</td>
<td>Anacardiaceae</td>
</tr>
<tr>
<td>Litsea perglabra</td>
<td>Lauraceae</td>
</tr>
<tr>
<td>Evodia elleryana</td>
<td>Rutaceae</td>
</tr>
<tr>
<td>Flagellaria indica</td>
<td>Flagellariaceae</td>
</tr>
<tr>
<td>Hymenophylla spp.</td>
<td>Hymenophyllaceae</td>
</tr>
<tr>
<td>Dendrobium spp.</td>
<td>Orchidaceae</td>
</tr>
<tr>
<td>Selaginella spp.</td>
<td>Selaginellaceae</td>
</tr>
<tr>
<td><strong>Guttiferaceous phase</strong></td>
<td></td>
</tr>
<tr>
<td>Calophyllum kajewskii</td>
<td>Guttiferae</td>
</tr>
<tr>
<td>Calophyllum vitiense</td>
<td>Guttiferae</td>
</tr>
<tr>
<td>Pometia pinnata</td>
<td>Sapindaceae</td>
</tr>
<tr>
<td>Vitex cofassus</td>
<td>Verbenaceae</td>
</tr>
<tr>
<td>Hymenophylla spp.</td>
<td>Verbenaceae</td>
</tr>
<tr>
<td>Dendrobium spp.</td>
<td>Verbenaceae</td>
</tr>
<tr>
<td>Selaginella spp.</td>
<td>Verbenaceae</td>
</tr>
</tbody>
</table>

sibly the guttiferae phase forms the climax forest; if not, it is a semi-climax point in plant succession.

**Farming**
Through experience, coupled with effective observations, the traditional farmer begins gardening late in the leguminaceous phase. From Table 14.1 it can be seen that legumes start appearing in the euphorbiaceous phase. No doubt it is possible that legumes could have been present, in the form of some herbaceous plants, as early as
the herbaceous phase but these would not have been particularly noted by the traditional farmer.

It is most interesting to note that the point at which the traditional farmer chose to begin gardening was that at which the soil had been under leguminose plants for a considerable period of time. He may have been unaware of the fact that legumes enrich soil fertility; but it can be safely assumed that his close association with his environment enabled him to arrive at a decision that coincides very well with a modern ecologist’s views.

Balancing Forces

I have decided, for practical reasons, to present the disturbances caused to a habitat or environment as something immeasurable. That is, any disturbance of the balance of nature cannot effectively be measured. Theoretically the only way by which this can be done is by taking into account all the things that are involved and affected in that particular area. This would necessarily include the total sum of both the biota and flora of the area, the soil and organisms and all other connected matters.

This is impossible; some of the biota may be only seasonal, they may use the area only for breeding, gathering food and the like, living somewhere else the rest of the time. If such disturbances do not occur at the breeding or feeding period, then the chances of including such organisms in the observations are very narrow. It is not therefore very accurate to give masses of figures in an attempt to represent what took place in nature. I propose instead to represent the situation diagrammatically.

In Figure 14.1A the line o-o represents a time when human disturbances are absent and there is a natural balance maintained. That is, the forces regulating the numerous activities that go on in an ecosystem of the area do not occur in favour of any one organism. When this does occur, it is purely by chance. Any deviation from this line will almost certainly benefit some organisms and adversely affect others. The numbers 1, 2, 3 and 4 represent the leguminoseous phase, euphorbiaceous phase, herbaceous phase and a farming or gardening time respectively.

In Figure 14.1B the balance line has changed position from the original or natural one, o-o, to line 4-4, representing a period of farming or gardening. Gardening benefits man, but is badly affecting other organisms by removing all vegetation and thereby the biota that inhabit the various ecosystems of the area as well. The arrows represent forces generated by the human as he acts to obtain what he requires.

Figure 14.1C represents the leguminoseous phase (line 1-1), in which the traditional farmer chooses to enter the successional pattern for gardening. The trend of movement as indicated by the arrows shows the pattern of recovery after gardening; that is, plant successions in the herbaceous and euphorbiaceous phases have been completed and gardening at the leguminoseous phase prevents the system from reaching the guttiferaceous phase.

The Present Farmer

The practices that are employed in the Solomons today differ considerably from those of the traditional farmer. This is mainly a result of the changes that inevitably develop in association with the growth of large permanent settlements and communities. The permanence of the settlements increases the chances that the same piece of land will be used more often and regularly, while the larger numbers of people make additional demands on soil output. It might be stressed that as yet the supply of farming land has not been exhausted; rather some land is being overused while other areas are not developed at all.
Fig. 14.1 Balance of forces model for traditional and modern farming practices
The use of sophisticated tools such as steel knives and axes or hoes also helps to promote changes from the traditional practices. With hoes the soil is being torn, so that those organisms that may have continued to live under the traditional practice in the soil are no longer safe. The most frightening thing in all this is that farming or gardening allows the soil to recover only to the euphorbiaceous phase.

Line 2–2 in Figure 14.1D is the point at which the present Solomon Islander enters for gardening. Considering the life expectation of the herbaceous phase, six months to one year (represented by 3–3 in the figures) and the fact that the farmer may enter for gardening in early or mid-euphorbiaceous phase (the phase has a life expectancy of about five years), the length of time during which the soil may undergo recovery is roughly three and a half years. In nature this is a very short period of time.

Under the traditional farming practice the minimum period under which the soil is left to recover is about ten years. Comparing this with three and a half years indicates the great dangers in present gardening practices. The present farmer is forced to act thus for the reasons given above; he does not bother to observe the plant successions, which have become meaningless to him in his present set up.

THE MODERN SCIENTIFIC FARMER
Modern scientific farming is being introduced at a rapid rate in the Solomons; unfortunately the people swallow it wholeheartedly, without realising its overall effects. There is now evidence everywhere of new developments mushrooming in all parts of the country.

Line 3–3 in Figure 14.1E is the point at which the modern farmer or agriculturalist enters for farming. This is in the herbaceous phase, and it can be seen that the soil has had no time to recover, though with the use of fertilisers production can be increased very considerably. The scientific farmer views leaving soil to recover under fallowing as uneconomical and time wasting, especially if felling of large trees (about 2 m in girth) is to be done. However, in failing to fallow, the farmer may permanently remove the native biota and flora of the area and possibly wholly extinguish such organisms from the country.

CONCLUSION
The proven wisdom of traditional practices is in danger of being replaced by modern methods that have not stood the test of time. The newer methods depend very heavily on costly artificial additives for soil improvement. Can the Solomon Islander afford these costs? Even more seriously, can he afford the risk that some plants and other organisms may be irrecoverably lost, upsetting natural balances and productivity in unforeseen ways?

The least we should do if we do not wish to run foolish risks is to study the traditional practices and native agricultural wisdom carefully before knowledge of them is completely lost. It has taken thousands of years of careful observation and experimentation to acquire this kind of knowledge and it can all be lost within the period of one generation. Furthermore, if this kind of information is to avoid being simply consigned to the archives it is essential that enough of it be included in the school curricula to permit the students to realise—and be proud of—the fact that there is much to be learned from the science and technology of their forefathers.
15 Urban Gardening in Papua New Guinea and Fiji

R.R. THAMAN

The subject of this chapter is the importance of gardening in urban areas of Melanesia. The urban landscape is becoming the environment within which an increasing number of Pacific Islanders must live. Part of this environment is and should be garden land, both on individual allotments and on open land within the boundaries of urban areas. This chapter focuses on the extent of urban gardening in two urban areas: Port Moresby, Papua New Guinea, and Suva, Fiji, as it existed in 1974–5, and attempts to show its importance and the great range of subsistence and limited commercial products which are produced. An attempt is made to relate the findings to the importance of data on urban gardening as inputs for planning decisions, and finally, suggestions are made as to what information is needed concerning urban gardening and possible policy decisions that could increase urban agricultural production.

The subject of this chapter is gardening in the urban areas of the Pacific Islands. Port Moresby, Papua New Guinea and Suva, Fiji serve as case studies. Urban areas are the primary environment for a rapidly increasing proportion of the population both in Melanesia and throughout the Pacific; these urban areas are undergoing rapid change and development to accommodate increasing population and the changing cultural aspirations of urban dwellers. An important feature of the Pacific Island urban environment is garden land, both on individual allotments, often referred to as dooryard gardens, and on open land within the urban areas.

Unfortunately, despite an increasing number of studies on urbanisation in the Pacific, very few data have been gathered on the extent and importance of urban gardening and, more specifically, urban food production. It is the purpose of this chapter to shed some light on the nature of gardening in urban areas and to stress why it may be a very crucial consideration in planning decisions that affect the quality of urban life. Furthermore, urban gardening may be of greater importance in the Pacific Island context than in urban areas elsewhere owing to the unique nature of Pacific Island towns.

As stated by Belshaw (1963:17), the Pacific Islands are one of the few areas in the world where towns are comparatively recent phenomena and were almost entirely absent before European contact. Suva and Port Moresby were established as recently as 1881 in the case of Suva, when it was declared the capital of Fiji (Nayacakalou 1963:33), and 1884 in the case of Port Moresby, when it was established as the headquarters of what was then the Protectorate of British New Guinea (Lea and Irwin 1971:80). Furthermore, rapid urbanisation as we know it today in the Pacific Islands has been an even more recent phenomenon, which has accelerated greatly since World War II.

In addition to and possibly as a result of their recent origin, Pacific Island towns are
also different from towns in other parts of the world in that their indigenous populations consist primarily of immigrants who have in common values and modes of behaviour that derive from their traditional rural backgrounds (Belshaw 1963:17). Consequently, it seems appropriate that the unique qualities of Pacific Island towns should be a major consideration in urban planning. Francis Bugotu (1973:1), the Permanent Secretary for Education in the Solomon Islands, suggested at the 1971 Living in Town Seminar in Suva, that it should be possible to 'bring into town life some of the quality and character of village life'. He goes on to ask:

Where and when do we start marrying village and town life if we think this is necessary for the survival of some of the things and attitudes we value? It is clear that urban societies have to be modern, but in the Pacific Islands this should mean Pacific Islands' towns and cities.

Finally, talking about problems facing urban immigrants, he states that:

Our mistake was that we did not try at the very beginning to spend enough time and thought on planning and finding out what we really would and should like—what kind of society, with its people living in what kind of houses, eating what kind of food, playing what kind of games, loving and hating in what kind of style? Living, in other words, what kind of modern island life?

These comments seem to stress the need to view Pacific Island towns differently from traditional African, Southeast Asian or European towns. In this context, it is suggested that urban gardening (primarily small-scale subsistence gardening) merits considerable attention in light of its contribution to the quality of life in Pacific towns.

**Urban Gardening in Port Moresby and Suva, 1974–5**

This section looks at two case studies of urban gardening to illustrate the nature and extent of urban agriculture in Pacific Island towns. The Suva study was conducted from September through November 1974 by final year geography students at the University of the South Pacific under the supervision of the author. The Port Moresby study was conducted by the author from December 1974 to February 1975.

Port Moresby, which will have an estimated population of about 80,000 by the end of 1975, is situated on the 'coastal hill zone' on the south coast of the Central District of Papua. This is Papua New Guinea's driest area, receiving a mean annual rainfall of just over 100 cm. The natural vegetation is predominantly *Eucalyptus-Themeda* savanna and derived grassland. Physically, the landscape is characterised by a series of rock strewn limestone hills or ridges ranging from 90 to 180 m in elevation with valleys in between. Much of the approximately 78 sq km area is under more than 20 per cent slope, with the soils ranging from lithosols and red gravelly clays on the steeper slopes and ridges to brown clays, texture contrast soils and dark cracking clays on the more gradual slopes and valley bottoms (Mabbutt et al. 1965:22).

The town itself consists of sprawling suburbs, shanty towns and traditional urban villages dispersed throughout the hills and valleys. There is a near absence of freehold land with a majority of the land being owned by the administration; the remaining (approximately 10 per cent) land belongs to the Motu and Koitabu people, the traditional inhabitants of the area (Langmore and Oram 1970:48). In 1973, just over three-quarters of the population were indigenous, the balance being primarily of Australian origin. Of the indigenous population, approximately half are from the Central District, with the balance coming from Gulf, Western, Milne Bay and Morobe Districts, with an increasing number from Highland Districts (Surmon and Ward 1973:15).

Suva, in contrast, is located on the windward southeast coast of the main island of the Fiji group, Viti Levu, where the mean annual rainfall is 300 cm (Ward 1965:48).
The original natural vegetation was probably tropical rain forest. The urban area, of about 28 sq km is situated on a deeply dissected peninsula of Tertiary limestone, with an average elevation of about 20–60 m. Residential growth is primarily confined to the ridges and flat area, with the steeper valleys remaining under gardens or secondary vegetation (Whitelaw 1967:17). The soils range from skeletal sandstone soils on the ridge tops through fertile clays to waterlogged hydromorphic soils in the low lying areas.

The town itself is composed of residential areas ranging from squatter settlements, government resettlement housing projects and long established high density residential areas to exclusive high income residential areas. The two major types of land tenure are Crown and freehold land. Only freehold land can be purchased outright,
whereas both types are often leased. In 1966 just over half the population of Suva were Indians and approximately 30 per cent Fijian, the balance being made up by others including Europeans, Chinese and other Pacific Islanders (Walsh 1974:7).

The surveys of both areas included: inventories of all food plants, animals and some non-food plants on sample garden allotments; questionnaire surveys to determine the factors affecting urban gardening; and reconnaissance surveys of open land within the two urban areas.

**Sampling Frame**

For the Port Moresby study, five sample settlements were selected in consultation with the Housing Commission (Figure 15.1). These were:

1. Morata, a new Housing Commission, 'self-help' migrant settlement situated in the valley behind the University residential complex. The residents are of heterogeneous ethnic backgrounds, with Goilala, Morobe, Gulf and Highland people predominating. The dwellings include low covenant government housing and no-covenant housing, with most holdings averaging 450 sq m.

2. Kogeua, an improved migrant settlement situated on a steep rocky hillside east of Koki market and occupied by people almost all from Meii village near Kerema in the Gulf District. The allotments average about 440 sq m, the dwellings are built by the inhabitants themselves and the Housing Commission has provided roads, pathways and reticulated water.

![Fig. 15.2 Sample villages in Suva](image)
3. Hohola, the first of the administration’s attempts at cheap housing for indigenous people (Stuart 1970:307; Langmore and Oram 1970:53). The houses are constructed of cement blocks, the allotments average about 483 sq m and the residents are primarily of Papuan origin.

4. Gerehu, a recent ‘integrated’ government suburb on the northernmost edge of the urban area. The dwellings range from low covenant housing primarily for migrant settlers, and medium to high covenant housing for expatriates and higher income indigenous civil servants. The allotments average 450 sq m.

5. Kila Kila, a Koitabu urban village built just after World War II along a wartime aircraft parking bay. The houses are generally high quality, constructed by the owners themselves. The Koitabu are the traditional landowners, and individual urban allotments are considerably larger than other sample settlements, the median size being 1600 sq m. Most households also have usufruct rights to village agricultural land within 4–5.5 km of the settlement.

The number of households sampled in each settlement were: Morata thirty-five, Kogeva eighteen, Hohola ten, Gerehu four, and Kila Kila twelve.

In the case of Suva six sample areas were selected (Figure 15.2). These were:

1. Nabua, a settlement on the northern boundary of the town in an area of undulating topography. Most households own freehold land although a considerable number are on leaseholdings and squatters are present in some areas. The inhabitants are both Indian and Fijian.

| TABLE 15.1 |
| Distribution and frequency of staple and supplementary food crops on five sample Port Moresby settlements |

<table>
<thead>
<tr>
<th>Plant Names</th>
<th>Gerehu (4)</th>
<th>Kogeva (18)</th>
<th>Hohola (10)</th>
<th>Morata (35)</th>
<th>Kila Kila (12)</th>
<th>Total (79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botanical Name</td>
<td>Common Name</td>
<td>Freq.</td>
<td>%</td>
<td>Freq.</td>
<td>%</td>
<td>Freq.</td>
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<tr>
<td><strong>Staple Crops</strong></td>
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<td>Musa spp.</td>
<td>Banana</td>
<td>4</td>
<td>100</td>
<td>7</td>
<td>59</td>
<td>2</td>
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<tr>
<td>Manihot esculenta</td>
<td>Cassava, manioc</td>
<td>3</td>
<td>75</td>
<td>9</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Ipomoea batatas</td>
<td>Sweet potato</td>
<td>4</td>
<td>100</td>
<td>7</td>
<td>59</td>
<td>6</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>Taro</td>
<td>4</td>
<td>100</td>
<td>12</td>
<td>67</td>
<td>4</td>
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<tr>
<td>Dioscorea alata</td>
<td>Greater yam</td>
<td>3</td>
<td>75</td>
<td>4</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Xanthosoma spp.</td>
<td>American taro</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>61</td>
<td>6</td>
</tr>
<tr>
<td>Dioscorea esculenta</td>
<td>Sweet yam</td>
<td>3</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Alocasia macrorrhiza</td>
<td>Giant taro</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td><strong>Supplementary Food Plants</strong></td>
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</tr>
<tr>
<td>Saccharum officinarum</td>
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**TABLE 15.1—contd**

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<th>Morata (55)</th>
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<td>Freq. %</td>
<td>Freq. %</td>
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**Note:** Percentages were calculated by dividing a frequency by the number of sample allotments and multiplying by 100.
2. Raiwaqa, a predominantly low income Fijian residential area with both single and multi-unit dwellings provided by the Housing Authority. The area has both sloping and flat land, with many of the units being held under a ninety-nine-year lease from the Government.

3. Vatuwaqa, a predominantly Indian settlement in a low lying poorly drained area. Most of the land is under freehold tenure with some households leasing their allotments.

4. Nasese, an area occupied mainly by civil servants and professionals with all ethnic groups represented. It is located on the flat coastal plain, the main tenure types being leasehold and Crown land (in the case of civil servants) and limited freehold.

5. Toorak, an older high density residential area situated close to the central business district in a hilly area. Most ethnic groups are represented here, although Indians are predominant. Most of the land is freehold with some families holding private leases.

6. Tamavua, a high income residential area with homes of expatriates, politicians

---

**TABLE 15.2**

Distribution and frequency of staple and supplementary food crops and tree crops on six sample Suva settlements

<table>
<thead>
<tr>
<th>Plant Names Nabua</th>
<th>Raiwaga</th>
<th>Vatuwaga</th>
<th>Nasese</th>
<th>Toorak</th>
<th>Tamavua</th>
<th>Total</th>
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<tbody>
<tr>
<td>Common Name</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
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### TABLE 15.2—contd

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<th>Plant Names</th>
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<th>Vatuwaga (20)</th>
<th>Nasese (20)</th>
<th>Toorak (20)</th>
<th>Tamavua (20)</th>
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<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
<td>Freq. %</td>
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| Tree Crops                |            |              |               |             |             |              |             |
| Cocos nucifera           | Coconut    | 13           | 65            | 8           | 40          | 19           | 95          | 14          | 70          | 14         | 70         | 18         | 90         | 86         | 72         |
| Mangifera indica         | Mango      | 6            | 50            | 7           | 35          | 15           | 75          | 10          | 50          | 13         | 65         | 10         | 50         | 61         | 51         |
| Carica papaya            | Pawpaw, papaya | 11           | 55            | 4           | 20          | 9            | 45          | 9           | 45          | 12         | 60         | 11         | 55         | 56         | 47         |
| Citrus limon             | Lemon      | 10           | 50            | 4           | 20          | 18           | 65          | 12          | 60         | 11         | 55         | 6          | 30         | 56         | 47         |
| Artocarpus altissimus    | Breadfruit | 10           | 50            | 5           | 25          | 12           | 60          | 9           | 45          | 7          | 35         | 10         | 50         | 53         | 44         |
| Psidium guajava          | Guava      | 4            | 20            | 0           | 0           | 10           | 50          | 7           | 35          | 11         | 55         | 9          | 45         | 41         | 34         |
| Citrus sinensis          | Orange     | 5            | 15            | 6           | 30          | 8            | 40          | 4           | 20          | 3          | 15         | 7          | 35         | 31         | 26         |
| Citrus aurantifolia      | Lime       | 5            | 15            | 0           | 0           | 7            | 35          | 5           | 15         | 2          | 10         | 0          | 0          | 15         | 15         |
| Annona muricata          | Sour sop   | 1            | 5             | 0           | 0           | 7            | 35          | 4           | 20          | 2          | 10         | 0          | 0          | 14         | 12         |
| Ficus americana          | Avocado pear | 2          | 10            | 0           | 0           | 8            | 15          | 5           | 15         | 2          | 10         | 1          | 5          | 11         | 9          |
| Citrus reticulata        | Mandarin orange | 0        | 0             | 0           | 0           | 7            | 35          | 1           | 5          | 1          | 5          | 2          | 10         | 11         | 9          |
| Artocarpus integrifolia  | Jackfruit  | 2            | 10            | 0           | 0           | 4            | 20          | 0           | 0          | 2          | 10         | 0          | 0          | 8          | 7          |
| *Pomeloa pinata*         | Dava (Fijian) | 6        | 5             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Muraya horngigi*        | Curry leaf  | 6            | 5             |             |             |              |             |             |             |             |             |             |             |             |             |
| Citrus grandis           | Shaddock, pomelo | 0        | 0             | 0           | 0           | 1            | 5           | 0           | 0          | 2          | 10         | 2          | 10         | 15         | 5          |
| *Spondias dulcis*        | Polynesian vi-apple | 1      | 0             |             |             |              |             |             |             |             |             |             |             |             |             |
| Terminalia catappa       | Malabar almond | 3         | 15            | 0           | 0           | 0            | 0           | 1           | 5          | 0          | 0          | 0           | 4          | 3          |             |
| *Syzygium malaccense*    | Malay apple | 3            | 15            | 0           | 0           | 0            | 0           | 1           | 5          | 0          | 0          | 0           | 4          | 3          |             |
| *Areca catechu*          | Betel nut   | 2            | 2             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Averrhoa carambola*     | Carambola   | 2            | 2             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Moringa oleifera*      | Horseradish tree | 2       | 2             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Dracontomelon vitiense* | Tarawao (Fijian) | 2     | 2             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Syzygium jambos*        | Rose apple  | 1            | 1             |             |             |              |             |             |             |             |             |             |             |             |             |
| *Flacourtia rubra*       | Governor's plum | 1        | 1             |             |             |              |             |             |             |             |             |             |             |             |             |

Note: Percentages were calculated by dividing a frequency by the number of sample allotments and multiplying by 100.
*Data for individual settlements not available.

and business executives situated along the top of a well drained ridge. Most of the land here is either freehold or Crown lease.

The number of households sampled in each area was twenty.

**Extent of Cultivation**

In both Port Moresby and Suva, a great range of staple crops, supplementary food plants and tree crops were cultivated in dooryard gardens, that is on the land behind or adjacent to the house under tenure to a given household (Tables 15.1 and 15.2). Eighty-one different species were inventoried in Port Moresby and sixty-three in Suva. The Suva figure is possibly an understatement owing to the inability of some student enumerators to identify unfamiliar species.

In Port Moresby 98 per cent of all households cultivated some staple crops, the most common species being bananas, cassava, sweet potato and taro, which were cultivated by 92, 75, 68 and 56 per cent of the households respectively. Yams, American taro and sweet yam were also cultivated by one-sixth to one-third of all households. In Suva ap-
proximately 78 per cent of all households cultivated staple crops, the most common species being cassava, taro and bananas, which were cultivated on 55, 55 and 54 per cent of the allotments respectively. Plantain, American taro, sweet potato, yam and giant taro were also cultivated to a lesser extent.

With respect to supplementary food plants, 99 per cent and approximately 80 per cent of the households in Port Moresby and Suva respectively cultivated supplementary food plants. Of the forty-four species inventoried in Port Moresby, the most common species were sugarcane, pineapple, edible hibiscus, yard-long bean, watermelon, pumpkin, *suwea* (a Kerema name for a legume cultivated by Papuans), amaranths, corn, lemon grass, peanuts, chilli pepper and tomatoes, which were all cultivated or protected by over 10 per cent of the sampled households. Other frequently encountered plants included betel pepper, hyacinth bean, spring onions, egg plant, English cabbage, wing beans, and a bushy species of fig with edible leaves known as *metemete* (Kerema).

Of the twenty-nine different species inventoried in Suva, the most commonly occurring were edible hibiscus, chilli peppers, sugarcane, egg plant, various beans, tomatoes, English cabbage, lettuce, Chinese cabbage and cucumber, which were protected or over by 10 per cent of all households. Other frequently encountered plants included pumpkin, pineapple, pigeon pea, kava, carrots, okra, bitter cucumber, spring onions and coriander.

With respect to tree crops, there were twenty-nine and twenty-four species represented in Port Moresby and Suva respectively. In Port Moresby 96 per cent of all households cultivated or protected at least one species of tree crop. The three households that cultivated no tree crops were all recent arrivals to the Morata settlement. In Suva, 80 per cent of all households had some tree crops.

In Port Moresby, the most common species were pawpaw, mango, coconut and Malabar almond, which were found on over 50 per cent of all allotments; and sweet sop, betel nut, guava, rose apple, jam fruit and breadfruit on over 10 per cent of the allotments. Other frequently encountered species were sour sop, water apple, *ubuto* (Koitabu) and citrus trees. Single species of citrus trees might in fact be more common, but identification of the individual species was difficult.

In Suva the most common species were coconut, mango, pawpaw, lemon, guava, and orange, which were found on over 25 per cent of all allotments; and lime, sour sop, and avocado pear, which were found on over 10 per cent. Other frequently encountered species included mandarin orange, jackfruit, *dawa* (Fijian), curry leaf, shaddock and Polynesian vi-apple.

In addition to these food plants, there are also found in both Port Moresby and Suva a range of useful non-food plants, which are used in the preparation of handicrafts, dyes, medicines, fish poisons, personal adornment and material goods. Some of the more common species include: pandanus (*Pandanus* spp.), cotton (*Gossypium* spp.), kapok (*Ceiba pentandra*), paper mulberry (*Broussonetia papyrifera*), sisal hemp (*Aguave sisalana*), annatto (*Bixa orellana*), tuba (*Derris* spp.), bottle gourd (*Lagenaria* sp.), bamboo (*Bambusa* spp.), Job's tears (*Coix lachryma-jobi*), *Cordyline terminalis*, and frangipani (*Plumeria* spp.).

With respect to the area of a given holding devoted to urban gardening, accurate data for Suva were not obtained. However, in the Port Moresby study, each allotment was mapped and estimates of percentage cover were made for those crops generally planted in contiguous plots. Plants such as minor food plants, tree crops, and scattered staple crops were not inventoried with respect to their coverage, although it was quite considerable at times. Table 15.3 shows the breakdown of land use into percen-
Agriculture and the environment

TABLE 15.3
Breakdown of land use on sample allotments in Port Moresby

<table>
<thead>
<tr>
<th></th>
<th>Gerehu</th>
<th>Kogeva</th>
<th>Hohola</th>
<th>Morata</th>
<th>Kila Kila</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median size of allotment</td>
<td>450m²</td>
<td>425m²</td>
<td>450m²</td>
<td>450m²</td>
<td>1600m²</td>
</tr>
<tr>
<td>% food crops*</td>
<td>40</td>
<td>11</td>
<td>22</td>
<td>38</td>
<td>23</td>
</tr>
<tr>
<td>% ornamental</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>% animal structures</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% structures</td>
<td>9</td>
<td>15</td>
<td>11</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>% open area</td>
<td>44</td>
<td>71</td>
<td>62</td>
<td>46</td>
<td>66</td>
</tr>
</tbody>
</table>

* This figure would be considerably higher if scattered individuals and tree cover were taken into consideration.

...tages under contiguous food crops, ornamentals, animal structures and open space or lawns. As can be seen from these figures, the most recently settled areas, Gerehu and Morata, seemed to be the most heavily cropped. Both areas were low covenant areas with predominantly low income migrant families. The medium to high covenant areas in Gerehu were not sampled, but reconnaissance surveys showed only limited use of land for agricultural purposes by expatriates and high income indigenes in these areas.

In the cases of Kogeva, Hohola and Kila Kila, there seem to be a number of reasons for the lower incidence of cropping. Kogeva is situated on a very steep and rocky site with very low agricultural potential. Furthermore, the figures are somewhat misleading because two households in Kogeva that had almost no cultivation were each currently cultivating almost 100 per cent of vacant adjacent allotments. Five households also had gardens near the Laloki River about 16 km from town.

In the case of Hohola, it seems that, with time, the need or motivation to cultivate crops for subsistence purposes has waned. Some people received food from kinsmen in coastal areas such as Hula, Kairuku or Bereina; some felt that soil fertility had declined; some simply felt no need or had no time to produce crops for subsistence purposes. In the cases of both Kogeva and Hohola, greater population density might also have been a factor. These older settlements had 8.7 and 8.1 people per allotment respectively, whereas the newer settlements of Gerehu and Morata had densities of 6.8 and 6.4. Kila Kila had 8.7. There were no significant differences in the sizes of allotments in these settlements. The decrease in cropping due to increased population might be correlated with either an increasing number of wage earners or the need for an increasing amount of what Little (1965:237) refers to as 'personal space'.

In the case of Kila Kila, the allotments are about four times as large on the average as the allotments in the four other settlements and, despite the fact that a considerable portion of these allotments was cropped, all households in Kila Kila also had from one to four additional gardens in the hills within 5.5 km of the settlement. Finally, in all cases, if the tree crop cover and scattered individual food plants and valuable non-food plants were taken into consideration the percentage 'crop' cover would be higher.

Another consideration is the incidence of cultivation by households on open areas within the urban area (Table 15.4). Of the sixty-seven sample allotments (Kila Kila is not included), there were twenty-five households (37 per cent) who took advantage of open areas. These areas included road frontages, empty adjacent allotments, rights of way for proposed or existing paths and roads, and empty land including hill sides,
swampland, etc. There were also twenty-five households that had garden land outside the urban area in locations including the Laloki, Brown and Vanapa River areas, Sogeri, Kairuku, Bereina and Hula.

In the case of Kila Kila, the Koitabu residents are the traditional owners of a considerable proportion of the open land within the urban boundary and, as mentioned before, all households have from one to four ‘bush’ gardens in addition to their oversize town allotments. The average area under cultivation on bush gardens for each sample household was 1135 sq m or 0.114 ha. Yams were almost always the main crop in these gardens, with some sweet yams, cassava, watermelon and corn often planted along the borders or, in the case of cassava, to demarcate division between plots within a communal fence. When the yams are harvested, bananas, cassava, watermelon, corn, beans or even sweet potatoes often follow. These gardens are generally located on the hills directly behind Kila Kila, in the valley between Kila Kila 1 and Kila Kila 2, or along Taurama Road.

In the case of Suva, 20 per cent of the sample households planted along road frontages despite City Council regulations forbidding such practices. There were also twenty-four households growing crops on ‘unused’ open land, ten in Nabua, four in Raiwaqa, two in Vatuwaqa, seven in Nasese, and one in Toorak. This practice was most common in areas such as Nabua, Raiwaqa and Nasese, with a high proportion of Crown and leasehold land and a relatively high proportion of Fijian residents. The planting on these open areas is generally limited to cassava, taro and edible hibiscus and is found primarily on Crown land. There seems to be very little objection to the use of these lands on a usufruct basis. An estimated 50 per cent of the available open land in Suva might be under such cultivation. In Port Moresby, there is also considerable cropping on open land by squatters, usually with the consent of the Koitabu or Motu owners.

**Animal Production**

When compared with cropping in the urban areas, animal husbandry seems to play a minor role. There were, however, some households in Port Moresby that kept pigs and chickens (Table 15.5). The pigs were tethered or kept in a box in two cases in Morata and, in the remaining three cases (one in Morata and two in Kila Kila), they were kept in pens. The chickens and ducks, in most cases, were kept in cages or boxes at night and allowed to forage during the day. There were no cows, goats or horses found on any of the sample allotments in Port Moresby.

In Suva, there was a higher frequency of animal keeping (Table 15.6). Although no pigs were kept, a number of households kept chickens and 11 per cent kept ducks. The noticeable absence of all livestock in Raiwaqa is due to Housing Authority restrictions
TABLE 15.5
Number and distribution of households keeping animals in Port Moresby

<table>
<thead>
<tr>
<th></th>
<th>Gerehu</th>
<th>Kogeva</th>
<th>Hohola</th>
<th>Morata</th>
<th>Kila Kila</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Chickens</td>
<td>—</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

TABLE 15.6
Number and distribution of households keeping animals in Suva

<table>
<thead>
<tr>
<th></th>
<th>Nabua</th>
<th>Nasese</th>
<th>Raiwaqa</th>
<th>Tamavua</th>
<th>Toorak</th>
<th>Vatuwaqa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Horses</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Goats</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Chickens</td>
<td>3</td>
<td>5</td>
<td>—</td>
<td>7</td>
<td>5</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>Ducks</td>
<td>1</td>
<td>3</td>
<td>—</td>
<td>7</td>
<td>—</td>
<td>2</td>
<td>13</td>
</tr>
</tbody>
</table>

against the keeping of animals other than dogs and cats in the government housing area.

There are also City Council regulations, which apply to all urban settlements, specifying the types of pens, distances from dwellings and sanitation requirements for poultry keeping. In only 69 per cent of the cases where people kept livestock were they aware of these regulations; in many other cases, people disregarded them because of the small-scale nature of their production. Cows, goats and horses were generally tethered and allowed to graze on open land when this was available. Chickens and ducks were generally penned, although allowed to roam free during the day, except where they were raised for commercial production.

Distribution of Products

Most people grew crops and kept animals for home consumption, although a considerable number either distributed the products to friends and kinsmen or sold them. In Port Moresby, in addition to home consumption, 64 per cent of the households distributed the products to their wantoks (kinsmen or close friends) and 38 per cent sold products at the various market places in Port Moresby. The items most commonly sold were bananas, sweet potatoes, cassava, corn, pawpaw, sugarcane, coconuts and tomatoes plus seasonal fruit such as rose apples, water apples, mangoes, guavas and breadfruit. Other crops grown in dooryard gardens that were reportedly sold were peanuts, watermelons, suwea (a legume), betel pepper, sour sop, vi-apple and betel nut. One householder also sold gladioli from his ornamental garden. The people from Kila Kila also sold some yams, cassava and other produce from their bush gardens.

In Suva, a greater percentage of the sample households grew crops for subsistence consumption, with only three households out of 120 (2.5 per cent) producing crops for
sale, one a Chinese family in Tamavua that cultivated cassava, taro, English cabbage, beans, chillies, cucumber, pumpkin, amaranth, tomatoes, strawberries, grapefruit and gourds for sale. Many families also gave surpluses to friends or families. Three households reared chickens for sale of meat or eggs, with one of these households also raising ducks commercially.

Technology
In both areas, urban gardeners seem to rely entirely on hand tools. A great majority of all households in Port Moresby owned picks, spades and either grass or bush knives. A considerable number also had crowbars or sharpened pipes, digging forks, rakes and axes; in many cases they still used digging sticks. The situation was similar in Suva where the most important tools included spades, digging forks, hoes, rakes and bush knives.

Unfortunately, no information was gathered on the use of water in Suva. In Port Moresby, where water shortage is more critical, most households indicated that watering was a necessity, especially during the dry season between October and January. Almost half the people indicated that they watered their gardens twice a day during the dry season, whereas another 25 per cent indicated that they watered their gardens only once a day, usually in the late afternoon. There were only nine cases where people did not water their gardens, for one of three reasons: their water source had been cut off; the cost of the water was excessive; or they cultivated no crops that needed regular watering. In approximately two-thirds of the cases where water was used, rubber hoses were the main means of distribution, the rest used cans, drums and buckets. Dishwater was also often used, and taro patches and small gardens were often planted near water outlets to take advantage of water seepage and wastage.

In Gerehu, Kogeva, Hohola and Kila Kila, almost all homes had private water pipes that could be used for both domestic and agricultural purposes. In Morata, however, only five of thirty-five sample households had private pipes that were operative. Some allotments had had the pipes installed, but had not paid the opening fee; some had pipes that had been closed owing to failure to pay water bills; and some allotments had no pipes. Most Morata households, approximately 78 per cent, relied on community pipes, which were often at a considerable distance (beyond hose length) from their allotments.

Very little is done to improve soil fertility in Port Moresby. Eleven households used garbage, although most gave it to garbage collectors, and a couple used chicken, pig and horse manure, grass or ashes. In Suva, a higher percentage of the people used fertilisers, with twenty-three of 120 households using poultry waste, compost, sulphate of ammonia or potash.

In no case in Port Moresby did anyone indicate using pesticides, whereas in Suva three households used insecticides. In only three cases did Port Moresby informants indicate problems with pests, whereas in Suva thirty-one households (26 per cent) mentioned that pests such as fungus, insects, snails, birds, rats and mongooses were a major problem.

Most households in Port Moresby and Suva depended on friends, relatives or their own gardens for planting material. Seeds of introduced vegetables such as tomatoes, lettuce and cabbages are occasionally purchased from trade stores. This practice is more prevalent in Suva.

Labour Input
In the Port Moresby area, women seemed to do most of the work in dooryard gardens. Excluding Kila Kila, over 75 per cent of all households indicated that women did most
of the gardening. In Kila Kila, the women were also responsible for most gardening on both town and bush allotments, with some of the older males, who were not employed at wage earning jobs, also helping. The average time spent working in dooryard gardens (not including Kila Kila) was 4.5 hours per week with a range of 0–20 hours per week. The average Kila Kila household visited its bush garden(s) at least two or three times a week, especially during the yam planting season, and devoted more time to gardening than households in other settlements.

In Suva, the average amount of time spent by households on urban gardening was 5.5 hours. In ten cases, households hired paid labourers who worked an average of 4 hours per week. In both cases accurate labour input data are extremely difficult to obtain, because labour input is often sporadic and not part of a set routine. Furthermore, it is difficult to differentiate between labour input devoted to food production and that devoted to ornamental gardening.

Problems
Despite evidence of considerable agricultural production in Port Moresby and Suva, there seem to be a number of problems faced by urban gardeners. In Port Moresby, unfavourable climate, poor soils, cost and availability of water, insufficient land, theft, loss of soil fertility, pests, insufficient time and lack of government help were the most commonly mentioned problems.

Very little except watering can be done about the dry climate. Many of the sample allotments, especially in Kogeva and Morata, had very poorly developed rocky or stony soils, which impeded agricultural production. The major problems relating to water included the high cost (a frequently mentioned problem in Kila Kila), the distance of community faucets in Morata, water cancellations in Morata, and fear of a City Council regulation against the use of water for gardening purposes between 8 a.m. and 6 p.m. Insufficient area for cropping was another commonly expressed problem in all areas except Kila Kila.

In Suva, one of the major problems seemed to be insecurity of tenure, primarily in Nabua and Toorak, where a number of people had short-term leases or were squatters. City Council regulations, although not strictly upheld, were also considered a disincentive. These prohibit the cultivation of crops along road frontages and the keeping of pigs, goats, cows and horses within the city limits; they also set certain specifications for pens and sanitation for poultry rearing. In Raiwaqa, where the Housing Authority allows the rearing of no animals, apart from dogs and cats, the regulations are strictly enforced. Fifty-three per cent of the sample households also mentioned insufficient land as being a major problem. Other problems included: pests such as diseases, insects, rats, dogs and mongooses; poor sandstone and hydromorphic soils; theft (approximately one-third of all households had experienced theft); insufficient time; high costs of poultry feed and fertiliser; boundary problems with respect to ownership of crops; and unfavourable response to gardening or livestock rearing by neighbours.

Although these two case studies of Port Moresby and Suva do provide valuable information on the nature of urban gardening in the Pacific Islands, they were not designed on a comparative basis and the same criteria were not used to select sample settlements. In Port Moresby, for example, the sample settlements were selected primarily from low and middle income areas, whereas in the Suva study high rent districts were also studied. Nevertheless, both studies show that there is a great range of food plants and, to a lesser extent, non-food plants, and livestock grown or reared in the urban areas, and that a considerable proportion of the land in urban areas is devoted to crop production.
IMPLICATIONS OF URBAN GARDENING

The importance of urban food production and its implications for planning are not completely understood. The lack of data, both on the extent and nature of urban gardening and its importance to the urban population is one major problem. Increasing interest in data collection has, however, recently been shown by city planners and administrators.

In Port Moresby, the Housing Commission is interested in obtaining all available data on urban gardens, has itself conducted a survey on urban gardening (Nolan 1974), and has supported studies by the Department of Geography of the University of Papua New Guinea (1973; 1974), which have focused in part on urban food production. The Housing Commission was also exceedingly helpful in assisting the author in this present study. Others have also been instrumental in drawing attention to the importance of urban food production. Andree Millar, Director of the University of Papua New Guinea Botanical Gardens, and Dr John Guise, then Minister for Agriculture, were responsible for a campaign encouraging the cultivation of food crops in Port Moresby. Mrs Millar, in particular, has conducted studies of urban gardens and food plants in different urban areas in Papua New Guinea, writes a regular column in the local newspaper and has a regular radio program, all designed to stimulate both food and ornamental cropping in the urban areas. In the case of this study, she was exceedingly helpful, and provided valuable assistance in identifying plant specimens collected from sample allotments. Finally, Mr Michael Somare's Government has also expressed continual concern at the related problems of food supply and nutrition, especially in some urban settlements (Forbes 1975:17).

In Fiji members of the Directorate of Town and Country Planning have also shown considerable interest in obtaining data on urban food production and have given support to the study of urban gardening in Suva conducted by students and staff of the Geography Department of the University of the South Pacific (Basha et al. 1974). The Committee on Food Supplies (1974) in the Solomon Islands has made studies of the production of major staple crops, primarily sweet potato, in Honiara and stressed the need to increase production per head in both rural and urban areas.

Data collection on the extent of urban gardening is evidently receiving increasing priority, but there is at least an equal need for data on the possible implications of urban agricultural production for the people involved. This is a difficult problem and is often assessed on purely economic or political grounds. As stressed by Cohen (1973, 1976), any problem relating to the allocation of both natural and cultural resources should be looked at from a number of different 'environmental orientations', not just from a purely economic, political or strategic orientation. If planners and other groups responsible for resource allocation attempt to use a 'multidimensional' approach, it may be possible to avoid what Cohen describes as excessive 'social prices' for the cultures involved. Consequently, I have decided to use Cohen's conceptual model in evaluating the implications of urban gardening.

In his paradigm Cohen suggests four major 'environmental orientations' or ways of looking at the allocation of space or environmental features, which in our case would be urban gardens or potential garden land. These orientations are:

(a) the 'instrumental orientation', which examines the exploitation of a resource in terms of technical feasibility and economic profitability;
(b) the 'territorial orientation', which looks at the relative importance of controlling land physically or politically;
(c) the 'sentimental orientation', which considers the sense of attachment or belonging that people have for a resource; and
(d) the ‘symbolic orientation’, which looks at the aesthetic, moral or religious value of a resource.

The value of Cohen’s paradigm is that it allows us to look at the implications of the use of urban land for gardening from a number of different points of view. It enables us ‘to ask new questions and gain a more profound insight into a field’ (Cohen 1973:62), in this case to give us a multidimensional view of urban gardening.

Instrumental Orientation

Using first the instrumental orientation, which Cohen divides into technical and economic sub-orientations, we must ask whether the exploitation of urban land is either technically feasible or economically profitable. In the case of technical feasibility, the Port Moresby and Suva examples show that it is, in most cases, despite poor soils and adverse climatic conditions, technically feasible to cultivate a great variety of food crops and to raise some animals in urban areas. Furthermore, given the introduction of improved technology, including new plant species or varieties, and possibly more efficient means of utilising available water, the technological feasibility of urban gardening might improve considerably.

From the standpoint of economic feasibility, it is difficult to determine the true economic importance or profitability of urban gardens. Langmore and Oram (1970:30) say:

Earnings from wage employment are the most important, though not the only source of income for indigenes living in Port Moresby ... and that the value of gardening and fishing by town residents and of gifts made to and from relatives in rural areas must be considered when estimating income.

Although Langmore and Oram may have been referring more to agricultural production by urban residents in areas beyond the Port Moresby urban boundary, the studies in Suva and Port Moresby showed that there was some production for cash sales. Of even greater importance than cash income derived from urban gardening, however, is the non-cash income contributed by urban gardening to the ‘real incomes’ of urban dwellers.

If the household becomes able to obtain more homegrown food while getting the same amount for its cash income as before; or if its cash income is able to buy more food while homegrown food goes on as before, an increase in real income of the household has taken place ... no satisfactory way of measuring this accurately has been developed yet, but we believe that non-cash or so-called ‘subsistence’ incomes are more important in towns, and cash incomes more important in rural areas, than has been generally understood. (Committee on Food Supplies 1974:6).

The importance of this non-monetary food production becomes increasingly more crucial in times of inflation when it provides a buffer or safety valve against increasing food prices or when family incomes are near the subsistence level. As Harré (1974:7) says: 'The individual whose cash income is very low is likely to maximize his subsistence activities, firstly because subsistence is necessary to achieve a minimal standard of living—perhaps even for survival at any standard.' This comment is pertinent with respect to future urban development in Port Moresby, where it has been estimated that, by 1990, only 26 per cent of all indigenous workers will earn weekly wages in excess of $A24, while 44 per cent will earn weekly wages below $A13 (Cochrane and Womble 1970:103). As the results of the recent Port Moresby Urban Development Study conducted by Maunsell and Partners and Voorhees and Associates indicate, ‘for an urban development plan, to be viable, [it] must be able to cope effectively with a large and predominantly very poor indigenous population’ (Cochrane and Womble 1970:103).
Both the Directorate of Town and Country Planning in Suva and the Housing Commission in Port Moresby have indicated that one of the most pressing needs is to gather data on both the incomes of urban households (especially those in the lower income brackets) and the importance of subsistence production in contributing to the real incomes of these families. Only in this way will it be possible to determine how much land an urban resident needs or should have: ‘we must encourage self-sufficiency and are worried that 450 square metres might not be enough land’ (T. Stanley, pers. comm., 1974).

Finally, with respect to the economic profitability of using urban land for gardening purposes, there are undoubtedly alternative uses that would provide greater cash returns, but is is not clear at this time whether some of these alternative uses would be as important as the non-cash economic gains that might be realised through expanded agricultural utilisation. Furthermore, it might also be a significant factor in reducing the drain of overseas funds, of which $A3,504,000 were spent in 1970/1 on imported fruit and vegetables, much of which went to Port Moresby (Forbes 1975:17).

Territorial Orientation
Territorial orientation is divided by Cohen into strategic and political sub-orientations. The strategic importance of urban land was probably greater in the past when defence and dominance were more important. Nevertheless, it can be assumed that most people in urban areas do have a modified sense of territoriality, which is often manifested in the construction of fences, hedges or other barriers. It can also be argued that most people need a certain amount of ‘personal space’ (Little 1965:237), which they control themselves. Kimber (1973:7), in her study of dooryard gardens in Puerto Rico, suggests that dooryard garden space, apart from its function as space for growing food and ornamental plants, for social and processing activities and for household chores, represents social territory ‘in which persons define their own places and express their self-images’. It is her contention that the ‘dooryard garden, in addition to its other characteristics, is a unit of social space and is an important expression of the genre de vie of a people’.

The political sub-orientation, on the other hand, relates to legitimate control or sovereignty over property. This is a major factor affecting urban gardening, and security of tenure seems to play an important role in determining what types of crops will be grown. In Suva, there were numerous cases of people who grew no crops or planted no long-term perennial crops because of short-term leases or because they were squatters. If crops were grown, they were usually short-term crops and little care was taken to improve soil fertility or to make improvements. In Port Moresby, although no studies were made of squatter settlements, a similar problem probably exists. It seems that, with respect to improving the husbandry practices and expanding urban agricultural production, governments could either implement programs designed to provide secure tenure to urban dwellers or to allocate open areas or urban garden reserves, similar to the ‘allotment’ system in England. In Port Moresby, where the administration probably controls over nine-tenths of the land (Langmore and Oram 1970:48), decisions regarding the allocation of land for such purposes will probably be easier to implement than in other Pacific towns, such as Suva, where much of the land is freehold. In this vein, Terry Stanley of the Housing Commission in Port Moresby mentioned (pers. comm.) that they were presently exploring the possibility of establishing new settlement areas with ‘oversize’ allotments on the periphery of the urban area in an attempt to stimulate self-sufficiency in new settlements.
Sentimental Orientation

In the context of the sentimental orientation, which Cohen has divided into primordial belonging and prestige orientations, an evaluation of urban gardening is much more difficult, owing to the intangible nature of people’s sentimental values. Cohen’s definition of primordial belonging is an individual innate sense of belonging or sense of attachment to an area or culture (Cohen 1973:32–3). This sense of belonging, according to Weil (1952:41), is perhaps ‘the most important and least recognized need of the human soul’. Furthermore, it is probably much more developed and comprehensive in the context of a traditional society, where a person has a ‘strong sense of belongingness to one’s community and land’ (Cohen 1973:34).

In the urban environment, where there is a problem of adaptation for people going from a familiar to an unfamiliar environment, the maintenance of a ‘sense of primordial belonging’ would seem to take on greater importance. In a study on the Gazelle Peninsula, it was found that urban immigrants had a much higher incidence of neurosis, psychosis and personal discomfort than the local Tolai because they were exposed to the social strains of settling in a foreign and unwelcoming atmosphere (Pulsford and Cawte 1972:122). The importance of preserving something of the ‘rural area’ is further stressed by Breese (1966:98):

The phenomenon of ‘rural transplants’ or survivals in the urban areas is a common one. Indeed, it may be these rural transplants or survivals of rural practices who insulate the new migrant against his new environment until he can become accustomed to it. As a result, there may not be nearly so much cultural shock involved in the move from a rural to an urban area as may at one time have been thought. The cultural shock is related to the change from a subsistence economy to a cash economy.

Similarly, Mylius (1973:113) stresses:

that the traditional social relationships and style of life provide a stable base from which to move out. The integration of the traditional style and modern standards is a useful one if individuals are to retain their identity. This requires a recognition of the value of the traditional relationships and style of life and acceptance of the advantages of communal settlement at certain stages in the integrating process.

Unfortunately, in urban areas, it is often difficult to recreate a cultural environment that is similar to the immigrant’s rural environment, owing to the inherent nature of towns and cities. However, it is suggested here that urban gardening may be one of the most effective ways to provide a familiar ‘garden environment’ as well as limited amounts of traditional foods or material goods that would be otherwise unavailable in the urban areas. From her experience in Puerto Rico, Kimber (1973:20) asserts that ‘traditions are represented in dooryard gardens’. This opportunity to recreate the traditional cultural environment with its familiar plants and preferred foods seems to be very important. The studies in Port Moresby and Suva indicate that people do just this, and revealed marked differences in crop combinations and methods of cultivation between the different ethnic groups. In Port Moresby, the gardens of Highlanders were characterised by sweet potatoes (often planted in small mounds), peanuts, corn, pumpkin, amaranths and a variety of beans, including snake beans, wing beans and hyacinth beans (Table 15.1). Papuan gardens, on the other hand, often had the legume suwoa, taro, edible hibiscus, rose or water apples, betel pepper and betel nut palms.

In Suva similar patterns were encountered, with Indian households growing chillies, amaranths, egg plants, okra, bitter cucumber, angled loofah, mint, coriander, jackfruit, horseradish tree and curry leaf (Table 15.2). Fijians planted primarily taro, American taro, cassava, edible hibiscus, sugarcane, bananas, and breadfruit, whereas Chinese families were more apt to have vegetables such as spring onions, Chinese cabbage, lettuce, radishes and other short-term truck crops. Despite the fact that a
number of ubiquitous crops and trees like cassava, bananas, pineapples, pawpaw and sugarcane are cultivated by most ethnic groups in both Suva and Port Moresby, the different ethnic groups do seem to retain many of their own characteristic crop combinations and agricultural practices within their urban gardens. In addition to food plants, ceremonial or medicinal plants, plants such as pandanus or Job's tears, which are used in handicraft, and many other culturally significant plants could also be grown in the urban areas to enhance the sense of primordial belonging.

Whereas the sense of primordial belonging is considered to be innate, the 'prestige' sub-orientation focuses on the sentimental value of derived or learned prestige (Cohen 1973:32–3). There seems to be a correlation between social class and whether or not prestige is gained through subsistence food gardening in urban areas. Harré (1973:1–3) suggests that people living at or near the subsistence level (although possibly gaining prestige from their friends and kinsmen if they have a particularly good garden), do not cultivate for prestige, but rather to produce food. In the case of middle income families who are struggling for upward social mobility, there is often a stigma attached to and an avoidance of manual labour, and a food garden is not as prestigious as an ornamental garden. In the upper social stratum, a person may also value an ornamental garden over a food garden, but in some cases may choose to 'demonstrate a common touch' and practise subsistence gardening (Harré 1973:3–10). In most cases, however, prestige is an intangible concept and it depends a great deal on an individual's or a social group's aspirations. Nevertheless, in many societies, the possession of a productive dooryard garden would seem to bring considerable prestige to the owner, especially in cases where prestige is gained by growing particularly good yams or by distributing produce such as breadfruit or rose apples to kinsmen or friends. Furthermore, with some form of socialisation, it should be possible to make an urban food garden a more prestigious possession at all levels of society.

Symbolic Orientation

Cohen has divided the symbolic orientation into the aesthetic and moral-religious sub-orientations. The aesthetic value of a resource depends upon the tastes of the people involved. In the case of urban migrants in an unfamiliar environment, it would seem that a garden with familiar plants and a familiar structure and other cultural features would be aesthetically more pleasing than an area with no garden land or insufficient space. People from all cultures tend to rearrange their environment, whether it is a room, allotment or entire city, and, as Lowenthal is quoted as saying (in Cohen 1973:48): 'People see their surroundings through preferred and accustomed glasses and tend to make the world over as they see it.'

The moral-religious sub-orientation relates to environmental features as they symbolise the sacred (Cohen 1973:53). The importance of urban garden land in this context varies from society to society depending on their particular beliefs. The Hindu population in Fiji often have religious shrines, known as Sthan, in their gardens, giving the gardens themselves considerable sacred value. Plants such as sweet basil and betel pepper, which are used in religious ceremonies, also have sacred value.

Similarly, in Port Moresby, there are cultural groups who attach spiritual or magico-religious importance to certain crops. For example, to the Koitabu residents of Kila Kila the yam has a certain sacredness; in new garden plots it is usually planted alone, and after weeding is completed the people are forbidden to enter the yam patch until it is time to harvest. Melanesia, in fact, is renowned for garden ritual (Malinowski 1965a; 1965b), and it might be assumed that there is widespread moral-religious significance attached to urban gardening in Melanesian towns.
Nutritional Orientation

The final orientation does not seem to fit comfortably into any one of Cohen's environmental sub-orientations. It is what I will call the nutritional orientation. This relates to the value of the environment in terms of the physical health and nutritional status of the people involved. It would be hard to dispute the fact that, if people are growing food to supplement other resources, they must be benefiting from the exercise. The true benefit of urban gardening in terms of nutrition is in fact probably underestimated. S.V. Parkinson, formerly Head Nutritionist at the Fiji School of Medicine, remarks that traditional food patterns of the peoples of the South Pacific are nutritionally sound and are excellent sources of calories, proteins, vitamins and minerals; that traditionally the classical forms of malnutrition do not appear to have been common; that traditional food patterns appear to be changing rapidly, particularly in towns; that urban substitutes often provide a less balanced diet, lower in proteins, and lower still in vitamins and minerals; and that traditional food tends to be more expensive than processed urban substitutes (Parkinson 1973:85–91). All these factors seem to stress that urban food production, particularly if increased, could have a significant role in improving the nutritional status of urban migrants.

By using Cohen’s paradigm, we have been able to look at urban gardening from a number of different perspectives and to gain some understanding of the implications of planning decisions that might affect the urban agricultural situation. The real difficulty, however, is determining how much value should be attached to the various orientations. It is obvious that there are sectors of the economy or society that would appraise the values of each orientation differently, and in order to come to some kind of compromise, trade-offs must be made. As Cohen (1973:10) states ‘we are constantly forced to make an intuitive “value calculus” by deciding to give up a certain degree of realization of one value, so as to be able to realize another value to some degree’. He goes on to say:

The extent to which the realization of the claims of each environmental orientation infringes upon the chances to realize the various environmental purposes could be termed the ‘social price’ of that orientation. Each orientational mix, hence has a certain ‘social price’ attached to it… The total ‘social price’ represents a fair estimate of the chances of survival of a society in all its aspects, political, physical, institutional and cultural; whereas the internal composition of that total price indicates the areas of stress and possible future changes in society. (Cohen 1973:77)

In short, any decision that brings about a change in urban gardening will probably have repercussions throughout the society.

Suggestions Concerning Urban Gardening

There seems to be no simple solution to the problem of increasing urban agricultural production, and any program designed to maximise such activity must be broadly based and include a number of different strategies. The following suggestions are offered as possible means of increasing urban agricultural production in Pacific towns:

1. The collection and analysis of data on urban gardens should be continued so we may gain a better understanding of their true value in terms of different environmental orientations.

2. Serious thought should be given to establishing garden reserves than can be used by urban households with insufficient or no garden land; enlarging the size of present allotments, and establishing urban settlements for the low income groups in areas of highest agricultural potential, because it is these people who depend most heavily on urban food production.

3. Publicity campaigns, such as those currently operative in Papua New Guinea,
should be mounted or continued in order to stress the importance of urban gardening; to improve its image; and to make people aware of the types of aid that gardeners can receive from various agencies.

4. In areas like Port Moresby, where water seems to be a controlling factor, attempts should be made by appropriate authorities to minimise the effects of shortages on agricultural production.

5. Broadly based programs of plant introduction should be pursued, as there is great scope for the integration of new plant species and varieties into the present urban agricultural systems. There are an estimated 3000 edible plants available on earth; of these only 200–300 are presently eaten (Thornton 1974:2). In Fiji, the Research Division of the Department of Agriculture has a plant distribution program through which items such as taro and banana suckers, citrus, guava, breadfruit, coconut and pawpaw seedlings, and young passionfruit, pineapple and strawberry seedlings are sold at nominal prices. In the past, however, there was a greater selection, and plants such as coffee, cocoa, betel nut, cabbage, tomatoes, lettuce, etc., and fruits such as rambutan (Nephelium lappaceum) and mangosteen (Garcinia mangostana) were also available. A similar program conducted by the University of Papua New Guinea Botanical Garden, is operative in Port Moresby, but the emphasis seems to be more on ornamental plants. The success of this program can be seen in Morata, where a large percentage of the inhabitants have plants such as the jam fruit tree (Muntingia calabura) and a wide range of ornamentals. Such programs should be continued, expanded and more widely publicised.

6. Agricultural extension and research should be expanded and emphasis should be placed on improving urban agricultural production. Fertiliser and crop variety trials and soil surveys should be conducted in urban areas to assess agricultural potential. Research might also be conducted to determine optimum cropping sequences or combinations for urban areas. Model garden allotments might establish the optimum economic utilisation of various sizes of urban allotments and serve as an example for urban dwellers of what is possible in using their land. Extension officers should be encouraged to visit gardens in the urban areas.

7. Markets, such as those in Port Moresby suburbs (Forbes 1975), should be established to provide outlets for the surplus production of urban agriculturalists. As is evident from the Port Moresby study, the market system seems to provide a considerable incentive for the sale of surplus produce, such as rose apples, sugarcane, etc., which might not be marketed otherwise.

8. New regulations that make legitimate the planting of agricultural crops on road frontages and verges and de-emphasise the aesthetic importance of ornamental gardens might also lead to increased agricultural production. This might be particularly true in Suva.

9. The planting of non-food plants that can contribute to the household cash and real incomes should also be encouraged. Plants such as pandanus, kapok, cotton, Job’s tears, sisal, hemp and tuba (Derris spp.) are of considerable economic and social value. One Gilbertese household in Suva, for example, planted half of their entire allotment in pandanus, which was used for weaving baskets for sale to tourists.

10. In some areas, the importance of the women’s contribution to the family income through gardening should be stressed; this might provide an incentive for increased production.

11. Nutritional data on both traditional and recently introduced food crops should be gathered and educational programs should be developed to teach people ways of food preparation that improve palatability and maximise the nutritional potential of given foods.
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References


16 Energy Flow in the Rural Tropics

OTTO SOEMARWOTO

Rural ecosystems are vital for the survival of a country. Damage is being suffered by these systems, which impairs their structure and functioning. An indication of this damage is the leakage of valuable topsoil and nutrients from the rural ecosystem. This leakage is here caused by the denudation of forest to increase food production (it is commonly caused by overgrazing). To rehabilitate and maintain the rural ecosystem, energy is required. Electrification of rural areas, especially for education, is needed. Still existing traditional methods of diversified crop production in the farm fields and the home garden have been shown to be productive and reduce the needs for energy subsidies, i.e. fertilisers and pesticides. Consequently they should be maintained and improved, particularly in this time when fossil fuels have become scarce and expensive.

The energy crisis has affected both the poor and the rich nations. Particular attention has been paid to the role of energy in industry and transportation and the purpose of this chapter is not to contribute to the already voluminous literature in these fields, but to discuss the flow of energy in ecosystems and its role in the maintenance of the structure and functioning of Indonesian ecosystems.

SOURCE OF ENERGY OF ECOSYSTEMS

The second law of thermodynamics states that any system that exists above absolute zero temperature tends to change from a less probable state of lower entropy to a more probable state of higher entropy; that is, it tends to change from a more orderly state to a less orderly one. This is due to the fact that thermal vibrations continuously cause disorder in the system and consequently, to maintain order and functioning, a continuous supply of energy is required.

The energy requirement for antithermal maintenance of an ecosystem can be expressed by the Schrödinger ratio R/B, in which R is the total community respiration and B the total community biomass (E. Odum 1971). Margalef (1973), applying this concept to man and his environment, extended the value of R to include all exchanged energy, including energy used in transportation, heating, etc., and the value of B to include man and his artifacts. An extensive discussion of the role of energy in society was presented by H.T. Odum (1971).

Under present Indonesian conditions the entire source of energy for ecosystems is the sun, harnessed in: the products of primary and secondary production, and of higher trophic levels; fossil fuels; and the potential energy of river flows. This is schematically presented in Figure 16.1.

Marine and rural ecosystems are able to utilise solar energy directly, owing to the presence of green plants—the planktons in the aquatic marine ecosystem and the macro and microflora in the rural ecosystems. In addition rural ecosystems may also
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Fig. 16.1 Schematic presentation of the sun as the source of energy of ecosystems and the energy flow between the various ecosystems. The marine and rural ecosystems are capable of harnessing solar energy in primary production, part of which is channelled to the secondary and other production of higher trophic levels. Urban ecosystems are dependent on fossil fuels and food energy from the marine and rural ecosystems and also on hydro-electric energy from rural ecosystems.

obtain fossil fuels from cities. Urban ecosystems, on the other hand, are dependent on the importation of energy for their existence, food energy from the sea and the rural areas, electric energy from hydro-electric generators and fossil fuels. Ecologically, cities are subsidised ecosystems, since they thrive on energy subsidies. Because of this dependence, any disturbance in the marine and rural ecosystems and/or in the transport of energy subsidies to cities will disturb urban ecosystems. Hence it is vital to pay due attention to the maintenance of marine and rural ecosystems.

ENERGY FLOW IN A RURAL ECOSYSTEM

Rural ecosystems have been characterised as consisting of four sub-systems, the village, the farmland, the forest and the river (Soemarwoto 1975b). This is schematically shown in Figure 16.2. In densely populated areas, such as Java, the forest ecosystems have been drastically diminished to make place for farmlands. In many parts of the lowlands of Java they are even completely replaced by rice fields. Although rice fields do offer opportunities for intensification and higher yields per hectare (Geertz 1963), population pressure has been as important an impetus for extending rice planting. This process can still be seen in the mountain areas, wherever irrigation water is available. Thus the protective energy of the forest against soil erosion has been
replaced by the rice terraces. When irrigation water is not available, upland crops, such as maize and cassava, are grown. In this latter case the people usually do not take measures for soil conservation and serious destruction of the soil and water resources has occurred in many places.

Many rivers are heavily laden with silt. In the Citarum River near Jatiluhur, for example, estimated silt loads are $3.1 \times 10^6$ tonnes per year. In the Solo River $8.7 \times 10^6$ tonnes were estimated in the rainy season of 1971/72. Soil erosion, of course, means the loss of fertile topsoil, and the attendant loss of soil fertility and reductions in crop yields. It also reduces fish yields and threatens lakes, water reservoirs, irrigation canals and productive estuaries with siltation, and may stimulate growth of aquatic weeds and algae.

River flows have also become erratic. In the wet season they become very large, often swelling to devastating floods, while in the dry season they are reduced to a trickle or even nothing. These large fluctuations make the management of rivers, water reservoirs and lakes difficult. An example is shown in Table 16.1.

**TABLE 16.1**

<table>
<thead>
<tr>
<th>River</th>
<th>Max. m³/sec</th>
<th>Min. m³/sec</th>
<th>Ratio max. min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cilemer</td>
<td>203</td>
<td>0.033</td>
<td>6000</td>
</tr>
<tr>
<td>Cimoyan</td>
<td>115</td>
<td>0.001</td>
<td>115000</td>
</tr>
<tr>
<td>Ciluman</td>
<td>117.1</td>
<td>1.460</td>
<td>80</td>
</tr>
<tr>
<td>Ciu Jung</td>
<td>595</td>
<td>15.000</td>
<td>c.40</td>
</tr>
</tbody>
</table>

*Source: International Barlian Building 1975.*

Solar energy, when fixed by the forest ecosystem, has among others a protective function. Whenever the forest is disturbed additional energy must be supplied to the ecosystem for its protection. Generally speaking, since any exploitation of an ecosystem causes disturbance, such exploitation must be accompanied by energy subsidies to sustain it. With increasing population densities, the exploitation of the ecosystem increases, which in turn increases the maintenance cost of the ecosystem. The damages caused to soil and water resources indicate that insufficient energy is available to satisfy the cost of maintenance, which causes it to 'leak'. The ecosystem is being exploited beyond its carrying capacity. This is normally a phenomenon of overgrazing, but in this case it is caused directly by man.

When a rural ecosystem comes in contact with an urban ecosystem, an exchange of energy and matter between the two ensues. The exchange, however, is asymmetrical, the flow from the less developed ecosystem to the more developed one being greater than the reverse (Margalef 1968). Thus, although the rural ecosystem obtains fossil fuels and their products from the cities, the former is actually being exploited by the latter. As well as food energy, electric energy, which is harnessed by damming rivers in the rural ecosystem and which is actually badly needed for the maintenance of the system, is exported to the cities. As a result the destruction of the rural ecosystem continues unabated at an ever increasing rate, because of increasing urban population pressure (Soemarwoto 1974). Clearly, to overcome this problem, the rural ecosystem must be supplied with adequate energy to increase its carrying capacity, at least to keep up with population growth. Although rural electrification, for example, is difficult and
Fig. 16.2  Schematic diagram of a rural ecosystem consisting of four subsystems, the village, the farm field, the river and the forest. The energy for maintaining the structure and functioning of this ecosystem comes from the sun. The more isolated the ecosystem, the less energy is imported and exported. There are efficient material cycles in this ecosystem. Its diversity is high, which gives high stability. The figure also indicates the flow of energy between the rural and the urban ecosystem. The flow of money is in the reverse direction from that of the energy flow, except for hydro-electric energy, where the urban ecosystem does not pay the rural ecosystem.
expensive, it must be attempted with full strength, since rural survival is at stake, and since the rural ecosystem is vital for the whole country, as shown in Figure 16.1. Furthermore the costs imposed by soil erosion and the destruction of water resources are far greater than the costs of energy distribution to the rural areas. Micro-hydroelectric power and methane produced from organic wastes, for example, could contribute significantly to the energy need of the rural ecosystem. This energy could then be used to boost education for the development of local capabilities for rural industrialisation, management and marketing, and to reduce the consumption of firewood from forests. The development of local capabilities will reduce the degree of and eventually eliminate the exploitation of the rural ecosystem by the cities.

J.S. and C.E. Steinhart (1974) show that the energy subsidy to the United States food system to obtain 1 calorie equivalent of food increased from about 1 calorie in 1910 to about 9 calories in 1970. On a worldwide basis, H.T. Odum (1971) has cited data that to increase food production two-fold, an increase of ten-fold of pesticides, fertilisers and mechanical power is needed (see Table 16.2).

TABLE 16.2

<table>
<thead>
<tr>
<th>Agricultural System</th>
<th>Energy subsidy input Food calories output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shifting agriculture</td>
<td>0.02–0.05</td>
</tr>
<tr>
<td>Wet rice culture</td>
<td>0.02–0.1</td>
</tr>
<tr>
<td>Intensive rice</td>
<td>0.1–0.2</td>
</tr>
<tr>
<td>Low intensive corn</td>
<td>c.0.2</td>
</tr>
<tr>
<td>Intensive corn</td>
<td>c.0.5</td>
</tr>
<tr>
<td>Hunting and gathering</td>
<td>0.1–0.2</td>
</tr>
<tr>
<td>Range fed beef</td>
<td>c.0.5</td>
</tr>
<tr>
<td>Grass fed cows (milk)</td>
<td>c.1.0</td>
</tr>
<tr>
<td>Grass fed beef</td>
<td>2–5</td>
</tr>
<tr>
<td>Feedlot beef</td>
<td>10–20</td>
</tr>
<tr>
<td>Low intensity eggs</td>
<td>0.5–1.0</td>
</tr>
<tr>
<td>Intensive eggs</td>
<td>2–5</td>
</tr>
</tbody>
</table>


Clearly with intensification the efficiency of production with respect to energy becomes less. Values greater than 1 indicate a net loss of energy in the production process. In times of abundant and cheap energy this does not matter much. But when energy supply becomes scarce and price is increasing we may soon face difficulties if we continue to follow this course.

Some estimates have indicated that Indonesia’s oil resources will be depleted in about thirty years. Therefore we must question the wisdom of becoming too dependent on fossil fuel energy subsidies, even if in the near future we can satisfy all our needs for fertilisers and pesticides from domestic production, which is doubtful, particularly in the case of pesticides. Alternative policies must be explored. To this end it was suggested that Indonesia allocate more funds for studies on the development of technology and marketing systems based on ecosystems with high diversity and on shifting the emphasis from synthetic pesticides and fertilisers to integrated pest control.
and compost (Soemarwoto 1975a). It was shown that traditional mixed cropping can efficiently reduce the pest population (Raros 1973). There are also traditional methods still practised, in which several crops, for example rice, tobacco, corn and Chinese cabbage, are grown simultaneously on patches of land as a mosaic. Such a mosaic pattern is presumably less prone to pest damage than large contiguous areas planted to one kind of crop. Therefore the traditional method needs less energy subsidy in pesticides than the latter. Pre-war practices of control by artona in coconut and rice borers in rice are also examples of pest management with little or no use of pesticide, but they are labour intensive. Green manure is also an effective way of using solar energy to obtain nitrogen for fertiliser. This should not be construed as a suggestion to ban fertilisers and pesticides, but rather to suggest their wise use in various combinations. To make an ecosystem with high diversity viable, specially designed technology and marketing systems should also be developed.

The village ecosystem, by virtue of its diversity, also exhibits a high degree of stability. Its diversity also makes possible efficient recycling of matter, in which man, who is part of the process, gains protein and other nutrients (Soemarwoto 1975a). This is schematically shown in Figure 16.2 for a village in West Java. The plants in the garden form an important source of carbohydrate, vitamins and minerals. Some plants and kitchen wastes are fed to chickens, fish, cattle and other animals in the village; these are periodically harvested for home consumption and marketing. Human waste is also fed to fish. In turn the wastes of the animals are composted and used as fertiliser. The cycling of matter maintains the fertility of the soil, while the plant cover protects it from erosion by the action of rain and wind. This can clearly be seen, for example, in the upper Solo River basin, where the intact village soils form a sharp contrast with the badly eroded fields outside the village. It should be noted that the recycling of matter is entirely fuelled by solar energy, which is quite different from the expensive waste disposal system in cities. Therefore, it has been suggested that a study should be made of the possible application of the village model of waste recycling in cities (Soemarwoto 1973). According to this model the city would then form a mosaic of buildings, roads, rice fields and fish ponds. Of course modifications would have to be made to accommodate the values of city people and to prevent public health problems.

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Mimeo., IRRI Seminar, Los Baños.


III  Fishing and the environment
17 Present Day Fishing Practices in Tatana Village

BOBBY GAIGO

Although modern influences are inescapable, the people of Tatana village still use many of the traditional fishing practices that helped in the past to make them among the most successful fishermen of the area. Accounts are given of the techniques and implements used, the locations, and time of day or season of the year appropriate to each of the different kinds of fish caught. Some of the customs and rituals surrounding traditional fishing are also recounted. The influence of the church and of European civilisation on some of these traditional ways is noted, as is the effect on fish populations of the world wars and of modern commercial and sport fishing.

According to our traditions the ancestors of the people now living at Tatana Village formed the first community in the Port Moresby area. Their population was large, as were their landholdings. We occupied land around Fairfax Harbour and the offshore islands of Daugo and Gemo. Old village sites may be seen in several places, including a fair sized one on Daugo Island. Even though the people of Tatana Village were among the first people to be contacted by the European along the Papuan coast we still retain many of our traditional ways. We have been particularly reluctant to exchange our fishing methods and beliefs for those that have been introduced by the foreigner. Whereas the European's attitude towards fishing is entirely of a commercial or sporting nature, fishing is very much a part of the personal, social and spiritual beliefs of our people. For this reason it is important that the many beliefs and rules followed by our ancestors be respected by us. We have always been successful and great fishermen and part of the reason for our success is the respect we have shown for the beliefs of our ancestors.

We catch many different kinds of fish. Some we obtain in the afternoon or evening when it is raining (this kind of fishing we call ihoi or raka-diho), other kinds we catch in the coral of the outer reef or the adjacent deep water (this we call deke), and still others we catch by using nets as in varo or one fishing for dugongs and turtles or ara-toro fishing for proper fish. There are many other kinds of fishing methods I have not named.

In ara-toro fishing people go out into the bay at high tide and drop gill nets. They then wait for low tide. When it arrives people and dogs run and splash the water and chase the fish into the nets. The fish are then either caught in the nets or speared. Ara-toro fishing takes place only during the months of May, June and July.

For each type of fishing we follow a certain set of rules. Thus when ara-toro fishing we must not:

(a) take fishing lines or hunting spears with us;

The author was assisted in the preparation of this chapter by Resena Gaigo, one of the leaders of Tatana village.
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(b) make any noise in our house immediately before departure, otherwise the toxic stonefish or the deadly stingray (dae-dae) will harm us;
(c) have any individual whose wife is pregnant fish although he may accompany us when we go out during high tide as long as he does not leave the canoe.

In addition, we must also follow the rules that apply to all fishing occasions, such as:
(a) not sweeping or cleaning the house until midday;
(b) not shouting or laughing when travelling to the fishing places; and
(c) not looking back to the house or village when leaving to go fishing.

If these proscriptions are not followed then fishing will be bad and the fish might leave the area.

When we go fishing for mullet (nobu) we do not drink water or tea or eat any food in the early morning otherwise we will not have a successful catch. The same thing does not apply to fishing for mullet at night. One of the ways of catching mullet is to place nets around the mangrove trees at high tide. The nets are tied to the branches and leaves of the tree so that when the mullet are driven into the mangroves they will not be able to jump over the nets. The mullet like to jump a lot. We frequently catch large numbers of these kinds of fish by this method, sometimes as many as five hundred to one thousand are caught in one net at one time. The nets for this kind of fishing may be one hundred or more metres long.

When schools of mullet are found at some distance away from the mangroves in the sand coral and sea grass areas we go out in many canoes and drop our nets in a very large circle. Then the people in a number of canoes place smaller nets within the circle of nets. One end of the smaller net is placed up against the inside of the larger net while the other end is pulled towards the centre and then drawn in an arc back to the larger net. In this way many mullet are often caught. Hand dip nets, a fishing spear (ikodo) and a spear gun are commonly used at this time.

The fishing spear we make of wood and to it we attach three long and thin sharpened and barbed wires at the tip. The spear gun is also homemade. The most common type is the tyre tube and pole gun which, when the tube is drawn back and suddenly released, shoots a thick barbed wire with considerable force. Fishing nets are now commonly made of foreign materials also, although the traditional net constructed from strings made from the bark of certain bushes or trees is still to be seen. We call the traditional net nagwa. It is hard work to make and it takes a long time to make a big one. First the bark must be stripped off the bushes or trees and either allowed to dry in the sun or boiled in water. Then the bark is rolled into pieces of suitable thickness, and finally the bark strings are carefully woven into a net.

The most commonly used nets today are those made from cotton or synthetic fibres or from thin strips cut from old truck tyres. After World War II the Australians and Americans gave large numbers of truck tyres (and trucks) to the people of the villages around Port Moresby, including Tatana. It was then that we discovered this new use for the tyres.

Mackerel tuna (toro) is another kind of fish that is sometimes caught in large numbers. During much of the year they are hard to find but when the west wind called nahara (lahara in the lingua franca known as Police Motu) is blowing—which is usually between December and May—then plenty of toro swim into Fairfax Harbour. On good days one thousand or more mackerel tuna are netted by the people of Tatana. If the south wind (nurabada) is blowing few of these fish are to be found.

Reef fishing is done in canoes with specially made circular nets. The nets are dropped just beyond the outer reef where the water suddenly becomes very deep. It is there that large numbers of fish are to be found. The men and women in the canoes
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shout and beat the surface of the water with canoe paddles in order to drive the fish into the nets. Then, when one of the divers indicates that enough fish are within the net, the net is pulled towards the reef until its bottom is flush up against the coral. The fish are then either speared or killed by fish poison. Fish poison is obtained from one of the several species of tree known as the dynamite tree (tuha and imura are the most popular types). This poison is most useful in killing fish that have taken refuge in the holes and nooks in the coral. Some kinds are so powerful that the fish are killed in just a few seconds while other kinds take up to five minutes to die.

We also practise a specialised type of deep sea fishing. This is in areas beyond the outer reef where ships or barges have sunk. These wrecks attract large numbers of fish. Nets are dropped over the ship so that they enclose it. Then we have our best divers go down and beat on the side of the ship. The fish, in trying to escape, move upward into the net. When enough have been trapped we pull on some ropes attached to the bottom of the net and seal off the bottom. The net is then drawn to the surface.

Kidu-kidu or tuna fish are also occasionally caught in the open sea as well as in the harbour by means of large nets. When in the harbour they are most frequently netted at night. After a tuna is caught it is important that its entrails be removed and thrown on to the land and that the fish be cleaned in a dish or bowl and the waste water poured on to the ground. It is also required that they be caught only by means of nets. If these rules are not followed then the kidu-kidu will be much more difficult to catch in the future.

The dugong or rui (which is one of two living members of the sea cow family Sirenia) is a large animal with very good tasting flesh. This animal eats mostly sea grass (nahua puta) although we know from examining the stomachs of dead specimens that it also eats a shellfish which we call rui bogana (dugong shellfish) and sometimes a seaworm (davara gaigaina) and jellyfish. The dugong as well as sea turtle are caught in very large and strong nets (voro or one) made especially for that purpose. Today we find the nets made of foreign materials are often broken by the dugong. When a dugong is caught it is an important occasion for the village and a big sing-sing with dancing and feasting is held and some beautiful ancient songs called hehona or rui are sung and the people cry for the death of the animal. We do this because it is a gentle animal, like a human being. It also resembles a human being in some other ways. When nursing its breasts look like those of a human female and they are located in the same general area of the body. The female’s genitalia are like those of women. The penis of the animal resembles that belonging to the human male and the dugong has a facial beard. Incidentally, if a man wishes to catch a dugong he must not have relations with his wife the day before going out on the hunt.

Dugong also resemble humans because they cough like human beings and also breathe the same way. They also yawn like humans. Sometimes at night the fishermen hear coughing and breathing and they ask the other fishermen who is coughing and when they find out that none of them have coughed then they know it to have been done by a dugong. The female dugong, once she gives birth, often takes special care of her son, and often the son cohabits with the mother as it gets older. On the other hand she is less protective of a daughter and occasionally chases the daughter away as soon as it is born.

Before going out to catch big fish, dugongs or sea turtles the clan holds a feast in one of the clan houses. The clan chief decides who will give the feast. In the house all adult members of the clan and senior members of the other clans—say twenty or thirty people—come and food is provided. The nets belonging to the man giving the feast are piled in the centre of the house. Nets belonging to the entire clan are also brought
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to the feast. No individually owned nets are brought. If the owner of the house giving
the feast has a new net then the clan leader speaks about it in a most respectful way and
tells people what the net will be used for. All nets in the Laurina Clan are given the
name gaburubada, although the nets of all the clans are called one or varo. Fishing
materials such as nets, spears and so forth that belonged to a deceased man are not
used for one or two years after his death. The clan leaders then decide that it is time to
use them and they hold a feast for this purpose in the house of the relatives of the
deceased.

The canoes behind the canoe that catches the dugong when they learn of it begin to
sing special traditional songs. When the canoes get in sight of the village the villagers
hear them and get excited and wonder whose clan net caught the dugong. When they
learn the other clans are quite upset. It might be said that the members of those clans
who did not catch dugong feel slightly ashamed. When a dugong is caught in a dugong
net, then one of the men dives into the water and ties a rope around its tail. After a
dugong is caught the people in the canoe dive down to the net and plug the nostrils of
the dugong with coconut husk or other soft material. The dugong is then put inside
the canoe. When on land the clan whose net caught the dugong holds a big sing-sing
and it is a time of great joy. They invite all the members of the other clans to come but
some are too upset to accept.

The dugong may be killed by a sharp hard wooden stick—a long one—and this
pierces the heart of the animal. Or more commonly the men do not kill the animal but
simply cut pieces off the live animal as the food is needed; eventually the animal dies.

The head of the dugong is placed inside the house roof of the man who tied the rope
around its tail. The tusk teeth are sometimes removed and cleaned and are used for
necklaces. Dugong fat mixed with coconut oil is sometimes rubbed on the skin to
make it shiny during sing-sings. The meat, skin and fat are eaten. The fat is cooked and
eaten with such things as taro, bush yams, sago, and mangrove fruits. As soon as
dugong is cooked it is then cut up and put into clay dishes and the children pass it
around the village and to each house. The children are very excited at this time.

A man who catches many dugongs has much prestige. Two generations ago he
could get married without a bride price and might have two to three wives. His sons
would gain much from his being a famous dugong hunter. Daughters are often of­
ered to them by their fathers.

Tatana people sometimes went as far as Nagava Island and Bava Island and
Haidana Island and a reef called Nagamara, 7 km from Daugo Island (see Figure
17.1). The reef, located on the western part of Daugo Island, was good for dugong and
fish. Fairfax Harbour was also good for dugong, as was a reef called Vahuna Bada
between Tatana Island and Port Moresby. The last dugong caught in Fairfax Harbour
was in 1963 by a Tatana villager by the name of Heni Heautani.

Today there are very few dugongs. There are also less fish than there were before the
coming of the European. This is because people from other villages and countries are
now permitted to fish in Tatana waters. It is also because during World Wars I and II
bombs were dropped in fishing areas and dynamite was sometimes exploded in our
waters. In addition, the motors of boats and new types of equipment, including the
face masks of the skin divers, frighten the fish away. The reflection on the glass of face
masks is something that worries us a great deal.

Some of the points I have made about Tatana apply to the other coastal villages in
the Central District, such as Rea Rea, Boera, Hula, Alukuni, Pari, Tobuseria, Barakau,
and Gaire. In the old days fishing in these villages was the same. They used only nets
and spears. Some Motuan villages did not use canoes because they did not know how
Fig. 17.1 Location map of Tatana
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They fished in the corals and shallow places, walking out and dropping their nets. They learned about fishing materials mainly from the peoples of Hula, Alukuni and Tatana, who were the first fishermen of the region.

Members of the village councils, village elders, and experienced fishermen with whom I spoke all tell the same story. In the old days people followed the customary fishing laws and there were always plenty of fish. Simple fishing methods were used. If a dugong was caught it was an important occasion with the singing of sad songs because people had a respect for the animal. Today many things have changed and it is more difficult to find fish. The Christian religion has taught us things which have become more important than the traditional laws. Villagers now do not stop outsiders from fishing their waters because of the influence of the church. This, together with the noise of outboard motors and the engines of big ships, the activities of commercial fishermen and sports fishermen, and the introduction of many new fishing techniques, has helped to frighten some fish away from our waters.
Chapter 18
Depletion of Shellfish in the Traditional Gathering Beds of Pari

PAMELA SWADLING

For 2000 years shellfish have provided an almost daily source of food for people living along the Port Moresby coastline of Papua New Guinea. Today the demands of an increasing human population have led to shellfish becoming a scarce delicacy for many of these village residents. This is made evident from the present state of two of the most popular food species, Strombus luhuanus and Anadara antiquata.

INTRODUCTION
Shellfish are a valued source of food for people living along the shores of Papua New Guinea. Archaeological data indicate that local residents have exploited the shoreline in the vicinity of Pari Village, in the Central District near the capital Port Moresby (see Figure 19.1), for 2000 years. This chapter presents findings as to the present state of two of the most popular food species. One, Strombus luhuanus (Linnaeus 1758, see Hinton 1972, Plate 3, Fig. 12), is a herbivorous gastropod; the other, Anadara antiquata (Linnaeus 1758, Cernohorsky 1972, Plate 61, Fig. 3), is a filter feeding bivalve. The people at Pari call these species roku and kwadi respectively.

All the population samples considered here are taken to reflect the nature of the shellfish available in a locality to human predators. It is presumed that they took the largest shellfish available and paid little attention to any juveniles present.

Strombus luhuanus
The blood mouth conch, Strombus luhuanus, is a very popular edible shellfish in Papua New Guinea. This is undoubtedly due to the quality of its flesh and its natural abundance. The general outline of the shell is conical, but it is made distinctive by a chocolate brown columella, red outer lip and siphonal notch. Feeding on algae and detritus, it is found on the sand patches of rocky or coral reefs from the intertidal zone to a depth of about 10 m. A considerable population density is usually achieved in favourable areas.

The main beds of Strombus luhuanus near Pari are along the coast to the east. These concentrations have specific names, which are taken from hills and other shoreline features. Those near Pari are called Konekone, Garogarona and Boiourena (see Figure 18.1). At each of these places it is necessary to dive for the shellfish, as the beds are never uncovered at low tide.

The author wishes to thank Tahuni and Puka Gaba and Pastor Tom of Pari Village for their help in collecting samples; and Susan Bulmer for the opportunity to examine the Taurama midden material; and, for a number of discerning comments, Dr W. Ponder, Malacologist, Australian Museum.
Fig. 18.1 Location map with inset showing Pari *Strombus luhuanus* and *Anadara antiquata* beds

The Pari *Strombus luhuanus* beds are now said to be well fished. For instance it takes two experienced people more than two hours to fill a three-litre billy at the Garogarona bed. Apart from the personal observations of people who are familiar with the area and its resources, the existence of considerable exploitative pressure...
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on the *Strombus luhuanus* from the Pari beds is evident from the nature of the shells themselves.

With the advent of human exploitation there are changes in the size frequency and growth rate of a shellfish population. Shellfish gathering produces a consistent mortality of the larger individuals within a population over a period of time; this is far higher than usual for the particular species. By adding to the mortality rate in this way, predatory humans produce changes in the average age and growth rate of the exploited population. The continual gathering of the older, larger, individuals in a bed has the effect of inducing a rapid turnover of age classes, with the consequence that there is a general reduction in the age range, and hence of the overall shell size of the population. That is to say, the heavier the exploitation, the more dominant the younger age classes will become. This is evident when comparing the length range of the lightly exploited population from the bed east of the sandspit on Motupore Island (the University of Papua New Guinea research island) with that of the heavily exploited Garogarona bed (see Figure 18.2). The bed at Motupore is gathered only by the caretaker’s family. The bimodal curve of the two populations is probably due to sexual dimorphism. Males in the Strombidae family are usually smaller than females (Abbott 1960:33).

![Graph showing the distribution of juvenile traits in lightly and heavily exploited populations of *Strombus luhuanus*](image)

**Fig. 18.2** The distribution of juvenile traits in lightly and heavily exploited populations of *Strombus luhuanus*
Although it is impossible in tropical areas to determine quickly the actual age of shellfish by counting the winter growth cessations found in temperate countries, certain features can be used to determine whether a shell is a juvenile or an adult. The most marked feature in *Strombus luhuanus* is the development of a thickened lip in older individuals (see Figure 18.3). Associated with this lip formation is the prior development of a deep U-shaped notch near the anterior end of the shell. This notch is used as a 'peep hole' for the right eye. Another juvenile trait is the presence of flutings on all whorls. They are usually found only on the uppermost whorls of adults. The preponderant distribution of these traits among new recruits is evident in Figure 18.2. As expected the latter are more frequent in the heavily exploited Garogarona bed.

**Fig. 18.3** Developmental stages in *Strombus luhuanus*

*Anadara antiquata* is a bivalve shellfish found in shallow water. It is usually buried in areas of sea grass on the intertidal zone of coral reef platforms. The richest bed at Pari is immediately out from the west end of the village, in the area called Minitoa. This species is the main shellfish gathered by people along the coastline from Gabagaba to Hood Point.

Pari people now say that their bed is well fished. No relatively unexploited population was available for comparative study. It is quite likely, however, that the bed out from the small village of Walai, where the human population is fewer than a hundred, is under less gathering pressure than the Pari bed. The Walai bed certainly does not appear to be as thinned as that at Pari Village. It is relatively easy for a woman and her children to find over a hundred *Anadara antiquata* during an excursion at Walai, but difficult to find even 30–50 at Pari. Table 18.1 illustrates the size frequency of *Anadara antiquata* populations.

Shell length was taken from the anterior to the posterior sides of the shell. The percentage greater than 50 mm long was estimated to give some indication of the number of older individuals present. Depth was measured using calipers from the hinge of each valve through the umbo or beak of the shell. This measurement gave the extent of shell curvature obtained by each valve.
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TABLE 18.1
Size frequency of the present day Anadara antiquata populations from Walai and Pari. Prehistoric samples from the Taurama and Motupore archaeological sites provide comparative material.

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Shell length mm</th>
<th>% population 50+ mm long</th>
<th>Value depth range mm</th>
<th>Average depth mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pari</td>
<td>57</td>
<td>29–52</td>
<td>4</td>
<td>7–13</td>
</tr>
<tr>
<td>Walai</td>
<td>100</td>
<td>30–59</td>
<td>13</td>
<td>7–17</td>
</tr>
<tr>
<td>Motupore Excavation Level 1</td>
<td>18</td>
<td>37–73</td>
<td>18</td>
<td>9–22</td>
</tr>
<tr>
<td>Taurama Excavation Level 1</td>
<td>40</td>
<td>30–75</td>
<td>40</td>
<td>7–28</td>
</tr>
</tbody>
</table>

The Taurama archaeological excavation is some 2.5 km from Pari (see Figure 18.1). Motupore Island can be seen from the site of the Taurama excavation. These two sites are registered in the PNG Archaeological Survey File of ancestral and prehistoric sites as AJA and AAK respectively. Excavation level 1 represents the latest occupation material found in AJA square 7x and in AAK square N21/11. Hence the shells cited in Table 18.1 are those found in the first 10 cm of deposit in each of the 2 m excavation squares. Subsequent samples give comparable results.

The Minitoa bed out from the west end of Pari Village is the only established Anadara antiquata population in the vicinity of Pari and Taurama. The Anadara antiquata consumed and dumped at Taurama in prehistoric times were probably gathered at Minitoa, as the immediate coastline lacks suitable substrate conditions where other beds might have been established in the past. At no time during the prehistoric occupation at Taurama do the Anadara antiquata attain the degree of exploitation found for the present Pari beds.

DISCUSSION
The Anadara antiquata and Strombus luhuanus shellfish being gathered at Pari today exhibit a high preponderance of juvenile traits. The youthfulness of both species is also evident from their relatively thin shells. This dominance of younger age classes and reduction in average shell size is a feature of heavy human exploitation.

The natural supply of shellfish available at Pari is diminishing. The continuous gathering pressure experienced by the shellfish beds in the immediate vicinity of Pari has never been realised before. This situation is largely the result of the rapid population increase at Pari from about 140 in 1910, to 650 in 1961, and to some 1400 people today (I. Maddocks, pers. comm., 1974).

Although still greatly valued and sought after, shellfish are not satisfying the local demand. The increase in exploitation experienced by the Pari beds in recent decades has reduced the present stocks to a low level. This means that the shoreline is not providing the backyard source of protein that might be imagined. Tinned fish is now being bought by these coastal residents, when it can be afforded, to meet a need previously met by their own natural shellfish resources. Shellfish are
thus becoming a delicacy for most of the coast residents in the vicinity of Port Moresby.

Two alternatives remain for the future. Continued exploitation giving increasingly reduced yields or some conscious manipulation of the natural environment to the long-term advantage of those involved. Closed seasons for certain species could be an immediately employed measure. Extending the substrate required by the desired species by artificial means could be a subsequent way of increasing the yield.

References
Small Village Fishermen in Melanesia: A Southeast Asian Example

DOMINGO D. TAPIADOR

The so-called Green Revolution in agriculture has left the low income small farmer out of the mainstream of agriculture and economic development. Similarly new fishing techniques such as trawling, gillnetting and modern purse seining have led to overfishing while leaving behind low income small village fishermen, many of them still below the poverty line. Increasing the productivity and income of these people raises questions as to the capability of the resource base to sustain them, training and extension requirements, fish distribution and marketing, ancillary and substitute occupations, etc. However some progress is being made in Southeast Asia through a new FAO technique of holding field workshops and developing follow-up field action projects for low income small village farmers and fishermen; and it is hoped that this technique may be of interest to Papua New Guinea, where similar village level conditions exist. This technique has been developed and tried in a number of countries at the initiative of an FAO/UNDP Regional Project known as ASARRD (Asian Survey of Agrarian Reform and Rural Development). The experience so far shows considerable potential. Under the ASARRD project two kinds of experiments have been attempted. First a process of problem-identification has been stimulated at the field-level in some rural areas through a special methodology of Field Workshops. These multi-level, multi-disciplinary workshops have been held in the rural areas of eight countries of this region (Indonesia, Nepal, Sri Lanka, India, Bangladesh, Korea, Thailand and the Philippines). Secondly, as a follow-up to the field workshops, action projects on the formation of grass-root institutions of this disadvantaged and under-privileged farming people are being initiated in some of those areas where workshops were held. In this paper only the first part of the experiment—Field Workshops—has been considered. The workshops are area specific, allowing identification of problems in the unique settings where they occur. Village participants speaking in their local languages are assisted in their planning by technicians, administrators, educators, sociologists, economists, representatives of banking or financial institutions, etc.; district, town, provincial and national officials also participate. Appendixes to this paper give notes on the management of field workshops.

Fisheries are a major and significant industry in the Asian and far eastern region, second only in importance to agriculture, for it provides an economic means of livelihood for some six million village fishermen and is a major source of cheap animal protein for a region that has nearly two-thirds of the world’s population. To meet the region’s increasing need for food, fisheries have developed quickly compared with the rest of the world. Fish production has doubled in the last decade and the region now produces roughly 40 per cent of the world’s total fish catch. In aquaculture, or fish farming, which has the longest history and tradition in the region, over 80 per cent (or over 90 per cent if China is included) of the world’s total produc-

The opinions expressed here are those of the author and do not necessarily represent those of FAO or IPFC.
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The part of the region that could have particular relevance to Papua New Guinea is Southeast Asia, for it is an adjoining area and in many respects the geography, climate, fisheries resources and characteristics of the fisheries are common or similar.

The Secretariat of the Indo-Pacific Fisheries Council has recently, on the occasion of its twenty-fifth year anniversary, reviewed the developments in fisheries of the member countries in the region. In the last two decades most of the countries, in particular those of Southeast Asia, have experienced sizeable increases in fish production with total fish catch having practically quadrupled. Thailand, especially, has shown an extremely rapid growth of more than five-fold increase during the period 1958–67, for an average annual rate of growth of 19 per cent. Most of the countries bordering the South China Sea also experienced high growth rates ranging from 6.3 per cent per annum in Indonesia to 9.7 per cent in West Malaysia.

In the fifties and early sixties and before, the major problem of the governments of Southeast Asia was the accelerated development of fisheries to meet the increasing needs for more fish protein and to earn foreign exchange. The construction of bigger and more modern fishing vessels and the introduction of new fishing techniques, such as trawling, gillnetting and modern purse seining in the 1960s resulted in a spectacular increase in fish production in Thailand, Malaysia and the Philippines. This expansion occurred so rapidly in fact that Manila Bay in the Philippines, the Gulf of Thailand and the western coast of peninsular Malaysia are now considered overfished. Besides the problem of overfishing, there is the intriguing question of who has benefited from this great and rapid expansion.

The Problem of Small Village Fishermen

The fisheries of Southeast Asia are characterised by the vast number of small-scale village or so-called 'artisanal' fishermen who constitute over 90 per cent of the total labour force in the fishing industry. The lot of the small low income village fisherman is tragic in the sense that, while his country has rapidly and greatly developed, he has been left out of the mainstream of that development; in other words, he has not concurrently benefited from such development and he still remains poor. Even in Malaysia, where earnings are already substantially higher, surveys and studies made by the Division of Fisheries of the Ministry of Agriculture and of the University Sains Malaysia, have revealed that about 90 per cent of fishermen on the east coast and 40 per cent of fishermen on the west coast of peninsular Malaysia are below the poverty line. (The poverty line as used in the study is based on a per capita income of Malaysia $25 per month, approximately United States $11 per month.)

The so-called Green Revolution in agriculture has left behind the low income small farmer in the mainstream of agriculture and economic development; similarly, the rapid development of fisheries in Southeast Asia has also neglected the low income small village fishermen. Mr Michael Somare, Prime Minister of Papua New Guinea, has said that the guiding principle in development should be 'the greatest good for the greatest number of people'. If this is accepted, then perhaps the greatest challenge in the field of fisheries development in the region is development for the low income small village fishermen.

This is, of course, no easy task, for the problems are many and complex. For example, questions such as the following will need to be answered: if the vast number of small village fishermen are to modernise and increase their productivity and income, can the resources available sustain them; if so, how will they do it; how about credit, training and extension, infrastructure, fish distribution and marketing; how about an-
cillary or substitute occupations for them? What is needed is a total approach to
development, including the development of people, in this case fishermen, and not
only, for example, the development of the resources, increase in GNP or development
of an export industry.

Dr D.L. Umali, FAO Assistant Director-General and Regional Representative for
Asia and the Far East, has recently said that he, and his staff in the FAO Regional Off-

cice in Bangkok, believe that ‘development occurs when the farmer or the fisherman in
the village gets the support and the skills that harmonize with his life style and environ-
ment’. Furthermore, Dr Umali has stated that we have to stop imposing, even uncon-
sciously, our ideas and our models, and let the farmers’ and fishermen’s views and
perceptions, for once, shine through. It is the farmers and fishermen who can win the
world’s battle for food. It is the farmers who till the land and plant and harvest the
crops and the fishermen who fish and bring the catch to land. But the main difficulty,
as experience as shown to date, is how to reach the village farmer and fishermen and
get them involved in the development process. One answer might be seminars or
workshops held in the villages.

FIELD WORKSHOPS FOR VILLAGE FARMERS AND FISHERMEN

In line with the process of articulating a philosophy of service biased in favour of the
low income small Asian farmer and fisherman, the FAO Regional Office in Bangkok
has recently, with financial support from UNDP, been experimenting on a new and in-
novative approach to reach them. The methodology of approach is basically through
the holding of field workshops. Some of the general unique features of these field
workshops are:

1. They are multilevel, meaning that village people, village and/or district officials,
town officials, provincial and national officials participate.

2. They are held in rural areas near the ‘scene of action’ so that small farmers of the
area are able to participate and the other participants deliberate in the midst of the ac-
tual situation.

3. They are multisectoral or multidisciplinary, meaning that there are participants
who are technicians, administrators, extension workers, educators, sociologists,
economists, scholars from universities, representatives from banking or financing in-
itutions, etc., and farmers and fishermen.

4. They are task-oriented, problem identification and solution-seeking workshops
and not merely ‘talking’ shops. The villagers in their own surroundings and in their
national (local) language, and with the assistance and participation of the multisectoral
participants, identify and discuss their own problems and draw up possible solutions to their problems.

5. They are area specific, as the problems identified and solutions suggested are
relevant to the specific areas.

6. They are planned, organised and managed by the nationals of the countries con-
cerned; FAO provides the idea, the initiative, the guidance and the assistance when
necessary. In other words, FAO remains in the background.

* The FAO-UNDP Regional Project ASARRD based in FAO Regional Office, Bangkok since April 1973 has
a team of three members and a Director-cum-Team Leader. But in all its work it has functioned as a joint
team with the regional specialist officers of the FAO Regional Office. The final report and recommenda-
tions of the Project are under preparation. FAO’s intention is to make the operations initiated by the pro-
ject a regular and continuing program activity of the regional office and to offer advice and assistance
where required.
7. Every session of the workshop arranges solutions in two categories—those that should be initiated within 6 months and those to be initiated within 2 years. On several ‘short term’ items the departmental and agency officials of various levels present are able to make commitments for action on the spot. Thus a kind of commitment meeting is held at the end of every session. The longer term solutions can be the basis or components of a Field Action Project.

8. For five out of the eight countries where Field Workshops were held it was possible for the ASARRD project to prepare Field Action Projects on the basis of the problem-identification and solution-seeking objectives. The innovational features of these project proposals are the formation of grass-root groups of low-income farming people and the provision of a booster-cum-risk-guarantee fund to provide credit for income-raising activities of these groups that may normally not be entitled to credit for want of security.

FAO, through funds provided by UNDP, makes available to the follow-up field action project in the country a ‘booster’ fund of US$30,000 the bulk of which will serve as a ‘guarantee’ fund for the loans to the small farmers and fishermen; the banking or credit institution in the country is requested to raise ten times the guaranteed amount to make available as loans to small farmers and fishermen. The Field Action Project has been introduced in a small area in Nepal. It is hoped to introduce similar experimental projects shortly in Bangladesh and the Philippines. The leading banks in these countries have agreed to advance credit on the basis of risk guarantee.

The field workshop is, in essence, a methodology or a tool that can be used successfully (as experience to date has shown) in the developing world, for example Papua New Guinea, in:
(a) identifying the problems and the solutions required of villages;
(b) planning development programs and formulating specific action projects, based on local or field level planning (from bottom up) in contrast to the more common handing down of plans and projects from the top;
(c) bridging the gap (communication, assistance, etc.) between the government and the people;
(d) greater involvement of the villagers, or ‘democratisation’ of the village through group discussions and open exchange of views;
(e) greater chance of success of village projects (for the villagers will be less likely to be sceptical of a plan or project that they helped to formulate);
(f) promoting the establishment of farmers’ or fishermen’s groups, associations or co-operatives;
(g) attracting outside assistance (domestic, foreign, bilateral, multilateral) for field action projects; and
(h) encouraging the participation of everyone concerned (from the government administrator to the extension worker, from the academic to the practical civic-minded citizen) in rural or village development work.

Relevance of the Field Workshop for Papua New Guinea
Papua New Guinea is basically a village society, in both agriculture and fisheries. Among the eight major aims of the present Government are more equal distribution of economic benefits; decentralisation of economic activity, planning and government spending, with emphasis on agricultural development, village industry, etc.; an emphasis on small-scale artisan activity; and a more self-reliant economy. To achieve these aims, it is necessary that the Government effectively reaches the small village
farmers and fishermen; I feel that the methodology of the field workshop for low-income small village farmers and fishermen offers a hopeful possibility.

While Papua New Guinea is now the world’s third largest producer of skipjack tuna, there are only a hundred or so native fishermen engaged in that fishery and the rest of the thousands of fishermen in the country are village or subsistence fishermen. If the Government of Papua New Guinea desires and requests FAO assistance in organising and conducting a field workshop, the requested assistance would certainly merit attention.

It is not possible in this short chapter to give detailed suggestions for the planning, organising and management of field workshops. However, to give an idea of the organisation of such a workshop, I have appended an outline of the way in which they are suggested to be organised.

**Appendix**

**The Methodology of Field Workshops for the Development of Small Farmers and Peasants**

A. Field Workshops for Formulation of Field Action Projects

1. The Field Workshop Approach

1.1 Usually identification and feasibility studies of a project are done by a team of specialists. They study the material, meet senior policy makers and officers and sometimes visit the area of the proposed project. A Field Workshop undertakes this process at the field level, i.e. in the concerned rural area itself. Its purpose is to identify the problems of the small farmers and peasants in the area, to seek short-term and long-term solutions to them and to work out the components of a field action project for the development of small farmers and peasants. This task is undertaken jointly by some of the prospective beneficiaries (i.e. small farmers and peasants from the area), local agencies that are normally responsible for the operation of programs at the field level, supervisory officials and agencies at the middle level and the top level decision-makers, planners and directing officials.

1.2 This is, therefore, a practical approach to involve the rural people and local operational personnel in the process of developing a project from its inception. Not only will this make the project itself more realistic, its implementation should also be better because the small farmers and peasants and the operational personnel will feel identified with the project in the planning of which they will have had a hand.

1.3 Specialists responsible for drafting the project and giving it a documentary shape must attend the field workshop. It will give them a valuable source material and essential direct experience. An additional advantage will be that departmental and agency officials of different levels will have an exercise in co-ordination at the field level so important for projects.

1.4 Though the principal objective of the problem-identification field workshop is to formulate the essential components of the Project leading to the formulation of a project, it will in the process identify some short-term problems to solve which participating departments can make commitments.

2. Kinds of Field Action Projects and Their Identification

2.1 Project identification field workshops may be organised for various situations. Broadly two kinds of field action projects for small farmers and peasants can be visualised; first, field action projects for small farmers and peasants in areas with normal on-going programs of rural and agricultural development, and secondly, field action projects for small farmers and peasants in areas where a major project of infrastructural development (e.g. irrigation, soil conservation, flood control, communications and transport) or of specific production expansion (e.g. livestock, dairying, marketing, credit) or of the integrated rural development type, is to be launched with or without external assistance from bodies like the World Bank, Asian Development Bank etc. (the first case may cover some items that in the second case may be already provided in the major project. An important objective of project-identification in the second case is to see that the large investments do not leave out the small farmers and peasants and that
a provision is built-in for them. Therefore before the World Bank or ADB or such a financing body approves operations, it should insist on the holding of field workshops in some areas within the larger area to be covered by the project.

2.2 For Field Action Projects of the first kind, the process of identification of the components may have to begin from the scratch and may include suggestions for ab initio technical examination of the potential of infrastructural development. The project will seek to enable small farmers and peasants to take better advantage of the facilities available from the existing delivery mechanism, i.e. the on-going programs of various departments and agencies. It may also have proposals for infrastructural development of special relevance to small farmers and peasants. The choice may be greater but additional resource availability may be limited or uncertain at the stage of project identification.

2.3 Field action projects of the second kind have to be identified within the setting of a major technical development program with more or less assured resources. The financing body is, however, interested in seeing that the large investments do not leave out small farmers and peasants and that in fact they are actively involved. The field action project will therefore be a project within a larger specific investment program or project. Its infrastructural base is already assured technically and financially. What it has to propose and build up is the mechanism for the utilisation of the benefits of the new major delivery mechanism by small farmers and peasants of the area.

2.4 In either case, the process of identification will be the same, identifying problems and solutions at the grassroot and working out the components of the Field Action Project.

3. Methodology

The methodology of field workshops differs in several respects from the general run of workshops. Its special features are the emphasis on multi-level, multi-disciplinary participation, focus on the local specific task-orientation (i.e. problem identification, problem solving and project identification), functioning through discussion groups and living contact with villages and farm household.

3.1 Selection of area: An area is selected both because the venue of the Field Workshop should be in the midst of a rural area and because the focus of the Workshop will be on the problems and development of the small farmers and peasants of a particular local area and not in general of the region or the country. Even within the area, the workshop should concentrate on the households of small farmers and peasants in two or three villages; and in any case not more half a dozen villages. From the workshop discussions will emerge findings and solutions that will be typical of the small farm and peasant households of the area. This will lead to the identification of the components of the Field Action Project.

3.2 As stated in para 2 above, field action projects are visualised for areas with normal on-going programs or those in which a major development investment is contemplated. Within this framework two criteria can be applied in selecting the area for the workshop: the area should have a substantial number of low-income small farmers and peasants; and if it is an area with normal on-going programs, benefits and active participation of small farmers have been minimal; if it is an area where large developmental and infrastructural investment is contemplated, the concerned authority should be interested in involving and benefiting them in their program.

3.3 Participants: Selection of participants must reflect a multi-departmental, multi-disciplinary and multi-level approach. The desired number is about 80 to 100 persons. They should consist of a good mix of small farmers/fishermen, landless farm/fishery labourers, rural credit workers and government development and land reform staff from all levels—field, supervising, technical, administrative, policy and planning. The desired ratio is 2/3 from the area under study and 1/3 from higher levels. Special care must be taken to ensure that typical and genuine small disadvantaged farming people are selected. Specifically, participation in this type of field workshop should include the following:

(i) Selected low-income small farmers/fishermen, tenants, sharecroppers and landless labourers within the project area from among those likely to be covered by the field action project. (There will be some additional farmer participants at the meeting to be held in two villages during the Workshop. See para 3.10 (C)).
(ii) Local field level workers of the various government departments and agencies and local institutions whose operational functions and responsibilities touch the small agricultural producers and workers.

(iii) District/provincial level supervisory and technical officials of the government departments and other agencies concerned with crops, poultry, livestock, fishery, inputs, irrigation, soil, credit, extension, land reform, rural institutions and general administration.

(iv) Representative officials on the decision-making and policy levels of government departments and other agencies such as groups concerned.

(v) Representatives of credit/financing and marketing/processing institutions whose operations cover the development area.

(vi) Representatives from education and research institutions (specially agricultural education) concerned with development in the area.

(vii) Extra-governmental bodies and non-governmental organisations that are actually concerned with field development in the area.

3.4 By having people from diverse backgrounds and levels gathered in a rural area, undistracted by their normal work and engaged in a purposeful exercise jointly with and about small farmers and peasants, it is possible:

(a) to improve the vertical and horizontal lines of communication between and within departments of government and extra governmental agencies and establish new ones, if necessary;

(b) to expose officials and agencies to a situation in which co-ordinated and joint action becomes a practical necessity;

(c) to give small farmers and peasants an opportunity to come into contact with diverse officials and agencies at the same time so that they appreciate the multiple factors in a low-income small farmer's existence;

(d) to provide a common learning experience to a representative cross-section of rural development personnel with focus on problems of the small agricultural producers, and with priorities as seen from below;

(e) to demonstrate bottom-upwards program planning based on active participation of all concerned with implementation, including small farmers and peasants.

3.5 Workshop Language: The national language most common to all participants, from farmers to national planning level officials, is used and has been found to greatly facilitate communications.

3.6 Location: The venue of the field workshop is as close as possible to the area under study, depending upon the availability of meeting facilities for such a large group. When a number of field workshops are held in different areas, these may be followed by a two-day round-up session at the national capital to obtain endorsement to the essential elements of the project. Otherwise a meeting of some of the principal participants jointly with the top policy-making officials may be held at the capital for the same purpose.

3.7 Duration: Experience has shown that a workshop in a rural area should be of a duration of 5 days. If there are sessions in different areas, 5 days should be given for each area. These will be followed by a round-up meeting in the capital for a day or two.

3.8 Tasks: A field workshop being task oriented, its participants are expected to perform certain tasks collectively and in groups. The tasks should be explained at the commencement of the workshop. They should also be displayed on a banner on the wall. The various stages of the work schedule should relate to one or more of these tasks.

The following list of tasks is based upon experience. But the list may vary according to the theme and setting of a workshop:

(i) Identify the positive and negative aspects of on-going programs and projects in the selected area and villages that affect small farmers and peasants.

(Means: Papers and discussions at plenaries, and visits to villages.)
(ii) Identify the problems experienced by small farmers etc., arranging them under agreed problem heads and stating causes where possible.
(Means: Group-meetings and Farm Family Consultations.)

(iii) Identify bottlenecks in the programs of government and non-governmental agencies that have relevance to small farmer development, stating causes where possible.
(Means: Group-meeting and plenaries.)

(iv) Consolidate problem lists prepared by Groups.
(Means: Steering Committee of Group chairman and rapporteurs, and sometimes joint meetings of Groups.)

(v) If the workshop area is to be covered by a major infrastructural development or integrated development program (vide para 2.3), then examine the main features of that program and pin-point items in which small farmers and peasants will need special arrangements.

(vi) Receive new ideas and information relevant to the major problems under review.
(Means: Plenary Session.)

(vii) Develop solutions to the problems identified:
(a) according to time-horizons 'A' for initiating action within 6 months and 'B' for initiating action within 2 years;
(b) stating the body responsible for initiating action and those expected to cooperate;
(c) indicating action desired on the part of small farmers etc., themselves.
(Means: Group-meetings. Solutions may, where necessary, refer to the relevant items of major infrastructural or integrated development contemplated in the area.)

(viii) Consolidate solutions and pin-point items for quick follow-up action.
(Means: Steering Committee of chairmen and rapporteurs of Groups.)

(ix) Draft components and outline of a Field Action Project for small farmers and peasants.
(Means: Groups.)

(x) Commitment by local and regional officials and agencies for quick action on matters within their competence.
(Means: Joint meeting of officials and agencies, chairmen and rapporteurs of groups and of plenary sessions.)

(xi) Encourage small farmer-participants to form Planning-cum-Action Groups and consider preliminary steps for group-planning from below as a follow-up of the workshop.
(Means: Meeting of small farmer-participants and some expert participants particularly participants from non-government bodies.)

3.9 Background papers and notes: In advance of the workshop a background paper should be prepared preferably by a research body, on the condition of the small farmers and peasants of the area of the workshop. It should give some basic information on the area, its agriculture, land-system, and available statistics regarding small farmers and peasants, an idea of recent development projects and their impact on low-income farmers and peasants and an indication of major issues. Within each area village notes on 2 or 3 villages should be prepared. Within each of those villages, detailed studies are prepared on six families—two small owner farmers, two tenants and two landless labourers. The research body should constitute a team consisting of one economist/social scientist and one or more officers of the area concerned with implementation of programs in the area to prepare these papers based on visits to households, study of records and other papers, and discussions with local officials and personnel connected with on-going programs and projects. The same joint team should prepare for each relevant department and agency a brief outline of its work in that area and of its staffing pattern. The notes are expected to be short, factual and for the sake of brevity may have illustrative charts and diagrams. The idea behind forming joint teams for preparing papers is that in this way the research body can impart to the field officials some skill in preparing field studies, and the field officials can correct any rigidly academic methods.

In some workshops, notes on specific issues such as indebtedness of small farmers', problems of marketing and transport or any other issues relevant to small farmers are also prepared. Likewise international participants may make presentations on relevant experiences elsewhere.

Notes should be made available in the national language and in English.
The Melanesian environment

3.10 Methods of conducting business of workshop: The workshop should conduct itself through meetings of task-oriented discussion-groups or units (each about 10 to 15 members), consultation with farmers' families in villages, meetings of groups inside villages with additional farmer-participants, Steering Committee and plenaries (including joint meetings of officials, agencies, groups, chairmen and rapporteurs):

3.10 (a) Discussion Groups: Each discussion group should be a multi-structured unit, viz., it should have some senior and some junior officials, some small farmers and peasants, some participants from institutions and agencies. In a small group even the small man can express himself without inhibition. A subordinate belonging to a particular office should not usually be put in the same group with his immediate superior.

Experience shows that in order to induce spontaneous and full participation by small farmers in group-meetings, farmers who are used to being together may be put in pairs or parties of three or four in the same groups.

Group discussions should be purposive and directed towards the performance of the tasks mentioned earlier. In particular the attempt should be: to understand the points of view of small farmers and of field staff on the problems and possible solutions; to develop greater awareness among participants of the linkages between problems and the necessity for coordination; and to identify project components based on felt needs of farmers and field staff.

With regard to problem identification, problem solving and project formulation by groups, the following points should be noted:

(i) Proforma: Every group provided proforma with columns for problems, solutions, time dimensions, responsibility for action and other relevant items. The chairman and rapporteur of every group should complete the entries, but every member should have the same proforma for making his own entries while taking part in the discussions. Some problem areas should be indicated for the sake of convenience in listing them under categories.

(ii) Consolidated Lists: Before groups begin discussing solutions, an attempt should be made to make available to them the lists of problems made by other groups. This should be done by consolidating the problem lists of all groups. At the end, a consolidated list of problems and solutions should be prepared jointly by the chairmen and rapporteurs of the groups.

(iii) Project components and outline: Each group should take up one or two particular topics on which it will list components it considers important. For example, grassroot groups, diversified income-raising activities, tenurial matters, total credit, small-scale land, water and soil development, low cost technology, financial and administrative matters. A proforma should be devised.

(iv) During group-discussions, the blackboard should be used for making lists and facilitating discussions. The process of arriving at consensus is facilitated also by frequent reference to the actual situation which is generally explained by the farmers. Thus the tendency to dwell over conceptual generalities can be curbed.

3.10 (b) Consultations with Farmers' Families: Each group should divide itself into smaller (3 or 4 members each) parties or sub-groups. On the second day of the workshop every party should visit two or three homes and hold consultations with them in an informal and 'chatty' manner. Some guidelines on the points on which information and opinions are to be sought should be given to each party. The aim should be not a census-like questioning, but a consultation on a footing of equality to ascertain their real problems and suggestions for action by government, other agencies and by themselves. In particular farmer family consultation is an attempt to carry the workshop to the individual farm family; it is an opportunity to policy-makers to gain direct knowledge of the social and economic situation of a sample of small farmers; it is an occasion to cross-check findings of discussion group and case studies; it is an attempt to involve the family in local level planning. Sub-groups, on return, should exchange experiences with their respective groups, and during the recording of problems frequent references may be made in the groups to the first hand experiences. A side result is that in addition to the case studies, some first-hand accounts of individual farm-families become available.
3.10 (c) Village meetings of Groups: This innovation has also considerable potential for the bottom-upwards process of development. The day following the visits to farm-families the groups should hold their meetings in the village itself in a central place in school rooms or under trees. Every group should be joined by a batch of additional numbers of farmers, because at the group meetings held at the venue, only limited numbers can attend.

The purpose of the meetings is (a) to commence discussion on problem solving in the village itself; (b) to give to participating small farmers a preliminary experience in group planning; (c) to get a more intensive understanding of the viewpoint of specific sections of small farmers. For example one group may discuss with tenants, another with small owners, and a third with landless agricultural labourers. However, sometimes joint meetings may be preferred.

An alternative arrangement that needs to be tried is to identify small neighbourhood groups of small farmers etc., in the village considerably in advance of the workshop and to give them facilities and guidance to prepare for their role as discussion groups. The identification can be done by the experts who visit the villages earlier for preparing case studies, village notes and area papers.

The village groups will thus be counterparts of the main discussion groups of the workshop. They should receive workshop documents adjusted to their needs. They should hold their preliminary meetings. They will thus be prepared for their role in a serious and practical consultative process.

Participation in the workshop may well provide the incentive for the neighbourhood groups to go a step beyond their role as discussion groups i.e. to transform themselves into multifunctional production groups. That will be a positive step in the process of planning from below.

3.10 (d) Steering Committee: All group chairmen and rapporteurs should be constituted into a steering committee along with the coordinator of this workshop. The steering committee's main tasks should be the consolidation of problems listed by groups, consolidation of solutions, joining the commitment, meeting of officials and agencies and giving shape to the project components and outline as presented by the groups.

3.10 (e) Plenaries: Plenaries are few and used mainly for the following items of work:

(i) Introduction and explanations of the purpose, essential features and procedures of the workshop should be made in the plenary session by the director or co-ordinator on the first day. These should be supported by visuals, charts and slides.

(ii) Presentation and discussion of area papers, village notes, and case studies should also take place in the plenary on the first day before the groups start their work. The presentations need to be supported by visuals—maps, charts, diagrams etc. These give background information based on observations by experts and are usually followed by questions seeking clarification.

(iii) Information departmental activities: Notes on the main features and achievements of departmental programs are presented. The maps and extent to which small farmers and peasants have benefited from them are discussed. These presentations and the explanations that follow enable participants—and in particular small farmers—to assess on-going programs. While this provides an opportunity for departmental satisfaction over achievements, it also exposes want of co-ordination among them. At subsequent group discussions and village visits, the practical aspects of departmental activities are tested.

(iv) New technical information: Some specialists also attend the workshop as resource personnel. Before groups start into the problem solving phase of a workshop, new ideas and information on experience elsewhere in tackling similar problems are explained in the form of illustrated talks at the plenary meetings. Specialists are also attached to groups where they offer suggestions. Participants may thus become aware of different ways of solving the problems.

(v) Commitment meeting: The experience of group meetings, village visits, farm family consultations and meetings in villages, has a stimulating effect upon departmental officials. They also appreciate better each other's problems. They are willing to consider immediate action on matters on which they have the discretion and competence
to go ahead. On the fourth day of the workshop, a meeting is held to secure informal agreement of departmental officials and agencies to take early action on such points. This is a joint meeting of officials and of the chairmen and rapporteurs of groups.

(vi) *FAO's Note on Essential Features of Field Action Projects* is considered at the plenary as a prelude to the preparation of the outline by the groups.

(vii) **Conclusions and recommendations:** The plenary session considers and endorses the following:
- consolidated findings and recommendations of the groups under various problem-heads;
- recommendations to government on matters requiring policy decisions;
- decisions taken at the 'commitment' meeting of officials;
- proposals for a possible experimental field action project on the institutional development of small farmers of the area.

3.11 **Agenda:** The agenda of the field workshop should, therefore, be carefully worked out to achieve an optimum use of the suggested methods (para 3.10) for the performance of the tasks (para 3.9) by the mixed gathering of participants (para 3.3). The actual agenda may vary from workshop to workshop depending on local conditions, but the following order of items of work should broadly be included in a five-day workshop:

(i) Inauguration, introductions and explanations of essential features and procedure of the field workshop (plenary).
(ii) Area paper, village notes and case studies with short discussion (plenary).
(iii) Information on departmental programs and questions on them (plenary).
(iv) Problem-identification (groups).
(v) Consultation with farmers' families in villages (sub-groups).
(vi) Village meetings of groups (groups).
(vii) Consolidation of problems (steering committee of chairmen and rapporteurs, sometimes joint meeting of groups).
(viii) Examination of main features of a new major investment program for the area (plenary).
(ix) Presentation of new ideas and information on experiences elsewhere (plenary).
(x) Problem-solving (groups).
(xi) Consolidation of solutions (steering committee of chairmen and rapporteurs).
(xii) Consideration of FAO note on Essential Elements of Field Action Projects (plenary).
(xiii) Drafting the components and outline of field action project for small farmers and peasants of the area (groups, one group drafting on a particular item).
(xiv) Commitments on local and regional officials and agencies for quick action (joint meeting of officials, agencies along with group chairmen and rapporteurs).
(xv) Adoption of reports on solutions, quick action commitments and field action project.

Though the number of items is large, not all will require a long time. Some time can be saved by having additional sessions after dinner, such as that for item (ix) or some of the joint meetings. The advantage in having a workshop in a rural area is that there are no other diversions and everybody can get intensely engrossed in workshop matters.

3.12 **Management:** A central co-ordinator should be appointed right at the beginning. For every area session there is to be a local co-ordinator, and a local organising committee. Upon them falls the main burden of conducting the workshop. Therefore local representatives of concerned departments and agencies including non-government bodies are members. There should be a central co-ordinating committee also. Sometimes an editorial committee is also appointed to keep a watch on the progress of the preparation of papers and generally editing the material.

3.13 **Follow-up arrangements:** Two steps are necessary for pursuing the follow-up action of the field workshop. First, the local organising committee, with some additions, should become the follow-up committee. Secondly, the small farmers who attend the workshop should be encouraged to form their own neighbourhood groups. It is best if the decision to form these committees is taken on the concluding day of the workshop, instead of leaving the matter to a later date. The follow-up committee and the farmers' groups will be in contact with each other and the follow-up committee should make use of the groups in pursuing action. In this way the liveliness created locally by the workshop can become the starting point of an action program.
All emerging nations today confront the problem of developing their natural resources to enhance the quality of life of their people in the face of growing awareness of potential damage to natural environments resulting from resource development activities. River systems are repositories of immense quantities of power and food—important resources that can be beneficially developed if adequate preparatory studies and precautionary measures are undertaken. The experience of fisheries development in the Mekong River system can provide some useful information for planning in Papua New Guinea. Policy there has been to embark simultaneously on (a) formulation of strategies, based on surveys and studies of the area, to counter expected adverse effects; (b) development of programs to increase fish production, based on premises derived from appropriate experiences in other tropical rivers; and (c) rehabilitation measures for commercially and biologically important fish and shellfish likely to be endangered by dam construction. The unique characteristics of each particular river system, and especially delicately balanced estuarine ecosystems, must of course be studied and inappropriate generalizations guarded against. The tradeoffs between the benefits of irrigated agriculture and damage to fish populations from pesticides and herbicides must be considered and the possibility of aquaculture rather than agriculture envisaged in certain cases. With regard to now well known hazards, a positive approach should be taken so that, for instance, nuisance plants like water fern and water hyacinth may be seen as potential resources given appropriate processing.

First of all, I should confess that I know very little about the fisheries or the environmental features of Papuan rivers and estuaries. What I do know is that Papua New Guinea lies in the tropical zone, a situation that it shares with the Mekong basin. Therefore, I assume that fish of Papua New Guinea, their life histories, habits and habitats are broadly similar to those of other tropical river systems. On this assumption, I shall set forth to describe at some length in this chapter my understanding of problems of fishery management relative to river development in the tropical zone. It is this understanding that forms the rationale of Mekong fishery program.

The Mekong development project is one of the very few large river development projects in the world that have adopted a truly broad and yet intensive multidisciplinary approach for its long-range planning in water resource development. One of the important aspects in this planning is the development of fisheries in the Mekong basin, as in many other parts of Asia, fish is the principal source of animal protein in the diet of the people and it is likely to remain so, in view of the high cost of production of other protein foods. Fish exports contribute considerably to foreign exchange earnings in Mekong riparian countries; for instance, in the Republic of Vietnam fish and fish products constitute 51 per cent of the total value of exports and earn more foreign exchange than any other commodity. In view of the importance of
fisheries in nutrition and economy of Mekong riparian countries, fishery studies and development activities have become an important element in the Mekong program. One of the initial impediments in the formulation of the Mekong fishery program was the absence of adequate information on the biology and habits of the fish, their ecological relationships and disposition of various fisheries. Therefore, we had necessarily to embark on studies and surveys to obtain basic information on fisheries. However, all developing countries are impatient to get ahead, to make up for the time lost in the race for economic progress. Understandably, therefore, they loathe protracted, time consuming studies; they want immediate concrete manifestations of the results of development programs. Nevertheless, it is a truism that an adequate scientific information base is essential to formulate meaningful development and management programs for any living resource. Therefore, in the Mekong, we have concurrently embarked on programs of surveys and studies, and development activities in the field of fisheries. The information base for early development programs was derived from the available fishery related biological and ecological information pertaining to similar river systems in the humid tropical regions of the Ganges and the Brahmaputra basins in the Indian sub-continent. Initial, rapid surveys of the Mekong River have established that a great similarity does exist between those rivers and the Mekong, in respect not only of fish fauna, but also of environmental conditions. It was observed that over 80 per cent of the fish species occurring in the Mekong are also distributed in those rivers. Therefore, in formulating Mekong fishery development program, we have taken full advantage of the knowledge available from river systems with broadly similar environmental and faunistic conditions, and at the same time have launched a program of specific studies on relevant aspects in the Mekong itself. Results of specific studies in the Mekong serve to verify our initial premises and form the bases to improve or modify existing programs.

Problems of Dams and Fisheries

It is well known that river development activities affect fisheries in many ways. Much has been written in public presses on the catastrophic effects of river development activities on the environment, including aquatic life. While, undoubtedly, in certain instances river development activities did precipitate environmental disruptions in some measure, popular articles on the subject have unfortunately tended to be unbalanced, one-sided and even falsely alarmist. Concerned as we are with the overall development of the Mekong River basin, we have closely examined the existing information on environmental aspects of river development in an attempt to place the whole problem in what we believe is a properly balanced perspective. Results of this examination have shown (Pantulu 1975) that no two river systems are exactly alike, especially if they are located in different ecological zones, and that blind extrapolations of experience from one river system to another are not necessarily valid. Effects of river development on the environment are not always harmful; they are multifaceted and could at once be harmful, beneficial or innocuous, depending on the facet observed. Furthermore, through adequate preparatory studies and implementation of effective precautionary measures, it is possible to alleviate or offset some of the adverse effects and to enhance the benefits, thereby rendering river development activity on balance a beneficial enterprise. All decisions pertaining to river development necessarily involve tradeoffs; the problem is to ensure that the tradeoffs are based on the fullest possible knowledge and understanding and are intended for the ultimate benefit of the people.

Modification of the riverine environment by dam construction affects fisheries of the river system in many ways. The two major premises fundamental to the under-
standing of such effects in relation to modern concepts of protection and management of fisheries relative to river development are (Pantulu 1973a):

1. Impoundment drastically alters the riverine environment by bringing about substantial changes in the morpho-ecological nature of rivers. Fast flowing sections are converted into relatively static environments and long-established interrelations between organisms are transformed radically. Changes in temperature regimen, volumes and cycles of discharge, velocity of current, gradient, substrate, mineral content and other parameters take place. Alterations in spawning grounds resultant on flow and erosional depositional shifts inhibit propagation and development of both lythophilous and rehophilous species. If spawning grounds are eliminated, species may even disappear. Both qualitative and quantitative changes also take place in food chains and available foods. Fishes narrowly adapted to specific sets of environmental conditions cannot withstand sudden environmental alterations beyond rather narrow limits. Hence, many components of riverine fish faunas can be adversely affected by sudden and drastic changes that follow upon dam building.

2. In many species of fishes, there are races of populations that are perpetuated from specific spawning areas or 'homes'. When dams deprive access to spawning areas for homing spawners, a specific race can be destroyed.

These basic premises, which place rigid restrictions on the latitude available for modification of riverine environments, have emerged largely as a result of the vast experience in the Pacific northwest of the American continent, with particular reference to the Pacific salmon populations. Unfortunately, assessment of fishery problems in relation to dams everywhere in the world has now been conditioned by these premises, irrespective of such considerations as levels of tolerance of different species to environmental change, their migratory habits, biology and ethology.

Tropical river environments exhibit violent seasonal fluctuations. As a measure of adaptation to widely fluctuating environmental factors, many of the fish species that inhabit these rivers have evolved wide ranges of tolerance. Any realistic assessment of effects of river development on species populations should take this into account.

A tropical river has a seasonally conditioned regimen, and is thus a violently fluctuating environment. In the Mekong system, the conditioning factor is the monsoons. In tropical rivers in general, flash floods and large-scale inundations are common features. The annual amplitude of variation in discharge between the dry and flood periods is very high; in the Mekong at Kratie, Khmer Republic, it ranges on the average between 1764 m³ per second for the dry period and 52,000 m³ per second during floods. Owing to differences in substrate and continued scouring action of floods over a long period of time, depressions or 'pools' are formed in the beds of rivers at several places. These pools often assume considerable proportions; in the Mekong, some of them in the Laos/Thailand region are a few kilometres long and more than 50 m deep. In the stretch of the river in the Khmer Republic, D'Aubenton (1963) located several 'troughs 40 to 60 m deep'. These deep pools retain water all the year round and offer a sort of 'transient lacustrine' environment during the dry months. The months February to May usually constitute the low water period, when the wetted perimeter in the river is at the lowest. During this time of the year, fluvial sections of many of the tributaries are reduced to a mere trickle of water and the only relatively stable aquatic environment is provided by the often isolated pools in the stream beds. It is here that the residual fish population takes refuge.

In the lower Mekong, water temperatures generally are high and fluctuate within the wide range of 20°C to 37°C at different points during different months of the year.
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Hydrogen ion concentration values range between pH 6.0 and 8.2, and dissolved oxygen values run between 2.8 and 7.5 ppm (from oxygen deficient to saturated) in different sections of the river. Water level in the river starts rising by about the end of May, reaches its peak in August or September, and finally subsides in November. With the onset of floods, water temperatures rise and dissolved oxygen and pH levels fall, mainly as a result of decomposition of the vast amount of organic debris brought in or inundated by floodwaters. In the Mekong basin, it is estimated that in the Vietnam delta alone, an area of about one million hectares is inundated and that water level rises by 4–5 m with current velocities varying from 0.2 m per second in February to about 1.4 m per second or more in August. Flood induced changes in the environment return to normality and conditions of the dry period begin to set in during December or January.

Fluvial sections of the river itself are not very productive, owing to the relatively high turbidity, fast current and shifting sandy nature of the bottom. Plankton production in this fluvial environment is low compared to that in the pools, the oxbows, and other inundated regions beside the rivers. These three regions are the true pockets of biological production in the river system.

More than 400 different species of fishes have been recorded from the lower Mekong basin. In contrast, the basin of St Lawrence River, with its Great Lakes, in the temperate zone at some 45°N latitude in North America, has only 150 species. In the Mekong, during the dry months of the year, carps (family: Cyprinidae; 54 per cent), catfishes (families: Siluridae, Clariidae, Schilbeidae, Bagridae, Sisoridae and Akysidae; 19 per cent) and murrels (family: Ophicephalidae; 8 per cent), together constitute about 81 per cent of the fish fauna. The remaining 19 per cent consist of featherbacks (Notopteridae), herrings (Clupeidae), climbing perches and gouramis (Anabantidae) and other miscellaneous groups. This composition varies slightly during different seasons, but averages substantially the same from year to year.

The life cycles of a vast majority of fishes depend prominently on the annual flooding and inundation cycle in many tropical rivers. With the onset of floods and concomitant submergence of fields, ditches, swamps, bayous, oxbows, and other low lying areas over considerable distances on either side of the river bank, a predominant section of the fish population 'migrates' laterally from the rivers to the inundated areas, mainly for spawning. These migrations, barring a few exceptions, are lateral (towards and into the inundated land bordering the rivers) rather than up or down the rivers (from estuaries to headwaters, or vice versa or from pools to rapids, etc.). The distances traversed in the 'lateral migrations' and the duration of sojourn in the inundated zone differ with different species, depending on their physiological requirements and environmental tolerances. Fishes with low oxygen requirements, or those with accessory respiratory mechanisms in addition to gills, like murrels, some catfishes, and climbing perches and related species remain for longer periods in the peripheral zones of inundation, where dissolved oxygen and pH are generally low, owing to decomposing organic matter including submerged terrestrial vegetation. Many carp family members (Cyprinidae), which generally have higher oxygen requirements and lower tolerances to pH fluctuations than the foregoing, occupy the proximal zone of inundation, spawn there and are among the earliest to move riverwards with receding floods.

If the flood recedes quickly, as it happens during years of relatively sparse rainfall, large numbers of eggs and hatchlings become stranded and die through desiccation. In contrast, when floodwaters remain for a relatively long period, as in years of heavy rainfall, there may be large-scale mortalities of fry and fingerlings owing to deoxygenation and drastic changes in pH resulting from decay of organic matter in flood
waters. In some areas, then, flood regulation that eliminates either very high or very low flood might actually be beneficial to fisheries.

The observed high fecundities in most of the tropical river fishes, except in those that exhibit parental care, are an adaptation for species survival in the face of natural periodic large-scale mortalities. Some of the young that result from the spawning activity in the inundated zone enter the main river and repopulate it. Others are left behind in the water bodies inland, grow there and provide a rich crop of fish. Thus, a sort of natural restocking of the water bodies on either side of the river takes place annually when floods occur. The fact that fish fauna represented in residual stagnant water bodies is essentially the same as the riverine fauna is an indication that many tropical river species can thrive in relatively still water environments. It is also obvious from the above, that annual inundation is of paramount importance to the propagation and survival of the vast majority of tropical river fishes. Any river development program that completely eliminates annual flooding is bound to cause disruption in natural fish production and thus cause damage to fisheries.

While dams do change the inundation pattern in different degrees of magnitude depending on how discharges through them are regulated, in general they do not significantly alter other critical environmental features, such as temperature, dissolved oxygen and pH (except in deep stagnant waters of some reservoirs). Pantulu (1973b), citing the post-impoundment situation in the Nam Pong River (Mekong basin), concludes, with supporting data, that changes that occur in these critical environmental features in the top strata of reservoir waters and the residual river are well within the normal range of fluctuations to be expected in natural rivers in the pre-impoundment phase. Thus they are within the adaptive tolerance ranges of most fishes concerned.

It is apparent from the above that the temperate zone derived rigidity of restrictions on the latitude available for modification of the riverine environment need not necessarily be applicable to tropical situations. This contention is further substantiated by the observed species composition of fish populations in the pre- and post-impoundment phases. Many tropical river species thrive in the relatively stable lacustrine environments that replace the widely fluctuating tropical river environment above the dam. It has been observed that, following the creation of different reservoirs, 2–30 per cent of the original river species have disappeared, depending on the location of the dam. Fewer species have disappeared in mainstem reservoirs, which have access to unaltered rivers and tributaries, than in tributary reservoirs. Notwithstanding the reduction in the number of species, there has invariably been an increase in fish production in a submerged river as a result of large quantities of fish food that develop in the expanded aquatic environment in the reservoirs. The average production per hectare in an unaltered tropical river is estimated at about 12 kg a year, whereas reservoirs have produced anywhere from 30–180 kg a year and more, depending on their location, morpho-edaphic features, and efficiency of fishery management measures. To cite two outstanding examples in the Mekong, the Nam Pong reservoir in Thailand has been producing on an average 1600 tons of fish, valued at $US$800,000 equivalent annually, while the Nam Ngum reservoir in Laos yields 1800 tons annually, valued at $US$1.4 million equivalent at current market prices in that country. In both these instances, fishery benefits compare favourably with, and even exceed, electric power benefits. Similarly, representative conservative approximations that have emerged to date for stabilised annual metric tonnage of fish catch sustainable with good management for some African reservoirs are: Lake Nasser 12,000; Lake Volta 40,000; Lake Kainji 4500; and Lake Kariba 6000 (K.F. Lagler, pers. comm.). In view of the foregoing, it is ironic that, despite the magnitude of benefits
they generate, fisheries are often relegated to an ancillary role in planning water resource development projects.

It is sometimes argued that the fishery ‘largesse’ does not always last. Whereas it is true that in many reservoirs there is typically a decline in fish production after the first peak of increase, owing to a phenomenon known as trophic decline, even the lesser ultimate levels of stable production are invariably much higher than those in unaltered rivers. Moreover, proper fishery management efforts can minimise the extent of decline in production, as exemplified in various reservoirs in the USSR. In the Nam Pong reservoir in the Mekong basin, even ten years after the creation of the lake, there is as yet no evidence of decline in catches. Dam construction has thus seldom brought about changes in water quality in the fresh water stretches, which are outside the range of fluctuations occurring in natural rivers; it has only removed or dampened the amplitude of fluctuations. By virtue of the fact that many fish species of tropical rivers are adapted to life in the relatively static environments of pools in river beds or inundation zones beside the rivers, a vast majority of them actually thrive in the relatively newly stabilised environment of man-made lakes. Whereas, undoubtedly, a few riverine species do locally disappear in the lakes made by damming rivers, this loss is more than compensated by the increase in actual fish production. Furthermore, although dam construction in the tropics has not, owing to water quality changes, appreciably affected fisheries in the fresh water stretches of the rivers, water budget changes either have precipitated or could precipitate adverse effects on site in the residual river immediately downstream of the dam, or off-site effects in estuaries and adjacent inshore marine areas.

A case in point is the observed sudden steep decline in the Indian shad (Hilsa ilisha) fishery in the inshore areas of the Bay of Bengal and the Hooghly estuary (Pantulu et al. 1967), coinciding with the construction of the Maithon Dam in 1957; this was the third dam to be constructed in a series in the Damodar valley in India. The Indian shad catches, which before 1975 used to comprise 60 per cent of the total landings of fish in the area, suddenly declined to 5 per cent. This decline was attributed to the drying up of a 164 km stretch of spawning grounds of the fish in the residual Damodar and Rupnarain Rivers. However, since 1972 there are indications that these populations are building up, perhaps as a result of increased survivals in adjacent spawning areas in the Hooghly.

Off-site effects of dam construction could be very significant in the dynamic tropical estuarine ecosystems, about which, admittedly, very little is known. Estuaries generally are among the most highly productive ecosystems on earth. This productivity is usually attributed to delicately balanced interactions amongst various biotic and abiotic factors in an unusually shallow and fertile water area. Crucial among these factors are shifting salinity and temperature gradients; allochthonous nutrients that regularly flow into the system and are quickly recycled there; the nutrient laden substratum that is constantly in the photic zone; a general freedom from predators; and an optimisation of the ecosystem by a delicately balanced, long-time evolved form of time sharing in which larvae, young, juveniles, and even adults of a host of different organisms utilise the food resources at different times and thus minimise competition. Estuaries are valuable nursery grounds for many marine and fresh water species. Many principal offshore fisheries are dependent on fish stocks, the young of which must have access to the protection and nourishment afforded by estuarine tidal flats during the early stages of their life histories (Pearse and Gunther 1957). Despite the great advances of techniques in offshore fishing, most of the world’s marine fish catches still come from coastal waters and predominantly from those under estuarine influence.
Any water control in the estuaries could bring about far reaching environmental changes. The magnitude of the environmental changes would naturally depend on the scale of water control that is practised. Only specific studies in a given situation can give the necessary insights into the actual effects that should be anticipated in a particular area. Changes in the configuration of the basin and reduction in net volume of flow into estuaries, by water resource development activities like upstream dam construction and poldering, bulkheading and filling, dredging, ditching of marshes, diversions, barriers, sea walls, tide control structures in the estuaries themselves, could result in alteration of drainage pattern and circulation, which in turn could affect seasonal and spatial distribution of critical environmental factors such as salinity, temperature, magnitude of flows and velocity of currents. Changes in volume and seasonal distribution of fresh water inflow could also result in reduction of influx of terrigenous nutrient materials resulting in a general deterioration of the estuarine habitat and in a measurable loss of productivity. Changed hydrographic structure and behaviour in the estuary could lead to upstream movement of deoxygenated bottom waters because of combined salinity and thermal stratification effects. Besides, siltation and intrusion of sea water could increase and the wetted perimeter (land-water interface) could decrease, leading to destruction of food and cover for fish. All these environmental changes could lead to alterations in vegetative cover, loss of nutrient material, reduction of spawning, nursery and feeding areas and an overall reduction of potential for fishery production.

Although changed river flows can have adverse effects on aquatic life, there are also instances on record where upstream movement of higher isohalines in an estuary could be beneficial under certain conditions to some estuarine populations. Steadied transport of nutrients could also potentially benefit the fisheries in that regulated flow could affect the estuarine penetration and abundance of both desirable and nuisance organisms and also enhance the spawning success of some species.

Instances of both positive and negative effects of water management on aquatic life in estuaries abound in scientific literature; a few are cited below as pertinent examples. According to Gunther (1967) and MacIntyre and Holmes (1971), alterations in the drainage pattern of marsh lands have led to significant ecological changes in the Mississippi delta. Rich oyster grounds and other shellfish spawning areas have become barren as a result of these changes, though fin fish yields have not apparently been affected. Moreover, leveeing the mainstreams has resulted in an increase in the velocity of current, leading to an increased transportation of silt; resultant alluviation, sedimentation and flooding of swamps have virtually eliminated marshes and estuarine conditions. Other important effects in the Mississippi estuary area are deposition of enormous quantities of silt directly in the Gulf of Mexico; decrease in nutrient drainage from land; increase in salinity and decrease in stability; and occurrence of island erosion and inland movement of bays. The estuary has changed, usually in ways detrimental to aquatic life. Sudden influxes of fresh water and resultant instability of the estuarine system around the river mouths have generally lead to a decrease in fertility (Cronin 1967).

Korringa (1967) cites an instance in the Netherlands where closure of the Zuiderzee by diking eliminated the traditional fisheries for herring and anchovies in that body of water, though it resulted in an increase in eel populations and the consequent development of new fishing industry. Segerstrale (1951) cites an instance in Finland, where average changes of 0.5–0.75 per cent in salinity have produced beneficial alterations in the effective distribution of estuarine species.

Despite the alarming possibilities of adverse effects from water resource develop-
ment, estuaries are remarkably resilient systems that resist change; they also have the capability of quickly healing many of their man inflicted scars (Cronin 1967). Well planned manipulations based on an adequate understanding of the estuarine environment could well result in overall benefits. The gross ecology of an estuary can be managed advantageously. There is room for a great deal of new thinking in the release systems of river water, diversion of large volumes and alterations of channels, currents and tides (Lagler 1972). Aquaculture possibilities can be vastly developed. For instance with good upstream management, certain areas could be reclaimed more profitably, more quickly and at a lower cost for aquaculture than for agriculture. There are examples in Asia (India, Taiwan, Philippines, etc.) where brackish water areas reclaimed for aquaculture at an average once only cost of $US500 per hectare are yielding an annual fin fish or shellfish crop valued at over $US1200 per hectare. Net returns in such aquaculture operations are said to average $US500–650 per annum. It is understood that average cost of reclaiming deltac lands for agriculture is far higher and that the returns from agricultural operations are far lower than for aquaculture. There is therefore an urgent need for understanding the ecology of any specific estuarine system before attempts are made to forge any far reaching changes that would adversely affect its valuable resources. Otherwise the very object of water resource development could be negated.

Migratory Fish

It has almost become axiomatic that dams interrupt life cycles of fish by inhibiting or obstructing their migrations and consequently lead to decline in the fisheries. Some calamitous consequences of dam construction have indeed taken place under certain environmental conditions, with specific fish species that undertake long-range migrations and have ‘homing’ requirements. In the rivers of the Pacific northwest of the American continent, for instance, the predominant commercially important fish are five species of the migratory Pacific salmon. These fish have a remarkable life story. Spawned in fresh water, they grow to adulthood in the high seas and perform spectacular migrations, sometimes of more than 1600 km, to reach upstream spawning grounds in river systems. The destination of each and every fish is the very same spawning ground where it had hatched and passed its early larval stages. There is so little straying from the parent stream that homing access to this stream determines the survival of the species stock in each spawning stream. This access can be denied by a dam.

Research indicates that the fish migrations such as those of the salmon are not consciously performed acts in the anthropomorphic sense, but a series of movements executed in response to imprints in the fish brain of environmental gradients. Specific features of environment, including water chemistry, current velocities and temperature, release specific behaviours comprising a series of directed movements that make up the entire pattern of migration and spawning. If a dam causes environmental changes beyond rather narrow limits, the environmental clues that trigger the pattern of homing migration are lost. Almost all salmon unable to reach the parent stream spawning ground die without reproducing. In such cases, dams that obstruct migrations are rightly adjudged harmful to the fish.

What has happened to the Pacific salmon in dammed north American stream systems has unfortunately formed the basis for present day popular thinking that dams anywhere in the world are inevitably detrimental to fisheries. In tropical rivers like the Mekong, however, commercially important migratory fishes are generally few. Consequently, the detrimental impact of dams as barriers to migration may be very small. In
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contrast the Indian shad, which performs seasonal migrations in most of the rivers in the Indian sub-continent and in Burma, is of very considerable commercial value. Dams in the Indus, Cauvery, Krishna and the Godavari Rivers have, by virtue of their location, had different degrees of adverse effect on shad migrations, although these have not been of catastrophic proportions. The main effect has been a restriction in the range of its distribution to the stretches of the rivers below the dams. In this case, obviously, the dams have not barred access to all the spawning grounds of the fish. However, in the Hooghly River in India, construction of a series of dams on its major tributary system has resulted in a catastrophic decline in the fishery, as we have already seen.

Another group of important migratory fishes in the tropics are the eels, *Anguilla* spp. These eels grow and become adults in fresh water rivers and, at maturity, migrate to unknown spawning grounds in the sea. Their young elvers return to fresh water rivers to complete the life cycle. Eels are hardy fish, which are known even to take short cuts around river bends by wriggling through moist grass, or to climb steep wet walls or waterfalls. They have considerable commercial value both locally and as an export commodity, but this potential has not yet been tapped in many of the countries in Southeast Asia. Considering their hardy nature and their capacity to survive out of water for prolonged periods, only the largest dam would limit their production.

Besides the two migratory groups of fishes mentioned above, in tropical Asian river systems there are about a dozen important species of marine or euryhaline fishes that are known to undertake relatively short seasonal migrations in the marine estuarine zone for feeding or breeding purposes. Very little information is available about the directive and causative factors for the migrations. It is conceivable that dams would affect these valuable fisheries adversely, but precise information on their stock movements and biology is essential before any specific statements regarding the effects of dams on them could be made.

The important potomodromous fishes that are known to undertake within river migrations in Asian rivers, and that could be adversely affected by dam construction, either as a result of environmental changes brought about by dams or by obstruction to migrations, include catfishes of the genera *Pangasius* and *Pangasianodon*, the major barbels, *Barbus* (Tor) spp., *Probarbus* spp. and the giant fresh water or river prawn (*Macrobrachium rosenbergii*). The giant fresh water prawn makes up highly valued catches from freshwater rivers and estuaries and has a great aquaculture potential, with a growing demand in both local and world markets. This species is known to spend its adult life in fresh water areas and to migrate to estuaries and brackish waters for spawning; environmental salinity is the important factor for the reproduction and survival of the young. Salinity regimen changes in estuarine areas caused by impoundments upstream are known to affect the species. Decline in the fishery of the giant fresh water prawn due to dam construction was reported in the Krishna and the Godavari estuaries in India. In the Mekong, detailed studies are being conducted to elucidate the problem and also to develop large-scale culture of the species as a rehabilitative measure taken in advance of the onset of the apprehended adverse effects.

The other riverine migratory species—the catfish and the major barbels—are also of considerable commercial value; in a river like the Mekong or the Ganga their fishery may be worth a million dollars (equivalent) or more annually. In such waters a careful evaluation has to be made of the probable effects of dam construction on the fisheries, and rehabilitative measures to offset any anticipated losses have to be implemented as a part of the new water management scheme. In the Mekong development program, artificial propagation of endangered species and their large-scale cultivation in water
bodies is the principal ameliorative measure that is being adopted to offset anticipated losses (Pantulu 1973b).

**Water Weeds**

One of the undesirable consequences of man made lakes is the proliferation of nuisance aquatic macro-vegetation. Virtually every major hydro-electric project built in the tropics has been plagued by one or more pest plants (Nelson et al. 1970). Principal offenders in this category are the water hyacinth (*Eichhornia crassipes*), water fern (*Salvinia auriculata*) and water lettuce (*Pistia stratiotes*). Besides being instruments of the spread of diseases, weeds adversely affect fish populations by shutting off of solar energy from the phytoplankton and by the pollutional effects of dead and decaying weeds. Furthermore, weeds utilise nutrients that would otherwise be available in the production of fish food organisms, and themselves also cause oxygen loss during hours of darkness and on very cloudy days. Perhaps the most insidious consequence of weed proliferation is transpirational loss of water generated by these plants.

Proliferation of undesirable aquatic vegetation in reservoirs is a manifestation of the unutilised productive potential of the waters. Fortunately, man is learning that this vegetable production potential can be diverted to channels advantageous to him (Little 1968). Introduction of ‘large numbers of phytophagous fishes is reported to withdraw 30 per cent from the quantities [of water plants] being formed annually’ (Gaziev 1973). It is, however, recognised that the introduction of new species could cause several problems of a different nature and that considerable care has to be exercised in deciding on any introduction. Gaziev (1973) further reports that 200,000 tons of protein concentrate, utilisable in cattle feeds, are extracted from blue-green algae harvested annually from a reservoir in Dnieper River. Useful aquatic plants like water cress and water chestnut, which are valued ingredients of Asian cuisine, could be grown extensively in reservoirs, thus inhibiting growth of obnoxious weed plants. Above all, weeds themselves can be utilised, after suitable processing, as animal feeds. Thus, given adequate research effort, it is possible that human intervention could greatly alleviate the nuisance value of aquatic vegetation.

**Agriculture**

Besides power development, improvement of agriculture is generally considered the raison d’être of river development. Intensive agricultural operations, involving the use of pesticides, herbicides and fertilisers, have been very harmful to fisheries. Increased fertiliser loads would lead to development of excessive algal blooms, with associated massive oxygen depletion and fish kills. Pesticidal and herbicidal pollution is as serious a hazard to aquatic life (and to consumers of aquatic organisms) as intensive agriculture could introduce. The absence of pesticides and herbicides, on the other hand, could be a serious hazard for agricultural production. Therefore, decisions regarding the development of agriculture in predominantly fishery areas have to take the relative benefits of fishery and agricultural development into consideration.

**Conclusion**

Papua New Guinea, like other developing countries, may not be able to afford the luxury of a protracted period of basic studies before launching development programs. Therefore, it would have to draw heavily on applicable information and experiences in other tropical rivers with identical fauna and broadly similar environmental conditions in the formulation of its development programs. In the Mekong, faced with a similar situation, we embarked simultaneously on surveys and studies to identify
problems, anticipate adverse effects and formulate development and management measures; on development and management programs to increase fish production, based on premises derived from appropriate experiences in other tropical rivers; and on rehabilitation measures for commercially and biologically important fin fish and shellfish likely to be endangered by dam construction.

Projects under the category of surveys and studies deal with collection, collation, analysis and interpretation of basic information on fisheries, including both scientific and socio-economic aspects, for the mainstream Mekong and its tributaries throughout the lower basin, including estuarine and inshore waters, and selected reservoirs typifying four major ecotypes. Development projects at present are concentrating on establishing pilot projects to demonstrate ways of enhancing fish production in various Mekong man made lakes, by culturing fish in fish farms utilising irrigation water made available by dams. Rehabilitation activities are designed to demonstrate how existing production of selected endangered species of fin fish and shellfish could be enhanced by artificial propagation and culturing techniques.

All emerging nations today are confronted with the staggering problem of developing their natural resources to enhance the quality of life of their people, in the face of increasingly disquieting remonstrations of 'ecologists' on the disruptive effects on the environment of resource development activities. River systems are great natural resources; repositories of immense quantities of power and food. Some ecological costs would certainly be involved in exploiting these resources; but the price to be paid would be small compared to the benefits that could be realised by developing river systems after proper planning and with due caution and ameliorative action.

REFERENCES
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Fishing in the Emerging Economy of Papua New Guinea

GARTH I. MURPHY

Three kinds of fisheries can be distinguished, each having different social and economic goals, requiring different kinds of technologies, and having increasingly complex resource management, organisation and supervision needs. The development of the simplest—artisanal fisheries—requires only the introduction of drying and salting techniques to take advantage of surplus and of modern fishing materials. These fisheries are often regulated by traditional bans and should be examined to see whether their basis is a social one that has become meaningless or a biological one that might provide an appropriate management technique. Export fisheries require complex gathering and concentrating networks and highly technological fishing and preserving practices but take advantage of distribution networks that are already in place. These fisheries attract foreign capital and expertise, and there may be some advantage in allowing them to do so, at least in the initial stages. The necessity to establish a distribution network makes commercial fisheries the most difficult to initiate. Fishermen, middlemen and consumers must be educated to the requirements of fish preservation, and some kind of government supervision is usually necessary to ensure fair prices and returns for fishermen and consumers. Although the establishment of large-scale pond culture presents the same problems as does that of commercial fisheries, a promising kind of development for a country like Papua New Guinea would be small-scale village level pond culture. Here simple techniques where overly vigorous management is not required could yield high quality food cheaply and without the necessity for middlemen or complex preserving practices.

In many respects fisheries development is an ideal activity for emerging economies. Fisheries generate cash flow with little social dislocation. The resources involved are renewable into perpetuity. Their exploitation introduces technology applicable to other sectors, and some of them generate badly needed foreign exchange. This list is by no means exhaustive. For instance, fisheries and fish processing tend to be labour intensive, again a desirable attribute. And, perhaps most importantly, some fisheries can produce badly needed high quality protein at a reasonable cost.

I would like to try and distinguish among the several types of fisheries. My remarks may seem to belabour the obvious, but it is frequently observed that the different kinds of fisheries developments are not clearly separated. It is important that this be done because of the strategy and tactics associated with them, and the social and economic objectives are quite different. I will consider artisanal fisheries, export fisheries, and commercial fisheries, in that order. The order was selected because the problems associated with them become more complex from one to the other. This may come as a surprise, but let me explain myself.

I am defining artisanal fisheries as simple gathering techniques close by the residence of the fisherman, accompanied by relatively simple distribution methods,
again confined to the near vicinity of the fisherman. These are the traditional fisheries, the fisheries that are in place so to speak in many parts of the world. Often the catch is distributed amongst family and friends, or simply traded for other goods without any exchange of money.

The development of these fisheries is relatively simple, and often needs only transferring techniques from one locality to another, introducing simple preservation methods such as the drying and salting of the excess catch, and obtaining modern fishing materials. Often artisanal fisheries are regulated by traditional bans of one sort or another and frequently these have a biological basis. These taboos and bans should be carefully examined, however, because often they were established for long since forgotten social reasons, and would therefore be an impediment to expanding the catches.

Export fisheries represent the second level of complexity, both technological and social, and the reasons for placing them in the second level are as follows. Export fisheries require a complex gathering and concentrating network, often accompanied by the use of highly technological fishing and preservation techniques. But in developing an export fishery, people need be concerned with only half the system, for the distribution is already developed in some other place in the world. All that is needed is to assemble the product of the fishery, properly preserved at the export dock, put it on a ship, and cash the cheque. Although rarely verbalised, I think it is this relative simplicity that contributes to the early development of export fisheries, even in economies that are unable to provide an adequate ration of protein for their citizens.

Of course the other reason for early development of export fisheries is that, though they usually require a lot of capital and a lot of advanced technology, the reality of the implication of export is such that their development is attractive to private capital and expertise from abroad. Properly managed—that is with a proper set of rules—export fisheries are the easiest way to introduce modern fishing and preservation technology to an emerging economy. Once this technology is thoroughly rooted the stage is set to develop commercial fishing, which I shall consider next.

Digressing for a moment, however, I want to emphasise that fisheries resources properly managed are renewable. For this reason, and others, it is entirely appropriate that the early development of export fisheries be led by foreigners, with their capital and expertise, even at the risk of allowing some excess profits to leave a country. Unlike non-renewable mineral resources, the loss of some profits is a fairly small price to pay for development for, again, the resource is not depleted in a few years; it is always available to be utilised by the local people.

The main thing is to establish first the framework for development, and second the framework for the orderly transfer of the industry from people from abroad to local interests. Again, unlike mining, the labour component of fisheries industries is so great, relative to other costs, that there is little harm in allowing ownership or part ownership to be in the hands of people from abroad, so long as ultimate control of the enterprise rests with the local people. By contrast I imply that the enterprise eventually becomes manned completely by people from the society in which it is working.

As I have already indicated the most complex fishery development is creating commercial fisheries for home consumption. Because these are an entirely internal matter, they tend not to attract private capital or expertise from abroad. Some sort of institutional intervention is usually required to catalyse the process.

The gathering and concentrating techniques of a commercial fishery are by and large the same as for an export fishery, again often requiring fairly high levels of
technology. These problems are usually solvable in any society. However, development often falters in the third part of the system, storage and distribution (the first two being gathering and concentrating).

The preservation and distribution of the fish costs money and so the people for whom the fish are intended must have money to pay for the product. There is also a very high component of education required, as fish is a very delicate commodity. It requires care from the time it is landed to the time it is consumed. The fisherman, the middleman, and the consumers must be educated. Ice or other means of preservation must be provided, and the system seems to require some degree of government supervision, not only from the point of view of public health but, more importantly, to prevent the price of the final product to the consumer being too high, or the price paid to the fishermen so low that they are unable to enjoy a reasonable standard of living or a reasonable return on their investment. Obviously these are complex matters that are not susceptible to simplistic solutions.

I have been focusing on the development of marine fisheries. The development of fresh water fisheries has many parallels, particularly at the artisanal level and, with the possible exception of something like fresh water prawns, there are few or no export possibilities. There is, however, another type of fisheries development that needs serious consideration in a country such as Papua New Guinea, and that is pond culture.

Pond culture can be fresh water, brackish water, or salt water and the product can be for export (such as prawns) or for local consumption (mullet or milk fish or carp). Export crops from ponds are rather easily dealt with, provided there are already established export fisheries with facilities for handling the product, but rearing fish for local sale in a money economy provokes all of the problems described earlier with respect to commercial fisheries. As before, the first part of the system, rearing, is relatively simple but the distribution network is not readily established.

Another possibility is pond culture at the village level or artisanal level. The scheme involves a pond located at, or close by, the relevant village. Appropriate fish are stocked in the pond and the fish are harvested from time to time. This approach to fisheries development eliminates almost all of the problems described earlier. There are no transport problems. Fish are reared near the village, or in the village, and there is consequently no distribution problem, and no requirement for ice. The fish can be given to the consumer still flopping.

A reasonably good pond needs to be constructed, and someone in the villages needs some instruction on its management. Such ponds can be highly productive, but even if they are rather poorly managed they can still yield a significant crop of protein. The crop may seem trivial when viewed on a regional basis, but in the particular village it might provide the crucial bit of extra protein necessary to provide the people with a reasonable diet. Such schemes have been successfully implemented, for example, in some of the remoter parts of Indonesia.

Finally, I should like to comment briefly on the management of fisheries. First the goal of management must be established. There are three obvious possibilities. The first is to maximise social benefits, the second is to maximise foreign exchange, and the last is to maximise profit. If it is the desire to maximise social good then the biological tactic should be to stabilise fishing effort at a level that will supply the maximum sustainable yield. Exactly the same goal must be sought when considering an export fishery if the desire is to maximise foreign exchange. On the other hand, if the goal is to maximise profit, then fishing must be set at a level below that of the maxi-
mum sustainable yield in order that the fishing process be more efficient. Even with these goals thoroughly in mind, even the most developed countries with more than adequate scientific capabilities have experienced great difficulty in arriving at the appropriate levels of fishing effort. We should not be discouraged because it is probably easier to achieve these objectives in a new society, where industrial developments can be more easily controlled by the government.

The way to achieve maximum sustainable yield is to regulate carefully the rate of growth of the fishery. The only statistics necessary are total catch and total number of boats participating. The manager knows that he has reached the point of maximum sustainable yield when the addition of additional fishing units to the fleet does not increase the total catch or results in only a slight increase. Having arrived at this point empirically, the manager can stop further expansion of the fishery, and perhaps retrench some of the older fishing units when the opportunity arises.

I have elaborated somewhat more than necessary on this particular aspect of fishery development, primarily to indicate clearly that it is not necessary to have an elaborate scientific establishment to achieve scientific management of the resources. It is necessary only to realise what is implied by rational management, and then to devise ways of attaining the required information that are within the capabilities of the society.

Management is but a part of the conservation problem. I have already indicated that the resources are capable of serving the society indefinitely. I should also indicate, however, that it is possible to overfish marine and fresh water resources, even large impressive pelagic resources such as Papua New Guinea's skipjack. Too much fishing pressure sometimes results in their collapse, and apparently semi-permanent changes in the ecosystem such that the populations do not readily recover, even if the fishing pressure is removed completely. Apart from this there need be little additional concern about the pelagic resources.

The inshore resources are subject to the same constraints, but in addition the administrator must guard against habitat destruction through pollution or the use of harvesting methods that damage the substrate. The ecosystem is especially vulnerable in fresh water, lakes and streams, and one particular hazard must be guarded against: exotic species may or may not be useful for man and may or may not have an adverse effect on the ecosystems into which they are introduced. The temptation of quick solutions through introduction must be avoided and the resource administrators must insist on thorough studies, and trials of the new candidates in situations such that the new migrant can be completely eliminated if there is even a hint that it might be undesirable.

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Prospects for Fisheries in Papua New Guinea

R.E. KEARNEY

The major fisheries in Papua New Guinea at present are those for skipjack tuna and tilapia, with minor roles being played by coral reef fishing, mesh netting of barramundi, and prawn and crayfish trawling. The country’s major fisheries export operations are presently owned by foreign or joint ventures. It is not expected that the relatively low productivity of the Melanesian waters will give rise to any major new fisheries, nor is the importance of aquaculture expected to increase markedly in the near future. Further gradual expansion of the tuna fishery is likely, and markets also exist for increased quantities of prawns and crayfish. The tilapia is an introduced species with a limited history. It has the potential for substantially increased harvesting and marketing, the difficulty being in processing and transporting the product to the areas of greatest population density. If this could be done, tilapia could possibly provide an alternative to the canned mackerel that currently constitutes Papua New Guinea’s largest fish import and provides excellent cheap protein to much of the country. Following an examination of the efficiency with which current patterns of imports and exports meet the country’s needs, Papua New Guinea must decide the degree of self-reliance it desires.

It would appear that the problems facing fisheries development in Papua New Guinea are identical to those of other Melanesian countries and are extremely similar to those of all other tropical developing nations. It is, therefore, relevant to consider Papua New Guinea’s fisheries potential in the light of the world situation regarding tropical fisheries.

Most of the world’s major fisheries are concentrated in temperate or subtropical waters (see Gulland 1970) and the landings from tropical waters represents a disproportionately small fraction of the world’s total. This fraction may be projected to increase slightly with industrialisation of the tropical countries, which are generally less developed, but it is proven that the productivity of tropical waters is less than that of more temperate regions. Furthermore, the waters of the equatorial western Pacific Ocean (Melanesia) are considered to be comparatively unproductive in terms of total biomass per unit volume relative to other tropical oceans (Reid 1962). In addition, the shallow water areas that are normally responsible for high productivity and also provide the world’s major trawl fishing grounds are extremely limited in the western equatorial Pacific. We are, therefore, faced with accepting that the waters of Melanesia do not represent a likely venue for the establishment of fisheries of such size as would greatly influence the world’s total fish production.

Taking a more optimistic viewpoint, it must be noted that the population of Papua New Guinea, although far higher than that of any other country in Melanesia, is by world standards very small. Therefore, a fishery of a size sufficient to meet Papua New Guinea’s requirements need not be large by world standards. At present, Papua New
Guinea exports a far greater tonnage of fisheries products than it imports, a situation that is expected to continue for some time to come.

**The Present Fisheries**

As with all tropical oceans, the waters of Papua New Guinea harbour a great number of fish species (about 1,600 in all), most of which are suitable for human consumption. However, although the total number of species is high, the total biomass of even the dominant ones is, on the average, very low. Two obvious exceptions to this are the skipjack tuna (*Katsuwonus pelamis*) in the marine environment, and the tilapia (*Tilapia mosambica*) in fresh waters.

**Skipjack Fishery**

Papua New Guinea has since 1970 expanded its tuna fishery to such an extent that it is now the world's third largest producer of skipjack with an estimated annual production in the vicinity of 40,000 tonnes (88 million lbs, Department of Agriculture, Stock and Fisheries, unpublished data). Considerable research had been carried out concurrently with the development of the fishery and all indications are that the future of the fishery is assured, and that considerable expansion is possible (Kearney 1975). Predictions for the maximum size of the fishery indicate that in future years catches may approach an average of 60,000 to 65,000 tonnes per annum. All of the fish currently taken in this fishery is exported, but obviously the potential exists to meet the internal requirements for fisheries products in Papua New Guinea from this one fishery alone, even though it is not economically practical to do so at this time.

Although all the fishing is at present carried out by foreign dominated companies, this fishery does not detrimentally influence any local fisheries because the skipjack is a species not taken in any quantity by local fishermen. In addition, the fishing agreements with all the joint venture companies require progressive localisation of all fishing activities, resulting eventually in an industry manned entirely by Papua New Guineans. The success of the industry greatly increases the opportunities open to local fishermen wishing to pursue fishing as a career.

**Tilapia Fishery**

Tilapia as an introduced species has a limited history in Papua New Guinea, but it is rapidly assuming more importance as it consolidates its dominance of many of our fresh water river systems. At present, it plays a major role in the fisheries consumption of the people of the Central and the Sepik Districts but, undoubtedly, the number of other areas in which it is consumed in large quantities is increasing.

The Sepik River system harbours a massive tilapia resource, which is possibly still expanding. It has been impossible to date to make an accurate resource estimate for this region but preliminary figures from the Department of Agriculture, Stock and Fisheries estimate that it is of sufficient magnitude to yield 20,000-40,000 tonnes per annum (Glucksman 1974). This huge resource is currently being tapped only by subsistence fishermen in very localised areas of the Sepik District and, undoubtedly, a potential exists for increased harvesting and marketing of this species.

As with other fisheries products of Papua New Guinea, the biggest problem in developing the fishery has been in processing and transporting the product to the areas of greatest population density. Most of the waterways of the Sepik River system are inaccessible, making it difficult to move large quantities of fish in good condition. Research is currently being carried out to find methods of processing of tilapia—(such as salting, smoking, drying, canning and making into fish sausages) that will enable it
to be transported and sold cheaply in urban areas. To expand the fishery substantially, though, the final product must compare favourably both in flavour and price with the cheap high quality imported mackerel.

Other Fisheries
The remainder of Papua New Guinea's fisheries are:

1. Small-scale village fisheries based upon the harvesting of reef fish of many species. The total catch from these fisheries is estimated to be of the order of 13,000 tonnes per annum.
2. River, estuary and coastal mesh net fisheries for barramundi (Lates calcarifer) and a few associated fishes. The total catch from this fishery is less than 1000 tonnes per annum.
3. Trawl fisheries for prawns and crayfish, all carried out by foreign owned vessels. Total production of the order of 3000 tonnes per annum.
4. Miscellaneous fisheries of varying importance, including crayfish, yabbies, oysters, pearls, etc.

Fisheries Development
It is assumed that, as Papua New Guinea develops, the fisheries in the country will likewise expand and play an increasing role in the self-reliance and total productivity of the nation. It would appear that there are three major courses for such fisheries development:

1. Increased productivity from coastal salt water fisheries currently operating on a subsistence level. With the exception of the Gulf and Western Districts of Papua New Guinea, coastal fisheries throughout the country are largely centred on the exploitation of a wide variety of reef fishes. It is generally considered that the production from such fisheries is inadequate in the vicinity of the major population concentrations, but that in the more remote areas such fisheries are capable of producing more fish than is required by the people in the area.

Throughout the world, there are very few sizeable fishing industries based upon the harvesting of fish from coral reefs. Although such reefs produce a wide variety of fish, they are difficult to harvest and the total productivity is very limited. Such is the case in Papua New Guinea and, although many outlying areas have more fish than is required for their immediate needs, few of them have fish resources capable of reliably supporting a fishery of sufficient size to warrant the establishment of sizeable processing and transportation facilities. We are, therefore, faced with the unfortunate situation of having many areas that can produce more fish than they can utilise, but cannot produce fish in sufficient tonnage to enable the establishment of economically viable commercial enterprises. An additional problem arises because the fish taken from coral reefs are difficult to market in any quantity because of the great variability in the edible qualities of the various species and the need to market each species separately, even though the quantity of each is often small. Our only probable alternative is, therefore, to establish or expand small-scale village fisheries that rely upon the production of comparatively high priced products. Two such fisheries already operating rely upon the exploitation of the crayfish resources at Daru and Yule Island.

2. Increased output from large-scale commercial enterprises for the production of cheap fish to replace the current large import requirements and to accommodate the increasing consumption of fish in non-fishing areas. Papua New Guinea's imports of fish are largely accounted for by approximately 17,000 tonnes of canned mackerel per annum. Should Papua New Guinea be unable to obtain supplies of mackerel, the impact on the country would in-
Fishing and the environment

indeed be great: it must be considered both in terms of protein loss, particularly for people in some highland areas, and socially, as it plays an important role in the diet and customs of many Papua New Guineans. Not only is the mackerel of good quality and extremely cheap ($A5000 per tonne c.i.f. or 26c per 15 oz can), but it requires no refrigeration, is convenient to transport and keeps indefinitely. It would, therefore, be extremely difficult to replace. Nevertheless, the possibility of doing this should be considered.

Papua New Guinea currently exports far more fish than it imports. Therefore, although it is economically impossible at this time to get the exported tuna on the local market at a competitive price, the country does have the potential to be self-reliant in fisheries products if necessary. However, it is possibly most beneficial to the country at this time to try to use the export of tuna as a guarantee that imports of mackerel will be available. Such a guarantee would appear possible while most of Papua New Guinea's tuna is taken by Japanese dominated companies, as Japan is the source of almost all the mackerel imported into Papua New Guinea. It is also probably advisable to continue earning revenue from duty on the export of highly priced fish products and to use the revenue earnings to help meet the costs of importing cheaper processed fish in a form more suitable for distribution throughout Papua New Guinea.

The underexploited tilapia resources of the Sepik River system represent a possible source of large quantities of comparatively cheap fish, which could be used for even partial replacement of current fish imports. It is difficult to forecast if tilapia will be a suitable replacement for mackerel as a great deal of product research and market survey will be required before the acceptability of tilapia at the consumer level can be gauged. Tilapia is a comparatively difficult fish to process, having heavy scales and being relatively bony, and it may be that the processing costs will price it out of direct competition with imported mackerel unless some form of subsidy is given.

There are at present being undertaken several government and independent surveys of the tilapia potential of the Sepik River and, even if tilapia does not prove to be a direct competitor with canned mackerel, it can be expected that, by utilising various methods of processing, several products acceptable to the consumers and easily transported will be developed and that such products will play an increasingly important role in supplementing the diet of many Papua New Guineans.

3. The increased production of high quality, high price export products. Between 1969 and 1974, the export of fish from Papua New Guinea increased from approximately 250 tonnes to approximately 40,000 tonnes. Almost all of this increase was due to the development of the skipjack tuna fishery, although the export of high quality prawns and crayfish accounts for a proportionately larger percentage of the value of exports of marine produce. In order to appreciate why Papua New Guinea exports such a great quantity of fish but then also imports a great quantity of other fish such as canned mackerel, one must look at the comparative prices of various seafood products on the world market. High quality seafoods such as crayfish, prawns and oysters are regarded as luxury items throughout the world and command particularly high prices when compared with other foodstuffs. Moreover, in recent years, largely owing to the increasing influence of Japanese tradition on the world's fish consumption, certain species of tuna have begun to realise fantastically high prices. For example, fresh yellowfin tuna currently brings up to $A10 per kg in Honolulu, while first quality frozen southern bluefin tuna regularly sells for $A15 per kg in Tokyo. In both places, second grade fish of the same species is not considered suitable for the market and, therefore, it is sold for use in fish canneries at a price normally not exceeding 50c per kg.
Although such enormous price ranges are unusual, the fish marketing people even in Australasia have become accustomed to paying very variable prices for fish, depending on freshness and the desirability of the species.

Markets therefore exist overseas for Papua New Guinea to export fish of high quality, providing a potentially higher return than such fish would achieve if sold locally. The only factor limiting the export of high quality products at this time is the amount that can be caught and, in this regard, the country’s major problem is to expand existing fisheries or to develop new ones that are economically viable. As the country’s major fisheries export operations are presently operated by foreign or joint venture companies, the expertise and management needed for expansion would be available from outside the country. The main problem then remains to ensure that Papua New Guinea receives a reasonable return for the sale of its resources. Although there do not appear to be many additional potential export fisheries not being utilised, it is believed that the tuna fishery can withstand considerable expansion and that the prawn and crayfish fisheries are likely to continue at present levels.

Aquaculture
Murphy (1973) considered that the prospects for successful aquaculture in Oceania had been regarded too optimistically by many, a view I also hold. Many aquaculture projects have been proposed for Papua New Guinea and several have been given extensive trials. To date all projects seriously tested have been unsuccessful and many of those proposed appear unrealistic. Only in areas of the world where there is an overabundance of skilled cheap labour and extensive low lying areas suitable for aquaculture (e.g. parts of Southeast Asia) has aquaculture been particularly successful. Even in Japan, where the technological problems have been overcome and an extremely high price is guaranteed for cultured prawns (at least $A4 per kg), closed system aquaculture is still only marginally economical. There are numerous reasons why aquaculture is not suitable for Papua New Guinea at this time; the most significant are:

1. A high degree of technical skill is required for the management of fish ponds.
2. A comparatively small yield (normally less than 1.3 tonnes per ha) is obtained from them. Thus, even if an average price of 65c per kg is realised, the total annual productivity is likely to be less than $A850 per ha, or one man would need to own and operate a minimum of 1.5 ha of ponds to obtain the Papua New Guinea minimum urban wage, assuming the ponds do not cost anything to run.
3. If hand feeding is carried out, the food necessary to grow fish or crustacea is normally between five and ten times the yield.
4. Papua New Guineans are not yet accustomed to paying extremely high prices for highest quality sea foods.

The prospects for aquaculture in Papua New Guinea do not, therefore, appear bright, at least in the immediate future. We should, however, continue to search for systems of fish husbandry or culture that may be applicable to Papua New Guinea at some time in the future.

Conclusions
In terms of total fish production, Papua New Guinea has probably passed its period of most rapid expansion. What is now required is a period of more gradual change to increase the participation by Papua New Guineans in the major export fisheries and to expand existing subsistence fisheries to help meet the country’s growing food requirements.
The fisheries resources of the country, being annually renewable provided they are properly managed, appear adequate to meet the demands placed upon them. At present no restriction of the fishing effort appears necessary for the major tuna and tilapia fisheries but some of the more localised industries, for example the barramundi and crayfish fisheries, may need stricter management policies to ensure their continued productivity. There is good reason to be optimistic about the country's future as a fishing nation, but it would appear that substantial imports of certain fisheries products will be required for many years.

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Problems and Perspectives of Tropical Fisheries

W. HERBERT L. ALLSOPP

The problems of tropical fisheries are reviewed with regard to the organisational, socio-economic, cultural and technical aspects confronting a new fisheries department in an effort to establish an effective fishing industry with the upsurge of modernisation. Policy decisions and strategies of development are seen to be dependent upon the available resources, peoples, administrative organisation and international circumstances; the implications of the pursuit of certain objectives are discussed. Some technical problems in other areas, which seem of some relevance to the Papua New Guinea situation, are reviewed with emphasis on the movement from traditional to industrial fisheries and the influence of export oriented production on the artisanal and subsistence operations. Specific mention is made of some aspects of joint venture operations and of the need for a statutory fishery advisory and development body. Superficial comments are made on the program and on possible prospects for Papua New Guinea’s fisheries development.

The problems of tropical fisheries are very complex and far ranging. A comprehensive review of all problems is not intended here—only some assessments of the complex challenge of tropical fisheries, based on past experiences. With priorities and international objectives varying from country to country and between ethnic groups, cultural origins and geographical areas, no single pattern can be established as a blueprint for development. An attempt is made here, therefore, to consider some problems in clearer perspective and to propose concepts and actions that could improve the development procedures and obtain effective results from the viewpoint of the developing country and with due regard to efficient and rational management.

In the pre-war period, tropical fisheries were hardly recognised to be of significance, and were taken for granted. Fishing was done by people of no professional capabilities and was generally not a reliable source of income. In the war years, food became a more important commodity, since the salaried or city dwellers could no longer rely upon imported fish. Gradually it was realised that tropical fish could provide regular sustenance for people, as well as sport and tourism. With independence and the responsible review of natural resources in the sixties, many tropical countries considered the industrial potential of fisheries and the essential role that they could play as an income multiplier. In the seventies, there has been an effort at serious assessments of the future potential of this multiple use resource.

Tropical fisheries industrial development therefore dates back at the most forty years, while in the last twenty years it has seen the greatest expansion. The world catch reached a peak of 70.2 million tons in 1971, while it declined to 65.7 million tons in 1973. Of this, tropical and sub-tropical fisheries provided 20 per cent of the world’s catch of 19.6 million tons in 1948, while 37 per cent of the current world’s catch of 66 million tons has been provided in 1973 (Gulland 1973). What is now produced from
tropical waters is more than what was produced by the whole world in 1948, a mere twenty-seven years ago. The pace of change is therefore very rapid. The need for fish is tremendous, the scouring for new resources is far ranging and unprecedented. Fisheries have grown at a rate of 6.6 per cent a year during the last decade alone, and the number of fully exploited species has also increased so rapidly that even finding conventional forms of underutilised resources is difficult (Alverson and Paulik 1973). In this competitive struggle, new entrants to the race face perplexing dilemmas of technical and political choices.

Tropical countries seek to accomplish in fisheries now what has taken generations of evolving technology, human skills, and wide experience to achieve in the developed fisheries of the world. The pace of development may be stepped up through modern technology, but it would be naive not to appreciate the magnitude of the problems. This is one of the most complex of tropical industries: an unseen, mobile, non-proprietary resource, its real extent at best guessed at. Convincing arguments or tangible demonstrations of its real worth are required. There are human problems of a most complicated and politically explosive nature. There are also technical problems of great diversity; biological problems that are often unique; and administrative, managerial or decision making problems that are without local precedent.

To compound the problem, tropical fisheries comprise a great number of species. In a trawl catch, some sixty different species can generally be found, whereas in temperate countries the catch of trawls generally comprises no more than ten species. These multispecies resources are a common property resource, belonging to no one country when the fish are migratory. Generally there are few or no scientific data for the species. Facts of the nature of migrations, the seasonality of their occurrence, etc., have to be acquired. While for temperate countries it is possible to rely on a neighbour’s observations, generally, in tropical countries, the neighbour is in the same dilemma of ignorance of the stock. It is a situation in which, for lack of scientific data, management and development procedures are at best speculative and conservative in approach, without an adequate basis of complete scientific data (Allsopp 1975).

This imposes certain policy problems as well as investment and financial considerations. Further, marine, estuarine and coastal and inland resources require different approaches.

**Assessment of Realities**

1. **Strategies.** Once the firm policy decision has been made to promote fisheries development in any tropical country, the following circumstances must be considered. Fisheries will compete with tangible, evident, land based developments for funding by government and private enterprise. At some stage of planning an assessment is needed of total local national requirements; how to obtain them; possible deficit or surplus; public sector investment needed; the social implications of industrial development; and the economic impacts of the planned procedures. If fish requirements are to be obtained by industry or small enterprises, there are capital or labour intensive implications. Decisions have to be taken on whether to allow foreign investment or joint ventures, or whether it should be left to local enterprise alone. Should there be high seas or inshore operations, how much fish can be obtained by capture methods, what can be had from fish culture? To add to the perplexity, fisheries have only exceptionally been developed by deliberate, scientific surveys or governmental promotional efforts and state enterprises, and para-state joint ventures, etc. It is generally private entrepreneurs, the intrepid fishermen who have shown that the resource exists and can
be gainfully exploited. More recently, foreign investors have also been the promoters of the exploratory fishing surveys. There are other considerations like co-operatives, infra-structure facilities of ports, boats, access roads, etc., which may mean a slow progress. Governments must decide if they should go for ‘quick’ money with such things as shrimp, oysters, lobsters, tuna, and whether this money should be used as a means to subsidise slower fishing development efforts in co-operatives, training and community development.

2. The Resource. Some idea of the quantity of the resource must precede development. Later, through the accumulation of catch statistics from fishing operations, the seasons, distribution, migratory patterns and possible safe level of exploitation may become clearer. A fail-safe assessment is needed for investment enterprise. To harvest the resource, consideration has to be given to the choice of boats and of gear, together with foreseen markets and prices. Stability of prices, which may depend upon market storage facilities, has an immediate impact on the management, development and access to the resource.

3. The People. Operatives have to be available for efficient production or harvesting, marketing and processing industries, and for effective distribution of fish products. To raise the level of the fisheries from a traditional operation to an industrial operation requires trained people at all levels, and thus the actual utilisation of the resource depends upon the efficiency of people. Where unskilled hands operate expensive machinery or valuable products, it may be most inefficient and expensive labour. The impact of fisheries includes employment, food supplies for cities, subsistence supplies at village levels, and supplies for export. Export quality standards require products to be of high hygienic standards to be competitive in overseas markets. Tropical producers are competing in the world market with their instructors and benefactors (FAO 1971).

4. Organisation and Administration of Fisheries. While the technical assessment of the resource and organisation of the fisheries will be in the hands of scientists and technicians, the policy strategies, final administrative decisions and responsibility for action will rest with high levels of government. The organisation of research investigations and experimental fishing or exploratory surveys, the development of industrial and artisanal or small ownership fishing, the extension services for co-operatives, the training requirements of staff and operators of the industry, and the best places to train them are all matters that are best decided at an early stage in fisheries development. Other considerations may concern siting of industrial development, harbours, markets, etc.; estuarine pollution; mangrove swamp utilisation; and beach and tourist developments.

5. International Matters. The decisions in regard to joint ventures are generally not in the hands of fishery administrators. Further, the activities of a fishing vessel on the high seas, and within the territorial or subjacent zones of fishing, are generally matters beyond the capabilities of small fisheries departments, and often beyond the jurisdiction of the ministries concerned. The voice of fisheries is generally weak compared with those advocating exploration for oil or submarine mining development, or other activities that are generally matters of international finance and that would bring to the territory concerned a wider prospect of employment and revenue earning, often without direct compensation to the deprived fishery sector. International activities concerning the law of the sea (and other matters relating to the jurisdiction of territorial seas) and the decisions in regard to international commissions, development and exploration, are now also matters a young fisheries department is saddled with.
Some tropical countries have clearly stated their fisheries objectives to be the satisfying of local food requirements, the replacement of fish imports, and export earnings. Others intend also that fisheries should serve as an increasing employment source for fishermen and supporting services, with the prospect of the industrialisation of artisanal enterprises. In some cases aquaculture development is advocated in the Pacific region. Socio-cultural developments through co-operatives and community developments are often emphasised. Other objectives include the development of potential resources beyond the present capacity of the local entrepreneurs, and involving foreign capital (Lawson 1975).

With such objectives, it is usually recognised that the constraints are imposed by lack of trained people, boats and equipment, infra-structural services (mainly port facilities), maintenance of equipment (boats, gear and deck machinery), frozen storage facilities, supplies of ice and other necessities for fishing at sea. A major constraint is often the need for investment capital for large enterprises and stabilising of loans and credit systems for small artisanal endeavours. There is also the constraint of competitive employment in industries, and the loss of the more efficient, progressive and intelligent fishermen to other industries.

In artisanal fisheries, community involvement is an essential feature. With small-scale fishing, the fishermen or producers, the boat builders, the sail makers, the gear and net repairmen and the engine maintenance men are all in the same community—perhaps within the same family. The people who land the catch, process it, and sell it are all part of a community unit. Generally the boats are multipurpose, and often the fisherman is himself the engine repairman, or his wife is the processor. He may also be a part-time farmer or otherwise self-employed in the off season. As soon as the fishing operation becomes more complicated, it requires greater specialisation in the type and size of boat, the type of engine, useful aids such as echo sounders, radios, etc. As soon as the quantities of fish landed become too great for the small community to process, the need to move to established ports and to cities or townships causes a dislocation of the artisanal fisheries complex, which is a vertically integrated unit. All the participating services that can contribute to income multiplication and community involvement in the rural area become completely disorganised. The result of this is a rural to urban drift, which governments have now recognised in many countries of Africa as being one of the inherent problems in the industrialisation of fisheries (Allsopp 1974). There are ancillary employment problems in the supporting services, which used to be based at the small village level. The labour intensive activity that was present there has now resulted in unemployment in such village areas, with the result that new communities have been established around the port to serve the fishing fleet, at the expense of fishing communities that still exist and that are now deprived of fish and the income that it earns. This becomes a social and economic problem with which governments have had to grapple, but it is also reflected in the decision to proceed with a particular system of fishery (FAO 1971).

There are therefore a number of conflicts that develop. There might be varying policies required by the social obligations of the government, such as the desire for cheaper food or greater production, or export orientation with the foreign exchange earning capacity that it implies. There might be a decision for increased employment and greater efficiency in the industry, but this would involve considerably more foreign costs in that, when it becomes capital intensive, with employment of engines and special types of gear, it involves increased foreign exchange to replace the labour intensive operations of artisanal fisheries. A shift from the artisanal and traditional
methods means change from a subsistence economy to a monied economy, where the key word is profitability, when it was formerly survival and self-sufficiency. The policies concerning domestic consumption and exports are therefore important decisions. The quality and prices of export commodities generally reflect upon domestic consumption in both ways. The low standards of living of artisanal fishermen compared with industrialised fishermen again reflect the cost of living and the type of fish. The phasing out of inefficient, undesirable traditional methods must be gradual, and the decision to do it creates many difficulties, since it is not mere evolution but a psychological change seen as too revolutionary and even unacceptable in certain areas where the fisherman's tradition of individuality is soundly entrenched. Policy objectives must also consider the economies of scale in processing, marketing and production.

Such development trends are also affected by foreign exchange, inflation in fuel costs, engines, echo sounders, gear and other such imported items. Their prices are increasing at extraordinary rates, which are therefore reflected in the basic cost of production, when the new methods of fishing are largely dependent on foreign exchange inputs. This contrasts with artisanal production methods, which involve very minimal foreign costs. The ideal of obtaining high efficiency with limited foreign exchange, and yet obtaining products that are readily saleable for the export market, is not easily attained. The foreign markets and the stability of prices and demand for particular products also affect the program and policy objectives of a government's fishery department.

Basically then there is need for effective planning and co-ordination, but there is also a need for economic profitability assessments to help in the decisions and choice of development strategy. Generally there is limited capital for national fisheries development, and there is equally competitive foreign development and even, to some extent, overcapitalisation of export oriented fishing (Holmsen and Pinkardi 1968). As a result of this, there are often tendencies for the more efficient fishermen from the village areas to go into the industrialised fishing of a foreign enterprise, thus depriving the artisanal sector of the few progressive people who can help to catalyse development in the rural communities. This makes the fisherman less dependent on his own resources; he contributes to the development of a far different enterprise, and he becomes merely a 'spoke in the wheel'.

**Specific Technical Problems in Tropical Areas**

In the developing countries, the voices of fishery administrators and scientists are far less potent than other voices that may influence development programs. Even in the developed countries it has been only recently possible for the advice of fisheries scientists to become acceptable. Therefore, in the tropical world, with only limited data and with less convincing information to support conservation advocacies, a cautious approach is generally hard to sustain and defend when there is a great demand for food or for employment, and possibly an attractive offer of a joint venture for the exploitation of a little known and newly discovered resource (Allsopp 1975).

With regard to resource management problems, investigations into the level of rational exploitation for shrimp and lobster stocks have been particularly difficult in South America, Central America and West Africa. While there have been declarations of the catch landed by shrimp trawlers, it has been very difficult to assess how much of the by-catch has been, in fact, discarded. Off the coast of the Guianas an average of 80 per cent of the trawl catch is fish that is quite acceptable for human consumption but, because of the comparatively high value of the shrimp catch, the fish is discarded and
the boats bring back only shrimp for the export market. This problem has been described as one of considerable significance off South America, West Africa and the Gulf of Thailand. It is hoped that procedures for the processing of the fish, which are now being investigated, will find a suitable technological process for minced fish products that can be of high value for human consumption (Allsopp 1975).

In the case of the Guianas, the decision to require the landing of a quantity of fish as well as shrimp by all the shrimp trawlers operating there is proving effective as a management tool in bringing more fish for human consumption and, at the same time, inclining the fishermen to a more rational cropping procedure. It is urged that management measures should have clear pragmatic objectives. Unless some effective economic alternatives prove satisfactory, it will be difficult for governments to accept that the regulation should be introduced, and even more difficult for it to be applied.

Studies on the rational cropping levels for spiny lobsters have been somewhat problematic, but the caution that has been exercised in the management program in British Honduras has proven very beneficial (Allsopp 1968). The diversification of the enterprise away from highly priced commodities like lobster tails to other products, which the fishermen are now obliged to bring into the processing plant in order to satisfy their export licences, has proven successful. The key to rational cropping was diversification, and the government has obliged the co-operatives that fish for lobsters to involve themselves in collecting fish, conch, and other products, which are exported and form a substantial part of their income earnings. The satisfactory result of the statistical survey and stock assessment for spiny lobsters has shown that, even with unschooled fishermen, the compliance with the measures, once they have been shown to have beneficial results on the fishery, is high and quite rigidly enforced in the co-operatives. It was in the interests of all to ensure that no infractions were committed by members, as the licence for handling the exporting of the lobsters was thereby jeopardised.

The specific problems of the speed and degree of national involvement that must be considered in the industrialisation of fisheries often confront planning economists. Generally industrial development is anxious to move faster than the biologists can provide data. This has been the case in most of the countries of western Africa, where the development of fisheries has been impelled, not so much by what technical data the governments had as the basis for action, as by the evidence of the larger vessels of foreign flags fishing the waters off their shores (FAO/IRBD 1968). It was therefore evident for all to see that the feasibility study was being daily pursued by the foreign flag vessels harvesting the resource. Accordingly governments were most anxious to be involved in such fisheries—either as full participants, as state enterprises, or in joint venture activities. In most cases the same operational efficiency is not obtained as with the private fishing companies operating on their own (Holmsen and Pinkard 1968).

The development of reef fisheries in East Africa and on the coast of Central America has provided quite a serious challenge. The difficulty of transforming the artisanal enterprise systems and practices to a more industrialised procedure has indeed proven difficult, and many reef fisheries have become places for tourist fishing and skin diving. Further conflicts have been involved in the problem of mangrove swamp development, the conversion to brackish water culture, and the real estate developments that have taken place. The impact of these changes on the juvenile stages of very important commercial fisheries (lobster, shrimp and many euryhaline migratory fish) has been difficult to offset. In many cases the governments have welcomed the area’s development because it provided specific employment. However the development of tourist areas has often resulted in more limited beach areas for fishing communities. There is
the problem of choice between the artisanal fishery and the development of tourist beach resorts. In other cases the industrial conversion of mangrove swamp areas for wood chips or mining has done unknown and unassessable damage to fisheries.

Traditional fishing gear has often been described as being unselective of species, of limited durability, inefficient in capture, and creating great biological problems in conservation of other stocks. However, it is cheap, it involves generally very limited foreign exchange, and it is labour intensive in its operation, preparation and maintenance. On the other hand, careful monitoring is needed to see which systems may have to be phased out or eliminated because of biological problems created through indiscriminate capture of juvenile species of commercial importance.

A similar consideration might apply to fish culture activity and fish capture (South East Asian Aquaculture Seminar 1973). Where there are available the aptitudes and skills of people who are normally disposed to the husbandry practices of rearing animals and fish, aquaculture should be particularly desirable (FAO 1968). No foreign exchange is involved and it makes use of swamp land and coastal areas that are otherwise either unusable or little used. In fact the studies by the Philippine Development Bank indicated that their fish production requirements can be obtained more cheaply through fish culture than through the foreign, capital intensive high seas fisheries (Philippine Fisheries Commission 1973). Fish culture methods are therefore advocated by them. It should be noted, however, that they have already a long tradition of fish culture, which still needs improvement and perfecting.

The problems of domestic marketing are generally almost intractable. Domestic marketing is usually unorganised, small-scale, variable in quantity and price, and perpetually varying in quality standards. For exports there have to be standardised quality, organised storage, and greater economy of scale. Therefore volume and price stability are essential in the establishment of an overseas enterprise. The major constraint for developing artisanal fisheries is marketing, and therefore it might well be that a government’s role, as was the case in British Honduras, could be to encourage exporters to purchase or accept for storage fish products intended for domestic sale, with a view to stimulating local production. In British Honduras this helped to eliminate the market variability that bedevils artisanal fishery production, and helped stimulate increased production by the small-scale producers, who eventually joined the co-operatives, which now carry out all export operations (Allsopp 1968).

Export oriented products have advantages as well as disadvantages. It is often said by the local consumers that the high prices of shrimp, lobster and fish products destined for export are beyond their purchasing power. They generally urge that some percentage of the product should be available for local use at reasonable prices. It is important, however, to consider both price and quality. The rigid standards that have been imposed for export products have had a definite beneficial effect on the quality and standards of fish available for local sale, though the prices that the export products obtained were too high for local sales. In Belize, a policy decision on exports was made: the co-operatives that exported fish, lobsters, shrimp and conch were required to sell certain quantities for the local market, and to invest in diversification of fisheries (Allsopp 1968).

Further questions must be asked about export oriented products. Who comprises the crew of production vessels? Are the statistics being handled by nationals? Are they honest records of catch and biological data? Is cold storage available for local use as well as export sales? Who sells the products abroad? What is their real value? How much benefit accrues for the country? Who ensures the diversification of fishing enterprise, and the increasing involvement of nationals? Export oriented fishery
products indirectly impose certain socio-economic obligations on both the producer and the government. Export profits must directly benefit the fishing industry, not just get lost in the general revenue for well-being of the whole country.

Other specific problems that have plagued the development of tropical fisheries have been loans and credit, the organisation of co-operatives and production stimulation. Providing loans only to trained peoples who, by their greater efficiency, can earn more in order to pay them off without getting further into debt, has proven very effective. Normally, artisanal fisheries are associated with high interest credit and perpetual indebtedness. The provision of loans through government services can break this chain only if the loans are profitably applied and managed with a great deal of discretion. A good fisherman is not necessarily a good business manager.

Infra-structure services such as ports, market storage and maintenance supplies have often catered to a seasonal management where fishing is not year round. Very often governments consider that the establishment of such facilities should be revenue earning, and this imposes on the fisherman a new burden, which he seeks to avoid by not using the facilities. Many try by every possible means to land fish and maintain traditional activities without using any new facility for which the government charges even minimal tax. Establishment of facilities should therefore be avoided until such time as the usage of the facilities becomes clearly acceptable and desirable (FAO/IRBD 1968).

Education and extension services are often advocated as the only way of transferring technological improvement to the industry. Nevertheless, it must be acknowledged that, however desirable, education is an expensive and slow process. Fishery training schools have been established in many parts of Africa and Central America, and the impact they have had on fishing has been slow. It is perhaps too much to expect that their impact will be immediate. The cost of running these schools, the provision of instructors, the actual tangible benefits sometimes make it very difficult to satisfy governments of their clear desirability. It is, however, necessary to start some time and it is cheaper to do so immediately and enlarge with time than to do so later. It is often decided that fishery educational training institutions are so costly that they should be borne on a regional basis and that it is cheaper to send fishermen and fishery officers to be trained overseas. Eventually, the actual decision may depend upon the size of the industry, both actual and potential. It seems logical that at certain levels overseas education is desirable, but for some levels training has to be done on a local basis.

Perhaps it may be felt that too much emphasis has been placed on the development of artisanal fisheries as compared with industrial fisheries. In fact, this is the crux of the problem; in that the use of the industrialised fishing methods for producing the required fish often creates far greater problems than it solves. This problem has been illustrated particularly in Ghana, where the establishment of new ports caused a dislocation of the small, efficient village fishermen. Planked vessels needed ports, not unprotected beaches (FAO/IRBD 1968). A number of ancillary problems are created when governments promote the artisanal fisheries as well as industrialised fisheries. This problem is now being investigated by a program that studies the efficiency of production methods, processing systems, and marketing procedures. It is hoped to learn which systems should be perfected, improved or eliminated, and to establish the profitability of any innovations. This may provide guidelines for increased efficiency to maximum capability of the artisanal fishing so that it can be assessed in relation to what can be expected from the industrial sector.

At the same time, the industrial sector of the fishing industry is pursuing its own vigorous development, with factory ships, cold storage facilities, and frozen fish dis-
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tribution centres. This frozen fish is often subsequently smoked and handled in the rural areas in competition with the artisanal fisheries. Therefore, efforts being made by the artisanal fishing sector do not gain any protection from the government, because all fish produced finds competitive sales in the rural and outer district markets, where the consumer is seeking to obtain the cheapest available fish. It is hoped that this study, when completed, might provide some illuminating information for West African fisheries, and it may well be that, as a model, it will provide some useful answers for other parts of the world as well (Allsopp 1974a).

JOINT VENTURES AND CO-ORDINATED DEVELOPMENTS

One of the systems that is often advocated for the development of fisheries in the tropics is a partnership between the developed fishery enterprises of the more advanced countries and the local enterprise. These joint ventures are advocated for a variety of reasons, some of which are more admirable than others. Where joint ventures have indeed been successful, a number of circumstances have contributed to the success, but in many of the cases there are indications that people are a little less than satisfied with the results. In one case in West Africa it was stated ‘all it has done is to provide a free hunting licence in your own back yard’ (FAO 1971). Therefore it seems evident that the needs of the country have to be considered in making the contract and arrangements for joint ventures. The fisheries resources of the country are sought and skills in fishing operation, processing, storage, commerce, management, financial turnover and manpower are offered (Pownall 1972c). Thus, the terms and pre-conditions should perhaps ensure that shore staff as well as sea going crew progressively undergo training in operational and managerial functions. This will ensure that all biological data, records and accounts are accurately provided for national assessments. It is also important that there should be diversification of operations. If a joint venture takes only lobsters or only shrimp, it is very likely that there will be harmful side effects on the industrial activities of the local industry. Joint ventures should accept local production, and co-operatives could be partners in such joint ventures. Governments may hold shares as well as the private sector.

The technical and financial feasibility of the joint venture has probably been well assessed by the entrepreneurial foreign enterprise first. The assessment of socio-economic and financial profitability is the recipient government’s concern. This has to be carefully appraised, not only from the viewpoint of foreign exchange, employment, income multiplication and influence on an area, but also with respect to the total impact that such a program, when fully realised, will have on the further fish production activities of the country (Holmsen and Pinkard 1968). There are many cases in which joint ventures have proven to be an admirable vehicle for the development of fisheries. There are also many cases where the joint ventures have not been quite so successful. Caution seems to be the key word. Joint ventures are generally pursued by private companies whose profit motive is far more overriding than the altruism with which national bilateral agencies are normally endowed. In short a government-to-government agreement is more likely to be philanthropic than a developing country and private company arrangement. Equally, it must be appreciated that fishing operations have been less successfully pursued by governments than by private enterprise; it might be considered preferable to enter into contracts with successful fish producing companies of known acumen and experience, rather than with the para-governmental bodies many centralised economies have established.

One of the important problems in the operation of high seas fisheries has always been the risk of overfishing and depletion of stock to a dangerous level. In these days
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of factory ships, great flotillas of immense catching capacity and ready mobility with the latest equipment for fish finding and processing aboard, there is nothing more dangerously naive than to believe that overfishing cannot happen in one's own waters. Overfishing is, however, often a scare slogan used by tropical biologists against the small entrepreneur who is drag seining and using small mesh size nets. More recently fishermen have become very vocal in saying that, while controls affect the small entrepreneur who is a national and well within jurisdiction, there is no control over foreign flag vessels that are based elsewhere but operate in the high seas off the shores of these countries. The same migratory fish are in fact being exploited by both the in-shore traditional fishermen and the high seas venture. Fishermen therefore consider that it is better to join them. It is clearly better to have a joint venture than to suffer the depletion of the stocks by vessels of foreign flags over which no control can be exercised.

It can be seen that the activities of a fisheries department are multidisciplinary, involving various levels of the community and very many different departments of government; port authorities, the navigational controllers, commerce, revenue and licensing sectors, import officials and a number of other national sectors of the country, such as community or district organisations, would be involved in fisheries development. This multidisciplinary activity imposes a new reality, that of development conflict and the need for collaboration and co-operation in the development of fisheries. The need is perhaps best serviced by an advisory committee in which a number of different departments have a say for the benefit of the national interest (Allsopp 1968).

Papua New Guinea Perspectives

In view of the author's ignorance of the Papua New Guinea situation, comments may seem presumptuous and at best are risky. They are offered objectively, but with all the limitations that may be attached to ideas of an 'instant expert'. The literature on Papua New Guinea has been quite eloquent in describing its 'geographical randomness', 'inexplicable diversity', and completely unexpected changes; certainly a great variety of environments exists, both on land and in the sea. All that this amounts to is that it is a typical tropical country with the surprising and unexpected situations for writers who are accustomed to the greater uniformity of the temperate regions.

The success that has been achieved after eighteen years of actions of the Fisheries Division is most commendable. The fisheries have been raised from a subsistence endeavour of known though limited value to an industrial activity involving $6.2 million worth of fish exports as well as local earnings (Pownall 1972a). The role of the Fisheries Department in the promotional, developmental and entrepreneurial arm of government has clearly been shown to be quite different from the control monitoring function of the industrialised fisheries departments in other countries.

Some prospects of particular significance are worthy of comment. Among matters of special interest would seem to be the Planet Deep and the New Britain Trench, and it may be of value to urge that the United Nations Environment Programme undertake their management and financing as an international nature park for global scientific investigation. This would be well beyond the capacity of research interests in Papua New Guinea. Of further interest is the fact that all local fishing enterprise is in the shallow water up to the edge of the continental shelf, with the offshore deep water fisheries being operated by foreign enterprises, and that the statistics for these are being collected (Department of Agriculture, Stock and Fisheries 1973).

There has been a tendency in research studies to concentrate on the species of fish of
export, rather than local food, potential. Thus tuna, prawn, crayfish, barramundi, pearl oysters and other molluscs are the main focus of attention (Lewis et al. 1974; Pownall 1972a). Prawn resources are described as being of well known areas of distribution, and further research is not being carried out. Prawn fisheries may still need careful continuous monitoring, and their future may well lie in aquaculture activities as in the Philippines. No mention is made of freshwater Macrobrachium culture, and the potential of this could certainly be explored. Though spiny lobsters or crayfish are dominated mainly by Panulirus ornatus, there seem to be six species of limited availability, but there are no evident comments in the literature about the extent of resources on the reef face towards the continental deep, where normally the larger lobsters congregate in greater numbers.

Efforts to cultivate Lates calcarifer or barramundi are of interest. It would be useful to consult the Thai Fishculture Station at Songkla, where this carnivorous fish is being effectively bred and cultivated. Pond culture seems to have experienced difficulty, and tilapia, gourami, carp and other exotics have been introduced (Department of Agriculture, Stock and Fisheries 1973). Perhaps there is a greater need to study the ecology of the indigenous species, not just their taxonomy. There seems to have been extensive introduction of exotic fish for sports fishing, for aquariums, and for mosquito control (as if the indigenous species never learnt to eat mosquito larvae and only Gambusia affinis has developed this worldwide appetite for them). It is surprising to find that from 1942 to 1971, at least twenty exotic species have been introduced. Should not more emphasis be given to the ecology of local species?

Molluscan resources, particularly oysters, cockles and scallops, seem worthy of further investigation. There is need to study the life cycle and to breed the rare and valuable species, protecting them from the enthusiastic collectors that gather them from the reefs and send them overseas. These can be much more profitably exploited if they are cultivated. Aquaculture, rather than harvesting from the reef, would probably be ideal for coastal communities. The potential of pearl aquaculture should perhaps be more widely explored, but the enterprise may also provide a means of attracting support for food oyster culture, which may turn out to be one of the most attractive areas for co-operative enterprise. Success has been obtained in Sabah in ten months by tray culture techniques. There is great potential for hanging culture, the secret being to grow them in areas of minimal fouling, where they will grow well but will not reproduce (Allsopp 1975). The potential of local species needs to be examined; indications in Sabah show that Crassostrea belcheri, the local oyster, is much faster growing than other species that have been tried under similar conditions.

Taxonomic studies are useful particularly in indicating the wider use of the species described; ecological studies should follow. As I have said before (Allsopp 1975): 'Being able to call fish by their Latin name may impress your colleagues, but not the fish! However, when you know how and where they feed, breed and frolic, you may be able to improve fishing.'

One can only commend the proposed development of skipjack tuna potential (Lewis et al. 1974) and mention that, as in the tuna fisheries off Africa, it is necessary to ensure an increasing national involvement, so as to avoid being a mere spectator at the progressive exploitation of this resource. The cost of stock evaluation and surveys should really be borne not by the developing country, but by the development enterprises, and it is of course significant that the availability of adequate bait resources may hold the key to the exploitation of skipjack tuna.

These superficial and hasty comments on the work that has been so admirably undertaken in Papua New Guinea might seem didactic and even provocative. It may be
said that it is well and good to talk of ‘symptoms’, but it is necessary also to overcome or avoid the ‘diseases’, described as being endemic in tropical fisheries development. In answer I quote the saying that ‘in matters of ecology and fisheries development, it is only the damn fools that have dogmatic answers, and many of the right questions are not generally asked’!

I have indicated need for economic studies to determine the systems to promote and the cost effectiveness for investment purposes of different fishing methods. The need for regulatory measures based on statistics has been emphasised. The obtaining of accurate statistics is essential, but this presents a difficulty both with the unschooled fishermen and with the aggressive and highly literate industrial fishermen, who wish to keep secret not only the extent of their success, but also the precise location of their catches. It is very commendable that in Papua New Guinea a pre-condition for licensed ventures, particularly for distant water and new areas, has been the obligatory provision of statistics. It is equally important that vessels that fish the waters and land their catches abroad should provide statistics, because this contributes to determining the total sustainable yield.

In regard to fishing technology, the advantages and disadvantages of innovations seems to be one of the areas that needs specific attention (Pownall 1972a). In fact, the use of indigenous methods versus exotic introductions symbolises the conflict of economic development versus cultural habits. When fishermen move from outrigger canoes to powered craft by way of plywood doreys and aluminium or even ferro-cement boats, there is a great gap to be overcome, with problems ranging from spare parts to basic financing; the costs for engine maintenance, fuel, echo sounders, radios, safety devices, ice and refrigeration, and the cost-benefits for all these should be carefully assessed. Usually it is advocated that minimum innovations should be introduced, that gear types constructed should be as simple as possible and that their efficiency be demonstrably clear before they are advocated for extension purposes. Tentative introductions and subsequent modifications will prove only confusing and bewildering to fishermen. It is also useful to standardise the use of new engines and gear, so that training, spare parts, supplies and general efficiency are less variable.

An outrigger canoe needs little hull maintenance as compared with the plywood dorey and ferro-cement craft; any may be equipped with an engine. The maintenance of an engine is critical, and the efficiency of these craft will depend upon their being able to fish a certain minimum number of days. Unless the engine is well maintained, the boat may not be able to operate even a minimum of 150 fishing days a year. If it can land a catch for 200 or 250 days a year, however, it may prove to be very profitable (Holmsen and Pinkard 1968). It may well be that a minimum number of fishing days (say 180) is necessary for the boat to break even on its operational expenses. It might be noted that in some places Japanese vessels have been able to fish in the tropics as many as 300 days a year, and that their profitability was three times that of similar nationally owned craft and twice that of foreign flag vessels fishing in those areas (Allsopp 1973). The operational efficiency of vessels is entirely dependent upon crew efficiency and turn-around of the vessels and thus of the shore maintenance services. Another important aspect is that prototype fishing vessels take some time from evolution to perfection, and are not the same as fishery research vessels. Very often the research vessel indicates a resource, and governments require that it serve as a prototype vessel for commercial activity.

A system of co-operative organisation, modified for local circumstances, should be very carefully considered. Co-operatives grow slowly, they do not appeal to the very poor or the very rich and, unless incentives are provided, it is often very difficult to en-
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Sure their continued progress. Low cost gear, duty free fuel and other incentives to ensure their increasing financial stability are some of the things that should be very carefully considered if development of co-operatives is encouraged (Allsopp 1968).

The prospects for aquaculture of various indigenous species should be very carefully investigated. Coastal aquaculture, in particular, requires little feeding and utilises resources that would otherwise remain idle (Southeast Asian Aquaculture Seminar 1973). It should be borne in mind that development actions are a result of logical considerations, public pressures, political inputs, technical assessments, and physical, economic and biological considerations. In fisheries as in other developments, the logical is not necessarily the most successful. Generally the program that has the greatest political and social content and cultural appeal is the one that is most readily accepted, eagerly promoted and financially supported. Nature being a perverse master, the most successful program is sometimes in defiance of scientific principles and sometimes it confounds the predictions and projections of what the resource can yield or what the people are capable of producing. The labour intensive nature of artisanal fisheries has to be weighed against efficient production methods. Governments cannot continue to protect inefficient methods. There has to be a progressive phasing out of subsidised protected practices, as well as the rapid introduction of efficient modern technology. Time is against us, people are impatient, and solutions must be found.

Southeast Asia is the area of the world with the greatest population and consumption of fish and, though Papua New Guinea’s population does not apparently suffer from the inherent shortages of food, it is well to consider that emphasis should be placed on increasing efficiency of production of fish for human consumption. Papua New Guinea has been described as an appendage to Southeast Asia, and may well become an important part of its larder.

The fishing industry is rooted in the deep distant past. It is inadequately but valiantly serving the needs of the present, and has been in many countries very heavily invested in for the future generations of people. It is a renewable resource. It is hoped that the management and development procedures in this industry in the tropics can indeed serve future populations, who will derive their livelihood and sustenance from fish, from both the sea and inland waters and that future generations will look back upon these formative years with satisfaction and gratitude that we, custodians of this natural resource, have served posterity responsibly. The challenge is to satisfy the increasing needs of man and the relentless and demanding natural environments of tropical fisheries for the mutual benefit of both man and nature.

References


IV Conservation of the environment
Some Papua New Guinean Views on Conservation

S. TAGO

Papua New Guinea, as it becomes more developed, must observe certain principles: the people must have a safe, productive environment in which to live; they must protect that environment for future generations; pollution must be controlled; habitat and wildlife management must be taken into account; and the people must be educated to live in harmony with their environment.

This book focuses on a subject that has received a large amount of deserved attention recently, not only in the world scene, but also in the regional context of the South Pacific and Melanesia in particular. Indeed, the world, our only one earth, is beset by a number of large and looming problems that are causing anxieties and disturbances. Environmental concerns are very much a part of these problems. Since the well known Stockholm Conference, sponsored by the United Nations in 1972, the international community has increased its understanding of the issues involved: a global environmental monitoring system, the law of the sea, population and food conferences and, very soon, conferences on human settlements, water, trade and development.

We in Papua New Guinea might appear far away from such large problems, but in fact we are not. Our independence has given us a full seat at the community of nations and our own environmental concerns are themselves a real consideration. We have now entered the development game. It will be different from the others we play. The stakes—our future survival and well-being—are higher. The penalties for not obeying the rules set by nature are there for us to see. We can look to other countries of the world, the so-called developed countries—Japan, for example, where several hundred people have died or been permanently crippled by eating mercury polluted fish or are suffocating from the exhaust fumes of their own cars. While the issues discussed here are serious, they are not beyond solution. Papua New Guinea has a chance to avoid the undesirable problems and plan its development for enjoyment and satisfaction.

We have generally taken our environment for granted. This makes the task that faces me as Minister for Environment and Conservation a difficult one, for what is generally taken for granted is not likely to be a policy issue. This is changing, however, as we increasingly realise that there needs to be a deep and lasting commitment of our people to maintaining and improving, and certainly protecting, our resources base. This notion, for example, is central to one of our national goals:

The natural resources and the environment of Papua New Guinea should be conserved and used to the collective benefit of the people and they should be replenished in the interest of future generations.

The resources base, which is all we have, is what has given us the capacity to survive
and to live and must give us the potential to develop. That, and our communities, together with the magnificent variety of our cultural heritage and its natural background is the true wealth of Papua New Guinea. But we must be careful neither to forfeit this wealth for the short-term economic gains nor to ignore that such gains might be made at the expense of our people and their expectations.

Nevertheless, we must have economic growth, which means changing the environment. As we know, it is at this point that injury to the environment can take place. If nature is abused beyond its limits, its revenge is inevitable. The question is not whether we should have economic growth. We must. Nor is the question whether the impact on the environment must be respected. It has to be. The solution to the dilemma clearly revolves not about whether but about how we are to manage our development.

Our Government's eight aims and the national goals provide an ideological framework within which the future of Papua New Guinea will be determined. They provide the guidelines and directions that are essential for the planning of the future and for developing the policies and programs that we require. With this in mind we have tentatively defined a number of environmental principles from which we will work:

1. *All our people have the right to a safe, healthy, productive and culturally satisfying environment which permits a life of dignity and well-being.* In this context I can do no better than quote the report of the Constitutional Planning Committee:

   We believe that the people of Papua New Guinea, both today and tomorrow should be continually aware that in striving to improve their human lot they should not make the mistake of blindly destroying their rich natural environment—the land, the rivers, the sea, the fish, the animals and the birds. Use of these resources should be weighed carefully against the real cost to the country in terms of damage which will be caused to the whole way of life of the people in the vicinity of a particular project—the destruction of land, rivers and wildlife in the course of the operations of, for instance, a large mining or timber enterprise. The need is for the integral development of man which also concerns spiritual, psychological, cultural and social development.

2. *We are the trustees of the environment for future generations and our approach to development must reflect this.* I quote the Constitutional Planning Committee's report again:

   We should develop a sense of respect for all our natural resources and the environment. We should not be afraid to use those resources to contribute to our development, but should be sure not to over-use them to the extent that they are rapidly exhausted, especially at this stage of our history when it is foreign interests who gain by far the most benefit from the exploitation of our natural resources. Our needs should be weighed against the needs of our children, their children and the generations which follow them.

3. *Pollution of land, air and water in quantities which cause the degradation of the environment must be controlled.* The more we develop, the more we process various kinds of resources and this has the inevitable result that we produce more wastes, which have to be managed. The pollution they may cause has to be prevented, if possible, but certainly controlled. We increasingly view the recovery and recycling of resources, as well as the refraining from industrial and other processes that produce uncontrollable wastes, as a basic necessity in our management of nature. Central to this approach is our recognition of the limit to nature's capacity to cope with large quantities of waste material and our desire to protect our common property rights—the water, air and land. Our Government will adhere, as much as possible, to the 'polluter pays' principle, meaning that we will expect developing agents to bear the costs of meeting the standards we set for waste discharge. In this context, I must say that as a Government we have been remiss also, and that some of the most glaring examples of environmental degradation are the result of government activity. This is an area where we need to
give close scrutiny and concerted action. Good intentions are no substitute for good performance.

4. Habitats and wildlife management must receive consideration in planning our development. We have a series of unique and complex ecological systems in this country and their conservation is of great importance for the present and the future. Without trying to determine future generations' priorities we collectively have a responsibility to keep the options open and prevent the unnecessary loss of unique species and natural areas. Of course there are problems associated with establishing and managing reserves, not least finances and the determination of a land use priority in competition with other forms of development or use. Another problem involves customary land tenure but here our approach in the long term may well have strengths that are important to the success of overall environmental education. Because almost all of our land is under customary tenure it means that we must be careful in site selection in the first place. Moreover, early consultation with landowners must be started to find out about local land use and development ambitions and to explain carefully the concept of national parks, wildlife reserves and management areas. Local committees may be set up and where this occurs, a significant degree of participation, right through to the establishment of regulations for control, can be created. Once an area is established it is essential that education be carried out, particularly among the children, who are the future citizens and leaders.

5. Protection and enhancement of the environment requires education directed toward living with our environment. In the past our informal education was necessarily ecological in its content. We lived within our environment and if we transgressed its thresholds then by bitter experience we discovered the results. But this has changed. One of the major tasks of our present education system today is to recreate awareness of our responsibility to our common property—air, land, water and the other natural resources—and our cultural heritage. And this awareness must be extended throughout the community—to our children, our elders (perhaps the most knowledgeable already), my fellow politicians and our administrators. Only in this way will we be able to respond to the challenges that face us.

Finally, I should like to illustrate the concern of the Office of Environment and Conservation with environmental issues in its day to day operations. It is normal practice for any development project to prepare a financial and technical study. These usually ignore the social and environmental effects of the proposed activity. Our approach has been to set the requirements for environmental studies for a number of major projects under consideration by the Government. These need to be introduced at the earliest stage in the planning process. In essence, the objectives of these studies are to ensure that:

(a) the effects of the project on the environment are examined;
(b) different ways of accomplishing the project objectives are examined and assessed in order to reduce the effects on the environment;
(c) the ways of protecting the environment from bad effects are proposed and evaluated;
(d) the project is examined in relation to the present land use and potential regional development of the area;
(e) the interested public and people in the area affected are consulted on the environmental effects; and
(f) once the project starts a continual watch is kept in order to warn about problems that might arise.
Central to this approach is the principle that prevention is better than cure—any development project that does not take into account the effects on the local environment inevitably results in future, unforeseen social and economic costs.

Recommended safeguards developed during the environmental study must be taken into account when implementing the project. We have no desire to have our environment contaminated or wantonly abused. We have also been careful to include in our guidelines not only the physical and health aspects, but cultural considerations as well. We are concerned that a development project does not adversely affect our culture, but supports and enhances it. Hence at all stages during the decision making process for a project, the people should be consulted. The recognition of people’s rights is likely to produce a more acceptable pattern of development. This means that the advantages and disadvantages of a particular project must be explained to the community and the community’s wishes must be respected.

The questions we may well ask of a timber project, for example, are: what provisions have been made to reduce erosion and silting of streams and rivers as a result of logging operations; what effects logging will have on wildlife and fish resources in the streams; whether large-scale logging operations will affect villages and their traditional supply of food and cultural materials; whether health care facilities and services are planned to meet the increased demand during the logging operations; what will happen to the land after the forestry operations; how cultural values and areas of importance to the people will be safeguarded, and so on. These and many more questions will be asked not only in logging and timber but in mining operations as well. Whether they will be a source of land erosion and what provisions have been made to reclaim spoil dumps and tailings; what measures will be taken to prevent water pollution from mine site drainage into the river systems; what pollution controls have been taken in the processing operations to prevent discharge of wastes into surface and underground waters; whether mining operations will threaten important archaeological sites, and so on.

In these matters we enjoy one of the few advantages of being late starters in the development game. We are in a position to avoid the costly and needless mistakes that have been made elsewhere. Although we are ‘late’, one of the last, we are fortunate to be able to learn from other people’s experiences and mistakes. Hence we will not become a haven for exported pollution and groups who seek to capitalise on short-run exploitation for quick profit. It is well that foreign enterprises wishing to invest in Papua New Guinea recognise this. In the development process, we must build into industrial, agricultural, forestry, mining and other projects the practical preventive measures necessary to avoid the degradation the developed world has already suffered. Anti-pollution technology is available; resource management practices are available. They work well. They can be adapted to meet Papua New Guinea conditions. Making sure that this happens requires the political will on our behalf and the social responsibility on the side of investors. Equally well, existing industries, factories and the Government must assume a greater responsibility for the environmental damage that they have caused and are causing. The challenge is to us, our public servants, teachers, village elders, local government councillors—indeed to all Papua New Guineans to discipline our desires for quick exploitative development and temper it with concern so that we do not slowly destroy what is unique in our country.
GABRIEL B. GRIS

Papua New Guinean societies are traditionally communalistic and its goals should be in keeping with this. It should not simply adopt the western world’s free enterprise system, but should base its aims and institutions on its age old cultural values. Only then will independence be a reality.

The theme of this book, the Melanesian environment: change and development, inspires us to ask what kinds of changes are envisioned? Are these changes for the better? Who decides these changes? We should also ask: development for whom (leaving aside the vexed and difficult question of what development means)? Who would be concerned about the Melanesian environment—Melanesians, boards of directors of foreign firms, shareholders? What is important—conservation of a healthy environment for Melanesians, or for that matter human beings, or the profit making motives of foreign private enterprises and the shareholders?

The land abounds in nature’s gifts of natural resources. Is Papua New Guinea able to hold off the do-gooders, whose intent is to rape the terrestrial and marine resources and pollute the environment for tokens? Melanesia has resources that could be developed for the benefit of Melanesians, but it is faced with a dilemma. This dilemma relates to options available for the exploitation of the natural resources with minimal disturbance to the ecological setting, including the land, the sea, the inland waters and the air. To achieve this goal there has to be firm government control. There will also have to be specific and stringent requirements for preserving a reasonably healthy environment and these have to be followed by foreigners and indigenes alike. The principle of free private enterprise1 and the forces it generates, I believe, would make the attainment of a reasonably healthy environment difficult, if not impossible.

I believe that the challenge confronts us all and the issues are as vital to us in Melanesia as they are to those in other settings. Many of the industrially advanced countries are perennially plagued by the hazards of ‘development’, and man, who claims to be the master of his creation, often sadly finds himself its servant. Man, his dignity, his well being and the conservation of a reasonably healthy environment for his well being and enjoyment appear to be of little importance in the hierarchy of a ‘western’ man’s value system. Profit making and associated values appear, at least in certain countries, to have displaced man from the central position I believe he should occupy in the scheme of things.

Papua New Guinea seems to have accepted implicitly the principle of free enterprise and the social organisation based on that value. Is free private enterprise and human economic organisation based on that value the only option open to us? I do not believe so: indeed the attainment of the Government’s eight point aims is being thwarted by the political and economic forces generated by free private enterprise. Even if free private enterprise is inevitable, what checks and balances should be instituted to ensure that Papua New Guineans benefit at least as much as foreigners and that the benefits are evenly distributed amongst them. If it is not, is it too late to change direction?

Papua New Guinea appears to me not to be moving in the direction that will permit it to attain the aspirations expressed in the eight point aims. It is a sad fact that Papua New Guinea hopes piously that the existing capitalistic institutions will enable it to attain its communalistic goals, though any serious reflection will reveal that the use of

1 The phrase ‘free private enterprise’ is inappropriate to describe this phenomenon as the word free refers only to the relative freedom for early starters. The same degree of freedom does not usually exist for late starters, particularly if the early starters are big, have wide connections elsewhere and are influential.
capitalistic institutions to attain communalist goals would be extremely difficult, if not impossible.

What has been said so far concerning the need to formulate appropriate development strategies, the meaning of development, the need to promote the right kind of change, the avoidance of changes and effects of development which will be deleterious to man, and the questioning of profit making as a very high ranking value are all responses to the stimuli which I receive from the world around me—where I live and work, Port Moresby, Papua New Guinea, Melanesia and the world. I would now like to return to what I consider to be the more important issues. I believe that man, his dignity and his well being rank very highly in the Melanesian hierarchy of values. The well being of man in my mind is central to all human endeavours.

I believe that the Papua New Guinean social organisation (social, economic, political and educational) is sufficiently malleable to permit new directions to be taken and desirable changes to take place. It is also my belief that we cannot hope to achieve the aspirations expressed in the national goals and directive principles proposed by the Constitutional Planning Committee and passed by the House of Assembly in October 1974, and the eight point aims if we continue to have institutions based on foreign values and ideology and with operations conducted within the alien ideological framework. I believe that the desirable ideological framework now exists in its basic form—in the national goals and directive principles and the eight point aims. This does not necessarily mean that these guiding principles should be accepted as gospel truth for all time. They must be changed to reflect the changing aspirations and needs of an evolving society. For now, however, they are the appropriate framework within which new institutional policies, objectives and priorities can and should be formulated.

Our dilemmas are those experienced in attempting to adapt the guiding principles to the existing institutions instead of adapting the existing institutions to the new ideological framework. These problems exist in our public and private institutions—the private companies, the financial institutions, banks, finance companies, insurance companies, the public service, and the learning institutions including our universities. All these institutions are founded on what I will call, for convenience, the capitalistic, acquisitive, materialistic, competitive, individualistic, profit making, free private enterprise set of values. I am not by any means suggesting that any form of communism or socialism adopted elsewhere would be appropriate here. I am suggesting, however, that the basic ideological framework already exists in the Papua New Guinean social setting and that the basic values already exist in our societies; they should be the foundations for our institutions, both old and new. Essentially I am saying that our peoples are communalist and communism is the basis for our traditional way of life. Our values therefore must be communalist.

One accepts that as the Melanesian societies evolve their values will change (values of a particular group change through internal drive to better its lot and through interaction with external influences) but, while it is one thing for Papua New Guinea to adopt a set of blended values, it is yet another to have alien values imposed and implicitly accepted.

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2 The eight point aims could be said to be the first formal attempt to change emphasis and direction. Both the national goals and directive principles and the eight point aims attempt to set out new directions based on Papua New Guinean values. The eight point aims were endorsed by the House of Assembly in February 1973 and form the broad framework for economic organisation envisaged in Papua New Guinean communities.
Let me now present in pairs of opposites some of the values I regard as important: competition, co-operation; materialism, spiritualism; acquisitiveness, sharing; individualism, communalism; rights and welfare of an individual, rights and welfare of a group; freedom, responsibility; privilege, obligation. I am not arguing here that the seemingly contrasting values within the set are necessarily mutually exclusive. Man possesses these contrasting characteristics, but the setting within which he is socialised fosters to a greater or lesser extent either one or the other of each pair. I believe that when a Melanesian speaks of the Melanesian way, he speaks of a situation in which co-operation, spiritualism, sharing and interdependence feature more prominently than their opposites.

There is no doubt that much basic and detailed work needs to be done in promoting Papua New Guinean and Melanesian values and in translating them into operational and institutional objectives to meet our communistic goals. To be able to choose the right set of values, to develop a suitable ideological framework, to reorientate the existing institutions and to adapt them to the new guidelines—in short, to promote the well being of Melanesians—we have to be fairly independent intellectually because until we are, political and economic ‘independence’ is but an empty phrase.

**KAROL KISAKAU**

_in the past there has been little direct benefit to the people or the nation as a whole when Papua New Guinea's resources have been exploited by foreigners. The time has come for nationals to decide to use resources for their own benefit. Conservation and economic development should ideally be directed towards the rational use of resources to achieve a high quality of living. In practice, economic development tends to place stronger emphasis on increase in production. While conservation is concerned with sustaining quantitative yield, it also emphasises management of more qualitative aspects of human environments. Proper consideration of ecological principles will assist those concerned with development or conservation to achieve their goals with few undesirable side effects. Lack of ecological realism can doom development efforts, on the other hand, just as surely as can ignorance of the technological, economic, political or social factors.

I should like to highlight some of the issues concerning the exploitation of Papua New Guinea natural resources by foreigners. In the past there has been little direct benefit to the people and the nation as a whole. The time has come for nationals to make decisions on how to use their natural resources for their benefit. Conservation and economic development should ideally be directed towards a common goal—the rational use of our resources to achieve a high quality of living for our people. In practice, economic development tends to place stronger emphasis on the increase of production, aimed at enhancing the material well being of the people. While conservation is concerned with sustaining quantitative yield, it also emphasises management of more qualitative aspects of human environments, which can add depth and meaning to human life.

Proper consideration of ecological principles will assist those concerned with development or conservation to achieve their goals with a minimum number of undesirable side effects, reducing the likelihood of major environmental disturbances that could be harmful to all life within a region or throughout the world. Lack of ecological realism can doom development efforts, which then waste money and impair the conditions necessary for life just as surely as if the technological, economic, political or social factors were to be ignored.

Conservation has always been a way of life with Papua New Guineans, who have lived for centuries in harmony with their physical environment and created their own
social and cultural structures. They regarded land as the property of the community, with each family having traditional ownership and traditional rights to care for its portion. They used the fertility of the soil to grow food and fibre, and moved to new ground when the fertility declined. They hunted or fished in their dense forests or clean rivers; those living by the sea were good fishermen and divers. They always had enough for daily life and traditional ceremonies, and never thought of exploiting their natural resources for accumulation of wealth. They were guided by local taboos that, in fact, contributed to sound conservation of their natural resources.

Foreign powers have intruded upon this natural rhythm of life and imposed their alien laws and morals on the multitude of tribes in Papua New Guinea—all in the name of development. As a result, the social structure has been disturbed. Men were moved to foreign owned plantations, and from there drifted to administrative and urban centres. Land was alienated for various cash crops and an expensive infrastructure was set up to cater for such so-called economic development, but the majority of the indigenous people were almost totally ignored.

The people still cultivated their subsistence crops without irrigation, soil erosion control and fertiliser; animal husbandry remained very poor; and sanitation deteriorated as people were encouraged to live in small villages. In the plantation labour lines and urban settlements, the living and sanitary conditions were worse and created many health and social problems for which there are no realistic solutions even today. Yet we have been told that science and technology will improve our standard of living. There is no doubt that a few Papua New Guineans have done all right for themselves, but at the expense of their fellow countrymen. Besides, to keep the selected few in their new style of life, the country has to pay with its natural resources, now being exploited by foreign enterprises, with hardly any benefit going to the local masses.

Such a pattern of development is similar to what has happened to the whole of the developing world, where after two or more decades of independence people finally realised that it did not work and looked for new ways of solving their particular problems. It is interesting to note that many of them reverted to their traditional systems instead of perpetuating the alien ones that are not even working now in their countries of origin, now that they cannot get cheap fuel, raw materials and labour from their colonies or ex-colonies.

We have been told that Papua New Guinea’s gross national income has steadily improved during the past few years, but at what price? We only have three main resources in Papua New Guinea: forests, fisheries and minerals. Who are exploiting them? Not our people, who get only a pitance to part with their rights. We do not even have a fair say in the discussions and decisions relating to the exploitation of our resources, as the foreign companies deal with expatriate bureaucrats, with a few nationals as spectators, we do not even have strong legislation to safeguard our environment. For example, reforestation after clear cutting is not done because the clauses in the contract are vague, and there is no government policy regarding this important operation. Pollution of streams from industrial and mining wastes goes on without any control. Big schemes are planned without any mention of environmental impact studies, until there is a public outcry.

The benefits to the local people are dubious, and the deleterious effects on their environment and way of life are just ignored. Propaganda films and literature are prepared by the authorities to paint a rosy picture for the benefit of the local people, but no mention is made of the disadvantages. But they cannot fool all the people all the time, and some of the educated Papua New Guineans, who are still concerned
about their people, are questioning the acts of the old bureaucrats. This is not enough, because the old bureaucracy is very strong and still influences the political leaders and even some of our educated elite. We should be more articulate about our country, our people and our natural resources before it is too late!

We must protect our environment and conserve our natural resources. To achieve such objectives we must control development very thoroughly through careful environmental planning and utilisation of our natural resources for our sole benefit:

1. Mining should not be allowed unless we receive substantial majorities of the shares using our minerals as equity, with the remaining portion to be transferred to us after a limited period. If the foreigners do not accept our terms, let us leave the minerals where they are until we can exploit them ourselves. Moreover, there should be proper disposal or recycling of tailings and other wastes, protection of water courses, land reclamation, and local processing of the minerals.

2. Selective logging should be practised in all forestry operations, with reforestation and control of erosion done without any delay by the exploiters at their own cost. The logs should also be processed locally, with proper control and recycling of all wastes, by national enterprises.

3. Foreign fishing fleets should process their fish in Papua New Guinea, with the Government holding 50 per cent of the shares without contributing any money. After all, it is our sea, our fish. All wastes should be converted into animal feed for use locally.

4. Water and land management should be strictly controlled so as to avoid pollution by chemical fertilisers and pesticides. Soil erosion and flooding should be controlled through proper terracing and drainage; flood and drought through a decentralised water grid that can also be used for local hydro-power, irrigation, transport and recreation; and soil depletion through integrated livestock-aquaculture-agriculture projects.

5. Wildlife management and propagation should be encouraged among the indigenous population so that they can have a free source of protein, besides enjoying the natural environment that is part of their cultural heritage.

6. The development of both human and natural resources of Papua New Guinea should be the sole concern of Papua New Guineans, as we have enough resources for our small population to be able to manage on our own. Any contract the Government is making with any foreign enterprise should be made public, so that the people of this country can have their say or question the bureaucrats and the foreigners about their real intentions, so as to avoid another situation like the Purari scheme.

7. The development of Papua New Guinea should not be based on that of the industrialised countries that are themselves in one big mess: inflation, unemployment, urban blight, crime, and social disruption. The Government should recognise the need for utilising traditional conservation and simple management techniques in the development of our rural areas, where over 80 per cent of our people still live under traditional conditions. If overseas organisations want to help us, their societies must be similar to ours and their methods must be appropriate. More important still, they should live and work with our people in our villages, and not as our expatriates have done in the past.

8. A new social order is essential if we really want to improve the quality of life of our people, and this is possible only if we are prepared to safeguard our natural heritage from foreign exploiters and conserve it in our own traditional way, with selective transfer of science and technology from appropriate sources.

9. We should strongly support the idea recently put forward by Dr J. Gunther con-
cerning the establishment of a national science council that would provide information and advice to the Prime Minister and his politicians in areas such as the above.

**BROWN BAI**

*Future trends for environmental planning in Papua New Guinea centre around the Office of Environment and Conservation and its four broad categories of functions: policy formulation, co-ordination of policy implementation, creation of an environmental data base and communication. Development projects should be considered along with environmental impact predictions and evaluations that would cover prevention, abatement and rehabilitation aspects on the basis of risk-benefit analysis, criteria and standards, monitoring and surveillance. The Government should reserve the right to condemn the project or, if it is allowed to go ahead, to specify the conditions. The Government should maintain constant communications with the public. To give a sound base to development, the Government should engage in integrated land use planning and here again the people should participate.*

We are all concerned, in one form or another, that the development of our natural resources today contributes to building Papua New Guinea as a good place to live in. Our Government has recognised this concern and has made its position very clear in its national goals, which explicitly state:

The natural resources and the environment of Papua New Guinea should be conserved and used for the collective benefit of the people and should be replenished in the interest of future generations.

1. The natural resources including land, forests, birds, animals, fish, water, sea, air and minerals should be used wisely in the interest of the integral development of all citizens throughout Papua New Guinea.

2. The environment and its sacred, scenic and historical qualities should be conserved and replenished for the benefit of posterity.

The first step that the Government has taken to achieve these goals is the setting up in April 1974 of the Office of Environment and Conservation. This small but very important organisation will be working with other government bodies (such as Forests, DASF, Minerals and Energy) that are concerned with and responsible for aspects of environmental protection. The functions of the office broadly correspond with the way the Government sees the problem of environmental protection and management. Such functions can be grouped very broadly into four categories:

(a) policy formulation;
(b) co-ordination of policy implementation;
(c) creating a data base of environmental information;
(d) communication.

Policy formulation is a continuous process and therefore will greatly rely on gaining more knowledge and experience of environmental protection. These will in part depend on closer examination of existing projects and their effects.

The office will be responsible for developing environmental indicators and standards, ensuring that environmental impact studies of all projects are carried out, reviewing all legislation for environmental implications (e.g. new forestry legislation) and finally ensuring that operations of all projects are adequately monitored.

The office will also be responsible for keeping statistics and documentation regarding environment. Moves have been made to establish a section within the office to collect and use worldwide literature on environment and keep a register of relevant environmental data and projects. The office will also be responsible for co-ordinating all surveys and studies on environmental activities in Papua New Guinea.
In order to develop projects without too much social disruption it is very necessary that local people are kept informed and educated about environmental matters. To achieve this, the office is organising displays and demonstration projects, producing booklets and advising on school curricula. The office is also planning to establish a District Environment Committee, through which a series of background reports on environment and associated problems on projects within each district will be prepared. These reports will then be used as valuable pieces of information for district development planning exercises. The Wildlife Section of DASF is also actively encouraging the establishment of the wildlife management and protected areas, whereby local people, through their District Wildlife Management Committees, can manage and protect wildlife in their own areas. The vital importance of this system of management is that local people understand their wildlife much better than any foreigner and also have traditional ways of protecting and managing them.

Certainly planning for the environment is a major task and requires the full cooperation of all government organisations and public and private bodies to accumulate knowledge, set standards and monitor progress of projects and their likely effects. Today we have lots of projects developing without having adequate knowledge of their environmental and social consequences. In the next few years, considerable effort and resources will be devoted to examining the impacts of these projects and measures will be recommended to alleviate detrimental effects. A good example of this is the Bougainville Environmental Audit. Basically the aim of this project is to carry out an environmental audit of the copper mining operations, which will cover the following:

1. Recording and monitoring (a) pre-change conditions; (b) construction phase activities; (c) present operational conditions, including procedures for minimising social and ecological disturbances.
2. Conducting a risk-benefit analysis on all variations of the mining activities including extraction, processing, transportation and ancillary services and industries.
3. Recommending a program for monitoring and surveillance covering air, water, soil and biota within the ecological boundaries of the project and especially at the interfaces of and within the land and water systems including the port, delta, bay and continental shelf.
4. Recommending elements of a temporary and ultimate program of rehabilitation to be undertaken within the ecological boundaries and based on typical surface mining reclamation programs and on the target specific requirements of the Bougainville copper mining operations.
5. Advising on procedures for the preparation of criteria documents on cause-effect relationships in exposure of contaminants.
6. Recommending the format for an information system and data base for numerical and non-numerical information related to the mine operation.

However, a major aim of the Government will be to get adequate knowledge of environmental effects before projects are developed. This is very advantageous from the Government’s point of view since:

(a) it will be in a position to tell the polluters to pay for any disruptive effects on the environment;
(b) it can recommend to developers the direction of development they have to take to minimise environmental disruptions and bad effects on the local communities living in and around these project areas;
(c) it can also explain to local people the effects of these projects and continue this dialogue with them throughout the lifetime of the projects;
(d) it can get help in deciding whether the project is to go ahead or not. Clear examples of this can be seen with actions taken so far with the proposed Purari scheme, and with the Ok Tedi copper project.

Purari Scheme. There is a lot of concern by the Government and the public about the potential environmental and social effects of the proposed first dam development at Wabo. Preliminary examination of potential environmental considerations for the project was prepared by the Office of Environment and Conservation. Following this, a request was made to the UNDP for a team of consultants to assist the office in designing a comprehensive study of the Purari project. This study can be divided into four main components: ecological, sociological, demographic and public health studies. The study team will be headed by an environmental manager, who will be responsible for general direction and co-ordination of the entire study and the maintenance of liaison with the activities of other sector studies such as engineering, industry, port and other resource studies carried out by the University of Papua New Guinea, government agencies and other groups. This manager will be assisted by a number of project managers whose duties will be to supervise and carry out the research activities in the main impact areas.

To ensure that all relevant factors are considered two committees will be established. The Environmental Advisory Committee will provide a mechanism whereby international experts can sit down and critically review goals and progress of these studies. The Public Involvement Committee will be a mechanism through which the general public can voice their opinions. Public participation in planning and decision making is very vital for a project of this magnitude since if it proves to be feasible, it will greatly affect the way the people will live in future.

If we assume that the developer carries out the environmental impact studies at its expense and along guidelines set by the Government, then the other major study the Government has to make is of the social impacts of any proposed mine development around the area.

The Government will also be making moves to prepare land use and development plans for each of its major natural resource developments before actual development takes place. This will require resources and organisations not yet available to the Papua New Guinea Government. Present day developmental problems of the forest industry clearly show that neither the Government nor the company concerned is doing very much to make use of areas already logged out. Part of this difficulty might be caused by the fact that the land is still traditionally owned. However, this is no excuse for not trying to make arrangements with local landowners to get some projects going.

Finally the Government has realised the importance of involving local people in the decision making process and moves have been made to improve the quality and effectiveness of its extension services. These extension offices will be responsible for keeping the local people informed about development prospects in their areas and for receiving feedback from them. Many of the misunderstandings and confusion now existing with some development projects have come about partly because local people have been ill informed and have not been given chances to air their views.

Certainly, the road to achieving a well balanced type of development in our country is going to be tough; it will therefore need co-operation from all affected organisations and individuals. The Government will ensure that all environmental and sociological effects are well considered before development takes place.
Proponents of development in Papua New Guinea have suggested that the correct approach is to 'ask the villagers what they want'. A sixteen-month study of the Mekeo shows that it is unfair and unreasonable to ask people what they want before providing them with adequate information on which to base a choice, more particularly since several generations of colonial and church influence have provided a one-sided and generally non-Papua New Guinean model. The school, road, and hospital, which are the first choices of many people seeking development, must not be seen as unquestioned benefits. Schools that estrange children from their parents and their past can create an alienated elite, drifting towards urban centres and staffing bureaucracies that themselves further widen the gap between traditional villages and westernised cities and towns. Hospitals that treat people as 'labour' to be restored to working condition do not fill their proper role of promoting health for the whole population. A simple economic analysis of the effects of roads and of foreign aid shows that these too are too often agents for creating greater dependence instead of promoting self-reliance and raising the quality of life.

If we endeavour to develop Papua New Guinea, we must go back to the village people and find out what they want. I have now lived in my village for close to sixteen months and I will briefly discuss some of my experiences and the experiences of my fellow villagers who have also sacrificed their jobs to return to the village in the hope of assisting in the development of our village peoples who have so far been neglected by the Government. In the process, I hope I shall sufficiently destroy the academic myth that if we want to develop our country we merely have to ask the village people what they want.

My discussion may bear relevance to some other parts of Papua New Guinea, then again it may bear no relevance to the rest of Papua New Guinea at all. For we Mekeo people are very aristocratic; we are as aristocratic as the British. On balance, however, we are far more democratic than the British, and the structure, philosophy and lifestyle of our societies distinctly differ from those of the British.

All over Papua New Guinea today we constantly hear the term development used. We know or we think we know that a phenomenon known as development is a good thing. Consequently people in the villages, people in the cities, politicians, students, everybody in Papua New Guinea wants to develop. To a vast majority of Papua New Guineans development means 'road, school, hospital'. The Beipa'a Development Group, which I represent, does not believe that a school in itself, a hospital in itself or a road in itself is development. For it is our belief that we cannot say that a road equals development, or that a road plus a school plus a hospital equals development. We do believe, however, that any or all of these three are essential processes of development. Used in a manner that genuinely benefits the whole community they become tools of development. Used in any other manner, however, they become tools of gross exploitation of Papua New Guineans by capitalists.

It is, therefore, our belief that if our strategy of development is merely to consult village peoples and then to follow their desires, we will be overexposing our peoples, our resources and our nation to the hungry greed of the capitalist nations such as Japan, Australia, the United States, etc. In fact we know the schools, hospitals and roads have become the tools of exploitation of our peoples in the hands of these countries. Perhaps at this point of the discussion I should provide an analysis of each of those three infra-structures to clarify our belief that they are really tools of exploitation of our people.

Firstly the road. We, the people of Mekeo, now have the Hiritano Highway running right through to our villages. Some people contend that we are very fortunate in hav-
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ing the benefit of a highway. We do admit that we are fortunate but only up to the point beyond which it is Japan, Australia, etc. who profit from it. It is these countries who are now in a position to rob our people blind. On the Hiritano Highway PMV trucks\(^*\) are the normal means of transportation of produce of various types from Mekeo to the urban markets and of people to and from Port Moresby for a wide variety of purposes. These trucks, at an average cost of K4000, are all locally owned. Because these trucks are made in Japan, our money, which in turn is a part of the nation’s capital, is repatriated to Japan for the purchase of the trucks. For trucks to operate on the Hiritano Highway they need fuel. This fuel is imported into Papua New Guinea from the Middle East. Therefore money used for the purchase of fuel ultimately goes to the Middle East. A part of our much needed national capital is again repatriated elsewhere. When trucks break down we need spare parts to ensure their continuous functioning. As all spare parts come from Japan, our money for these essential items is also repatriated to Japan. We may do well to remember what Ralph Nader pointed out—that it is the sale of these spare parts that ensures the prosperity of the automobile industry.

Moreover, channels for the syphoning of the cash earned by our peoples from the sale of their produce at city markets are still in operation and in effect drain villagers dry. Cash earned by the Mekeo people is saved with the Bank of New South Wales. Money generated by the Bank of New South Wales is undoubtedly repatriated to its Australian shareholders. Therefore the saving of our money with this bank only enriches the already rich Australians. Cash not saved is used to ensure the upkeep of the family. Most of this cash is used for the purchase of tea, sugar, bread, biscuits, tinned meat, tinned fish, etc. Tea, while grown here, is processed in Australia—the money for the cost of tea goes to the Australians. Sugar is produced in Australia and the money for it again goes to Australia. Bread and biscuits are both produced in Australia—the money for these items is also repatriated to Australia. Tinned meat is also produced in Australia—the money for the tinned meat is also repatriated to Australia. Tinned fish is produced in Japan—the money for the tinned fish is repatriated to Japan. The brunt of the total cost, including freight charges, transportation charges, customs duties, inflation, etc. is met by the villagers who can least afford these items at these exorbitant prices. Regrettably, however, the villagers believe these items are essentials for living. After meeting their obligations the villagers are penniless and the whole cycle begins all over again.

We believe this should have illustrated beyond any doubt that the construction of the Hiritano Highway at K2,000,000 was only to benefit Australia, Japan, etc. In the final analysis it is the expatriate groups and individuals who are sitting pretty and making the money and not our peoples, who are drawn into this system to sweat and slave for these capitalists merely to survive.

Let us now proceed to analyse the school as an instrument of imperialist exploitation. Today in Papua New Guinea we know that only a very small minority presently engaged at primary school will manage to graduate at the top. Upon graduation this elite will enter and man the bureaucracy as loyal civil servants. This bureaucracy, under the disguise of an apolitical organisation, has become the most powerful enforcer of the pattern of exploitation illustrated above. Thus it has become the greatest obstacle to the genuine development and advancement of our peoples.

Teaching in the classrooms emphasises memory rather than reasoning, repetition

\(\text{An open-backed truck (sometimes canvas covered) with seats attached to its bed, and serving as a bus-cum truck.}\)
Conservation of the environment

rather than creativity and originality, for these are ideal moulds for docile civil servants. The purpose of education even today is to train our peoples not for independence but for subservience. Education has drummed into our people's heads that our ways were inferior, uncivilised and demonic. The chief agent in this domain is Christian pedantry which laid down these dishonest equations.

Christianity = civilisation, civilisation = white: white is therefore superior
Paganism = savagery, savagery = black: black is therefore inferior

Upon arrival on our shores Christianity staged a ferocious war for the total rejection of Melanesian religions, customs and lifestyles.

Both these institutions, the church and the school, are being manned by these black-white men who have been mentally colonised by the colonialists. They have accepted this institutionalised racism unquestioningly. To them the only legitimate way of life today and the only legitimate path of progress is through the western and Christian ethos. Education and Christianity have, furthermore, taken the leadership in our communities from the elders and bestowed it on this elite of black-white men, an elite educated in a white, Christian, imperialist and colonial philosophy of life. In embracing this philosophy the black-white man has rejected his society, his traditions, his people's lifestyle. He has rejected all that is Melanesian. In essence he is killing an essential part of himself—his spirit or what is more commonly known as his 'identity'.

The products of this system of education are now manning the establishment whose purpose is to exploit our natural and human resources (or rather those we have left). Ultimately therefore the school is the pillar of the exploitation of our peoples and resources. What we have seen demonstrated so far is proof in itself of the belief of the Beipa’a Development Group.

Let us now proceed to a rather delicate arena—that of the hospital. My organisation is clearly convinced that the services provided by the hospitals have regretfully stamped the hospital also as a tool of exploitation. Hospitals in Papua New Guinea function as repair workshops; their only task is to repair human bodies. Medical services facilitate the continued survival of the Mekeo peoples so as to ensure their sweating and slaving for Australians, Japanese, etc. In all rationality and in all humanity it is most beneficial to introduce to another race a discipline of science that has as its object to ease man's pain. It could not, however, be called an instrument of human advancement if behind the infra-structure that 'heals the wounds, minimises the pain' there is a super-structure designed to suck off all benefits generated from the slaving activities of the healed, as is the case now in the Mekeo.

From the above illustrations I am hopeful you will agree with my organisation that the construction of these infra-structures is not for development as the academics would like us to believe, but to serve as tools of our people's exploitation. The infrastructures were 'development' to our peoples. We have had to educate them to a level of consciousness at which they can clearly see for themselves and fully understand that such complexities were always covered by a humanitarian front. We have found this psychological enslavement of the Mekeo mind to be our greatest obstacle to the people's development. It is our belief therefore that the strategy of development should not be token consultation of the peoples but their re-education. Only then can the national planners and villagers jointly plan projects that would contribute towards their development. Not only would development be meaningful then, it would also play an essential part towards the ultimate liberation of the Mekeo man.

It has been said before and will be said again by our politicians and by academics of the western world that the magic ingredient that stimulates development in a country is foreign aid or capital—money. Both groups contend that development is attainable
in Papua New Guinea only through industrialisation, which demands a massive import of foreign aid into the country. Besides its printed propaganda, the likelihood that the Purari scheme will be established suggests that our Government in practice is in favour of highly mechanised, large-scale forms of development. The establishment of such a massive super-structure in turn demands a massive import of foreign capital into Papua New Guinea for the purposes of carrying out feasibility studies, constructing infra-structures necessary for the successful operation of the project and actually establishing the specific project. Let us end the illusion here and now—white men and their money never come into our country because they love us, our colour or our country. They come into the whole of Melanesia for the sole purpose of exploiting our resources, both human and natural, to satisfy their growing greed.

Through the book and from the pulpit white men drummed into the heads of our peoples that the construction of these infra-structures—roads, schools, hospitals, etc.—was essentially for the benefit of the people. They said these were 'development' and the attainment of this development, they told our people, was possible only with money, a resource only they—white men—could provide. Moreover behind these fronts they had already created a super-structure, or more precisely an economic system, designed to syphon off whatever token compensation they might have to pay for the exploitation of our peoples and our natural resources. The white man has thus created among our peoples a psychological dependence on their ways, goods, etc. This psychological dependence in turn has led to the degeneration of our peoples into a class of paupers dependent on the white man's economic system.

We as a group actively engaged in the genuine development of our peoples at the grass roots level know, from experience, that our task is not merely to be in possession of a good knowledge of the exploitative white capitalist economic system. Our task is
to relate this knowledge effectively to the villagers. From the start we were forced to acknowledge that ‘mind-fucking’ academic analysis through the ethics of capitalism, socialism, Marxism and Maoism was, for obvious reasons, futile for our purposes. We have now developed a strategy of communicating to our peoples that foreign aid, by its very nature, is an instrument of exploitation. This may appear to be unorthodox and rather simplistic, yet we believe it to be economically sound. On behalf of my organisation I now challenge all academic intellectual economists to prove our analysis, which I shall illustrate, to be wrong.

Most often in our deliberations a diagram, simple as it may be, has proven far more effective in assisting in relating the various subjects to the people. Even at this instance of the discussion on foreign aid I am inclined to believe that a simple diagram (Figure 24.1) would be most educational for some of our high powered academics.

To recapitulate, foreign aid is being imported into Papua New Guinea from such capitalist countries as Australia, Japan, the United States, etc. This aid is channelled through the monetary sector, both private and public. A greater share of this capital is utilised for the purpose of maintaining the infra-structures and super-structures aimed at the perpetuation of the exploitation of our peoples. A minimal proportion of this foreign aid manages to trickle down to the villagers in the Mekeo through the sale of betel nuts and other agricultural produce at the urban markets in Port Moresby. The cycle of money does not end here, however, and through our sixteen-month experience in Mekeo villages we have noted that this hard earned income tended to be sucked out rapidly through two channels back to Australia, Japan, New Zealand, etc. A vast majority of the Mekeo investments are with the Bank of New South Wales. I presume that the bank has a majority New South Wales shareholding. The profit generated through the subsequent investment of Mekeo savings by the Bank of New South Wales is therefore repatriated to Australia.

Of the other channels, the village trade store features most prominently. From the store Mekeo villagers purchase such goods as tinned meat, tinned fish, bread, biscuits, tea, sugar, etc. in the belief that these goods are essential for their survival. Money for the purchase of these goods is also repatriated to Australia and Japan. Our peoples have been told that these essential goods needed for their survival could be produced only in Australia and Japan. We know now these were nothing but lies, devised and propagated by the colonialists to ensure their ripping-off of our peoples. At this point of the monetary cycle, our peoples find that they are again penniless and so this cycle of misery starts all over again.

It is doubtful whether it is advisable for our country to continue along the conventional pattern of development—a pattern that relies heavily on massive foreign aid. Foreign aid tends to lead to the further degeneration of the local peoples, as we have shown. In our discussion with villagers we have found that such an analysis with the aid of a simple diagram has conveyed quite adequately the whole fallacy of foreign aid as the magic ingredient of this phenomenon called ‘development’. Only then could they comprehend the terms ‘self-reliance’ and ‘appropriate technology’, as embodied in the national goals, as relevant to their situation.

It is our belief that for development to be meaningful in the Mekeo it should become the essential step and the means by which our people are able to create and develop not only a Melanesian economy but also a new Melanesian man, who is mentally free from the degradations of oppression, exploitation, racial inferiority, colonialism and capitalism.
Ecological Guidelines for Proper Management of Marginal Lands

GERARDO BUDOWSKI

The problem of the fragile marginal lands, which cover 50-90 per cent of the area of most tropical countries, deserves special and urgent consideration because of present massive destruction due to faulty preconceived ideas and lack of managerial skill. Guidelines to follow are suggested. Greater stress should be placed on increasing production on land already under production instead of relying on the opening up of new land to increase agricultural output.

All over the world land use planning policies and their implementation are being transformed. The encouragement of and complacency about the careless opening of new lands and clearing virgin forests, draining swamps and transforming other natural areas into agricultural crops or grasslands for cattle have virtually disappeared. Opening roads for better communication and applying sophisticated techniques to increase yields are no longer accepted without some scrutiny. New concepts are rapidly being formulated, challenging old assumptions originated and transmitted under different conditions. New alternatives based on better ecological considerations and long-term values are increasingly advanced, though not without considerable difficulty.

The purpose of this chapter is to look at this new approach and consider some of its practical applications. First, however, let us analyse a few of the main reasons for this change.

1. There is now a much better understanding that various forms of land use in one area can have repercussions in other, often very distant, areas. Accordingly, whenever ecological interrelationships are included in planning assessments, greater caution is beginning to be exercised. One good example of this attitude is the building of dams and the recognition of their short- and long-term effects on areas and human populations often situated at a considerable distance.

2. There is more widespread recognition that a very large proportion of land, particularly in tropical areas, is fragile and clearly ‘marginal’ for sustained agriculture, grazing or timber production. Decision makers who understand this are properly reluctant to adopt short-term laissez-faire policies leading to the conversion of marginal lands from their natural state (such as forests or swamps) to other land uses in the hope of obtaining short-term benefits for agriculture, timber sales or grazing. The sad experience of areas, now completely denuded, that have had to be abandoned because of much reduced productivity is an eloquent illustration of the cost of a casual attitude to the development of marginal lands.

3. The false assumption that industrialisation in tropical regions is a panacea for adequate development and can cope with an excessive rate of population growth is being sharply questioned. Of course, there are exceptional cases where this has apparently been achieved, such as Puerto Rico, but the physical and social costs have
been high, the future is often jeopardised and the conditions are so exceptional that it would be unwise to assume they could be duplicated elsewhere.

4. There is a growing recognition of the importance of natural areas and their wildlife (wild plants and animals) as an important asset which, if properly managed, could become a powerful instrument for scientific, educational, tourist and of course economic development. Additional benefits include national pride and various other intrinsic cultural values linked with the emotional and social needs of human populations.

These changes have occurred pari passu with the emergence of new schools of thought in many disciplines. In economics, for example, indirect or social costs, often difficult to put into figures, are receiving increased attention and narrower evaluations restricted by concepts of supply and demand and the purely quantifiable are finding less favour.

Finally, in recognition of these factors, there has been tremendous response from international organisations both governmental (particularly the UN system) and other, regional and national, organisations who have often been inspired by the pioneering efforts of their government counterparts. The number of ministries or other high level agencies dealing with environmental concerns and the wise use of natural resources has grown considerably over the last few years. Fifteen years ago, this was considered a rather low priority. Yet now, for example, France has a Ministry of ‘Quality of Life’.

Admittedly this may be an oversimplified presentation of the trends, which are always difficult to evaluate. However, no one will deny that these changed attitudes have won enormously greater support over the last decades. Indeed, this appears to be one of the healthiest of some of the exponential curves that express current man/biosphere relations.

**THE NEED FOR ECOLOGICAL GUIDELINES**

Ecological guidelines for land use planning are not a new idea. Until recently, however, the concept has been little more than a vague plea to take account of the many complex social and ecological interrelationships, ignorance or heedlessness of which had often been at the root of unsuccessful development. Within every region a series of ecological principles must be recognised. Such recognition is a pre-condition of good planning. The need to conserve nutrients and the importance of diversity are just two examples of these principles. The value of these principles in planning economic development has recently been comprehensively reviewed, with special reference to tropical lands, in a recent publication produced for IUCN (Dasmann et al. 1973).

Ecological guidelines can be designed on the basis of these ecological principles. The guidelines reflect sound planning practice by integrating economic, social, cultural and biological considerations in the process of decision making. Guidelines for development of the forest areas of tropical South East Asia and America (Poore 1974, 1975) were discussed in two recent meetings organised by IUCN in co-operation with the United Nations Environment Programme and other international agencies.

The guidelines provide the decision maker with clearly stated, well supported procedures for ensuring that the appropriate use is allocated to any given area of moist tropical forest, so that policies and programs lead not to destructive exploitation but to sustainable development. They place great emphasis on the need for national and regional surveys, so that a clear appreciation may be gained of climate, topography, landforms, soils, hydrology, the flora and fauna, and the relationship of local peoples and the forest.
Such surveys will indicate, amongst other things, areas that should be left undisturbed. Up to now, evaluations have concentrated on suitability for agriculture and timber production, confining conservation to any land left over. But the guidelines lay great stress on conservation as a legitimate use of resources. The retention of undisturbed areas of forest as a resource is seen as no less vital to the development of non-industrial countries than, say, farming or mining, and even on rich agricultural soils portions of undisturbed habitat should be retained, to preserve a sample of the unaltered community and to provide a control for comparison with land under agricultural or other development.

Before permitting the transformation of tropical forests, every consideration should be given to exploiting more efficiently areas already altered. This applies particularly to timber production. The large areas that have already been cleared of forest, either for lumber or for agriculture, and then abandoned, could and should be used for plantation forestry. This would relieve much of the pressure on the remaining areas of undisturbed forest, which often could be used most profitably as storehouses of genetic diversity, as living laboratories, and as centres for recreation.

The guidelines also stress the positive contribution ecologists can make to development, provided their knowledge is drawn upon when policies, and not merely specific projects, are being formulated. Given the many different potential uses to which tropical forests can be put, an overall assessment, properly conducted with adequate ecological expertise, should be able to determine which use for which area is likely to contribute most to the well being of the nation.

**The Problem of Marginal Lands**

The guidelines are a practical response to the growing awareness of the fragility of the so-called marginal lands. Generally, marginal lands can be used for a sustained production of food crops, grass for cattle or sustained yield forestry only under very special circumstances. They cover large areas of the tropics, including Papua New Guinea, with its steep slopes, swampy areas and other places where special water-logged areas or particularly poor soils prevail. For most tropical countries, in fact, marginal lands cover an estimated 50–90 per cent of the area.

Marginal lands are marginal only for certain technologies and economic systems, not for others. Generally, they are regarded as marginal when they pose particular difficulties for industrial technologies and the market economy, despite the fact that many local people are able to utilise them most effectively, have done so for generations, and under appropriate circumstances could continue to do so (for all practical purposes) indefinitely.

A good example of this is the stable form of shifting cultivation, which has a rotation sufficiently long for secondary growth to regenerate the soil. If, however, because of new pressures (for example, the increase of populations, the influence of new technologies, the demands of urban markets), the equilibrium between man and land is destroyed, then the recuperation cycle is reduced to a point where the soil degrades, and the land becomes marginal to the point of uselessness. Marginal lands are often highly sensitive to misuse, and that is of course the reason why they rarely lend themselves to sustained production and must accordingly be handled with the greatest possible care.

**Who Manages Marginal Lands?**

One might think that because marginal lands cover 50–90 per cent of the area in tropical countries there are specialists particularly trained to take good care of them.
Unfortunately, that is not the case. Decisions affecting marginal lands are taken, not by specialists in these fragile areas, but by administrators with little understanding of their difficult properties. Often they may be agronomists, promoters of cattle, or foresters with a 'cut and get out' mentality. Agronomists may claim that provided the right crop is chosen and the right techniques used, they will obtain good crops. They often obtain good results on experimental stations with particularly good soils and through the application of costly techniques and management practices. Then they, or others, may unscientifically extrapolate such experimental results to ordinary farms over large areas—with results considerably poorer than the ones they had claimed.

Similarly, animal husbandry experts may claim that the right breed, the high price of lean meat in industrial countries, the introduction of aggressive African or certain local grasses and better management techniques for their pastures will also yield much greater incomes. And exploitation oriented foresters will promote their trade, encouraged by the extremely large investments that industrial countries are willing to make to get timber and wood (sometimes any kind of wood for chips) for processing in countries far away. Yet examples of sustained yield through careful management of the natural forests are notably rare. These outdated attitudes to land use are still too common in tropical countries. Sadly, they are often repeated and supported by the experts sent for technical assistance by international organisations, or by countries offering bilateral aid.

Against this avalanche of advice, those who promote the management of marginal areas for other purposes have very little chance of being listened to and understood. Yet those purposes for which marginal lands are very well suited include such invaluable benefits as national parks, protection of watersheds for clear and continuous flows of water, avoidance of erosion, maintenance of natural and cultural heritages for generations to come, promotion of science and education, management of wildlife on a sustainable yield basis, and the maintenance of a biological balance which also benefits nearby agriculture and far away cities and the coastal areas. Very often in the national administration, however, nature conservation has a very low priority. In most countries of the world it comes under the Department of Forestry and it is easy to visualise a conflict in which timber production oriented forestry has the upper hand. Clearly, new policies and a much higher status for conservation of nature are urgently needed in almost every tropical country.

CONCLUSION

Much greater importance must be given to ecological considerations if planning and management of land is to be at all adequate. This requirement is especially important in the utilisation of marginal lands. It is vital in these matters to seek the opinions of the people in contact with the land itself, the indigenous inhabitants. A fair assessment of the best possible uses of marginal lands cannot be made without consulting them. There is ample evidence that many indigenous peoples in the tropics have an excellent understanding of ecologically sensible land use. After all, for them marginal lands have never really been marginal.

REFERENCES


A review of the philosophy underlying the establishment in 1967 of the Papua New Guinea National Parks Board is timely in view of the changes that have taken place in this country since then. It is essential that any system of national parks and reserves be conceived of as a viable entity within the structure of society. In Papua New Guinea it is possible to do this using concepts of conservation unknown to many western societies, including customary land tenure and the present relatively balanced relations between people and land. Since Cabinet approval for the establishment of Mt Wilhelm National Park in 1974, there has been a preference for conditional alienation by leasing of land and for continuing involvement of customary owners in park management. Challenges to the Papua New Guinea parks system will probably be raised as demand for the visitor facilities and infra-structures associated with tourism increases. Expenditures of public money on tourist facilities will have to be evaluated and possible tenure requirements examined. Traditional conservation practices in Papua New Guinea, and throughout the South Pacific—such as tapu and tenant systems—must be considered. Today proposals for world parks and international parks bring conservation into the context of a world heritage of natural and cultural resources and bring particular urgency to the aim of an effective Papua New Guinean system of national parks and reserves.

The Papua New Guinea National Parks Board was established in 1967 following passage of what was then called the National Parks and Gardens Ordinance through the House of Assembly the previous year. Mr Dirona Abe, who had introduced the private member’s bill that became the Ordinance following a visit to the United States, was appointed Chairman of the Board, which position he retains today. Subsequent amendments to the Ordinance have not radically altered it and even amendments in the pipeline will not do so. What they will do, however, is increase the size of the Board from five to seven members, thus broadening its representation, require a decision from the House of Assembly for the revocation of a reserve, and give rangers more powers in their policing of by-laws. But to all intents and purposes the Board is still operating under legislation that was drawn up in 1966.

Much water has flowed under the bridge since that time. Many changes have taken place in the physical and political environments of Papua New Guinea and many changes have taken place in the attitudes and philosophies of the people. With the imminent approach of full independence for this country it is obvious that the time is right for a review of the past and the formulation of new ideas and philosophies that will be entirely relevant to an independent Papua New Guinea. What is needed is a Papua New Guinean system of national parks and conservation areas, not one imposed by Australia, the United States or even Europe, and a Papua New Guinean approach to conservation.
The functions of the Board are, of course, spelt out in the Act and the various amendments. These include amongst others, the management and development of land that is committed to the Board’s care in accordance with the purposes for which the land has been reserved; the promotion of the concept of national parks and the conservation of natural resources and the encouragement of public use and enjoyment in the land; the inspection and investigation of land to ascertain its suitability for a park or reserve and the making of recommendations accordingly; and co-operation with other nature conservation organisations.

To enable it to carry out the first function mentioned and as an extension of its investigation function, the Board has land committed to its care, control and management. Currently, land can be committed to the Board in two ways. Firstly, land that has been reserved under Section 27 of the Lands Act may, by notice in the Gazette, be committed to the Board’s care. Secondly, the Board may accept land as a gift, devise or bequest. However the Board is also bound by Section 81 of the Lands Act, which forbids a native to sell, lease or dispose of native land otherwise than to natives in accordance with native custom. Consequently the Board can have committed to its care, control and management only government land or land that is leased from the Government. Therefore some form or degree of alienation is inevitable. Before it can commit land to the Board, the Government must own the land either through outright purchase or by leasing the land from its customary owners. Alternatively some person or body holding land on lease from the Government can bequeath or give such land to the Board conditionally or unconditionally. Under the Act the purposes for which land can be committed to the care, control and management of the Board are ‘for a place for the recreation or amusement of the public, a national park, a monument, a botanical garden, a zoological garden, a reserve or sanctuary for the protection of flora or fauna or for any similar purpose’. This interesting array of alternatives does in fact give wide coverage to the conservation and recreation spectra.

To cover these various land uses the Board decided on the following designations: national park, district park, nature reserve, historic site and national walking track. These terms are still in use today and are readily recognised and understood by people generally. The Board is currently responsible for three national parks, one district park and one historic site, while negotiations are at an advanced stage for the establishment of another national park and a national walking track. Whether this should be viewed as a good record or a poor record of progress over eight years is a matter for debate. When considering this record we must keep in mind the many difficult problems that have had to be overcome to get even as far as this. These include a general lack of concern in the early days, since the whole country appeared to be one big national park (even today this response is not infrequently heard); the difficulty of establishing and training a new organisation in a field that previously had not been given consideration in the country; and, of course, the matter of land tenure. This last is the single most significant hurdle to the establishment of a world class system of national parks and reserves, as they are conceived of by western or more developed countries of the world. It need not necessarily be so to the establishment of a world class system of national parks and reserves as conceived of in the South Pacific generally and Papua New Guinea specifically.

Before 1974 all areas of land committed to the Board’s care were Government owned areas that had been purchased outright from the customary owners many years previously. In 1974, however, a submission was put before Cabinet for the establishment of a national park on Mt Wilhelm. It proposed not buying the land but leasing it. This was a break with tradition and Cabinet approved the concept of leasing.
customary land for conservation purposes both in principle and specifically as far as Mt Wilhelm was concerned. In Papua New Guinea, affinity between the individual and his land being what it is, even outright purchase does not alienate land in the mind of the individual concerned. Purchase of customary land by the Government by payment of a lump sum can, however, result in the loss of a physical and spiritual asset without any real corresponding gain. The anticipated advantages of the lease system as against outright purchase were that the customary owners retained the ownership of the land and that payments for use of the land would continue for the length of the lease and not be paid over in one lump sum, which would probably not benefit future generations at all.

In addition there was to be a condition inserted into the lease to the effect that the area would be for national parks purposes only and that, should the Government at some stage decide that it no longer required the land for this purpose, then the lease would be nullified and all rights revert to the customary owners. This would prevent any back door entry into major exploitative activity without the people’s consent. Moreover there would be a regular review of the rental paid so that the return to the people would keep pace with inflation.

Currently all negotiations for customary land for national parks or reserves are conducted on the leasehold basis. Outright purchase is not considered unless particularly requested by the owners. During negotiations any rights to the land customary owners wish to retain in the event of a lease being agreed to are discussed. In the case of Mt Wilhelm the people were prepared to give up all rights to the particular area of land. It is not expected that this will be the case very often. This is not a matter for concern as there is no good reason why traditional practices should not continue within national parks and reserves in Papua New Guinea. There may, of course, be occasions when some practices are incompatible with the purpose of a reserve or conservation area but, in general terms, traditional subsistence hunting, gathering and even gardening practices would be compatible in most cases. In a recent paper Dr Ray Dassmann, Senior Ecologist with IUCN, had the following to say (1975):

Few anywhere would argue with the concept of national parks, but many would argue with the way the concept has been applied—too often at the cost of displacement of traditional cultures, and nearly always with insufficient consideration for the practices and policies affecting the land outside the park.

Here in the South Pacific there is no doubt that more national parks, or something equivalent to them, are badly needed. There is some question, however, about what kind of national park, and how it is to fit in with the patterns of life, and the necessities of life, for those people who inhabit the Pacific. I would suggest that the ideal national park for the Pacific Islands would be fairly close to what existed here before the invaders from Europe and Asia took over. I do not propose, however, that we attempt to turn back the clock.

These sentiments are much in keeping with the reasoning behind Papua New Guinea’s current approach to the establishment of parks and reserves. It is an aim that traditional lifestyles should continue to flourish within national parks, where they already exist, for as long as the people concerned wish it themselves. The retention of traditional rights is obviously a prerequisite for such.

Negotiations are currently continuing for the establishment of our first national walking track. In this case no alienation of land is being sought, nor is it desired. It is hoped that the concept can become a reality through a simple agreement with the customary owners. In similar fashion, efforts are being made to establish a district park near Madang. In this case the customary owners, through their local council with the help and advice of the National Parks Board, are willing to manage and develop such a park on their own land. This will be their park on their land
and management and planning advice will be available to them as and when they require it.

The current approaches to the establishment of national parks and conservation areas can therefore be summarised briefly: avoidance of total alienation of land by outright purchase and preference for conditional alienation by leasing of the land; continuing involvement of the customary owners in the management of a park, once established, by direct employment, by training opportunities and by the need for continuing advice and information on cultural matters associated with the land concerned; concern that the customary owners receive any financial benefits that may eventuate through the establishment of a park (through the provision of necessary services, etc.). Where national parks are concerned, however, some form of tenure over the land is still being sought.

What then of the future? While no expert in the use of a crystal ball I am in no doubt that further modifications and adaptations will take place in the approach to the establishment of a system of national parks and reserves in Papua New Guinea. The term national parks conjures up in the minds of most of those who have been associated with it in its western context, a vision of tourist potential, outdoor recreation and visitor facilities in association with the conservation of the natural environment.

National parks can and will play a very large role in the development and control of the tourist industry in Papua New Guinea. The development of such parks will cost money—government money. It is hard to justify the expenditure of public money on a project that could be nullified by a sudden change of mind and therefore some form of tenure over these lands will probably still be required. However for all conservation areas, by whatever name, where major expenditure on the development of visitor facilities and the associated infra-structure is not envisaged, there seems no justification for alienation of the land. If suitable legislation existed these areas could be protected, in accordance with the wishes of the people, with no alienation at all. Already, customary owners of land are showing concern, in some areas, for the conservation of their forest. They wish their forest protected but do not want their land alienated to the Government in any way. There can be little doubt that these feelings will be mirrored, in many areas in the years ahead and that provision will need to be made for the legal protection of customarily owned land.

Much more attention will be paid to traditional conservation practices. These traditional practices should be expanded or adapted to meet the requirements of the present rather than allowing alien practices to be imposed. In a recent paper by the Minister for Agriculture on Niue this point was well illustrated:

Tapu, or taboo, are words now accepted in the English language and used freely by Europeans and Islanders. There are three ideas expressed by tapu—sacred, forbidden and combination of the sacred/forbidden concepts. There are many reasons for the imposition of a tapu on the landscape, these reasons being socio-historic and religious. Tapu can be imposed for shorter or longer lengths of time. But the effect of a tapu is a conservation effect. (Vivian 1975)

Although these remarks were made specifically in relation to a South Pacific island of very limited area, the principle can equally well be applied in Papua New Guinea. Traditional conservation practices existed and still exist here and full consideration should be given to them in our efforts to formalise the protection of areas. Similarly there already exists within traditional society in Papua New Guinea the mechanism whereby land is used for specific purposes by a person or persons other than the owner. Is it not possible that an extension of this traditional ‘tenant’ system might provide one possible method for the establishment of conservation areas?
During recent times the worldwide concern for the environment and the conservation of natural resources has mushroomed. Today conservation problems are no longer only national but regional and probably universal as well. There are now proposals for ‘world parks’, ‘international parks’ and collective action is being urged by United Nations organisations and related bodies in order that the world heritage of natural and cultural resources may be conserved. Therefore inevitably there will be pressure on Papua New Guinea to play its role in the conservation of representative samples of ecosystems found throughout the region. Consequently the need for a major system of national parks and reserves is urgent not only as far as this country is concerned but also as far as other peoples in the region and indeed peoples throughout the world are concerned.

Just as the original national park concept has been adapted to suit the conditions that existed in many countries that have adopted the concept, so must it be adapted to suit Papua New Guinea. What we really want and are indeed aiming to achieve is a Papua New Guinean system of national parks and reserves that can become a viable entity within the structure of this society.

References


Papua New Guinea has a wide range of tropical ecosystems. There are enough undisturbed areas to preserve them all. Nevertheless impact by man has been more severe than is superficially evident. Conflict between conservation and development will be strongest in forestry, intermediate in agriculture, and least in mining. The greatest threat to conservation is in the lowlands, which combine the richest flora and fauna with the largest potential for development. The preservation of many bird and plant species and the preservation of the traditional cultural heritage present special problems. Traditional man’s integration with his environment and with his land requires specialised conservation education, and national parks established on tribal land and managed together with landowners, rather than parks run by a government agency alone on alienated land. The selection of national parks and reserves could proceed through the intermediate stage of demarcation and inventory of broad conservation zones. The great scientific and educational value of Papua New Guinea for the world at large, together with the present inability of the country to devote large resources to conservation, justify and demand international financial and technical assistance in conservation projects.

In contrast to most affluent western countries and the densely populated Asian countries, Papua New Guinea gives the impression of having, up to now, largely escaped man’s destructive impact on the natural environment. Since it also harbours a rich variety of tropical ecosystems from dry monsoonal savanna to continuously wet rain forest, from lowland fresh water swamp to alpine mountain, from coral reef, beach ridge and mangrove flat to active volcanic peak, it can easily be understood how observers from the west see here a chance to practise conservation in a manner that must forever be denied to them in the developed world with its long history of destruction (Schultze-Westrum 1971).

While not denying the considerable potential for conservation in Papua New Guinea, this chapter argues that a successful conservation policy for Papua New Guinea does not simply require learning from and avoiding the mistakes made in other parts of the world; it must be developed from a clear understanding of the local natural, social, and economic factors that are affecting attitudes to and prospects for conservation.

The need for action in the near future emerges from the brief section on Papua New Guinea in the report of the Australian Subcommittee for Section CT of IBP (Specht et al. 1974:591), which emphasises the lack of factual information and the difficulties of

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The essential feature of the indigenous way of rural life is that it is part of the ecosystem, not a replacement of it as in the west and parts of Asia. This direct involvement is most obvious with the swamp dwellers, who exploit sago and game in the forest, aquatic animals and plants in the waterways. But it is still clearly present in the shifting agriculture system, relying as it does on an ecological balance sustained by natural regenerating forces in the ecosystem. As long as man functions as an integral participant in ecosystem processes he is unlikely to have any conscious concern for conservation, but will simply act as one competitive element amongst all the others. Concern can develop only when his primary field of economic and social activity has become divorced from the natural environment. A second consequence of the integration of man and environment in Papua New Guinea is that land is part of man's life system, not just a form of wealth as in the west. Separation from his land cuts at the roots of his existence.

Thus two basic considerations must be borne in mind when planning conservation in Papua New Guinea:

(a) the western concept of conservation is alien and irrelevant to hunters, gatherers, and subsistence cultivators;
(b) the transfer of legal titles to land will not undo the original owners' associations with that land.

Let there be no illusion about the severity of traditional man's impact on the natural environment. In contrast to Schultze-Westrum's apprehension about 'the transition from traditional land use to modern commercial exploitation of natural resources' it can be expected that permanent land use based on modern technology and sound ecological principles will be the more conducive to achieving the long-term objectives of conservation.

Shifting cultivation. With a rotation period of 5-20 years or more the areas of forest destroyed are many times the areas used for crop production. On the one hand the area of natural forest destroyed usually remains limited because of preferred or forced (by tribal competition for land) reutilisation of land under secondary vegetation. On the other hand such repeated clearing, through short rotations and with the use of fire, can lead to the introduction and extension of grassland. This not only represents a stronger degradation of the ecosystem, but can in turn lead to migration of clans or tribes to new areas of virgin forest, where the process is repeated. From a vegetation map by Pajimans (1975) and discussion with J.C. Saunders (pers. comm.) I estimate that up to 40 per cent of the forest area bears the imprint of interference by man. The population responsible for this in a country of 470,000 sq km, has grown to 2.5 million from less than 1.5 million in 1950, but can be assumed to have been rather stable at this lower level before World War II. Man's capacity to fell forest has been increased by the introduction of western tools, but there is little evidence that this had led to more land clearing than is required for the immediate needs of a growing population.

Burning and hunting. As mentioned, fire is the mechanism by which degraded secondary woody vegetation is eventually converted into grassland, and by which such grass-
land is maintained. More directly, burning has led to a considerable increase of high mountain grassland at the expense of montane forest (Paijmans and Löffler 1972). It appears to be responsible for the development of most savanna vegetation from dry evergreen and deciduous forest and woodland. In places natural series on flood plains and volcanoes have been arrested at the grassland stage by fire. Without man’s intervention, grassland and savanna would probably be rare vegetation types in Papua New Guinea instead of covering some 15 per cent of the land as at present. The rate of grassland formation depends on climatic and edaphic factors. Whilst one might expect the area of grassland to have increased with the rapid population growth over the last thirty years or so, this has apparently not happened because the most vulnerable forest types had already been largely converted through thousands of years and have become rare.

Although representing a loss from the forest conservation point of view, man-induced grasslands and savannas have become in their own right stabilised ecosystems that contribute to the ecological and scenic diversification in the country, and may in turn require protection from destruction. As a hunter, man most clearly plays his role as just one other species in the ecosystem. With increasing numbers and particularly with increasing power (shotguns!) he may upset the ecological balance and must be controlled. This is indeed one of the acute conservation problems in Papua New Guinea.

Population pressure. Papua New Guinea’s favourable position for nature conservation is not due to innate or acquired conservation mindedness of traditional culture, but to a low population density. In addition a relatively inefficient destructive technology has made only minor impact against climatic and edaphic conditions that generally engender a strong resilience to disturbance in the vegetation.

Exponential rises in population numbers, combined with improving technology, make it imperative that shifting cultivation be phased out and agricultural production be concentrated on smaller but permanently and intensively cultivated or grazed areas. Hunting should be regulated rather than given free rein as a foraging and commercial pursuit, and forestry, fisheries, and mining ventures should be carefully balanced against conservation requirements.

Economic Considerations

Conservation as a Cost

In affluent societies conservation is primarily seen as a cost. It involves expenditure or forgoing of income justified to satisfy a want, not to produce increased wealth. Since conservation ranks low amongst human wants, its need is most strongly felt by those strata of society whose more basic requirements are already amply satisfied. With some notable exceptions, the least support comes from the poor and from secondary and primary industry workers who have more pressing problems to worry about and who may conceive of conservation as some sort of threat to their livelihood.

In so far as nature conservation requires financial sacrifice, it is therefore not likely to receive much support in a country like Papua New Guinea, which is busily trying to catch up on much more fundamental needs such as housing, consumer goods, education, health, and transport. This attitude will be reinforced by the apparent lack of urgency of conservation and pollution issues as compared with the situation in affluent countries.

In correctly noting the great opportunities for conservation in Papua New Guinea, the west would do well not to see this primarily as a national responsibility of that
country, but to realise that at this stage it is an affluent world at large that wants to grasp the opportunity and cannot countenance the destruction of yet another hoard of natural treasures. The obvious consequence of such an attitude would be to bear a large part of the cost of achieving the desired objectives.

Virtually the only way in which nature conservation can earn rather than cost money is by promotion of tourism. But this produces wealth for the nation only if visitors are attracted from abroad, although it may have its uses internally in providing extra earning capacity in parts of the nation lacking other resources.

**Competitive Land Use**

Economic impediments to conservation are most serious when the establishment of reserves not only involves financial outlay *per se*, but also prevents the development of natural resources for economic gain. It is because of this that national parks tend to be relegated to areas lacking any economic potential. It is however most important, particularly from the scientific-educational point of view, that sufficiently large tracts are set aside of ecosystems that are likely to be interfered with or destroyed in their entirety by economic development.

**Mining.** Conflict between conservation and mining in developed countries is much greater than would be expected from the small areas involved, because mineral deposits are not infrequently discovered (sometimes after the proclamation of parks) in scenic or unusually interesting areas initially thought to be free of such economic pressures. In Papua New Guinea, where there is still so much room for manoeuvring in the geographic location of parks, it would be good policy to subject proposed parks to mineral exploration before they are declared. This includes an appraisal of the areas as potential sources of construction materials.

Where mining or quarrying potential is demonstrated, it will be difficult, and often unwise, for conservationists to oppose its development, because of the increasing demand for and dwindling supplies of these resources. In many cases a suitable alternative site for conservation would be available and should be used. Frequently too it should be possible to reconcile mining and conservation interests by advance planning. Ecosystem disturbance may be minimised, pollution kept at acceptable levels, and particular sites absolutely protected. The mining operation can be beneficial in improving access, providing power and services, and adding a focal point of interest. Worked out areas may be treated and transformed for recreational purposes.

Although severe environmental damage in the immediate vicinity of a mine may be unavoidable, damage to the overall environment by mining and quarrying can be kept small because only small areas of land are directly involved. This assumes proper control of pollution from tailings and spoil, and limited open-cut operations. That there is no room for complacency in this field has been demonstrated for the Bougainville copper mine by Brown (1974).

**Forestry.** Forest is commonly considered a renewable resource. In practice there are great difficulties in managing tropical forests as such (Bahruddin Bin Haji Ghazali and Johari Bin Bahrudin 1972). In Papua New Guinea forest exploitation generally consists simply in the removal of all merchantable timber, leaving behind an impoverished forest or no forest at all in the case of proposed clear felling for woodchips. Regeneration to a new stable climax forest may take at least a hundred years (K. Pajimans, pers. comm.), if it takes place at all. Only a few territorial forests and timber reserves are earmarked for sustained timber production including forest plantation (Department of Forests 1973); they are not set aside for conservation as Schultze-Westrum (1971) assumes.
Logging permits sometimes extend over large tracts of land, because it is necessary to purchase only the timber rights from indigenous owners, not the land itself. In view of increasing demands for forest products, particularly in Japan, the forest industry may expand rapidly. Since forest ecosystems are of prime concern to conservation there is clearly a potential for conflict, particularly since at present conservation responsibilities and activities are not mentioned as part of Papua New Guinea forest policy (Department of Forests 1973).

Agriculture. Clearing of land for crop production is even less compatible with nature conservation than exploitation for timber. The areal impact is not so great however, because there is much less land suitable for agriculture than there is for forestry. In addition much agricultural development can take place on land already under secondary vegetation, or following on after timber extraction from forest land.

On the other hand there are many non-forested areas with conservation potential. Conflicts could arise in particular where natural wetlands are to be reclaimed for agriculture. Retaining parts of such areas as nature reserves can involve technological problems because of the disparity in water regime between the reclaimed and the preserved natural land.

Tourism. While in general terms conservation and tourism support each other, conflict can arise from damage to national parks by vandalism, littering, souveniring, trampling, noise and fire. This is largely a problem of the future in Papua New Guinea, and capable of solution by management, education, and policing.

If conservation is conceived to include cultural features as well as natural ones, a more serious conflict situation comes to light. Although Papua New Guinea is a very scenic country, there are in fact few if any features sufficiently outstanding to attract large numbers of overseas visitors. Neither are climatic conditions ideal for tourism. Wildlife, although most unusual in kind, is generally difficult to observe, in contrast, for instance, to that in the east African national parks. The real spice in the tourist fare that will lure the traveller to Papua New Guinea is the manifestations of traditional culture, which in their own tropical setting are truly exciting and unique. Being much more endangered by economic and social development than are the native flora and fauna, this traditional culture will increasingly become the centre of serious conservation conflict with difficult human problems to be solved.

Approach to Conservation

Priorities and Method of Park Selection

Priorities. Papua New Guinea differs mainly from densely populated countries in that there are still (commonly large) areas of intact natural ecosystems with a high potential for economic production, which can be expected to come under rapidly increasing pressure for logging and/or conversion into pasture, crop land, plantation, towns, and roads as economic development gathers pace. Priority should therefore be given to setting aside enough area of such ecosystems to satisfy the scientific and educational needs of posterity, even though this may involve forgoing some economic gain in the present, and even though the landscapes concerned may not be aesthetically attractive. Although areas proposed as national parks by the National Parks Board, as quoted by Schulze-Westrum (1971), are mostly on poor quality land or in inaccessible or remote parts of the country, there is now a growing awareness for a broader outlook and the need for parks to be accessible (N.C. Gare, pers. comm.).

Park selection method. The many options still open in site selection for parks allow a staged approach to this problem. A similar approach has been independently ad-
vocated by the National Parks Board of Papua New Guinea (N.C. Gare, pers. comm.). The first step should be the approximate delineation of large regional conservation zones known to include representative areas of significant ecosystems and/or unique terrain, water, vegetation, or cultural features worthy of special management or preservation. Normally large or small parts of a conservation zone will have no special conservation interest and/or will possess a distinct potential for economic development. Selection of such conservation zones would make use of general geology, landform, vegetation, soil, climate, and population maps as well as exploit the familiarity of individuals with special aspects and features of the terrain, flora, and fauna, gained through field work and airphoto interpretation. A first attempt at delineation of broad conservation zones has been made by Schodde (1973), while a new set of more detailed proposals by the author is appended to this chapter.

The second stage should consist of a more detailed inventory of each conservation zone, priority being given to areas under the greatest immediate pressure. The inventory would concern itself with fauna and flora, landform, vegetation communities and status, special geological and soil features, potential for mining, quarrying, forestry, agriculture, fisheries, water power and storage, recreation, transport and urban settlement, and, importantly, with indigenous land tenure conditions.

On the basis of such inventories potential national parks and different kinds of reserves can be outlined in detail in stage three, and both their positive and negative aspects documented. In addition spatial and functional relationships between selected parks and reserves and other areas within the conservation zones can be described. The final stage concerns the actual declaration or rejection of the proposed parks and reserves and the preparation of regional development plans for the conservation zone as a whole.

The system should be used in a flexible manner: it is not essential that every conservation zone should finally yield a national park, nor that every reserve is part of a conservation zone. And regional planning should not be restricted to conservation zones. However, the network of conservation zones must give representative coverage of all important ecosystems in Papua New Guinea, include the major unique natural and cultural features that could suffer from unlimited economic utilisation, and provide examples of regional planning that may be used in setting planning standards elsewhere.

Species Preservation Problems

The expectation that conservation of a single large area of each major ecosystem would automatically entail the preservation of all its species will not always be fulfilled. Diamond (1973) has demonstrated unexplained gaps, very localised occurrences, and strict altitudinal zonation without correlation with obvious ecotones in the vegetation, in the distribution of bird species. He also discusses the strong correlation between the size of an island and the number of species present on it, adding that New Guinea mainland ecosystems surrounded by or separated from each other by contrasting ecosystems also behave like islands. Both features appear to be the result of interaction between low dispersal rates of species, high speciation potentials, and high local extinction rates. Data collected on many land resources surveys (Haantjens 1965) and a detailed study by Pajjmans (1970) indicate a similar patchiness in the distribution of many forest tree species.

From these observations arise two conflicting demands on national parks. Patchy distribution would require many 'replica' parks to be scattered throughout the occurrences of major habitats. Maintenance of species diversity within parks requires them
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to be large: at least 1000 sq km, if the analogy with island size studied by Diamond (1973) is valid. Day (1971) suggests a minimum size of 200 sq km for full macropod fauna preservation, while in the United States true 'wilderness areas' should be at least 400 sq km (Gilligan 1963).

One might point out that a demand for many large parks, at first sight extravagant, could be met without significant economic sacrifice in the vast tracts of undisturbed mountainous terrain of Papua New Guinea that appear almost useless for economic development. Indeed, it is important that sufficient mountain reserves are created each covering as wide a range of altitudes as possible (Schodde 1973). This might not really solve the species preservation problem, however, because most mountain land is at higher altitudes with poorer species composition. Kikkawa and Williams (1971a) have demonstrated a steady drop in the number of bird species with increasing altitude, from over 300 at 0–500 m to fewer than ten at over 4000 m. This trend is paralleled in plant species and most likely also in mammals, insects, and other kinds of animal life. Thus it is clear that the most serious conflict situations are going to arise in the lowland forest ecosystems where there is the greatest pressure for forest exploitation and agricultural and urban development. A similar situation has already developed in north Queensland (Webb 1966).

A compromise solution could involve the setting aside of sizeable forested lowland hilly areas and poorly drained plains with below average or marginal economic potential, together with the retention of numerous small 'island' reserves of hill and plain forest in areas of great economic value. Small reserves should be at least 4 sq km in size (Webb 1966). Large parks could be particularly useful in the Western District (Fly-Turama River area) considering the concentration there of 76 per cent of lowland bird species that do not occur in the high mountain areas (Kikkawa and Williams 1971b).

In the small reserves the number of species would tend to decline with time. One could hope that different species would be lost from different local ecosystems without causing any nationwide extermination. Or one might attempt combating local impoverishment by management: restocking or protection of threatened species, control of unwanted invading species.

Land Tenure Problems

The complexities, particularly to western observers, of customary land rights in Papua New Guinea are certain to cause problems in acquiring land for national parks by the state. The real problem, however, goes beyond intricacies and potential high costs. To traditional man land is not simply a form of wealth, like capital and labour, but an integral part of his cultural heritage. Having been 'sold', the land continues to be part of man's life system and this will cause what westerners are apt to consider as squatting and poaching problems. Thus buying up the land is not nearly as final and effective a method to safeguard it as a park as it is in western society.

A system probably better adapted to traditional attitudes would be to involve indigenous customary landowners directly in the protection of those unused and virgin parts of their tribal lands which it is desired to manage as a park. Thus while remaining owners, they are persuaded to give up, sell or trade in any rights to use the land for purposes contrary to the aims of conservation: logging, clearing, cropping, burning, indiscriminate hunting and fishing. Such a policy could be particularly successful, if the local population were economically and managerially involved in the running of the park and any ensuing tourist industry. An approach of this kind has already been adopted by the National Parks Board in consolidating the small Varirata Park in the Astrolabe Range near Port Moresby (N.C. Gare, pers.
In arrangements of this nature it is obviously advantageous to restrict the number of parties to a minimum. To this end the boundaries of the conservation zones discussed earlier should be made to coincide as much as practicable with customary territorial boundaries of tribes or clans. Where land of two owner groups is intricately interwoven it might be possible to negotiate land exchanges so as to exclude one of the groups from the zone. Otherwise both groups should be either included or excluded. In determining the actual boundaries of national parks or reserves of various kinds, within or outside conservation zones, every effort should be made to locate them wholly within the territory of one kinship group, or at most two in the case of large parks.

Cultural Heritage
Preservation of traditional culture will strengthen feelings of identity of the people. It could also be essential for the development of a flourishing foreign tourist industry. This is not unusual. Much of Europe's and the Orient's attraction derives from it, while tourism in the new world suffers from a lack in historic-cultural appeal or a lack of promotion of the available assets.

The difficulty in Papua New Guinea is the extreme fragility of traditional culture. Its tangible manifestations are virtually all produced from vegetable and animal raw materials and have a short life span in the warm wet climate. Those of a practical nature (buildings, implements, cropping systems) are prone to replacement by technologically superior western forms. Those of a spiritual nature are under constant threat from missionary work and secular education. These tendencies have been reinforced by beliefs emerging from within the indigenous community that simple adaptation of the outward forms of Western culture would automatically bring western wealth as its reward (cargo cults).

Continued interest in traditional culture can only be maintained by confrontation, education, and adaptation. For confrontation it will be desirable to restore to Papua New Guinea part of the primitive art treasures removed from the country in the past and now housed in overseas museums. This material should be regionally displayed in museums or community centres built in regional style. Here lies a prime opportunity for the west to show that it is serious in its desire to help Papua New Guinea retain its national environmental identity.

Education can help in keeping alive both spiritual values and regional crafts found in surprising variety throughout the country. It can also aid in a process of adaptation producing suitable blends of traditional style and modern efficiency in building, dress, cookery, agriculture, fisheries, social customs, etc.

The hardest problem is the maintenance of authentic traditional features that are picturesque tourist attractions, but downright inefficient in an economically advancing society. Traditional village styles, long houses, spirit houses, rattan suspension bridges and dug-out canoes, as well as shifting and semi-permanent cropping systems, fishing and sago gathering methods, are in this category. The preservation of cropping systems could be instrumental in the preservation of gene pools of cultivars.

Dirona Abe of the Papua New Guinea National Parks Board suggested to a ministerial conference on national parks in Sydney in 1972 that cultural structures and their associated traditional activities, customs, legends, etc. could be kept alive as part of regional tribal national parks. He realised, however, that village groups, in the long run, would not be prepared to lead the primitive existence of their forebears just to
keep the past alive for their more affluent and comfortably living, but culturally alienated fellow countrymen.

The most realistic approach may be to erect and/or maintain (with judicious use of chemical preservatives and synthetic materials to increase the durability of structures) typical traditional villages and other structures, and to use these regularly or at special occasions for exhibits, demonstrations, and performances by traditional art and craft societies or clubs encouraged to form and grow within general regional communities. Where this requires capital outlay, subsidies and monetary rewards, such costs may at least partly be recouped from admission fees and general tourist revenue.

To place such cultural features within national parks may be unpractical, since the latter will occupy areas of undisturbed vegetation and the former are better located within populated regions. Both developments could be very well co-ordinated in the regional planning of larger conservation zones.

**Landscaping**

Too often conservation movements concentrate on total preservation of a few remote special areas, while being unconcerned about the gradual despoliation into 'cultural deserts' of large parts of a nation's land surface. An important aim of conservation should be to contribute to the general quality of life by helping to create diverse, aesthetically pleasing as well as economically efficient landscapes. National parks, reserves, and cultural monuments acquire additional significance and justification if they blend in, functionally, with the landscape. Diversified economic land use with each type relegated to the landforms and soils for which it is most suitable will further improve landscape quality. This can be combined with the preservation of enclaves of natural vegetation and the imaginative creation of man made quasi-natural or recreational landscape elements; for example, the management of local wetlands, the planting up of bare hills and roadside strips with appropriate indigenous plant communities, the scenic alignment of roads. Human settlements, so often blots on the landscape, can by proper location, layout, and design of buildings be made to accentuate and set off the natural features, particularly if regional traditional style elements can be worked into efficient modern designs. The aim of all this is both to impart a special character and flavour to a partly man made, partly natural environment, and to retain suitable habitats for wildlife (Frith 1974).

Possibilities for achievement in landscaping appear to be good in Papua New Guinea because the people seem to have a natural capacity of creating spatially attractive surroundings by attractive location of villages, leaving forest groves and riverbank vegetation, planting of trees and ornamental shrubs amongst their fields. Conservation zones, as discussed earlier, could serve as prototypes and examples for such regional planning.

**Education, Research, Promotion**

To achieve its goals conservation in Papua New Guinea needs to be promoted both within and outside the country. Education and research form a basis on which such promotion can be organised. The traditional 'bush' villager has more factual knowledge about his local environment than outsiders can give him. But, as argued before, he is too much an active participant in the ecosystems of his tribal lands to have any concept of conservation as a human responsibility for a world that is at his mercy. On the contrary he is rather inclined to consider himself at the mercy of a basically hostile environment from which he has to wring a precarious living. Educationally the task is to demonstrate how improving technology and increasing
numbers disturb the balance of power between man and the other elements of the environment; how sustained production requires conservation measures; how eventual survival depends on cooperation rather than conflict between man and nature; how this requires a change from a basically negative and hostile to a positive and protective attitude.

People in urban centres quickly lose familiarity with and knowledge of the natural environment, particularly the forest, and consequently increasingly perceive it as a hostile foreign world. The prime educational need here is to outline the essential functions of natural ecosystems in keeping the environment habitable; to instill an appreciation of them as finely balanced, multi-faceted vulnerable systems that deserve admiration and can be enjoyed; and to stress the need of their careful management if they are to be handed over as a national heritage to future generations. In addition emphasis should be given to the desirability of retention and development of traditional skills in art and crafts.

International promotion of nature conservation in Papua New Guinea should stress the significance of the country for international scientific research. Papua New Guinea is an astonishingly versatile open air laboratory and showcase of the humid tropics. Its value to the international scientific community should be acknowledged by welcoming and providing facilities for foreign scientists to work in the country. There should perhaps be a secretariat or agency with the task, preferably in cooperation with international scientific bodies, to co-ordinate and control research and collecting, determine priorities, and ensure that research results are made widely available. In return outside financial aid and expertise should be sought and provided to ensure that the ‘laboratory’ would remain available and functional. The image of Papua New Guinea as a giant laboratory is probably a good angle from which to promote conservation. In using this facility scientific organisations must share in its overheads and running costs, a considerable proportion of which would have to be devoted to conservation projects. A parallel image of the nation as a tropical showground may be useful in the promotion of foreign tourism.

Appendix

List of Areas of Conservation Interest

The list contains thirty major areas and a number of subsidiary areas catalogued with the main areas, all shown in Figure 27.1. Each area is briefly described in terms of its main function and in terms of nine headings numbered A to K:

A Status of area, either conservation zone (i.e. a large area within which it is likely that a national park and/or other types of reserves should be established, pending further inventory); or national park; or wildlife management area; or special area (i.e. small area conserved for a specific purpose).

B Climate, low land, high land, alpine, dry, intermediate, intermediate monsoonal, wet.

C Geology.

D Landforms.

E Vegetation.

F Soils.

G Wildlife

H Cultural aspects.

K Recreational aspects.

One to three asterisks after a feature denote special degree of visual or cultural interest. Information on G is very sketchy indeed. No attempt was made to tackle this aspect seriously in these listings.

1. VANIMO–BEWANI

Main function: Typical lowland variety of landforms and vegetation; very undisturbed but under
Fig. 27.1 Areas of conservation interest in Papua New Guinea
threat of forest exploitation. Uniform but not very high rainfall. Unusual coast features. Un-
disturbed fans.
A Conservation zone.
B Lowland, intermediate with little seasonality.
C Limestone, soft sedimentary rocks, igneous rocks, fan-glomerate, alluvium.
D Raised coral coast, karst lands, earth flow and slumped hills, rugged mountains, fans,
plains, swamps, lake blocked by landslide.
E Wide range of lowland alluvium, fan and hill forests, some swamp communities.
F Rendzinas, podsolic and latosolic soils, immature hill soils, planosols, alluvial soils.
G No data.
H Sparsely populated except along coast.
K Coastal recreation, some mountain walks.

2. LUMI–NUKU

Main function: Typical lowland variety of landforms and vegetation with special interest in
dipslope country and least disturbed sectors of middle Sepik fan plains with unusual soils and
microrelief. Partly sparsely populated.
A Conservation zone.
B Lowland, intermediate.
C Sequence of mainly finely textured sedimentary rocks from Eocene to Recent and from
marine to terrestrial. Strong structural expression, warping and faulting evident even in
youngest rocks.
D Dipslopes, partly with huge slumps, scarp front with small gorges in north. In south un-
dissected to strongly dissected fan plains of great variety in detail. Prior fan plain streams.
Young alluvial plain including unstable and stable flood-outs. Swamps. Young, yet very
deeply incised fan surface in north.
E Anthropogenous vegetation including much planted sago. Forests from slightly deciduous
hill forest to swamp forest with sago or Campnosperma, the latter, unusually, also on
weathered fan plains. Seral flood-out vegetation. Short grassland and fern vegetation.
F Immature hill soils; podsolic lateritic to brown podsolic and some latosolic soils or fan
plains. Less developed similar soils on dipslopes. Finely textured alluvial soils microrelief.
G No data.
H Typical hilltop villages, also some unusual plain and riverbank villages in south.
K Of minor interest for walking, touring.

2A

A Special area.
E Various kinds of tall open plain and fan forest. Tall forest with sago.

3. AMBUNTI–CHAMBRI–TIMBUNKE

Main function: Sepik River meander belt and great variety of swamps, including large peat
swamps. Herbaceous to forest swamp vegetation with important wild life and floristics. Also
hills rising as islands from swamps; lowest parts of active and weathered fan plains in north.
A Conservation zone.
B Lowland (hot inland climate), intermediate, rather monsoonal.
C Recent alluvium and peat, Late Pleistocene alluvium with minor older limestone. Intrusive
and metamorphic basement rock.
D Scroll plains of Sepik River with oxbow lakes. Sepik River confined between hills in one
part of plain. Back plain swamps with swamp lakes and drainage/flooding channels.
Ridges and isolated hills rising abruptly above swamps. Solitary lake in dense swamp
forest. Lower parts of tributary fan plains with blocked valleys and locally forming high
banks on Sepik River.
E Seral scroll forest and Saccharum; Campnosperma-sago peat swamp forest. Sago and
other swamp woodland. Phragmites and short swamp grassland; floating grassland;
aquatic vegetation. Also small crowned hill forest. Tall alluvium forest of various types;
dryland short grassland. Swamp orchids.
F Peat soils, silty and clayey alluvial swamp soils. Shallow and deep weathered red soils on
hills. More or less strongly weathered poorly drained podsolic soils with microrelief.
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G Rich variety of fish, reptiles, amphibians, water birds.
H Picturesque villages* on levees with unique levee agriculture. Remnants of haus tamboran, megalithic features. Carving of canoes, drums, shields, images; pottery.
K Cruising, hunting, bird watching, fishing, water sports.

3A. MAPRIK–WOSERA
A Special area.
H Special village styles* in original villages: famous haus tamboran,** wood carvings, singing, ceremonial yam growing. Unusual almost permanent agricultural land use on river terraces.
K Sightseeing, gold panning.

4. MURIK LAKES–TEREBU
Main function: North coast equivalent to Kerewo-Turama Park. Mangrove peats with succession of saline mangroves to fresh water woodland. Sepik mouth area. Also rare coastal cliffs in volcanic rock. Typical forested low hilly terrain.
A Conservation zone.
B Lowland: intermediate, rather monsoonal.
C Alluvium and estuarine deposits. Pleistocene sedimentary rocks; older volcanics.
D Sepik mouth,* tidal flats around lakes and waterways, subsidence area with changing vegetation. Sea cliffs* with adjacent sandy bay.* Typical low hilly terrain.
E Swamp woodland (which has replaced mangroves), mangrove, fern swamp. Tall lowland hill forest. Some grassland.
F Mangrove peat soils, alluvial soils, beach ridge soils, coral soils, moderately weathered hill soils.
G Estuarine wild life.
H Early missionary settlement and saw mill at Marienbreg. Villages perched between sea and lagoon and on Sepik River bank. Pottery at Terebu.
K Boating, fishing, hunting, beach life.

4A. KAMBARAGA
A Special area.
H Unusual swamp village totally built on stilts over the water, all traffic by canoe. Very large by New Guinea standards.

5. MÜLLER RANGE
Main function: Massive homoclinal ridges on sedimentary rock and limestone with huge dolines, scarps and gorges. Undisturbed forest over large altitude range.
A National park.
B Mainly highland, but ranges from lowland to almost alpine; wet.
C Limestone and fine to coarse textured sedimentary rocks.
D Massive homoclinal ridges on sedimentary rocks and limestone.* Limestone plateau with largest dolines* in Papua New Guinea. Spectacular scarps.* Strickland River gorge.* Lavani valley without drainage outlet and with small lakes, possibly a large polje plain on sedimentary window in limestone area.
E Lowland hill to lower montane forest with possibly some montane forest. Poorly drained grassland in Lavani valley.
F No data.
G No data.
H Unpopulated except for some people in Lavani valley.
K Walking, touring, canoeing, rock climbing.

5A
A Special area.
D Spectacular emergence of river from base of long high limestone scarp.

6. MT KAIJENDE
Main function: Most spectacular high altitude karst in Papua New Guinea. Undisturbed lower montane and montane forest.
A National park.
B Highland to alpine; wet.
C Limestone, minor sedimentary rocks.
D Unique arrete and doline karst.*** Extreme scarps and sweeping slopes down to Porgera valley.*** Synclinal limestone plateau formations with minor moraines and surrounded by scarps.**
E Lower montane and montane forest to scrub; sub-alpine grassland in valleys.
F No data.
G No data.
H Unpopulated.
K Walking, rock climbing, ?caving.

6A
A Special site.
H Most unusual traditional dress and customs in Porgera.

7. TARI–ANDABARE
Main function: Multiple highland assets mainly cultural and scenic: unusual traditional agricultural and cultural system; spectacular extinct volcano and volcanic plains; river tunneling through mountain ridge. Also typical high land swamp plains.
A Conservation zone.
B Highland; wet.
C Pleistocene volcanics: lava, ash. Some limestone, sedimentary rock, alluvium.
D Dissected crater area*** with scarps, domes, mud or lava flows; undissected and dissected volcanic ash plains with fans and swamps. Enclosed plain with meandering stream. Limestone ridges, one of which is pierced** by meandering Andabare River.
E Mid-mountain grassland; swamp grassland; lower montane forest; semi-permanent cultivated fields.
F Weathered volcanic ash soils, peat soils, hydromorphic alluvial soils.
G No data.
K Walking, touring, ?caving.

8. BOSAVI
Main function: Wildlife preservation in undisturbed forest area over large altitudinal range. Proposed national park.
A National park.
B Lowland to highland; wet.
C Pleistocene volcanics.
D Extinct volcano summit area with large crater scarps.** Long concave gentle volcanic slopes, undulating to ridged and merging into more or less dissected alluvial plains. Lake Campbell,* blocked by eruption deposits from adventive cones.
E Medium crowned hill forest. Some large crowned hill forest on gentle topography. Very undisturbed lower montane forest near crater.
F Deeply weathered latosolic soils.
G Echidnas (Zaglossus, Tachyglossus); tree kangaroo (Dendrolagus); vulturine parrot (Psitrichas); goura pigeons, birds of paradise, bower birds, crocodiles, varanus.
H Probably a few small villages. Club heads made of volcanic stones.
K Walking, bird watching.

9. LAKE KUTUBU
Main function: Transition from lowland to highland limestone karst and swamp forest. Spectacular lake. Gorges and valleys. Unusual cultural features.
A Conservation zone.
B Lowland to highland; wet.
C Limestone, some intercalated volcanics. Sedimentary rocks. Alluvium.
D Lowland cone and cockpit karst; highland tower and doline karst.** Wage River zigzagging from strike ridge to strike ridge. Gorges.** Long mass movement slopes on mud-
Conservation of the environment

stone. Swampy plains and Lake Kutubu** at about 750m. Sugu Nembi and Erave Valleys.** Waterfall** into Erave River. Poljes.

E Transition from lowland hill to lower montane mixed beech forests. Man made mid-mountain grassland and scrub. Campnosperma-sago swamp forest and woodland. Small very rare podocarp swamp forest near Mendi.

F Transition from red lowland to yellow highland latosolic soils; rendzinas and deep doline soils probably with volcanic ash; swamp soils.

G Aquatic life in Lake Kutubu seems important. No other data.

H Interesting villages and dress in highland area. Large spirit houses* and small wayside spirit houses* and bone shrines*, rattan suspension bridges. Big man’s houses in Kutubu area. Traditional Tegasso oil-pig trade route between high and lowlands.

K Walking, touring, water sports, *caving.

9A
A Special sites.
H Single or double long houses** in Kagua area.

10. MOUNT GILUWE–SUGARLOAF
Main function: Largest but most threatened glacial and montane to lower montane forest area, particularly for coniferous and beech forest. Undisturbed forest on sedimentary hills. Unique lava dome landscape. Typical volcanic ash plains and valley swamps.

A Conservation zone.
B Highland to alpine; wet, occasional snow Mt Giluwe summit.
C Andesitic lava and ash; sedimentary rocks; some alluvium.
D Largest glaciated area in Papua New Guinea on lavas,** with sub-glacial extrusive rocks. Long volcanic slopes range from weakly dissected to strongly dissected by gorges. Lava domes* of Sugarloaf. Ash plains, partly adjacent to gorges.* Adventive cones some with crater lakes.* Also normal ridge and ravine country, partly with low hilly summit area. Swampy alluvial plains with Papali Pond lake.

E Alpine grassland, montane forest, lower montane coniferous (a rare type), mixed coniferous and beech forest. A large area of mixed lower montane and some oak forest on sedimentary hills (which are now normally cleared of forest in the highlands). Other communities are Miscanthus, Miscanthus-sedge, sedge, Phragmites and short grassland.

F Old volcanic ash soils, partly poorly drained; brown soils on sedimentary rocks; some peat soils and alpine peat soils. Ash plain microrelief.

G Giluwe colony of Archboldia bowler birds.
H Dense population all around Mt Giluwe and Sugarloaf. Good examples of mound and swamp cultivation.

K Walking, touring.

11. MT WILHELM–RAMU RIVER
Main function: Conservation area extends around and from Wilhelm National Park to provide complete route to lowlands and to include populated scenic areas for overall planning of land use and tourism.

A Conservation zone.
B Lowland to alpine; wet.
C Granodiorite, low grade metamorphics, younger sedimentary rocks, Pleistocene to Recent fan deposits and alluvium, some limestone.

D Rugged ridge and ravine mountains; formerly glaciated area*** with big moraines, tarn lakes, U-shaped valleys. Hilly mountain summit surfaces and perched high mountain valleys. Limestone strike ridges and Chimbu gorge.** Chimbu valley** with terrace remnants. Upper Asaro valley* with fans. Ramu graben valley with variably dissected fans, flood plains, oxbows, and major mountain tributaries*. Sedimentary hilly lowlands partly forming anticlinal structure.

E Vegetation sequence from alpine grassland through montane forest, lower montane forest to lowland hill forest and various alluvium forest types in Ramu valley. Remnant hill forest area on sedimentary hills which are mostly under secondary vegetation. Also lower mon-
tane grassland in basins and Miscanthus grassland in valleys together with gardens and regrowth.

F Soils range from alpine peat to immature hill soils to weathered red and yellow soils on fans to alluvial soils.

G Salvadore duck. No further data.


K Walking, touring, mountaineering, ?canoeing.

11A A Special area.
E Unusual alluvium forests rich in palms on seasonally flooded lower Ramu plain.

12. TUA–ERAVE–PURARI RIVERS

Main function: Spectacular lowland gorge, karst plateau, swamp and strike ridge country requiring careful planning for tourism and conservation in connection with proposed Purari hydroelectric scheme. At present virtually undisturbed.

A Conservation zone.
B Lowland; wet.
C Limestone, sandstone, siltstone, mudstone.
D Homoclinal and strike ridges, karst plateaux, some earthflow slopes. Swampy valleys including Lake Tebera. Scarp* and spectacular gorges** across and along the strike. Karst features and underground sections of tributaries. Fast flowing large rivers* with local terraces, including junction of Tua and Erave Rivers.
E Largely lowland hill forest.
F No data.
G No data.
H Unpopulated.
K Touring, ?rock climbing, ?canoeing, water sports (particularly if storage lakes formed, which may however spoil gorges).

13. FLY RIVER

Main function: Unique middle Fly River flood plain and swamp, including blocked valleys, with their varied vegetation. Also dissected weathered plains, mainly forested.

A Conservation zone.
B Lowland; intermediate monsoonal.
C Pleistocene and Recent alluvium.
D Dissected plain; Fly River* plains; scroll flood plain, swamp back plain, blocked valley swamps and lakes.*
E Dissected plain: dry evergreen forest (with much bamboo), small crowned hill forest. River plain: tall open plain forest, swamp forest, woodland, grassland.
F Rich wildlife.
H Sparsely populated.
K Fishing, hunting, water sports.

14. BENSBACH–MOREHEAD RIVERS

Main function: This represents a declared wildlife management area. However, the boundaries proposed are different from those of the original plan in order to include a greater variety of terrain, and to include almost the whole of the catchment area of the Bensbach and Morehead Rivers.

A Wildlife management area.
B Lowland; intermediate to dry, monsoonal.
C Pleistocene sediments; Recent coastal sediments.
D Little or undissected old plains; estuarine coastal plain, beach ridges, mangrove strips. Upwarped low Morehead ridge. Captured Tarl River course.* Streams with local plain catchments.
Conservation of the environment

15. BALIMO–FLY RIVER

Main function: To cover Fly River mouth area and the gradual transition from woodland in the drier south to medium crowned hill forest in the wetter north. Also great variety of wetlands and important cultural assets.

A Conservation zone.
B Lowland intermediate (from rather dry and monsoonal in south to rather wet and less monsoonal in north).
C Pleistocene alluvium and Recent alluvium and estuarine deposits.
D Dissected (low hilly) plains; drowned valleys and back plains; Fly River levees, islands, mouth.
E From south to north: woodland, dry evergreen forest, small crowned and medium crowned hill forest, and all kinds of swamp vegetation. Along Fly River some open forest, swamp forest, woodland and mangrove.
F Strongly weathered poorly drained podsolic lateritic soils in south merging into latosolic soils in north. Poorly drained alluvial soils, probably peat soils.
G No data.
H Sparsely populated. In Aramia valley unusual long house** villages.
K Fishing, hunting, bird watching, ?water sports.

16. KEREO–TURAMA

Main function: Proposed area for one or more national parks to cover mangrove and freshwater deltas on south coast for vegetation, wildlife and cultural conservation. Sketched boundary may be inaccurate.

A Conservation zone.
B Lowland; wet.
C Recent alluvium and estuarine deposits.
D Tidal plains and islands, swamp plains; anabranching tidal channels.*
E Mangrove, swamp woodland, swamp forest, nipa.
F No data.
G Birds: sea birds, wading birds, cassowary, hornbill, birds of paradise, goura pigeons. Two crocodile species, monitor (Varanus), pitted-shelled turtle. Fish, shellfish.
H Villages on stilts, catwalks, canoes, carvings, Gobi shields.
K Boating, hunting, fishing, bird watching, some sightseeing.

17. KEREMA–VAILALA

Main function: Almost undisturbed example of very normal wet aspect of typical lowland hill country on sedimentary rocks. Also rather unusual basin plains and lower Purari gorge.

A Conservation zone.
B Lowland; wet.
C Lower Miocene to Pliocene mudstone, greywacke; Recent alluvium.
D Tightly folded parallel hill ridges; unique isolated ‘rim edge’; low hills. Basin plains of Vailala River, mangrove flats, beach ridges. Lower Purari gorge.*
E Small to large crowned hill forest; alluvium forests including basin forest. Mangrove, nipa, sago communities. Littoral woodland. Some tall swamp forest.
F Immature hill soils. Some podsolic soils, well to poorly drained alluvial soils.
G No data.
H Sparsely populated except along coast.
K Canoeing on Purari, some fishing and beach recreation. Touristically area seems to have little to offer.
18. LONG–KARKAR–MANAM  

*Main function:* Different types of volcanic islands, partly under strong agricultural and population pressure.

A Conservation zone.  
B Lowland, wet.  
C Lava, agglomerate, volcanic ash, mostly Recent.  
D Active volcanic cone of Manam;** semi-active slopes and large crater** of Karkar; dormant caldera lake** of Long with small active island vents; inactive volcanic islands Crown and Bagabag, the latter in the process of forming a coral atoll.  
F No data. Probably large range of mainly young volcanic soils.  
G No data. Probably small range of wildlife.  
H Rather dense population. Typical coastal large villages.  
K Touring, seaside recreation.

19. HUON  

*Main function:* Limestone landscapes: formerly glaciated alpine plateau, forested sloping surfaces with scarps and gorges, coastal coral terraces. Also typical normal mountain ridges and spectacular coastal fans. Wide climate range.  

A Conservation zone.  
B Lowland to alpine; intermediate (almost dry) to almost wet.  
C Limestone, volcanics, sedimentary rocks, raised alluvium.  
D Series of up to twelve coral terraces including some lagoons;* spectacular terraced fans.* Sloping limestone surfaces with scarps* and gorges.* Plateau* with dolines, glacial features and beheaded valleys. Ridge and ravine country on various rock types.  
E Alpine grassland, montane scrub, small crowned lower montane forest on limestone, coniferous and mixed lower montane forest, hill forest. Short grassland in coastal areas. Secondary vegetation.  
F Sequence of soils of increasing age on coral terraces. No other data.  
G Appears to include endemic fauna reserve as proposed by National Parks Board of Papua New Guinea.  
H Some populated areas along coast and in volcanic-sedimentary mountain areas.  
K Walking, touring, seaside recreation.

20. LAKE TRIST–MAGERI BAY  

*Main function:* Unusual lake set amidst undisturbed forested mountains including unusual forest on ultrabasic rocks. Interesting coastline. Undisturbed now, but possible threats by mining.  

A Conservation zone.  
B Lowland to highland; wet.  
C Metamorphics, ultrabasics; some volcanoes along coast.  
D Contrast between mountains on metamorphic and on ultrabasic rocks, the latter with spectacular* variation. Lake Trist** at 1500 m, with hardly any overflow channel and with adjacent small solution lakes, occurs in down-faulted zone. Spectacular coastal embayments.*  
E Small crowned hill forest and lower montane forest on ultrabasics. Normal hill forest, cover montane and coniferous lower montane forest on metamorphics and volcanics. Forests are virtually undisturbed.  
F No data. Probably shallow soils on ultrabasics but possibly deep latosolic soils on more level areas.  
G No data.  
H Virtually uninhabited.  
K Seaside recreation, water sports on lake (cold), walking.  

20A  
A National park.  
E McAdam Park, Bulolo, with example of hoop pine forest.  

21. MT ALBERT EDWARD  

*Main function:* A better location than proposed Mt Victoria and perfect complement to the other
high mountain conservation zones. Extends from alpine to lowland climate. High altitude basins of special interest, particularly the threatened and rare Podocarp swamp forest at Kosipi.

A National park.
B Alpine to lowland; wet.
C Metamorphics, in east basic volcanics.
D Formerly glaciated plateau-like area* surrounded by steep mountain ridges, sloping down to some lowland fans. High altitude alluvial basins* of Neon and Kosipi.
E Alpine dry and swamp grassland; large area of montane forest. Coniferous and mixed lower montane forest; lowland hill forest. Rare area of podocarp swamp forest. Orchids in Neon basin.
F No data.
G No data.
H Virtually unpopulated, but regularly visited for hunting and burning. Logging at Kosipi.
K Walking.

22. LAKE KOENA

*Main function:* Extensive lowland raw peat swamps with swamp woodland and large lake.

A National park.
B Lowland; intermediate.
C Peat and alluvium with some basic volcanic rock.
D Extensive peat swamp with low levees of meandering Mambare and Opi Rivers, and with Lake Koena in deepest part against edge of deeply weathered dissected plateau. Weathered alluvial terrace in west.
E Open swamp woodland. Open forest on levees. Small crowned forest on weathered terrace. Secondary vegetation on dissected plateau.
F Raw peat soils; hydromorphic alluvial soils; latosolic and brown podsolic soils on uplands.
G No data.
H Virtually unpopulated.
K Almost no recreational value.

22A

A Special area.
E Tall, rich fan forest on foot slope of Mt Lamington.

22B

A Special area.
E Blast area from 1951 eruption and tall hill slope forest of Mt Lamington.

23. PORT MORESBY


A Conservation area.
B Lowland; dry. Includes in one sector a rapid transition from dry to intermediate.
C Alluvium, limestone, chert, sedimentary rocks, volcanic agglomerate, reef limestone.
D Landforms of special significance for preservation: coastal cliffs,* salt flats, swamp with convergent drainage channels. Angabunga unstable river courses. Volcanic scarps with waterfall.** Dry zone landforms; concave ridges with pediments and basin plains. Wet zone landforms: deeply weathered ridges and plateau. Extensive fringing, patch and barrier reefs.
E Sequence from savanna, woodland, deciduous scrub and forest to normal hill forest. Alluvium forest, swamp forest, swamp woodland. Grassland, saline grassland, salt flat vegetation, stunted mangrove.
F 'Solonetzic' soils, lithosols, black cracking clays, alkaliine alluvial soils, deep red latosolic soils.
G Rich marine reef life.** Otherwise no data.
H Unusual villages built out to sea over coral reefs.
K Touring, water sports, including skindiving.

24. MUSA RIVER

*Main function:* An area of varied scenic, vegetation and wildlife interest, forming the catchment of
the Musa River and including the area designated to become a large hydro-electric storage lake. Need for catchment protection and possibilities for recreation as well as conservation. Depending on depth, a storage lake will inundate few to many of the features listed below.

A Conservation zone (catchment area).
B Lowland, with some highland in east; dry to wet.
C Basic to ultrabasic igneous and metamorphic rocks; normal metamorphics in east. Tertiary to Pleistocene sedimentary rocks and Recent alluvium.
D Fault bounded Musa basin: alluvial fans of which one is very active;* more or less dissected and warped old lake bed terraces; old mudflow fans, mostly dissected. Surrounding country: sharp hill ridges; slumped mass movement hills; rugged Quaternary conglomerate cliffs** and gorge;** mountain blocks, in places with summit surfaces; Musa and Bariji gorges;* Wowo gap,* steep slopes and high rocky summit** of Mt Suckling.
E Grassland; eucalypt savanna; fan forest including Casuarina forest;* small, medium and large crowned hill forest (unusually mossy* in Wowo gap); Araucaria forest;* oak forest; lower montane forest; alpine scrub and grassland.
F Calcareous alluvial soils, prairie soils; immature hill soils; unusual planosols and ferruginous latosolic soils.
G Zaglossus on Mt Suckling; large wallaby population in valley grassland.
H Scattered population of no cultural interest.
K Touring, walking, mountaineering. Any Musa valley storage lake would have great scope for water based recreation. Canoeing in main rivers.

24A
A Special area.
E Tall Musa Plain forest and regenerating forest on secondary grassland.

24B
A Special area.
E Tall seral forest on Mt Victory slopes as a consequence of eruption in last century; regenerating forest in former grassland area.

24C
A Special area.
E Tall alluvium forest on Goropu fan plains.

25. ABAU

Main function: Typical basaltic hills and varied coastal lowlands that may come under threat of forest exploitation. Includes largest and least disturbed beach ridge complex in Papua New Guinea and also important barrier coral reefs.
A Conservation zone.
B Lowland; intermediate.
C Tertiary basic volcanics, alluvium, limestone.
E Littoral forest, largest area and least disturbed in Papua New Guinea mangrove. Mixed herbaceous swamp, swamp woodland, seral stream bank vegetation. Open and tall plain forest, small crowned plain forest on old depositional surfaces. Small and medium crowned hill forest, some lower montane forest. Secondary vegetation near Abau. Lowland forests threatened by large timber concessions.
F No data. Indication of texture contrast soils on old surfaces, brown forest, latosolic and lithosolic soils on hills. Various alluvial soils.
G No data. Probably rich reef life.
H Thinly populated.
K Not attractive touristically or recreationally except possibly coral reefs.

26. CAPE FRERE

Main function: Spectacular coastal mountain area with large rainfall gradient. Unusual structural landforms. Hill forest rich in Casuarina.
A Conservation zone.
B Lowland; dry to intermediate or wet.
C Basic igneous or volcanic rock; chert and limestone; Tertiary to Recent sediments.
D Sheer mountain massif rising to 1200 m from sea. Structural or relict (domed) surface on igneous rock dissected into low ridges and ravines. Remnant coastal terrace and surface levels in otherwise pronounced ridge and ravine country. Some chevron ridges.
E Short grassland, either pure or in a pattern with valley forest. Some normal hill forest. Hill forest with much Casuarina.
F No data.
G No data.
H Sparsely populated. Church of England headquarters at Dogura.
K Boating, climbing, walking.

27. LOUISIAD ARCHIPELAGO
A Conservation zone.
B Lowland; intermediate.
C Reef limestone; high grade metamorphics.
D Ridge and ravine country on islands. Fringing, patch, barrier and atoll reefs.
E Small crowned hill forest. Some grassland, secondary vegetation.
F No data.
G Coral marine life; fish; dugong.
H No data.
K Water sports, fishing, skindiving.

28. WILLAUMEZ–HOSKINS
Main function: Forested volcanic cones and plains of great variety; volcanic breeding grounds of wild fowl (now wildlife management area). Threats from forest exploitation and agriculture.
A Conservation zone.
B Lowland; wet.
C Lava, agglomerate, volcanic ash.
D Series of volcanic cones forming Willaumez Peninsula with active caldera and lake in its tip. Series of extinct to active volcanoes (Pago, Wittori, Lollo, Mululus) in Hoskins area, with caldera wall, lava flows, active crater and ash-alluvial plains. Sulfataras and hot springs near Kapiura River and Garu.
E Tall plain forest; medium and some large crowned hill forest; seral volcanic vegetation; secondary vegetation and plantation.
F Rather young volcanic soils with multiple profiles in successive ash layers.
G Breeding grounds of wild fowl in hot sand areas.
H Fairly dense coastal population.
K Boating, touring, walking.

29. MT BAGANA
Main function: Active and spectacular volcanic environment with large crater lake.
A National park.
B Lowland (to highland); wet.
C Lava, agglomerate, volcanic ash.
D Active lava flow volcano with spectacular flows; large crater lake; braided ash outwash plains; dissected young volcanic lahar slopes.
E Volcanic seral vegetation; hill forest.
F Ash soils with lapilliitic horizons; very young grey ash soils; alluvial ash soils.
G No data.
H Unpopulated.
K Touring, walking.

30. MOUNT TAROKA–LALUAI POINT
Main function: Coast to highland climatic sequence on forested slopes of extinct but still well preserved volcano with interesting summit area. Unusual swamp forest, possibly threatened by exploitation.
The Melanesian environment

A Conservation zone.
B Lowland to highland; wet.
C Lava, agglomerate, volcanic ash; minor older volcanic rock.
D Slope sequence (0–2200 m) of extinct volcano: lava summit area with crater lake;* slightly and strongly dissected lahar slopes; volcano-alluvial plains terminating in swamps and beach ridges.
E Dense and open Terminalia swamp forest; Pometia-Vitex forest; mid-altitude forest; high-altitude Elaeocarpus-Schizomeria-Casuarina forest. Gulubia-Pandanus vegetation in highest areas. Secondary vegetation.
F Ash soils, commonly with hardpans; alluvial ash soils.
G No data.
H Only locally appreciable population.
K Touring or walking to the summit.

References
In order to ensure conservation of wildlife resources, it is essential to understand and assess the extent to which man uses them for subsistence, social and economic purposes, as well as the value he places upon these uses. Data on the extent of wildlife resource utilisation is necessary if an integrated development plan is to have any real long-term significance. Wildlife resources that were neglected in the past may play an increasing role in the present stage of development of Papua New Guinea. A study covering an area located on the north coast of West New Britain is described here; it aims to assess the quantity and value of wildlife as a food resource in relation to other available exploitable resources. Exact censusing is difficult, and placing a cash value on recorded resources even more difficult. However, care should be taken that the greater short-term cash potential of the timber resources is not overemphasised. It must be remembered that with the disappearance of the forest stands, the wildlife protein supply, minor forest products (e.g. rattan) and other forest plants utilised for social, cultural or medicinal purposes will also be lost or considerably reduced.

Besides food, wildlife and its products are utilised for various other purposes in Papua New Guinea: ornaments, medicine, weapons, etc. The use of bird of paradise and other bird's feathers for decorations is well documented. Although there are many brief references in the literature on wildlife utilisation in Papua New Guinea (for example, Chowning 1958; Rappaport 1967; Brown 1968; Meggitt 1958) no record and few quantitative data on wildlife utilisation appear to be available.

Reports on the importance of wildlife in the rural area in Papua New Guinea vary. In some areas in the Enga District, for example, wildlife is regarded as constituting a negligible amount of the animal protein intake to the diet (Meggitt 1958); Bulmer (1968) found that hunting wildlife provides a small but significant component of animal protein in the diet as well as a resource for other customary activities. It is well documented that in the highlands in general bird of paradise feathers are widely utilised for traditional activities of the people. In Tonda Wildlife Management Area in the Western District, where wildlife is plentiful, the animal protein source of food comes solely from wildlife; this is also the case in the Garu area in West New Britain.

In order to ensure the conservation and the wise management of wildlife resources heavily utilised by man, it is essential to understand and assess the extent to which he utilises them and the value he places on them for subsistence, and for social and economic purposes. Data on the extent of wildlife resource utilisation are necessary if an integrated development plan is to have any real long-term significance. Wildlife resources that were neglected in the past may play an increasing role in the present stage of development of Papua New Guinea.

The objective of the present study is to assess the quantity and the value of wildlife as a food resource in relation to other available exploitable resources. It is hoped that
wildlife resources will be recognised as one of the potential exploitable resources within Papua New Guinea and hence that conservation measures will be emphasised and implemented. Garu Wildlife Management Area in West New Britain was selected for the present survey because the Wildlife Branch has other ongoing projects there, the area is a self-contained unit, traditional hunting rights and landownerships are well defined, and various other background information on the area is available. The study was carried out from August 1973 to July 1974 as a secondary project on the habitat survey and assessment of the Garu Wildlife Management Area.

**The Study Area**

The study area under consideration is located on the north coast of West New Britain about 15 km southwest of Talasea (Figure 28.1). This area is situated between the Kulu River in the south, Riebeck Bay in the west, a straight line connecting the peaks of Mt Krummel and Mt Welcker in the east, and a straight line just south of Kambili Village in the north. The study area covers the whole 16,997 ha of the South Bagum Timber Area. Of this total, 8903 ha is the Garu government land that was purchased in 1966 for $69,039 and the remaining area belongs to the Garu Village; the coastal waters and the offshore reefs at Riebeck Bay, which are the traditional fishing grounds of the people, are also included in this survey.

The only permanent population within the study area is that of Garu Village, which was inhabited by twenty-six families with a total population of 166 people in 1972 (Village Population Register 1971/72, Department of the Chief Minister). Garu Village holds the hunting rights over the study area. Reef fishing and turtle hunting along the foreshore of Garu Village and the mouth of the Kulu River are shared by three villages, Garu, Kambili and Ganiboku. The people have always practised a subsistence and bartering economy, except for a brief period of employment opportunity during timber logging activities from 1966 to 1969.

The topography of the study area consists of a broad coastal plain adjoining the sea coast and to the east is the coastal plateau of volcanic origin with deep gullies that gradually give way to the shallow slopes westwards forming the broad coastal plain. Mt Welcker (1200 m) and Mt Krummel (1980 m) represent the eastern boundary and solfataric areas are located on the slopes of these mountains.

The area has a tropical humid climate with annual rainfall of approximately 3400–4500 mm, most of which falls between December and April. The soil ranges from complex poor to very poorly drained soil and peat under swamp forest inundated periodically during the wet season, to well drained dark brown loam on mountain slopes and dark brown friable clay loam on some isolated areas on the foothills. On the basis of soil potential it is estimated that approximately 50 per cent of Garu government land is not suitable for lowland tree crops and the other 50 per cent is suitable for lowland tree crops with limitation such as soil erosion, flooding, etc. (Land Utilisation, DASF, unpublished data on file).

**Vegetation**

Vegetation in the study area is typical of most lowland areas in Papua New Guinea.

1. Lowland rain forest (45 per cent) consisting of *Canarium-Syzygium-Meliaceae* association covers most of the area; this association is rich in wildlife as well as in most economical tree resources (e.g. canoe trees, fruit trees).

2. Hill rain forest (15 per cent) is similar to the lowland rain forest, but found on more hilly country; included are *Canarium-Sterculia-Pometia-Homalium* associations. Wildlife is similar to the lowland rain forest community.
3. Swamp forest (25 per cent) is found in low lying areas subject to inundation during part of the year, and is characterised by large spreading trees, *Buchanania mollis*, *Campnosperma* sp. some sago and nypa; wildlife is relatively poor in this association.

4. Mangrove forest (1 per cent) is found at the mouth of the Kulu River, and is characterised by *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Sonneratia alba* and *Carallia brachiata*. Except for the mangrove birds, large sized wildlife is relatively scarce; invertebrates such as mangrove crabs and molluscs are abundant.

5. Littoral forest (5 per cent) occurs along sandy dunes immediately above high water mark, and is characterised by *Casuarina equisetifolia*, *Calophyllum inophyllum* and *Terminalia catapa*; wildlife is moderately abundant.

6. Garden and garden regrowth (3 per cent) are found in the vicinity of the Garu Village; abandoned gardens and village sites are covered by short lived shrubs and trees such as *Macaranga-Glochidion-Pipturus* series; wild pigs and wallaby occasionally venture into this area.

7. Secondary forests (6 per cent) are areas that were lightly and selectively logged in the past; they are characterised by *Artocarpus-Horsfieldia-Evodia-Ficus* series, as well as other species such as *Myristica*, *Cananga*, *Anthocephalus*, *Aglaia*, etc. This association is found south of Garu Village. Slight disturbance of the rain forest creates an 'edge effect', which enriches the diversity of the habitats and hence the diversity of the fauna as well.

As in most other lowland rain forest in Papua New Guinea, the following timber species are found in the area: *Cedrella toona*, *Pometia tomentosa*, *Intsia bijuga*, *Octomeles sumatrana*, *Canarium* sp., *Eucalyptus deglupta*, *Vitex cofassus*, *Neonauclea* sp., *Homalium joetidum*, *Dracontomelum* sp., etc. It is estimated that 12,730 ha of accessible merchantable timber of various quality are present in the South Bagum Timber Area and could be extracted over a period of ten years.

**Fauna**

At present 135 species of vertebrate animals were recorded from the study area, ten species of mammals, fifty-four species of birds, thirteen species of reptiles, five species of frogs, and fifty species of fishes (Gilliard and LeCroy 1967; Miniotas and Lindgren 1972; personal observation). The outstanding feature of this area is the presence of wildfowl (*Megapodius freycinet eremita*) laying grounds, where the wildfowl hens lay their eggs primarily during the dry season from April to November (Downes 1972; K. Kisakau, pers. comm.). These grounds are located on the foothills of Mt Krummel and Mt Welcker on solfataric areas (Figure 28.1) that form a large natural incubator consisting of a network of surface and underground hot creeks as well as underground volcanic activities. The volcanic activities heat the soil in which the wildfowl buries its eggs for incubation (Downes 1972; Kisakau, pers. comm.); egg burrows are usually found along banks of hot creeks, under roots of forest trees or shrubs. There were about 15,000 egg burrows recorded on the ground in 1973, covering an area of 61 ha (Liem 1975). It was estimated that, in 1971, 15,000 wildfowl eggs were harvested (Downes 1972), and recently egg production was estimated at around 30,000 annually (Kisakau, pers. comm.). Wildfowl adults occur in various habitats but they are generally found in secondary and primary rain forest. Wildfowl are observed to have a large home range of 15–20 km radius. Besides the wildfowl, wild pigs, species of marine turtle (*Dermochelys coriacea*, *Erethmochelys imbricata*, *Caretta caretta*, *Lepidochelys ridley* and *Chelonia mydas*) and various fishes are relatively abundant in the study area. Occasionally wallaby (*Thylagale* sp.), cassowary (*Casuarius bennetti*) and even dugong (*Dugong dugon*) are found there.
Fig. 28.1 Garu Wildlife Management Area
METHODS
Various attempts have been made to census forest animals; Healy (1973), for example, estimated the population density of *Paradisea minor* in relation to display trees in Jimi valley and McLure (1969) made a population estimate of rain forest birds in Malaysia. To make an actual population census of forest animals with limited manpower and time is extremely difficult, and so indirect estimation from wildlife utilisation was made, by recording the animals hunted in the study area. Two persons from Garu Village were hired to record the weight and numbers of any wildlife hunted from the study area. For smaller species such as oyster, shellfish, crabs, only the weights were recorded. Most of the animals were identified to species, though for some species this was not possible.

Because turtles were frequently cut up before recording was made the data were lumped into one category for the five species collected; the green turtle (*Chelonia mydas*) is the most common, whilst leatherback (*Dermochelys coriacea*) is the least common. Approximately a dozen reef fishes are regularly fished from the reefs; the most common are mullet (*Mugil sp.*), stingray (*Amphotistius sp.*), sweetlip, surgeon fish, and parrot fish; because of unreliable field identification of the fishes they were also lumped into one category. This was also the case for invertebrate species, such as crabs, crayfish, shellfish, oyster, squid and sea cucumber.

RESULTS AND DISCUSSION
Data on the number of animals collected throughout the year are presented in Table 28.1; the weights of these animals are presented in Table 28.2. As can be seen from Table 28.1, wild pigs, fishes and other marine invertebrates were available and harvested throughout the year. Cassowary, wallaby and bandicoot were relatively rare, hence they were irregularly caught. Turtle, turtle eggs and wildfowl eggs are seasonal; the latter were collected throughout the year except between February and March, with a peak harvest from July to September. Turtles and their eggs were mostly harvested along the beaches between December and June, with the peak harvest from

<table>
<thead>
<tr>
<th>TABLE 28.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of animals harvested by Garu Village, August 1973 to July 1974</td>
</tr>
</tbody>
</table>

| January     | 230 | 1 | 60 | 17 | — | 1 | — | — | 366 | NC |
| February    | —   | 17 | 300 | 9 | 1 | — | — | — | 629 | NC |
| March       | —   | 13 | 1953 | 16 | 1 | — | — | — | 367 | NC |
| April       | 340 | 18 | 1460 | 11 | 2 | 1 | — | 1 | 584 | NC |
| May         | 2806 | 17 | 1100 | 3 | — | — | — | — | 555 | NC |
| June        | 2614 | — | 200 | 4 | — | — | — | — | 526 | NC |
| July        | 3779 | 3 | — | 10 | 3 | 2 | — | — | 72  | NC |
| August      | 3975 | 2 | — | 4 | — | — | 1 | — | 140 | NC |
| September   | 4789 | — | — | 1 | — | — | — | — | 435 | NC |
| October     | 1952 | — | — | 21 | — | — | — | — | 297 | NC |
| November    | 2004 | 3 | — | 16 | 2 | — | — | — | 361 | NC |
| December    | 1640 | — | 160 | 18 | 1 | 2 | — | — | 256 | NC |

Total: 24129 | 74 | 5283 | 180 | 10 | 6 | 1 | 2 | 4168 | NC

*Other* refers to shellfish, crab, crayfish, sea cucumber and squid

*NC* not counted
TABLE 28.2

Weight (kg) of animals harvested by Garu Village, August 1973 to July 1974

<table>
<thead>
<tr>
<th>Month</th>
<th>Megapode eggs</th>
<th>Turtle eggs</th>
<th>Wild pig</th>
<th>Wallaby</th>
<th>Cassowary</th>
<th>Dugong</th>
<th>Bandicoot</th>
<th>Fish</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>13.8</td>
<td>60</td>
<td>2.1</td>
<td>518</td>
<td>—</td>
<td>14</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>165</td>
</tr>
<tr>
<td>February</td>
<td>—</td>
<td>219</td>
<td>10.5</td>
<td>245</td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>216</td>
</tr>
<tr>
<td>March</td>
<td>—</td>
<td>1070</td>
<td>68.5</td>
<td>647</td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>140</td>
</tr>
<tr>
<td>April</td>
<td>20.4</td>
<td>1500</td>
<td>51.0</td>
<td>472</td>
<td>25</td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>216</td>
</tr>
<tr>
<td>May</td>
<td>168.4</td>
<td>1200</td>
<td>38.0</td>
<td>67</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>80</td>
</tr>
<tr>
<td>June</td>
<td>156.8</td>
<td>—</td>
<td>7.0</td>
<td>90</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>60</td>
</tr>
<tr>
<td>July</td>
<td>226.7</td>
<td>450</td>
<td>—</td>
<td>456</td>
<td>65</td>
<td>30</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>58</td>
</tr>
<tr>
<td>August</td>
<td>238.5</td>
<td>112</td>
<td>—</td>
<td>135</td>
<td>—</td>
<td>—</td>
<td>200</td>
<td>—</td>
<td>—</td>
<td>62</td>
</tr>
<tr>
<td>September</td>
<td>287.3</td>
<td>—</td>
<td>16</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>165</td>
</tr>
<tr>
<td>October</td>
<td>117.1</td>
<td>—</td>
<td>—</td>
<td>980</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>147</td>
</tr>
<tr>
<td>November</td>
<td>120.2</td>
<td>200</td>
<td>—</td>
<td>1067</td>
<td>25</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>160</td>
</tr>
<tr>
<td>December</td>
<td>98.4</td>
<td>—</td>
<td>5.6</td>
<td>588</td>
<td>9</td>
<td>50</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>1447</td>
<td>4811</td>
<td>188</td>
<td>5290</td>
<td>154</td>
<td>114</td>
<td>200</td>
<td>3</td>
<td>1589</td>
<td>498</td>
</tr>
</tbody>
</table>

*Other* refers to shellfish, crab, crayfish, sea cucumber and squid turtle weighed without shell

March to May; at all other times turtles were caught occasionally at the reef. The above seasonal pattern of harvesting fits nicely with the breeding season of these animals.

Monthly totals of animals brought in varied from as low as 354 kg in June 1974 to as high as 2386 kg in April 1974. The monthly average of wildlife harvested by Garu Village a year is around 1190 kg or approximately 40 kg per day. With the village having a population of only 166 people in 1972, the animal protein harvested is relatively high, namely 240 gm per head per day. This amount is above the minimum daily protein requirement per person per day set up by FAO/WHO (1965). This figure should, however, be interpreted with caution, since the gross weights of carcasses include the bones, fats and offal, and since it makes the assumption that all the wildlife harvested were consumed in Garu Village, which was not always the case. Nevertheless the above data give an approximate indication of the dependence upon wildlife for food in Garu Village.

To put a value on the wildlife resources of the Garu area is not easy, since the harvest does not generally enter the cash economy. Wildfowl eggs are an exception.

Prices for wildlife vary considerably from one area to another, depending on its availability, the demand in the area, and the use made of the wildlife products. For example implements for performing traditional activities may command relatively high prices.

In major town centres wild pigs command a higher price than in smaller centres. Nevertheless certain wildlife in some rural areas where the demand is high commands a high price; for example a fully grown cassowary in the Southern Highlands costs about K350-400, compared with the Western District lowlands, where cassowary is plentiful and costs considerably less. Despite these differences a conservative estimate of the annual wildlife resources collected in the Garu area is $9120.00 (see Table 28.3). This, of course, reflects only the cash value of those wildlife harvested in the area. There are other wildlife in the area that are not harvested or not commonly utilised by man; it is impossible to put a cash value on them, though they are not worthless (for example, there is the aesthetic value of having wildlife, or the value of insectivorous...
birds and bats in controlling insect populations, or the whole range of insects as plant pollinators, etc.).

Apart from wildlife the other major resource of the area is the timber resource. The net value of the extractable timber of South Bagum Timber Area for sawn timber is estimated at $210 per hectare or a total value of about $2.5 million over a period of ten years. This net value is after company taxes, royalties, etc., and makes the assumption that it has a 40 per cent recovery rate of sawn timber, and a net profit of approximately 15 per cent. Certainly the cash value of the timber that could be extracted over a ten year period is considerable, exceeding the cash value of the wildlife harvest in that area over the same period. However, with the disappearance of the forest stands, the wildlife protein supply, minor forest products (e.g. rattan), and other forest plants utilised by the people for social, cultural or medicinal purposes will also be lost or considerably reduced. Kwapena (1974) has shown that, in the study area, 125 species of wild plants are being used for various purposes, and play a significant role in the daily activities of the people.

The socio-cultural cost of the disappearance of these resources, a cost only the people involved could value, would be immeasurably high.

**Conclusion**

In certain areas in Papua New Guinea wildlife plays an important role for the livelihood of people, and in some areas it supplies sufficient animal protein need for the population. Some wildlife is important not only for providing animal protein but also important for social, cultural and traditional activities of the people. Hence conservation measures and wise use of existing natural resources should be observed and implementation measures carried out in land use planning for economic development.

**References**


29 Wildlife and Habitat Management in Papua New Guinea

NAVU KWAPENA

Papua New Guinea is rich in natural vegetation and much of its area is unspoiled wildlife habitat. With the development of roads, agriculture and forestry, the formerly ‘protected’ state of wildlife habitat is altered. The major ecological factors influencing the condition of wildlife habitat are human activities. All the wildlife habitat area is owned by individual clans or under a complex form of village ownership. Efforts must be made by government authorities, local people and wildlife experts to investigate and safeguard the welfare of wildlife, habitat and other natural resources in Papua New Guinea. Before we can talk about habitat conservation and wildlife resource utilisation, however, we must have thorough inventories so that we know what wildlife resources we have, what or how much area they occupy and what adverse ecological effects are influencing them from human activities.

Papua New Guinea is rich in natural vegetation and much of its area is unspoiled wildlife habitat. With the development of roads, agriculture and forestry, the formerly ‘protected’ state of wildlife habitat is altered. The major ecological factors influencing the condition of wildlife habitat would be human activities—mining, timber logging, agriculture, expansion of the road system and constructing easier access for hunters and plume traders to the wildlife habitat areas.

All the wildlife habitat area throughout Papua New Guinea is owned by individual clans or under a complex form of village ownership. Efforts must be made by government authorities, local people and wildlife experts to investigate and safeguard the welfare of wildlife habitat and other natural resources in Papua New Guinea. Because the wildlife habitat areas are native owned, the traditional use of wildlife habitat and natural resources will continue and be encouraged. However, care must be taken to manage the wildlife habitat and its resources wisely.

In Papua New Guinea the Government is negotiating with landowners so that areas can be declared wildlife management areas and hunting controls made law. The areas generally involve controlled utilisation of wildlife or threats to present wildlife populations. The Minister can declare areas only at the request of landowners, and make hunting rules only in consultation with the landowners. The educational and co-operative responsibilities of wildlife officers are therefore heavy. Examples of the areas at present under negotiation are:

1. Tonda. An area of 5000 sq km in the southwest corner of the Western District of Papua. This is predominantly savanna, with grass flood plains along the Bensbach and Morehead Rivers. Wildlife is abundant—water birds, jabiru, brolga, plains turkey, wallabies, pigs, wild dogs, Rusa deer (introduced), cassowaries, crocodiles and numerous small mammals, birds and reptiles. The place is diverse and includes gallery forest. Orchids are common and in great variety. This area has been declared. The people have
TABLE 29.1
Animals and birds used in Papua New Guinea

<table>
<thead>
<tr>
<th>Name</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Big Game</strong></td>
<td></td>
</tr>
<tr>
<td>Feral pig</td>
<td></td>
</tr>
<tr>
<td><em>Sus scrofa papuensis</em></td>
<td>To 1500m; mixed forest edge, grass, gardens, etc.</td>
</tr>
<tr>
<td>Cassowary</td>
<td></td>
</tr>
<tr>
<td><em>Casuarius</em> spp. (3)</td>
<td>Lowland, forest and savanna</td>
</tr>
<tr>
<td>Crocodile</td>
<td></td>
</tr>
<tr>
<td><em>Crocodylus</em> spp. (2)</td>
<td>Lowland, coastal estuaries, inland swamps, coastal plains, foothills to 450 m</td>
</tr>
<tr>
<td><strong>Medium game</strong></td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td></td>
</tr>
<tr>
<td><em>Rusa timorensis</em></td>
<td>Introduced from Irian Jaya (and, before that, from the East Indies)</td>
</tr>
<tr>
<td>Wallabies</td>
<td></td>
</tr>
<tr>
<td>Agile <em>Protemnodon</em></td>
<td>Coastal, savanna, plains</td>
</tr>
<tr>
<td>Scrub <em>Thylogale</em></td>
<td>Mainly lowland, forest edge and savanna</td>
</tr>
<tr>
<td>Forest <em>Dorcopsis</em></td>
<td>Lowland, mid-mountain forest</td>
</tr>
<tr>
<td>Bandicoots</td>
<td>Lowland savanna grassland</td>
</tr>
<tr>
<td><em>Peramelidae</em></td>
<td></td>
</tr>
<tr>
<td>Echidna</td>
<td>Lowland savanna</td>
</tr>
<tr>
<td><em>Tachyglossus</em></td>
<td>Mid-mountain forest</td>
</tr>
<tr>
<td><em>Zaglossus</em></td>
<td></td>
</tr>
<tr>
<td>Tree kangaroo</td>
<td>Mountain forest</td>
</tr>
<tr>
<td><em>Dendrolagus</em></td>
<td></td>
</tr>
<tr>
<td>Cuscus</td>
<td>Forest and savanna</td>
</tr>
<tr>
<td><em>Phalanger</em></td>
<td></td>
</tr>
<tr>
<td>Possum</td>
<td>Forest and savanna</td>
</tr>
<tr>
<td><em>Pseudochirus</em></td>
<td></td>
</tr>
<tr>
<td>Giant rat</td>
<td>Mountains 1400–2700m</td>
</tr>
<tr>
<td><em>Mallomys</em></td>
<td></td>
</tr>
<tr>
<td><strong>Small game</strong></td>
<td></td>
</tr>
<tr>
<td>Fruit bats</td>
<td></td>
</tr>
<tr>
<td><em>Nesonycteris</em></td>
<td>Trees in lowland forests and man made plantations</td>
</tr>
<tr>
<td><em>Melonycteris</em></td>
<td></td>
</tr>
<tr>
<td><em>Syconcycteris</em></td>
<td></td>
</tr>
<tr>
<td><em>Macroglossus</em></td>
<td></td>
</tr>
<tr>
<td><em>Pteropus</em></td>
<td></td>
</tr>
<tr>
<td><em>Pteralopex</em></td>
<td></td>
</tr>
<tr>
<td><em>Dobsonia</em></td>
<td></td>
</tr>
<tr>
<td>Small bats</td>
<td></td>
</tr>
<tr>
<td><em>Emballonura</em></td>
<td>In caves in high and lowlands and in hollows of dead logs and trees</td>
</tr>
<tr>
<td><em>Hippoecides</em></td>
<td></td>
</tr>
<tr>
<td><em>Pipistrellus</em></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 29.1—contd

<table>
<thead>
<tr>
<th>Name</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small game—contd</strong></td>
<td></td>
</tr>
<tr>
<td>Large rodents</td>
<td></td>
</tr>
<tr>
<td><em>Rattus</em></td>
<td>Lowland savanna and coastal plains and 1500–1800m above sea level</td>
</tr>
<tr>
<td><em>Melomys</em></td>
<td></td>
</tr>
<tr>
<td><em>Uromys</em></td>
<td></td>
</tr>
<tr>
<td><em>Hydromys</em></td>
<td></td>
</tr>
<tr>
<td><strong>Larger birds</strong></td>
<td></td>
</tr>
<tr>
<td>Crown pigeon</td>
<td>Lowland forest, scrub and secondary forest regrowth, coconut plantations</td>
</tr>
<tr>
<td><em>Goura</em></td>
<td></td>
</tr>
<tr>
<td>Palm cockatoo</td>
<td></td>
</tr>
<tr>
<td><em>Probosciger</em></td>
<td></td>
</tr>
<tr>
<td>Hornbills</td>
<td></td>
</tr>
<tr>
<td><em>Aceros</em></td>
<td></td>
</tr>
<tr>
<td>Wildfowls</td>
<td></td>
</tr>
<tr>
<td><em>Megapodius</em></td>
<td></td>
</tr>
</tbody>
</table>

proposed rules that will restrict the food or sport hunting of outsiders. A private company has built a tourist lodge and tourists will be allowed to take deer, ducks and fish only under licence and with royalty payments. Any proposal for sustained yield harvesting of the large deer herds would be closely supervised and subject to controls.

2. **Pokili and Garu.** These are two thermal areas on New Britain where megapodes (*Megapodius freycinet*) have large communal egg grounds. The people of the areas have traditionally harvested the eggs for generations, for food and trade. The annual harvest is many tens of thousands of eggs, and appears to be stable. The landowners and those with traditional hunting rights are concerned that changes and development will threaten the populations of birds. Some of the threats are logging (both areas are in timber leases), road building, use of guns for hunting and breakdown of the traditional harvesting rules (harvesting days, how many eggs each person each day, etc.). The declaration of the Pokili area is now in progress.

3. **Matupit.** Near Rabaul on New Britain, Matupit is another megapode egg ground where changes in the vegetation through coconut planting have affected the birds’ laying.

4. **Goodenough Island.** This is an island off southeast Papua where the agile wallaby has been almost hunted out since the introduction of shotguns. The people have indicated that they want all hunting of the species stopped.

5. **Angoram, Keram and Maprik.** These are areas in the East Sepik District in which the people are concerned at excessive hunting of all game. Cassowaries, wild pigs, crocodiles and birds of paradise are greatly affected.

6. **Ialibu.** This area in the Southern Highlands District is a communal hunting area along a series of ridges. The landowning clans have many internal land disputes but wish to conserve the populations of cassowaries and birds of paradise.

People of many other parts of the country are approaching the Department of Agriculture, Stock and Fisheries, expressing concern at the effect of changes and new hunting techniques on populations of wildlife. By advising landowners as they become
concerned, it is hoped that the Department will be able to ensure that sufficient wildlife and their habitats will survive during social and economic development, that wildlife will be clearly recognised as a valuable natural resource, and that any utilisation will be controlled. The Wildlife Branch is engaged in management work on some species of wildlife of economic value.

1. Crocodiles. With laws aimed at reducing the killing of large, breeding sized crocodiles, it is hoped that the large wild populations will be maintained, and small crocodiles harvested. Extension work is being carried out to develop crocodile farming as a village industry. People of the Gulf, Western and East Sepik Districts have shown great interest. Demonstration farms have been set up in:

(a) Western District: Lake Murray (1000 crocodiles), Balumuk in Tonda Wildlife Management Area (100);
(b) Gulf District: Aird Hills (200), Kikori (100), Murua (100), Ihu (50);
(c) Central District: Moitaka near Port Moresby (1000);
(d) East Sepik District: Pagwi (1000).

Breeding programs will be carried out at Moitaka and Pagwi.

2. Cassowaries. A New Zealand Wildlife Service officer under an aid program is carrying out husbandry, breeding and conservation work near Mendi in the Southern Highlands District. The birds are of economic and social importance to the people of the area and it is hoped to improve traditional husbandry techniques and conserve wild populations.

3. Insects. The Wildlife Branch is assisting Papua New Guineans to collect unprotected insects for the collectors trade, both internally and overseas. A conservation study will be undertaken to determine the effects of such collecting on insect populations and the need for protection of additional species or habitat.

WILDLIFE CONSERVATION

The main categories of wildlife used in Papua New Guinea are shown in Table 29.1.

There are also very many other kinds used—birds of paradise of different species, pigeons, parrots, honey-eaters, etc.—and smaller animals of lesser use—frogs, lizards, pythons, monitors, invertebrates. There are as well many varieties of insects and butterflies used. Out of all the butterfly species, seven are protected. Table 29.2 lists the

| TABLE 29.2
Important species protected in Papua New Guinea |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All species of birds of paradise</td>
</tr>
<tr>
<td>Manucodes</td>
</tr>
<tr>
<td>Rifle birds</td>
</tr>
<tr>
<td>Trumpet birds</td>
</tr>
<tr>
<td>Three species of egret</td>
</tr>
<tr>
<td>All goura pigeons</td>
</tr>
<tr>
<td>New Guinea eagle</td>
</tr>
<tr>
<td>All ospreys</td>
</tr>
<tr>
<td>Salvadore teal</td>
</tr>
<tr>
<td>Seven species of birdwing butterflies</td>
</tr>
<tr>
<td>Brown and rainbow trout less than 203 mm long</td>
</tr>
<tr>
<td>Boelen’s python</td>
</tr>
<tr>
<td>New Guinea echidna</td>
</tr>
</tbody>
</table>
important species that are protected. These animals are traditionally and culturally important as part of a national heritage and must be preserved and conserved. Some other important species (listed in Table 28.3) should be, but are not yet, protected.

Only Papua New Guineans can hunt or keep protected wildlife, dead or alive, and then only if they hunt them using traditional weapons and for traditional purposes. Other people can hunt or keep these species only with written permission from the Conservator of Fauna. Areas of land may be declared sanctuaries or protected areas to prevent hunting of all or some wildlife. Both the protected and unprotected animals in Papua New Guinea are so important traditionally and economically that there is a very great need for conservation and preservation of them.

**TABLE 29.3**

*Important species not protected in Papua New Guinea*

<table>
<thead>
<tr>
<th>Species</th>
<th>Protection Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crocodiles (2 species important for crocodile trading)</td>
<td>Protected</td>
</tr>
<tr>
<td>Cassowaries (important for traditional and economic purposes)</td>
<td>Protected</td>
</tr>
<tr>
<td>Wildfowl (culturally and economically important for their eggs)</td>
<td>Protected</td>
</tr>
<tr>
<td>Wild Pigs (important as bride price and main source of meat)</td>
<td>Protected</td>
</tr>
<tr>
<td>Wallabies (important as main game animal widely used)</td>
<td>Protected</td>
</tr>
<tr>
<td>Butterflies (important for butterfly farming by local people)</td>
<td>Protected</td>
</tr>
</tbody>
</table>

**PLANT CONSERVATION**

Forests are among the important plants in Papua New Guinea. Table 29.4 lists the categories of environment found there.

The total forest area of Papua New Guinea is estimated to be about 32–6 million ha of which at least 8–12 million ha have considerable industrial potential. So far there are about seven major forest habitats of wildlife in Papua New Guinea.

Papua New Guinea supplies some countries of the world with woodchips and other timber resources from different parts. There are also numerous other plant species

**TABLE 29.4**

*Forest environments in Papua New Guinea*

<table>
<thead>
<tr>
<th>Environment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lowland forest (up to 2000 m)</td>
<td>(a) littoral forests</td>
</tr>
<tr>
<td></td>
<td>(b) lowland forests</td>
</tr>
<tr>
<td></td>
<td>(c) secondary regrowth</td>
</tr>
<tr>
<td>2. Mid-mountain forest (450–2000 m)</td>
<td></td>
</tr>
<tr>
<td>3. Moss forest (up to 3500 m)</td>
<td></td>
</tr>
<tr>
<td>4. Alpine forest (up to 3500 m)</td>
<td></td>
</tr>
<tr>
<td>5. Savanna woodland (1000–2000 m)</td>
<td></td>
</tr>
<tr>
<td>6. Grasslands (1000–2000 m)</td>
<td></td>
</tr>
<tr>
<td>7. Swamps and swamp forests (1000–2000 m)</td>
<td>(a) rain forest</td>
</tr>
<tr>
<td></td>
<td>(b) mangrove forest</td>
</tr>
<tr>
<td></td>
<td>(c) nipa</td>
</tr>
<tr>
<td></td>
<td>(d) sak sak (sago palm)</td>
</tr>
<tr>
<td></td>
<td>(e) pit pit and swamp grasses</td>
</tr>
</tbody>
</table>
that are used economically and traditionally. In Papua New Guinea most of the rural communities depend on the wild plants as part of their diet and for other day to day uses. There is a tremendous number of wild plants such as orchids of various species, ferns, beautiful wild flowering plants and so forth. In Papua New Guinea these resources could be developed as part of the cash economy. Apart from the cash economy, the use of certain important plants such as orchids should be controlled as part of conservation measures.

**Wildlife Laws**

There are three main laws in Papua New Guinea that control what may be done with wildlife. These are the Fauna (Protection and Control) Act, the Crocodile Trade (Protection) Act, and the Customs Regulations.

**Fauna (Protection and Control) Act**

The Conservator (who is the Director of Agriculture, Stock and Fisheries) is responsible for putting this law into effect. He may declare some species of wildlife protected, and between 1968 and 1975 the species listed in Table 29.2 were declared protected under the Act.

The provision already cited, whereby only Papua New Guineans can hunt or keep protected wildlife, dead or alive, and then only if they hunt them using traditional weapons and for traditional purposes was also made under the Act. Other people can hunt or keep these species only with written permission from the Conservator.

Areas of land may, under the Act, be declared sanctuaries or protected areas to prevent hunting of all or some wildlife. Baniara Island, in the Milne Bay District, has now been declared a protected area for the agile wallaby. This means that this species cannot be killed on Baniara.

Areas of land may alternatively be declared wildlife management areas, after the landowners have agreed. The landowners can nominate a committee to advise the Minister for Agriculture, Stock and Fisheries on making rules about hunting on the land and the payment of royalties to landowners. Tonda Wildlife Management Area has been declared in the Western District and a committee appointed. Rules have been made to stop all outsiders except tourists hunting in the area. The tourists can hunt only in a certain area, and must pay for licences; they are allowed to kill only deer, ducks and fish. Royalties on the animals killed go to the landowners. Any other proposal that may affect wildlife must be referred through the Minister for discussion and approval by landowners.

The Minister may prohibit the use of certain methods or weapons for killing wildlife. Under a notice gazetted on 13 February 1975, the use of mist nets requires the Conservator’s permission. No person can import wildlife into Papua New Guinea and release it.

Rangers can be appointed to enforce the law. At present there are one full-time and many part-time rangers including livestock and veterinary officers and some district rural development officers. Rangers can search for and take wildlife if a person has broken the law.

**Crocodile Trade (Protection) Act**

Under this law, a person must have a licence to hunt for crocodiles unless he has lived in Papua New Guinea more than seven years. He cannot get a licence unless he has lived there two years. A person who wants to buy crocodiles must also have a licence and must have been resident two years.
A person wanting to export crocodiles must also have a licence. Any person who should have a licence and hunts, buys or exports crocodiles without one can be charged and fined up to $400. A licence can be cancelled after a conviction. When a person wishes to export crocodiles he must have a written permit from the Director of Agriculture, Stock and Fisheries, who is responsible for looking after this law.

The Director can limit the number of skins, and the area where skins can be bought on a licence. He may restrict the sizes of crocodiles or declare closed seasons. Regulations specify that no person who holds a licence or should hold a licence is allowed to hold or deal in crocodiles over 510 mm. The law does not stop a person killing a crocodile if it looks dangerous. Rangers under the law are the same people appointed as rangers under the Fauna Act.

**Customs Regulations**

Under these laws any person who wants to import or export any kind of wildlife at all, whether dead or alive, even if it is only part of an animal like feathers or skins, must have a written permit from the Director of Agriculture, Stock and Fisheries. The Wildlife Branch of DASF is responsible for the detailed matters involved in looking after these three laws. Any person who finds out that someone is breaking the laws should ask the nearest government officer to advise DASF headquarters urgently.

**Methods of Habitat Conservation**

In Papua New Guinea, several wildlife management committees have been proposed to manage wildlife and its habitat resources. The wildlife committees in each district of Papua New Guinea will reserve areas, make rules on collecting, harvesting and hunting of wildlife. They will also start crocodile, wallaby, cassowary and butterfly farming. The Wildlife Branch will encourage the local people to start farming these animals. Wildlife management areas, protected areas and sanctuaries will be set aside. More national parks will be set up by the National Parks Board. A start has been made in the following ways: wildlife management areas have been proposed in different districts of Papua New Guinea; insect trading and farming of the unprotected species has started; small-scale and large crocodile farming is going ahead; cassowary farming in the Southern Highlands has started; wildfowl egg harvesting is taking place; ornamental trade items are being made.

Papua New Guinea is blessed with a tremendous wealth of animals and plants in the immense area of unspoiled habitat. Habitat conservation should be considered in the overall planning of any social and economic development. The use of wildlife habitats is a culture and tradition of the people in Papua New Guinea, which must be preserved and passed on from generation to generation; those habitats provide a free resource to the majority of the Papua New Guineans who partly or wholly depend on this free resource. The rare species of plants and animals in the wildlife must therefore be kept untouched and sound habitat management principles must be fully applied and carried out accordingly.

There are developed countries that have lost much of their wildlife owing to the destruction of natural habitat, and we believe that this must not happen in Papua New Guinea. We look forward to the future of Papua New Guinea wildlife and habitat as part of our national heritage.

**The Work of the Government Authorities**

The Wildlife Branch of the Department of Agriculture, Stock and Fisheries, the National Parks Board and the Office of Environment and Conservation of the Depart-
ment of Lands are the main bodies dealing with the conservation and preservation of wildlife and its habitat in Papua New Guinea.

**National Parks Board**
The National Parks Board in Papua New Guinea aims to control certain areas of land with scenic views and of significant natural history value, to prevent the areas' resources being damaged and to provide facilities for visitors to the areas.

**Office of Environment and Conservation**
The Office of Environment and Conservation will assess the impact of development proposals on the environment and recommend measures to avoid unnecessary damage or pollution.

**Wildlife Branch of DASF**
The Wildlife Branch co-operates with landowners and those who use wildlife to ensure that any utilisation, whether traditional, economic or subsistence, is well planned, allows wild populations to be sustained, and minimises damage to habitat. Wildlife and habitat resources are determined to allow conservation, protection, mitigation of development effects and wise management of all species. The Wildlife Branch is responsible for several functions as illustrated by the following:

1. **Wildlife research.** An ecologist in the wildlife research group is responsible for each primary research project. After assessment of each topic in relation to world literature and the particular departmental requirements, it is the responsibility of the ecologist to draw up a research program taking into consideration objectives, priorities, finance and manpower. Some projects under way are the following:
   - (a) Crocodiles: nutritional studies; assisting in village farm projects;
   - (b) Deer: assessing the deer population and its biology;
   - (c) Wildlife survey: assessing the wildlife content of various habitats throughout Papua New Guinea; finding out what animal species are in Papua New Guinea (e.g. the survey on dugong distribution and wildfowls);
   - (d) Cassowaries: farming research by an officer from New Zealand aid program.

2. **Wildlife habitat survey.** The wildlife habitat group is specialising in habitat mapping, assessment and inventory of the various habitats and plants throughout Papua New Guinea. This group also plans and develops wildlife and natural reserves and investigates any adverse ecological effects from social and economic development. Both the habitat and research survey groups assess wildlife and habitats throughout Papua New Guinea where there are large-scale economic developments.

3. **Wildlife management.** Conservation and management of wildlife resources are inseparable. It is the duty of this group to investigate, design, implement and administer management programs based upon information supplied by the specialists of the research and habitat groups. It is this group that must develop the practical skills needed to maintain wildlife populations at the desirable level. Regional field stations are located throughout Papua New Guinea at the sites of intensive ecological studies. These stations function to maintain the responsibilities of the specialists in their programs as related to the research needs and the management of reserves. The crocodile management groups are everywhere in Papua New Guinea teaching local people and the government officers how to farm crocodiles using local materials. The wildlife enforcement group carries out crocodile trade fauna protection and assists with customs regulation work. The enforcement group is responsible for ensuring that no-one breaks the law in selling protected fauna and oversized crocodile skins. This
Conservation of the environment

group also ensures that insect dealers and other animal dealers for export and import obtain and produce appropriate permits or licences.

4. Wildlife management areas and reserves. Throughout Papua New Guinea local wildlife management committees have been formed. The functions of the wildlife committees in each district are to advise the Wildlife Branch or the Government on wildlife problems; to control and manage the harvesting, collecting and hunting of wildlife; to recommend wildlife laws for the management areas; to seek assistance from the Government to start wildlife farming; to ensure that people receive royalty payments for their wildlife.

5. Wildlife training and education. Wildlife training and education are important. In the Wildlife Branch, courses are being held for national park rangers, forestry students, agricultural diploma holders, police officers, wildlife officers and university students and staff. Many people from overseas and inside Papua New Guinea visit wildlife set-ups. The wildlife education group is responsible for taking visitors around.

PROBLEMS FACING PAPUA NEW GUINEA
Generally the major problems involved in wildlife habitat and biological resource conservation in Papua New Guinea are in the following:
(a) development of roads in wildlife rich areas;
(b) timber logging and forestry projects;
(c) monoculture agricultural development;
(d) large-scale mining and hydro-electric schemes in wildlife rich areas;
(e) excessive use of shotguns.
The Wildlife Branch has taken steps, with relevant authorities, to control and plan the development schemes in the areas where wildlife is important for cultural, economic and conservation purposes. More work needs to be done to control and manage the important wildlife habitat areas.

RECOMMENDATIONS
We Papua New Guineans feel that the modern conservation concept must be adapted for use in Papua New Guinea. A practical concept must be clearly defined, incorporating the following points:
1. Traditional utilisation of wildlife and habitat must be investigated thoroughly to determine the importance to each cultural group of each species.
2. Quantitative data is needed on wildlife resources available; minimum land requirements; amounts utilised and necessary for the people.
3. Conservation in developing countries is often conservation for the sake of the wildlife, but in Papua New Guinea, conservation must allow for exploiting the natural resources wisely.
4. There should be channels for providing information on the usage of natural resources to the people by radios, newspapers, and in schools, where wildlife study curricula should be developed. The appropriate government authorities, the people and the experts from the relevant departments should help in wildlife resource planning.
5. Wildlife Branch should be involved in wildlife conservation, education, research and training. More national concern on wildlife planning should be included in the overall planning of resources development.

CONCLUSION
In conclusion, I would like to say that before we can talk about habitat conservation and wildlife resource utilisation in Papua New Guinea or elsewhere in the world, it is
essential to find out what wildlife resources we have, what or how much area they occupy and what adverse ecological influences human activities are having. If we can find out all the information required, then we can ask ourselves, 'Are we capable of managing and using wisely the biological resources without altering too much or destroying the ecosystem?'

References
No approaches that set ‘development’ and ‘environment’ against each other will serve man’s best interests for very long. The path forward must be one where ecological, cultural, social, and economic aspects are integrated in the development of the human environment, making optimal use of existing and potential resources of the biosphere. Man must live within the limits of nature’s ‘annual interest’ and within the capacity of people and communities to change. In the areas of Papua New Guinea where people subsist totally within their environment this balance of man and nature is achieved. As horizons broaden and boundaries are no longer defined, however, it becomes easier to shift burdens on to other people, or on to nature. This has been the pattern elsewhere; developed man has seldom if ever paid the true price of the resources—human and natural—that he has transformed in order to ‘raise his standard of living’. Papua New Guinea is still in the fortunate position of being able to plan the future it wishes rather than awaiting a future it would be forced to accept.

To do this, in the area of environmental management, a number of requirements must be fulfilled. Scientists must provide reliable and usable information, and must see their role in bringing critical situations to the attention of decision makers. Decision making itself must be structured so that responsibility is placed where it can best be carried out. This will mean, for example, a variety of institutional arrangements; some centrally planned decisions being implemented locally; and a combination of intensified effort in training of national cadres combined with public information and participation.

Within conventional definitions, the question of environmental management still presents a number of difficulties if it is to be transposed to an operational level. This is especially so in the case of Papua New Guinea, and for reasons that tend to be conflicting in practice. The country is largely undeveloped—a sustained surplus is not yet available for raising the standard of living to the point where capital formation is sufficient to bring self-generating returns. A majority of the people subsist totally within their environment. This relationship between the people and the environment developed over time (within limits of population numbers and wants) has achieved balanced environmental management. If experience elsewhere is any guide, the balance is not likely ever to be reached again, in absolute terms, once ‘development’ occurs.

A relative balance can be maintained, nevertheless, but only if environmental management is an essential component of development. At this point in time, the world scene yields no clear guidelines on how this is to be achieved and what the costs will be to our habits and expectations. It does yield clear signs of the perils we face if we do not achieve balance.

These notions have been expounded cogently by a now numerous but by no means decisive group of scientists and other observers of the contemporary scene. There is no
advantage to be gained here in word pictures depicting famine, sickness, death, inflation, pollution, poverty, privilege, power and other apocalyptic sights. There is advantage, however, in suggesting that Papua New Guinea’s development, if based on environmental management, can to a significant extent avoid the most flagrant problems of traditional development and delay the advent of some other problems until it has developed the capacity to cope with them. The Sixth Special Session of the United Nations General Assembly on raw materials and access to natural resources, the Cucuyoc Declaration on inner and outer limits of man, and the UN General Assembly call for a new economic order are all recent benchmarks that are raising the kind and the level of discussions of national decision makers.

It is often stated that there is a fundamental conflict between the development process and environmental concerns. This need not be the case: it was the considered view of a recent group of experts on environmental management that using a rational and comprehensive approach to the overall management of the society, and with imaginative procedures for the generation of alternatives, the two sets of interests can be brought together and reconciled; in any event, both sets of objectives must be jointly considered in any balanced and integrative approach to societal problems.

Environmental management, then, is an overall process that integrates ecological, cultural, social, and economic aspects in the development of the human environment, allowing man to make optimal use of existing and potential resources of the biosphere. Technically, environmental management consists of choosing institutional arrangements, technologies and incentives to meet the goals specified for ‘environmental quality’. There is no absolute definition of environmental quality. The many philosophical statements that can be made do not necessarily lend themselves to decision making. In any specific problem area, defined levels of environmental quality may be above or below the levels acceptable to the population concerned; an example is the evaluation of risks to be taken in relation to human health.

Decisions made can affect forever the uses to which the environment can be put. Decisions made can similarly affect the ultimate fate of communities and of individuals. It is the ecological and the social responsibility of scientists to raise alarm signals when threshold limits are likely to be transgressed. Scientific criteria for environmental quality are becoming increasingly available, although it is true that they have been derived more frequently from areas where critical conditions of health and of pollution have already occurred rather than from as yet undisturbed pre-change conditions. Moreover they are seldom related to the social settings in which the problems occur; in fact criteria are based on cause-effect relationships, and the scientific documents that lead to them seldom describe the background conditions from which the causes arise. Yet the decision makers have to rely increasingly on scientific evidence in the allocation of activities and of the goods and services which derive from them.

Scientists for their part are increasingly realising their responsibility for seeing that sound decisions are made. Scientists run the large risk of being believed; they therefore need to be sure of their ground, individually and perhaps also collectively. Yet there is so much about nature that is unknown and may be unknowable to man with his present knowledge system.

It has been suggested that environmentally sound management at a given level could be achieved only by viewing and acting from the vantage point of a higher level. If decisions have to be scientifically sound and administratively manageable as well as politically desirable, there is a formidable problem indeed. What is the higher level and who occupies it in a society as diverse as Papua New Guinea, with its multiplicity
of organisational structures and institutions, sometimes conflicting and often competitive?

The very large demands that are already being made on the limited number of qualified national cadres almost preclude the availability of a higher level suitably sensitised to the necessity for living, ultimately, within the limits imposed by nature's 'annual interest' and within the capacity of people and communities to change. To live outside these limits would manifestly be in defiance of Papua New Guinea's eight aims and the remarkable high order consensus they express. There is no long-term sustainable substitute for environmental management. Conventional social and economic development is causing well known and generalised problems rooted in short-term, narrow vision, resources depletion and inequity between men.

We do not need the challenge of absolute and unarguable knowledge before we change our ways. An attempt will be made to examine some of the perspectives and concepts that should underpin an environmental approach to policy. A wide variety of institutional and ecological problems will be presented in terms of the challenges they pose to Papua New Guinea and some suggested avenues for response will be indicated.

**An Environmental Approach to Policy**

An attempt will be made to encompass a wide variety of environmental problems in terms of the challenges they pose to Papua New Guinea and to indicate some avenues along which responses might be found. Obviously, however, this discussion will not be exhaustive.

The scientific basis for environmental conservation and understanding of nature's processes is cogently and persuasively displayed in this book; world literature is gaining increasing momentum and strength. Additional comments on these subjects here could only be trivial. It may be of interest, however, to refer to the concept of 'eco-development', a concept that is hard to define, in spite of its rising popularity; it reminds us of what we were doing on the planet before we went wrong.

As nature processes materials and energy through vegetal, animal and mineral structures, so does man use social and institutional structure to process goods and services and information. Some structures are also machines, where matter and energy, in various forms, are transformed through technology and manpower into more desirable products and services. In this area man has, in the recent past, been particularly inventive and efficient—at least in purely economic terms. We know that this economic efficiency is not the ringing success it is often made out to be: man has seldom consciously paid the true price of the natural resources he has used. Nor, for that matter, has he paid honestly for the services of his fellow men. This underpayment has resulted in materials crises and social upsets, if not revolutions. Where man has been totally inadequate is in devising social and institutional structures and processes that would enable him to achieve his claimed objectives of improved well being, and to do so with a continued sense of purpose, of direction, of equity, of control.

At the level of the subsistence village, the relationships between man and man and man and nature achieve the economy of materials and of energy that is the sign of good management. As soon as life is extended beyond the boundaries of this limited environment and people are introduced to technologies and education processes that are inappropriate if not irrelevant, order and balance can be maintained only by artificial inducements and pious exhortations that development is an absolute good, that omelettes cannot be made without breaking eggs, and the like. This is possible because man, in a wider system, is then able to shift the burden of costs on to others and on to
nature and to reserve for privileged minorities benefits exacted at an incredibly high overall price, now rated in terms of survival for the species. This is a system out of control, spinning and casting wildly to keep precarious balance, leading invariably to certain defeat. That it has not quite reached this defeat yet on earth is owing solely to the resilience of nature and of man, and to his enormous capacity to sustain shock, but certainly not to good management.

Thus we need to design and redesign our structures and our processes to be economical in the full sense of the word. We should know what is basic and what is not, what we can have and what we can afford. We should be wary of using too much for too little, of creating systems that are ‘energy traps’ consuming more than they yield, of using more resources than are needed, of creating more wastes than we or nature can absorb, of paying obedience to value and knowledge systems that are self-seeking and that will doom us as a society in the not-so-long run. One of the reasons that makes it difficult for us to see how to avoid these pitfalls is that we are usually taught or trained to see solutions in terms of good or bad, of yes or no, of do or don’t. It is indeed much more difficult to blend meaningfully the varied needs and wants of a society that seeks achievement in an array of solutions that must encompass dualities such as village and city, conserver and consumer, majorities and minorities, ownership and use, and many other such. These are matters for informed debate, and Papua New Guinea should plan for an intensified effort in the training of national cadres in sufficient numbers at the same time as it strives for a responsible and responsive audience through public information and participation.

Many of the benefits of participatory planning will accrue from decentralisation of decision making, again avoiding an either/or posture in the realisation that some policies may benefit from being planned centrally but administered locally. An over-controlled system destroys initiative and ends up costing more than it benefits in that distrust and diffidence will move people to shift responsibilities and to reject, at a greater overall cost, a burden that otherwise they would have assumed. Benefits must be perceived to have value: environmental protection and conservation are hard enough to manifest without compounding the problem of structural defects in the system that claims to service these intangibles.

Management must rest on an adequate information base. We must assess carefully the base from which we proceed and we must have sufficient indicators to monitor and control our processes. Often indicators are used more as historical reminders in statistical appendices than as control elements to feed back into and help regulate our processes. Two problems arise here: one is the relative lack at this time of relevant, appropriate and timely environmental indicators, that is indicators related to the condition of social, ecological and resource productive systems; the other is that these indicators must be understood and used in decision making on a ‘real time’ basis, with a speed of response that must be faster than the processes from which they arise (if a driver does not control his car, the faster it speeds, the faster he eventually lands in the ditch!). There is some doubt that the present administrative system, with its many agencies and subsystems, can operate its communications network with the speed necessary. A case in point arises in the stabilisation of internal prices for export commodities that are subject to fluctuating international market prices. A stabilising, price buffer function may have to be introduced to prevent a backlash or a short circuit from occurring when planters of palm oil, for instance, are either collecting ‘windfall profits’ at $500 a ton, or suffering if it is selling at less than $150 a ton. In either case, the planter finds the system incomprehensible; he obviously cannot be expected to complain in times of feast but, in times of famine, there is every possibility that he will
harbour potentially disastrous resentment, to the prejudice of the success of such experiments as the Kimbe settlement scheme. A stabilisation effort, slow in being established, staffed through traditional bureaucratic methods, largely ignorant of the critical 'control' function required, may give the appearance of something being done but remain largely ineffective (prices may have shifted a number of times in the interval) and end up as another accretion to the inert mass of administration. What may be needed in this case is limited time, quickly responsive, decisive authority from leaders in fields such as production, processing, local government, export, finances, investment and international relations.

At this time, we may be reminded that decision making is an environmental concern in relation not only to stability of resources development and of local communities but also to basic efficiency of process, which finds its rationale in the principle of conservation of energy and of energy transformation (the second law of thermodynamics).

Our oil price example is not an isolated one; it lends itself, as do most other examples of trading in commodities based on renewable resources, to another consideration, hardly ever encompassed in environmental planning and management. Optimally, such commodities should be only the products of sunshine, water and carbon dioxide, which are, for all practical purposes, freely available. Most if not all of them contain other essential components—carbon, nitrogen, hydrogen, phosphorus, oxygen and potassium, fixed in potash, nitrates, phosphates and the like. Exports of palm oil are therefore net exports of components that will have to be reintroduced into the system at some time or another as fertilisers to maintain sustained yield, an essential feature of environmental management. Would it not be more efficient all around to barter palm oil exports for fertilisers at the point of sale (the lesser cash price received being reasonably the burden of the planter-producer) rather than having the Government, at some later but inevitable date, finding itself obliged to subsidise out of public moneys the required fertiliser imports? This is probably impossible: such products are in the hands of international oligopolies; prices for them fluctuate unremittingly; and Papua New Guinea has probably not the qualified talents necessary to strike a good deal on these manipulated markets.

A close look at even this limited example will show the range of basic policies of government that can be influenced by good environmental management: settlement, business development and industry, transportation, trade, finances, investments, science and research, information, and legislation would constitute a partial listing. Are we willing to encompass such wide ranging considerations in the process of developing policies? Certainly Papua New Guinea's eight aims give us reason to think so. But can we see the crises that loom ahead if we are not willing? And if we do decide to hold back, take stock and redirect our efforts towards achieving the eight aims, do we have the capability to do so? We need value free information, informed audiences, selfless administration, cohesive and responsive manpower, relevant education, organic stability, appropriate mechanisms, national dedication and so on. It is not so much the costs that will be imposed by changing values and expectations, by forfeiting short-term gains, by rethinking our processes, by ensuring stability, co-ordination and equity, it is the infinitely higher and unbearable costs of not doing so, and now. The world situation testifies to this. Melanesia and Papua New Guinea are still in a position to plan the future they wish; they do not merely have to await an imposed future.
V Extracting minerals and energy from the environment
The Gulf of Papua has the potential combination of vast cheap permanent power, vast supplies of fresh water, rapid forest regeneration, abundant limestone, natural gas, brown coal, and cheap bulk transport. It is located near large reserves of aluminium, uranium, and copper ores, which need these resources for processing. An industrial megalopolis is envisaged for the area; it would eventually produce large-scale international exports like electrolytic aluminium and copper, enriched uranium, paper, and a variety of timber products. The indigenous population could become largely self-sufficient in food by cultivating the Gulf region, and local markets would receive the benefits of cement and cement products, bricks, tiles, pipes and other ceramic products and basic petro-chemicals and plastics. The technical development envisaged would create opportunities, demanding large numbers of engineers, chemists, metallurgists, foresters, agriculturalists, geologists, surveyors, and mariners, together with larger numbers of supporting functions of all kinds. Development of the hydro-electric potential of the Purari River would be the first step; this would also enhance the area’s already great attractiveness for tourists, in addition to ensuring an artery for cheap transportation. None of the interrelated projects envisaged could be successful on a small scale. However, given the guarantee of political stability and a multi-billion dollar level concept, the prospects look extremely profitable.

Energy—or its famine—is the Damoclean sword that threatens our time. The hydro-electric power potential of the Purari and other Gulf rivers is stupendous on world scale. They drain country up to 4000 m with rainfall everywhere in excess of 2500 mm per annum and much of it double this. Cost per kilowatt for power development is probably the lowest in the world—and will continue so provided it is developed on a really large scale. The world’s consumption is rising geometrically, and such vast reserves of cheap power as lie latent in Papua New Guinea cannot remain neglected for long. Given guarantees of political stability, the vast capital will come—to multiply, which is the first interest of money, as of men.

Just across the straits on Cape York Peninsula, and in Australia’s Northern Territory, are the largest deposits of bauxite in the world. Nothing needs cheap power in large blocks more than the electrolytic refining of bauxite to aluminium. Bauxite ore is shipped half way round the world to cheap power; and cheap power, indeed any large source of power, is fast vanishing from the earth. The marriage of these neighbours, albeit a shotgun wedding, seems inevitable. Also in the Northern Territory is the largest source of uranium ore—more than 200,000 tons of uranium oxide, and probably more to be proved. A uranium enrichment plant gobbles more than a thousand megawatts of power—another shotgun wedding with international politics officiating. The Ok Tedi copper resource—and possibly others to be discovered—could export its product only as copper concentrate, but with the cheap transport
developments, as proposed below, and the use of pulverised brown coal (which occurs in thick seams in the Gulf of Papua) for firing the initial smeltings to matte and blister, electrolytically refined copper could be the most profitable product.

**Raw Materials**

The Gulf of Papua is richly endowed with indigenous raw materials, particularly water, limestone, cellulose, gas and brown coal, so that large-scale self-sufficient industries could be developed. The Gulf of Papua has such a surplus of fresh water that it is not valued. But water for industrial processes is becoming an increasingly scarce commodity in many countries and this water constraint will continue to intensify. Industries that need much water (for example paper, uranium enrichment, and many others) will be forced to seek out those few places that can offer it. The location of many kinds of industry will be increasingly determined by generous availability of water.

Limestone is the bulk cheap alkali of industry, an essential soil conditioner, and the raw material for portland cement and terrazzo. Large quantities of cement are needed for the construction of hydro-electric dams, tunnel linings and other works in the power development, and for the industrial complexes and airport runways based on that power. Cement is also needed for housing roof tiles, roads, kerbs and gutters, and sewer and drainage pipes. The Gulf could easily supply the whole of the cement needs of Papua New Guinea and still export to other regions. The area has pink and cream marbles suitable for dimension stone for load bearing walls, and for finishing polished surfaces that require the minimum of maintenance. Provided construction is restricted to two storeys, load bearing massive masonry is adequate, with a minimum of steel, and is suitable for tropical climates. Polished marble floors are permanent, aesthetic and cool. Masonry and marble have been declining on a world scale, mainly because of the labour content of their extraction. Papuans could be taught these skills and the labour cost would be competitive for some time to come, not only for monumental buildings but for housing as well. Marble is synonymous with luxury in building, yet for interior finish it is really economical, because once the marble is placed there, there is no rendering or plastering, no painting and no maintenance through the centuries; its high reflectivity produces economy in lighting.

Apart from power, water, and cement, and possibly sulphuric acid as a by-product of copper smelting, and nitric acid from the arc fixation process, perhaps the most important natural resource is cellulose, which regenerates at a rapid rate, and many bulk products flow from the combination: wood chips, wood pulp, chipboard, and other processed timber products, veneer, and fine selected timber. Already before World War II the Gulf had a substantial export to America of ‘New Guinea walnut’ flitches to be peeled there for the production of premium grade veneers.

High gas flows from the Gulf have already been proved, and more would develop with the demand. Kuru well ran wild for five months at a rate estimated at nearly 3 million cu m of gas per day. Barikewa was reported on test to have an open flow potential of 2.5 million cu m. and Puri after acidising yielded 130,000 cu m per day; several others have followed more recently. These are large flows—sufficient to support a liquefied gas industry in its own right, but more important for use in the indigenous industrial megapolis as cheaply transportable fuel for smelting furnaces, cement, brick and tile kilns, and as an industrial raw material for plastics and petrochemicals.

Between the Purari and Era Rivers there are thick seams of Upper Miocene ‘brown’ coals, which in fact are hard black cleated rocks. These could be used as pulverised fuel
for cement kilns, with the ash becoming part of the charge, or for firing copper smelters or brick and tile kilns based on the immediately adjacent mudstones.

**Transport**

Transport is the most intimidating and expensive item in New Guinea, but in the Gulf development envisaged, it could become the cheapest. Industrialised nations have converted their long-distance transport systems increasingly to heavy diesel trucks, passenger buses, and private motor cars on increasingly developed highways and to air, notwithstanding that the relative costs and energy efficiency of bulk transport by pipeline, barge, rail, road, and air are roughly in the proportion 1, 1.2, 1.5, 5.2, 82, and notwithstanding either that fuel costs and exhaustion will terminate this pattern by the end of the century. Short sighted as this fashion will prove for the bell-wether nations, the rugged terrain makes it still less practicable for Papua New Guinea. Water transport is still by far the cheapest for moving large heavy bulk low value products. What I contemplate in the development of the Gulf of Papua is that the first hydro-electric dam be at Bevan Rapids some hundred kilometres up the Purari River from its mouth (not to be confused with Bevan Island). The river is more than 300 m wide and is navigable to here by sizeable vessels—certainly to the sort of bulk transport barges that handle all West Germany’s bulk cargo on the Rhine. All the construction materials for the dam and associated works could be brought by barge. If the Bevan Rapids dam were designed with locks to pass such barges, easy navigation would extend a further hundred kilometres up the Purari to beyond Bevan Island (it is already navigable this far by well powered launches) and for some distance up the Aure. The top water level of the Bevan dam would be fixed so that the head of the storage reached one of the potential dam sites a further hundred kilometres upstream. Here a second hydro-electric dam, with navigation lock by-pass, would extend the navigable zone further upstream through Hatto Gorge. Similarly on the Aure, water transport upstream from the first dam would enable all construction materials and personnel for the upper dams to be transported cheaply without road construction.

The hydro-electric development would thus provide not only the bulk cheap energy for the Gulf industrial complex, but also its transport artery. The raw materials such as limestone and lumber, the materials for processing such as bauxite, copper concentrates and finished products, construction materials such as bricks, tiles, pipes, steel, and sustenance products could move freely on this artery, and indeed throughout the whole of the delta and into the Fly River, at costs lower than anywhere else in the world.

Adopting the LASH (lighter aboard ship) system there would be no rehandling of any product between its production point anywhere on this industrial complex and its final destination port elsewhere in the world. At the outset lighters could be towed to the lighter loading harbour at Hall Sound, but Port Romilly at the mouth of the Purari could be upgraded to LASH standard.

Extensive development of air transport, especially for people and mails, and of roads and feeder canals, would, of course, be necessary, but these would not be called on to carry any of the bulk heavy low product value loads. The cost difference between building roads to carry light motor traffic and those to carry also fleets of lumber jinkers and freight trains is very great.

**Self-sufficiency**

The Government of Papua New Guinea has already mounted a vigorous campaign towards indigenous self-sufficiency in foodstuffs, based on rice, sago, taro, various
tubers, local and introduced vegetables and fruits. Animal protein is less tractable, but progress is being made in improving strains and extending the production of pigs, poultry and eggs.

The Gulf region, including the coastal lowlands, foothills, and the highland shelves, is capable of developing and maintaining near self-sufficiency in food for a large industrial population. The building of barges and river craft using local timber could itself develop into a substantial local industry, for which the delta waterways are eminently suitable.

**A National Park**

One of the important long-term needs of the emergent nation is to set aside now adequate areas to preserve the natural heritage. Even in a country as primitive as interior New Guinea there are few areas free enough of indigenous people past and present to be devoted to such a purpose. Scientists of the future may well be grateful for the preservation of such a floral and faunal reserve. A couple of hundred square kilometres could be set aside from the peak of Karimui at 2800 m down to the Purari River at 200 m; this area is currently little altered from its virgin state, and would preserve all the forest, floral, and animal communities across a wide altitude range. The area is practically empty of people. The Pawaias who range through the middle Purari are a semi-nomadic people, very few in number, who have hunting tracks and occasional temporary hamlets of two or three huts. The Pawaias range over a very large area of very rugged country, and I have no doubt that this area could be alienated from them for garden and settlement purposes without prejudice to their land needs, and at quite low cost. The Palaeogene limestone, which forms the foundation under the dissected volcanic cone of Karimui, has suffered extensive solution, and 18 km west of Mt Karimui is a large valley 18 km long, 2 km wide and 600 m deep; it has no outlet, but drains through a very large underground river. This region might well be included in the Karimui National Park.

**Tourist Potential**

The industrial complex and the hydro-electric lakes would themselves become tourist attractions in their own right, as have the copper developments on Bougainville. The underground river, on the scale indicated in this pluvial climate, cannot fail to have extensive cave systems, inhabited, no doubt, by bats and glow worms. A tourist and conservation road up the 33 km long spur that runs southwest from the summit of Karimui then west along the south side of the solution valley mentioned could be the boundary of the national park; it would be a tourist road of immense value, with views across some of the wildest country in the world, highlighted by the hydro-electric lakes deep in the valleys.

**Synergism**

In summary, the Gulf has the potential combination of vast cheap permanent power, vast supplies of fresh water, rapid forest regeneration, abundant limestone, natural gas, brown coal, and cheap bulk transport. It is located near large reserves of aluminium, uranium and copper ores, which need these resources. Together this association will, in due course, explode. The cheap power potential, which cannot be neglected in the modern energy hungry world, will be the detonator. This will start a chain reaction, for each development feeds on the facilities of the other. But none of them can occur on a small scale, any more than Bougainville copper could have started on a small scale. The whole potential exists only on a multi-billion dollar scale;
then it would be extremely profitable. The large-scale international exports in sight are electrolytic aluminium and copper, enriched uranium, paper, and a variety of processed timber products. To more local markets the complex could supply cement and cement products, bricks, tiles, pipes and other ceramic products, and basic petrochemicals and plastics. For its internal market, the region could maintain a high degree of self-sufficiency.

People
Perhaps the most important yield of such development would be the opportunity it would create for the people. The technical development would demand large numbers of all kinds of engineers, chemists, metallurgists, foresters, agriculturalists, geologists, surveyors, and mariners, together with larger numbers of supporting tradesmen, artisans and labourers. Sustaining the technical force would be an equal number of people in commerce, communications, entertainment, and in the supporting professions of medicine, education, justice, and administration. The opportunities for the rising generation of young indigenous citizens are vast. But their training and preparation is an enormous task. I am certain that the boys and girls of the country have the intelligence, the integrity, the diligence, and the capacity. But as the old Chinese proverb has it: 'The time is shorter than you think'.
Mining or hydro-electric developments should proceed where it can be shown that they will benefit human and natural systems more than they will cost them. Lessons from such projects in the past, however, show that predicted benefits do not always materialise, and that costs tend to be unpredictable or un-predictable. The special problems of humid tropical environments only compound the ramifications of such projects. Examples to be heeded include the tin mining on the Klang River in Malaysia, where a series of corrective measures have still not righted the adverse effects of silting; the problems of disposal of mine tailings at the Bougainville copper mine; and heavy metal contamination in the Molonglo River near Canberra. Large-scale hydro-electric projects affect biological, physical, and human systems. Some of the impacts may be seen as adverse effects of the scheme itself, such as the effect of an impoundment on the cavities in limestone rocks, or crustal stresses producing tremors that affect the stability of the dam. Other impacts produce costs not for the scheme, but for the people of the region, such as changes in water quality, increased flooding and loss of agricultural or forest land. Changed settlement patterns, including urbanisation, have wider social ramifications, and past experience suggests that inequality of social and economic opportunity will be heightened rather than lessened.

The crucial interplay of growth and conservation of resources needed to secure the future of developing countries in the humid tropics is today sometimes lost between the extremes of excessive preservation and overambitious development promoted largely for personal or corporate gain (Dato Haji Taib Mahmud 1973). Major development projects, including mining and hydro-electric schemes, are based on feasibility studies of varying degrees of depth and precision. Often such studies fail to give due consideration to alternative means of attaining social goals, and often the socio-economic impacts of developments are not integrated into the fabric of national or regional life (SCOPE Working Group on Man-Made Lakes 1972). Recognition of social needs in terms of goods and services is found in most development proposals, but the scale at which benefits from development accrue may be quite different from that at which the costs are felt. The Kariba hydro-electric project in Africa exports all the electricity produced away from the dam area, save for that supplied to the Kariba township. The benefits accrue to people away from the dam site while great costs are incurred by those whose livelihoods are affected by the creation of the reservoir. Just as it is now recognised that the increases in food production from the ‘Green Revolution’ bring greater increases in income to those who are already wealthy than to the poor (Wade 1974), so mining and hydro-electric development may be of much greater benefit to a small section of the community than it is to the region or nation as a whole. Fortunately, the defects of existing project appraisal procedures have been recognised by the Water Resources Council of the USA (1973) and a system of
presenting accounts for the effects of projects on national economic development, environmental quality, regional development and social well being has been developed. These objectives have been applied to water resources developments in the Mekong in terms of: achievement of a higher degree of national income; the promotion of self-sufficiency in order to reach a balance of payments equilibrium; the development of a more equitable income redistribution; and the enhancement of environmental quality (Chaemsai thong et al. 1974). To the anthropologist, sociologist or politician, these objectives may still seem to be couched in the framework of western economic thought, but notions of social justice and ecological awareness are implied by the income redistribution and environmental quality objectives. While the large-scale funding for major development projects remains in the hands of institutions or corporations dominated by establishment economic theory, the criteria for project evaluation will remain in these broad beneficial or adverse effect terms. What has to be done is to broaden the visions of the financing institutions to incorporate more of the factors really important for true social progress and to develop ways of assessing those factors. In this discussion of the impact of mining and hydro-electric developments I will endeavour to highlight the types of factor neglected in traditional benefit-cost approaches and to point out long-term consequences of developments now being felt in some humid tropical countries whose water and mineral resources have been exploited for several decades.

**Dynamic Aspects of Man’s Impact on the Environment**

The impact of mining or hydro-electric development on the environment may not be felt at either the location or the actual time of the development. There may be both spatial and temporal lags in the appearance of environmental, economic or social impacts. Spatial lags are well illustrated by the Bougainville Copper tailings in the Kawerong River; effects are felt not at the mining site, but in the villages and forests downstream (Brown 1974). Temporal lags may be seen in these consequences of environmental change that appear months or years after the construction of major engineering works. Siltation in river mouths or erosion of nearby beaches following harbour construction or river training works illustrate such temporal lags. Eventually the consequences of environmental disturbance may become so severe that a new phase of construction is required to correct them. The restoration of beaches after loss of sand through man induced erosion on the Belgian, Floridan and Queensland Gold Coast shorelines is an example of this second phase of environmental modification.

The notion of environmental disturbance and natural adjustment may be expressed theoretically in terms of process-response systems. In undisturbed conditions over short time spans the various processes in the landscape are tending to adjust towards a steady state condition, within the framework of the prevailing climate and tectonic activity. When man intervenes, by changing vegetation or beginning construction works, such a dynamic equilibrium is broken. The trend towards steady state conditions is re-established when the disturbance phase is completed and the new crops, new river regime or new constructions are fully developed. The new trend may, however, be incompatible with the type of land use originally planned. When roads are cut into steep hill sides, natural processes may involve landslips in a trend towards a gentler and more stable slope angle. The landslips have to be cleared so that the road remains open and a series of adjustments by both man and nature occur.

In the man-environment process-response system, sequences of disruption or disturbance by man followed by natural responses and adjustments towards more stable conditions occur. One way of establishing these sequences is to examine the adverse
and beneficial effects of modifications to the natural environment. The achievement of satisfactory exploitation of a physical resource involves some initial costs in making that resource available, such as the loss of other forms of productive use of the land involved and the construction of access roads, and, sometimes hopefully, a larger benefit, either in strictly economic terms or in social and cultural terms, from the advantages gained. Many phases of exploitation, however, see the benefits being eroded as new costs arise. The massive effects of pollution, and the costs society has to face in reducing air pollution could be regarded as an example of this change from a phase of benefit to a phase of cost in the exploitation of the atmosphere. The phases of benefit could be regarded as equivalent to quasi-equilibrium trends, while the cost phases are periods of disruption and effort to adjust towards a new equilibrium (Douglas 1971).

**Process and Response to Mining and Land Development in Kuala Lumpur**

The inland part of the Klang River catchment on the western flank of the main range of peninsular Malaysia remained virtually uninhabited until after 1850, when the alluvial tin deposits of the interior foothill zone began to attract Chinese immigrants (Jackson 1964). Exploitation of alluvial tin by the lampang method led to the discharge of silt laden waste water directly into the river. Further downstream the silt settled out on to the channel bed, reducing the ability of the river to carry flood flows and thus causing more frequent flooding of riverine land. The expansion of the mining industry, the associated market gardening and the related colonial encouragement of plantation agriculture by European settlers seeing agricultural holdings as long-term investments suited for long maturing crops, firstly coffee and later rubber (Jackson 1968) led to increased storm runoff and soil erosion.

The response to these changes in land use was adjustment of the hydrological cycle and river systems. Channels became choked and flooding frequent. To cope with the new man induced natural hazard, legislation to control silt discharges from tin mines and a change in rubber plantation management from clean weeding to cover crops was introduced. Legislation against the cultivation of slopes over 18° and the discharge into rivers of water containing high concentrations of sediment from mining ponds exists, but the enforcement of such legislation is difficult. Legislation to control logging operations and the development of hill land for agriculture and to establish a soil conservation authority is still needed in West Malaysia (Leigh 1973).

While the legislation and change in management practices counteracted some of the early causes of deterioration of the Klang River system, the inflow of silt and high peak discharges continued, especially as the city of Kuala Lumpur increased in size. In 1926 a great flood affected most of peninsular Malaysia, every river rising to record or near record heights. Kuala Lumpur was badly affected and the 1926 floods were the spur to more comprehensive legislation on drainage and to a scheme to canalise the reach of the Klang River through the city. The straightened, double trapezoidal cross-section channel now carries the majority of floods safely through the city but, immediately downstream of the canalised section, the natural channel remains inadequate and the Malay kampongs and squatter settlements, full of poor recent migrants from the country to the city in search of work, still suffer frequent flooding.

As Kuala Lumpur expanded, urban runoff increased, with many tributaries now being unable to cope with storm runoff (Douglas 1972; Leigh and Low 1973). Development of industrial and housing land in some sectors of the city has aggravated flooding and disruption in others. Huge costs arise from flooded highways, damaged homes and river bank erosion. The rebuilding of culverts and modification of river channels are the second phase of environmental modification provoked by the initial
land clearance and urban development process. In Kuala Lumpur, environmental response to mining and land development processes is particularly dramatic because storm rainfall is intense and frequent and deep weathering of almost all rocks provides abundant debris for erosion by water once the plant cover is removed. The Kuala Lumpur case provides a vivid example of what mining and industrialisation can do to the humid tropical environment.

Mining and the Environment

While underground mining presents negligible claims for land, open cut, dredge or gravel pump mining uses large areas and leaves infertile wastes of degraded soil once ore reserves are exhausted and mining is finished. The exploitation of alluvial or subsurface mineral resources is tempting, for the returns can be high and immediate, and developing countries may derive particular benefit from such exploitation during their early years of growth. The sterile areas of land left by such methods of exploitation, however, present a sombre memorial for later generations (Watson 1961).

The Bougainville Copper development has given a solemn warning of the dimensions of environmental disturbance that modern mining methods may cause. Not only were large areas of forest and weathered rock removed before mining could begin, but the behaviour of the Pinei and Kawerong Rivers was greatly modified by huge volumes of sediment washed into the streams during road construction and the removal of overburden. Disposal of tailings into the Kawerong River has transformed the river from a meandering to a braiding habit, with associated increases in channel gradient and flow velocity. Despite careful control measures, the spread of the tailings has killed large areas of rain forest, threatened several villages, and deprived people of agricultural land and the fish that once lived in the streams (Brown 1974). Contamination with heavy metals and possible pollution of the marine environment at the mouth of the river could have wider implications and suggest a need for more stringent pollution control legislation.

Malaysia has derived great benefit from her tin mines, but not without many land and river management problems. In 1967 the Chief Inspector of Mines wrote:

Malayan rivers traverse an alluvial plain in their lower reaches with an accordingly low velocity and inability to transport a large silt load. The retention of mine tailings is consequently essential in order to avoid silting the rivers and damaging agricultural and commercial interests, both by burial of property under silt and by increased flooding. In 1952, for instance about 250 million m$^3$ of ground were treated for the extraction of tin concentrates. Owing to lack of effective retention measures in the past, villages have been made uninhabitable and areas of padi fields rendered useless, though soil erosion from agricultural holdings has undoubtedly contributed to the damage.

Possibly the most spectacular example of siltation due to mining occurred on the Selangor River where Chinese mining in the nineteenth century resulted in large quantities of silt being discharged into the river upstream of the town of Kuala Kubu. Additional silt was derived from areas cleared of forest on steep slopes adjacent to the mining areas. A dam built upstream of the town to protect it from floods and silt burst in 1883. The town became subjected to frequent flooding, every flood leaving a deposit of silt. The bed of the river became choked with sediment, and the channel tended to become wider and shallower. Gradually sections of the town became too flood prone to be habitable. The main railway line had to be relocated on two occasions and finally the whole town was abandoned for a new site on the valley side. The mining and land clearing processes had led to a drastic response by the Selangor River, which finally provoked a new set of costs in the relocation of the town.

Heavy metal contamination, such as that which has occurred on the Molonglo River
downstream of the Captain's Flat lead-zinc mine near Canberra, Australia (Weatherley et al. 1967), or in the East Finniss River downstream of Rum Jungle in the Northern Territory (Senate Select Committee on Water Pollution 1970), has particularly disastrous effects, killing vegetation and rendering soil barren and unfit for cultivation. The unprotected soil is subject to severe erosion with further complications of the behaviour of the river downstream. The Senate Committee also said that close control will have to be exercised to keep waste disposal from large mining complexes and townships at Gove, Groote Eylandt and McArthur River, and from new industries such as prawning, wood chip production and large-scale agriculture, within acceptable standards. Drainage from mining areas may be acid, as is coal mine drainage water (Biesecker and George 1966) or saline, such as the oilfield brines which affect the quality of surface streams in Texas (Rawson 1967) and other oil producing areas.

**Process and Response in Water Resource Systems**

Development of water resources is often seen as a means of distributing great benefits over a wide sector of the population. Indeed, the Ord River scheme in tropical north-western Australia has been defended on the grounds of its social and economic impacts on the region rather than its benefits to the Australian nation as a whole. Nevertheless, the view of massive technological investment as a panacea has come in for harsh criticism. Brower (1975) reports on the Skardu, Kashmir irrigation project, which required massive use of local labour to build roads and other works during the construction phase. Many men left the village to work on the road. Fewer were left to tend the crops. To ease the labour shortage, the villagers decided to have many more children. These were not very well fed because there were too few adults to work in the fields. Many children died. So their parents tried to solve the problem by having still more children. This further strained the limited fields on which there were too few tending to grow the food, so there was still more hunger. The women might have helped more in the fields but they were busy having children. Things kept getting much worse and children starved. But the villagers were brave. They knew soon the new road, the new dam, and the new canals would make it possible to have more jobs, grow more food, sell what they could not eat, improve their cash flow and establish a favourable balance of trade. The survivors would live happily ever after.

Brower says that eventually all the wonderful new works were completed and water was released from the dam into the canals. ‘But do you know what? The canals ran uphill from the dam and the water wouldn’t’. The panacea of the big scheme is seen as energy intensive and associated with many environmental costs and future problems.

The hydro-electric schemes marked for the Purari, Kikori and Strickland Rivers (Turvey 1973) have some of this big scheme aura. For Papua New Guinea they may fill something like the role played by the Aswan Dam in Egypt or the Volta Lake in Ghana. Yet, sadly, these great, imaginative, bold schemes have brought dramatic, unexpected, and costly environmental responses.

Lake Brokopondo in Surinam has some similarities to the reservoir which would be created by the proposed Wabo Dam on the Purari River. Set up to generate hydro-electric power for bauxite smelting, Lake Brokopondo covers over 1500 sq km of lowland rain forest land with 2000–3000 mm annual rainfall. Although, before the dam was closed, the oxygen content of the river was nearly always saturated at the surface, four weeks after closure stagnation conditions developed, oxygen was exhausted in the deeper layers, and only present in the upper 3–4 m of the water body (Leentvaar 1966). Gradually the oxygen content of the surface layers became stabilised, but at greater depths oxygen was still lacking and through the decay of organic matter hydrogen sulphide developed. Fluctuating water levels during the operation of the
lake produced some reaeration and oxygenation down to 6.5 m (Leentvaar 1973). Fortunately this lack of oxygen kept the water too acid for the breeding of vectors associated with malaria, bilhazia or filariasis, diseases that have caused severe problems around other man-made lakes in tropical regions.

Lake Brokopondo suffered great biological changes. Water hyacinth and floating fern (*Ceratopteris pterioides* and *C. deltioidea*) spread rapidly over the lake surface (Table 32.1). Transpiration by water hyacinth affected the storage volume of the lake, evapotranspiration by the plant being 1.4 times the evaporation from the free water surface.

<table>
<thead>
<tr>
<th>Year</th>
<th>Ha covered by water hyacinth</th>
<th>Ha covered by floating fern</th>
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<tbody>
<tr>
<td>1964</td>
<td>5000</td>
<td>1200</td>
</tr>
<tr>
<td>1965</td>
<td>17900</td>
<td>11700</td>
</tr>
<tr>
<td>1966</td>
<td>41200</td>
<td>17000</td>
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<table>
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<th>Year</th>
<th>Ha covered by water hyacinth</th>
<th>Ha covered by floating fern</th>
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<tr>
<td>Maximum capacity</td>
<td>150000</td>
<td>78000</td>
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<tr>
<td>Lake area in 1965</td>
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</table>

To eradicate the water hyacinth, 2–4–D spraying from aircraft began in 1965. By 1970 the water hyacinth was absent (Leentvaar 1973). Although nothing is reported on the side effects of 2–4–D on Lake Brokopondo, animals that depend on plants sprayed with 2–4–D have been shown to decline in number in the affected areas (Best 1972). Probably the short persistence, lack of biomagnification in food chains, and rapid excretion of 2–4–D by animals preclude chronic exposure and, therefore, chronic toxicity (Norris 1971).

The trees of the submerged forest will not decay in this acid, anaerobic water. Large stagnant areas develop within reservoirs of this type, with bare, dead tree trunks punctuating the still, lifeless water, as at Koombooloomba Dam on the Tully River in north Queensland.

Some hydro-electric plants have suffered from manganese deposition in penstocks. The stalked, budding bacteria, *Hyphomicrobium*, are thought to be of great significance in manganese deposition in power pipes at the Kareeya plant downstream of Koombooloomba Dam in humid tropical Queensland (Bayly and Williams 1973). Discharge of deoxygenated water from dams can have great effects on aquatic life downstream, possibly affecting fish harvests by riparian dwellers.

**Geophysical Aspects of Man Made Lakes**

The creation of an artificial water body places great stress on the earth’s crust beneath the reservoir, evidence of depression of the crust beneath Lake Mead in the western United States being well established (Jennings 1965), but recently the phenomenon of seismicity provoked by reservoir filling has been found to be widespread both in regions of high earthquake frequency and in regions thought to be stable (Rothé...
1973). Although the Gulf of Papua area lies to the south of the main zone of earth­quake activity (Denham 1970), rivers like the Purari flow through highly folded terrain of great lithological diversity. Crustal stresses produced by water impoundment could be expected to be diverse and unequal. Turvey (1973) has already indicated that the massive limestone formations traversed by the Kikori, Purari and Strickland pose major hydrologic problems.

The Koyna Dam on the basalts of the Deccan plateau of India (17°23′N, 73°45′E) one of the least seismic areas of the world, has produced its own tectonic response to the water impoundment process. Only a few months after the partial filling of the reservoir (860 x 10^6 cu m) in 1962 seismic shocks were observed, their intensity increasing throughout 1963. The epicentres of the tremors were either at the dam or 40 km upstream. The shocks continued up to 1967, when, on 10 December a destructive shock cracked the dam itself. At least some geophysicists attribute these events to the filling of the dam itself (Rothé 1973). Although the stresses caused by impounded water may be small compared with natural stresses, increased pore pressures may change the field of effective stresses. Reservoir impounding may increase the heterogeneity of the media, decreasing the competence of rocks and thus causing a release of the accumulated strain through earth tremors (Gupta et al. 1972).

ENVIRONMENTAL CHANGES DOWNSTREAM OF IMPOUNDMENTS

The impoundment process blocks the free flow of a river, the reservoir acting as a flow regulator and sediment trap. Depending on the level at which water is drawn out of the reservoir for return to the river downstream, the impoundment also creates changes in the thermal and chemical characteristics of the river. Changes in river regime downstream of the dam affect agriculturalists, fishermen and wildlife (Attwell 1970; Lawson 1970). In some cases the reduced flow of the river downstream during the years when the dam is filling allows salt water to penetrate further up estuaries and river mouths changing water quality and fisheries. Later releases of water may wash the salt water seawards down the estuary.

As the dam reduces the silt load of a stream, water released from the dam may scour the channel bed and erode banks downstream of the impoundment. However, lack of silt and regulation of river discharge deprive flood plain areas of the seasonal inundation and silt deposition that is often essential for vigorous regeneration of riparian vegetation. Lack of floods permits vegetation build-up in oxbows and other waterholes, which used to be washed clear by the floods. On the other hand, sudden, out of season releases of water from the dam have great effects on wildlife in the major river channel and floodplain (Attwell 1970). Navigation and traditional uses of the river have to adjust to new regimes. Reduction of flooding and reliability of regulated flow may be benefits, but loss of natural siltation and vegetation regeneration may involve some costs.

RESETTLEMENT SCHEMES ASSOCIATED WITH WATER RESOURCES DEVELOPMENT

Resettlement schemes have long been seen as a means of rural and national development and a solution of the problems posed by rural poverty and general landlessness. Quality of life is often seen by planners as associated with the bringing of urban amenities to rural people. It is thought that one of the best and easiest methods of injecting this urban element is through the creation of new nucleated settlements that can lead to rapid social and economic development, to ‘modernisation’ or ‘urbanisation’. Yet in many countries, such as Malaysia (Tunku Shamsul Bahrain 1973), land has been distributed without any concerted effort by government agencies to bring about
the necessary changes in attitudes or environments. Often material amenities such as roads, water supply, houses and religious buildings are given greater attention than preparation of settlers for their new lifestyle.

While in general persons moving to new land settlement schemes are volunteers who have applied to agencies for admission to a scheme, the new settlers affected by reservoir construction, mining and other forms of land development are forced migrants. Much more care has to be given to preparing these migrants for resettlement, even if they are relocated in the same valley. Records of past and existing resettlement schemes in developing countries reveal not only many problems, but sometimes outright failure and collapse. Resettlement agriculture does not necessarily bring higher standards of living. Some may gain much but others may have to revert to lower standards because their socio-economic conditions have not improved sufficiently to enable them to take advantage of the new conditions which may be expected to occur (Afriyie 1973).

With land such a 'hard' element of culture in Melanesia, with the whole structure of traditional agrarian systems resting on land (Brookfield and Hart 1971), resettlement could be one of the most crucial aspects of water resources and mining development in Papua New Guinea. The whole cultural underpinnings of the land issue will have to be evaluated when the lowest cost dam sites, in engineering terms, happen to involve inundation of densely populated valleys. The political and social implications of massive forced resettlement may turn out to be costs which exceed the benefits of optimum engineering design.

**Urbanisation, Industrialisation and Environmental Quality**

On the surface, it might be suggested that the new mining and hydro-electric developments would provide jobs for the people displaced by the new enterprises. Yet, the new developments are likely to be energy rather than labour intensive, using caterpillar tractors and Euclid trucks, rather than men and women with picks and shovels, and few of the forced migrants will have the technical skills to be immediately suitable for many of the jobs. New people will move into the region and add to the social pressures on the local population.

New settlements, both as construction camps and permanent towns will be created. With the new settlements will come environmental and social pressures. Land clearance changes stream behaviour with high sediment loads entering streams, concentration over 80,000 mg per litre occurring in streams affected by clearing for urban development near Kuala Lumpur (Douglas 1972). Industries discharge wastes into urban streams causing organic pollution (Ho Sinn Chye 1973). The discharge of industrial wastes with high organic matter in tropical waters is probably far more detrimental to aquatic life than in temperate regions. Bacteria and other microorganisms associated with the breakdown of organic matter become exceedingly active at high temperatures (George et al. 1966). If the ratio of waste discharge to natural river flow is high, deoxygenation of the river is likely to occur, reaeration not being effective for several tens of kilometres downstream. In major rivers, where waste discharge contributes only a small part of the total flow, as on the Ganges near Kanpur, seasonal low flows may be polluted, but storm runoff and seasonal flood discharges may restore the system (Ray and David 1966; Saxena et al. 1966). The high discharges of Papuan Gulf rivers will be a major asset in reducing contamination, but inclusion of adequate environmental quality criteria in the planning of development projects could help to avoid many of the problems that have been associated with industrialisation in other developing countries.
Urbanisation creates a modified physical environment with its own problems of land stability, air quality and drainage. Major tropical cities are beset with a range of geomorphological and hydrological problems, such as landslides and flooding in Rio de Janeiro (Mousinho de Meis and da Silva 1968) and quarrying and urban drainage in Singapore (Wong Poh Poh 1969). Coastal waters, especially harbours and estuaries, which may be vital sources of food for subsistence fishermen, are easily polluted, Kingston Harbour, Jamaica, being particularly badly affected by sewage and industrial wastes (Worthington 1971; Wade et al. 1972). While such environmental impacts may be minimised, social impacts of urbanisation, which include rural-urban migration and the growth of squatter settlements, place pressures on planners and administrators to adopt solutions that favour public health and public order but that are not socially desirable or acceptable.

The complications of the urban scene demonstrate the ramifications of the impacts of mining and hydro-electric development on the humid tropical environment. Some of the impacts may be seen as adverse effects of the scheme itself, such as the effect of an impoundment on the cavities in limestone rocks, or crustal stresses producing tremors that affect the stability of the dam. Other impacts do not produce costs for the scheme, but for the people of the region, such as changes in water quality, increased flooding, loss of agricultural or forest land. But the developments have wider social ramifications, particularly through forced migration of resettled villagers, immigration of skilled workers, growth of urban centres and the superimposition of economic activity dependent on world markets on an essentially local economy. The social responses to these processes will vary greatly from one group to another, but past experience suggests that inequality of social and economic opportunity will be heightened rather than lessened. The notions of social justice and ecological awareness in the planning of mining and water resources development ought to be far more than the symbols of political lip service they have been in many advanced Western economies. But environmental quality on its own should not be pushed to the extent of restraining the achievement of the social goals, income redistribution and higher living standards the people of the region themselves desire.

**References**


Environmental Aspects of the Purari River Scheme

CHARLES R. GOLDMAN and RODERICK W. HOFFMAN

Hydro-electric projects tend to build up their own economic and political momentum. This momentum, and the fact that hydro-electric projects involve much more than just economic and engineering problems, make the inclusion of biological and social planning from the very beginning of the project a necessity. A number of classification systems have been developed in attempts to predict impacts and improve planning; this chapter discusses in some detail impacts centring around the creation of a tropical reservoir, impacts of access roads and power lines, and the impact of the industrial centre to be created. Although reservoirs are created primarily for hydro-electric production, irrigation or flood control purposes, they in fact represent a new man-made ecosystem. Reservoirs can be used as fish protein sources, the basis of tourist trade, avenues of transportation, and focal points of social reorganisation and community development. Some wildlife and human habitats and possibly archaeological and historic sites will be lost and new settlement and employment patterns will result from dam building and, in the case of Purari, from subsequent industrial activities. Expert advice and planning are needed to ensure that public health and soil and water productivity are not seriously endangered by the new environments created. Increased involvement of Papua New Guinea in world trade and politics will result from the creation of an industrial centre and port. The basic question on development must not be merely is it possible, but is it desirable, and under what well defined conditions is it acceptable.

The success of hydro-electric projects can no longer be measured in terms of purely economic benefits or the amount of electrical energy produced. The ultimate success or failure is just as dependent upon the long-term ecological and sociological impacts of the project and high environmental and social costs are not always offset by the power produced or the revenue generated by hydro-electric production. Lack of the safeguards for the environment and the sensitivity to local social needs that might be interpreted as overcautious or overexpensive today are likely to be considered gross negligence and short-sightedness by future generations. Recent examples of problems with man-made lakes in the tropics help to focus attention on environmental and social impacts. As pointed out by Freeman (1974), hydro-electric projects tend to build up their own economic and political momentum and this leads to inflexible planning. This momentum, and the fact that hydro-electric projects involve much more than just economic and engineering problems, make the inclusion of biological and social planning from the very beginning of the project a necessity.

As seen by Figure 33.1 environmental impacts of hydro-electric projects are complex and require many specialists for their study. Lagler (1969) divided the analyses of hydro-electric projects into the following categories: economic and social problems, public health, agriculture and livestock production, forestry and forest product industries, wildlife, recreation and tourism, navigation and water safety, ground and
The Melanesian environment

### PROBLEM AREAS

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### TECHNICAL FIELDS INVOLVED IN PROBLEM SOLVING

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Fig. 33.1 Broad relationships and secondary problem areas of man made lakes and some, but not all, of the technical fields involved in problem solving. The heaviest line shows the most fundamental relationship (after Lagler 1969).
surface water development, water quality control, and aquatic nuisance plants. Impact areas are also often divided in relation to the dam site upstream, and inundation area downstream (Hagan and Roberts 1973). Goldman (1972) divided impacts according to physical, chemical, biological, human ecological and downstream considerations. In the recent environmental studies design for the Purari River development, Goldman et al. (1975) used classifications based on environmental, sociological, demographic and public health impacts. These numerous classification schemes, all for the same type of project, are an indication of the complexity of impact analysis associated with developing hydro-electric potential, and also of the need for a holistic approach to environmental planning.

It should be emphasised that the impacts of hydro-electric projects are not limited to the construction of a dam and power station. Indeed, the project is not merely the development of hydro-electric potential, but the development of both the energy producing and energy using facilities. The energy consuming component invariably has a considerable lag time, but must be readily developable to justify the projects in the first place. In recent tropical reservoir development, energy production has been planned primarily for industrial users. The Kariba Dam was constructed to generate energy for the copper belt mines (Balon 1974) and Akosambo Dam for aluminum refining (Moxon 1969). In Papua New Guinea industries such as aluminum refining, natural gas liquefication and perhaps even uranium enrichment have been proposed as possible energy uses of the Purari development. The impact of the energy consuming industry may well be greater than the impact of the dam or series of dams and transmission lines and industrial centre at Hall Sound.

The Purari River Development Scheme

Several plans have been proposed for the development of the Purari River basin. These plans range from the construction of twelve dam and power stations (Bryne 1972) to the single site at Wabo. Estimated power production ranges from 7200 megawatts (Nippon Koei 1972; SMEC 1974) for total basin development to 1500 megawatts from a power plant at the Wabo site (SMEC 1974; Lang 1974). Comprehensive basin development, including intensive agriculture, commercial forestry and commercial fisheries exploitation has also been evaluated in brief by Barr (1974).

This chapter concerns the impacts of the plans to construct a dam and power station and tropical reservoir on the Purari River near the Wabo Creek confluence (see Figure 33.2), power line and road access to the dam, and consideration of the industrial complex to utilise the energy. The dam itself would be of the earthen fill type, 140 m in height and 700 m in breadth. It would create a lake of 260 sq km and 14 cu km volume. The lake would have a moderately dendritic form, since there are few large tributaries entering the Purari River in the area to be inundated.

Generation of electricity by the Purari River does not depend on a large lake volume. The flow of the river, and the consistency of this flow are reportedly adequate to produce hydro-electric power without a large storage capacity. The dam must be constructed, however, to provide the necessary head for power generation. Recorded annual flow rates of the Purari River range from 920 cu m per sec to 10,235 cu m per sec with an average of 2470 cu m per sec. Although this is much smaller than the Mississippi River and Amazon River (19,675 and 198,219 cu m per sec respectively) it is considerably more than the amount flowing through the Sacramento River (986 cu m per sec) and Colorado River (665 cu m per sec) and the Zambezi River (1200 cu m per sec).
Human Ecological Considerations

Relocation of Inhabitants

The most severely affected area is the immediate catchment basin. This area is primarily lowland rain forest, with three canopy layer heights and a ground and shrub layer. These layers restrict light penetration to the ground. *Pterocarpus, Anthoscepalus, Intsia* and *Endospernum* are a few of the several genera present. Forest regeneration is poorly understood in tropical areas (Gomez-Pampa *et al.* 1972) and the management of the forest ecosystem will become a problem if people migrate to the lake area or if forest resources are utilised.

The first impact is the flooding of people's homes and land. Three hundred to four hundred people, referred to as Pawaia and Pepikes in government patrol reports, live in the area. The villages of Uraku, Kairuka, and Tato would be lost. Construction of a dam will necessitate resettlement of these people. Although the number involved is relatively small (compared to 70,000 in the Volta project, 50,000 by construction of Lake Kariba, 100,000 by the Aswan High Dam, 50,000 by the Kainji Dam (Brokensha and Scudder 1968) and 1500 at the El Cajon project in Honduras), the Government's efforts at resettlement will be very important to the successful acceptance of the project by local people. These people must be included in planning processes and various avenues of communication should be kept open with them at all stages in the project (Brokensha and Scudder 1968).

International experts on the relocation of people after reservoir building emphasise the fact that resettlement and related sociological impacts of hydro-electric projects must be treated as integral parts of the development and must not be viewed as annoy-
Extracting minerals and energy from the environment

ing side issues (see Chambers 1966, 1969; Brokensha and Scudder 1968; Scudder 1966, 1973). During field work on the El Cajon project in Honduras, Goldman and co-workers found that local people expressed preference for being relocated to new agricultural areas and working as a community to rebuild their homes if the area was inundated. This information was obtained only by direct communication with the local inhabitants (Goldman 1972).

Salvation of Archaeological and Historical Sites

Archaeological and historical sites are very likely to be in the inundation area (R. Wagner and M.J. Mountain, personal communication). The Purari River has served as an avenue of communication and trade between the highlands and lowlands. Numerous limestone caves were probably used for shelter in past times. These sites should be discovered and saved. They are a part of Papua New Guinea’s heritage, and their loss would be an unnecessary break with that heritage.

Although the salvation of world famous archaeological structures such as the Abu Simbel’s temples, which would have been inundated by Lake Nasser, is accepted as a worthwhile project (Gester 1969), less spectacular archaeological sites are no less important to developing nations.

Environmental Impacts

Geological Considerations

The Variant Dam disaster in Italy in 1963 serves to underscore the importance of thorough geological investigation throughout the inundation area. There, a massive landslide into the lake displaced most of the reservoir’s 44,600 million gallons. Although the dam was well engineered and suffered only minor damage, the huge volume of water passed over it and 3000 people were killed below.

Reservoirs have been implicated in increased fault activity (R. and H. Ehrlich 1972). Faults are reported in the Wabo area and forty-four seismic events have been recorded in the area within 100 km in the 4–7.2 range on the Richter Scale (Bureau of Mineral Resources earthquake file). Much of the area is limestone and fissures are present. Further study of the area’s geology and geomorphology will lead to an evaluation of earthquake hazards and the dangers of landslides. Subterranean drainage systems will also need investigation. A thorough geological investigation will also lead to an understanding of erosion.

Watershed Considerations

Impacts of the dam will result from both the destruction of an existing environment and creation of a new one. Impacts will involve the entire drainage area. The upstream area becomes the watershed of the new lake and will greatly affect its water quality. The immediate area that is inundated becomes lake shore habitat, and downstream areas are variously affected by water quality and flow changes.

Allen (1972) describes the sedimentation problems at the Anchicaya hydro-electric project in Colombia. The new Simon Bolivar highway and increased habitation in the watershed increased erosion rates. Increased population and increased cash cropping have been instrumental in destroying the natural balance of ecosystems in Panama, resulting in destruction of soil humus and loss of soil nutrients (Croat 1972). The upper area of the Purari drainage has steep terrain and is densely populated. The population is also increasing. This sets the stage for the exhaustion of soil resources. Watershed management is the only practical solution to controlling erosion rates and
nutrient inputs into reservoirs (Allen 1972) and careful advanced planning is essential to conserve this non-renewable soil resource.

Some people in the highlands already utilise soil conservation practices of considerable sophistication. Gardens are often fenced and tended carefully, and the benefit of the nitrogen fixing *Casuarina* tree is recognised. These systems should be used as much as possible in watershed management plans. Increasing populations are already making more intensive use of land in the highlands.

**LIMNLOGICAL CONSIDERATIONS**

Although reservoirs are created primarily for hydro-electric production, irrigation or flood control purposes, we must not forget that they represent a new man made ecosystem. The type of aquatic ecosystem they become is in part determinable in the planning stages. Care taken during planning and construction will enhance or detract from the project's overall success. Reservoirs can be used as fish protein sources, the basis of tourist trade, avenues of transportation, and focal points of social reorganisation and community development.

The trophic state (food producing or fertility level) of the reservoir will largely determine its utility. The particular trophic state of the reservoir results from interactions of climatic conditions (especially solar radiation), nutrients, stratification, aquatic weeds, algae and fish populations. Nutrient inputs are a major factor in determining the biological productivity of the reservoir. Natural soil structure and erosion play a major role in nutrient as well as strictly sediment input. As stated earlier, increased erosion resulting from more intensive agriculture in the watershed is important in establishing the level of nutrient loading of the system (see Croat 1972). Tropical soils are particularly subject to leaching and rapid nutrient loss if the natural vegetative cover is destroyed.

Reservoirs, owing to short replacement times, have productivity determined more by the nature of the inflowing water than internal lake recycling (Beauchamp 1968). Replacement times for several tropical lakes are given in Table 33.1. Wabo Lake has a relatively short retention time, and this makes the river a very dominant influence on the various characteristics of the lake. The short replacement time also influences strategies for lake management, as will be discussed later.

<table>
<thead>
<tr>
<th>Lake</th>
<th>Replacement Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchicaya, Colombia</td>
<td>0.7 days</td>
</tr>
<tr>
<td>Wabo</td>
<td>1.8 months</td>
</tr>
<tr>
<td>Kariba</td>
<td>3.6 years</td>
</tr>
<tr>
<td>Lanao, Philippines</td>
<td>6.5 years</td>
</tr>
<tr>
<td>Victoria</td>
<td>170.0 years</td>
</tr>
</tbody>
</table>

The dominance of a river on lake characteristics can be seen by following the limnological changes from the point of inflow to the dam. For example, oxygen levels are high where the Zambesi River enters Lake Kariba because of the high oxygen content of the river waters. Oxygen levels decrease along a gradient towards the dam (Coche 1974). Thermal stratification does not develop near any of the rivers flowing into Lake
Extracting minerals and energy from the environment

Volta, but does develop near the dam (Viner 1970a). Phytoplankton communities also reflect the change from riverine to lacustrine dominance in Lake Volta. Cyanophycean (blue-green algae) dominated communities are replaced by diatoms towards the lake’s centre (Viner 1970b).

Flowing waters can have very high productivity, as shown by Odum (1956). River systems had highest production rates below polluted areas. Unpolluted rivers had daily production rates in the range of 0.4–14.0 g of carbon per square metre. Most of the river systems reported by Odum (1956) were also classed as heterotrophic (having a gross production rate/community respiration ratio of less than 1).

Large river systems and their associated estuaries are largely dependent upon energy fixed in the neighbouring terrestrial or wetland systems. This allochthonous matter was shown to comprise 99 per cent of the energy entering Bear Brook, New Hampshire (Fisher and Likens 1972). Considering the density of tropical forest canopy with resulting high possible allochthonous organic inputs and low light penetrations (see Fittkau 1964), the same predominance of an allochthonous energy source is expected in tropical streams.

Inorganic matter enters the streams in dissolved and particulate forms. It is convenient to think of two material pools in aquatic systems, organic and inorganic. Both pools have particulate and dissolved forms, and matter from one pool can be converted to the other by biological processes. Autotrophy produces organic matter from inorganic and adds energy to the aquatic system while heterotrophy tends to reverse the process and mineralise organic matter. Of course, interactions between various factions are possible, such as the self-aggregation of dissolved organics to form particulate organics (Riley 1963; Lush and Hynes 1973). If a system is based on heterotrophy it means that respiration dominates photosynthesis, and there is a net loss of energy from the system. The pool of organic matter, both dissolved and particulate, undergoes an overall degradation towards the inorganic. Some of this inorganic material may, of course, be recaptured by photosynthetic members of the system.

In contrast to riverine systems, lakes are usually dominated by autotrophy. Productivity exceeds respiratory losses, resulting in a net increase of fixed energy in the system. There is a net conversion of dissolved inorganic matter to the organic pool. Such a system can be even more efficient in a reservoir of short retention time. Provided the relationship between retention time and productivity is balanced, the reservoir may act as a chemostat, constantly bringing in dissolved nutrients and exporting fixed organic matter in both dissolved and particulate forms.

Lewis (1974) and Talling (1965) have shown that tropical lakes can have very high photosynthetic productivity. Lewis (1974) reported 2.6 g of carbon per square metre per day as gross production for Lake Lanao, Philippines, and Talling (1965) reported 4.2 g for Lake Victoria. Both authors noted the high photosynthetic rates without high algal population densities. These high rates show the high potential of converting incoming inorganic nutrients to phytoplankton biomass in tropical lakes. This is true even with a fast replacement time such as would be encountered at the proposed Wabo reservoir.

It is very likely then, that a key change in water characteristics due to impoundment will be in the balance between autotrophic and heterotrophic products. A net increase in fixed energy available for downstream organisms could result, but unfortunately this is not certain.

This picture is complicated by the fact that larger rivers begin to have productivity/respiration ratios nearer lake values. This may not, however, be the case in the Purari River, owing to its high turbidity and consequently very limited light penetrations.
How much suspended material will settle out in the upper reaches of the reservoir is of great importance. As a river enters a standing body of water, its velocity is decreased and the heavier components of its silt load are deposited. The major bed load will be deposited close to the point of inflow, and will eventually form a delta. Figure 33.3 is an idealised cross-section of the sediment build-up at the mouth of a river. The form and extent of sediment deposition will depend on lake basin morphology, size distribution of the sediment load and river velocity. Silt may or may not be deposited with the bed load. The lighter, finer silt will be carried further into the lake and its fate will depend upon interactions of lake water and inflow densities and basin shape.

![Idealised cross-section of sediment build-up at the mouth of a river](image)

**Fig. 33.3** Idealised cross-section of sediment build-up at the mouth of a river: A. original lake bottom; B. early deposition; C. later deposition.

The inflowing water will flow through the lake at a density level determined by the density gradient of the reservoir water. Underflow, interflow and overflow density currents are all possible, and these density currents will be responsible for distributing sediment loads away from the delta and deposition of 'bottom set' (Neel 1963). The pattern of density flow can be utilised to manage lake and downstream water quality. Management is made possible by the use of multiple level outlets. The difference between a natural lake basin and a reservoir basin, with inflows and outflows, is seen in Figure 33.4. Thermal structure has also been included in the figure.

As seen in Figure 33.4, natural lake basins generally have surface inflows and outflows. During periods of thermal stratification, only epilimnetic waters are removed from the lake. This water will be warmer, have higher living organic matter concentrations and be well oxygenated during the day. If stratification is permanent or semi-permanent, the hypolimnion may be richer in dissolved nutrients, anoxic and may contain hydrogen sulphide. Outflow will always have water processed to some degree by lake communities.

In man made lakes, outflow can be taken from any level desired, if the dam is constructed with multiple level outlets. Water levels can be mixed in the outflow to yield more desirable characteristics for the downstream ecosystems. It is also possible, and sometimes desirable, to alter thermal stratification by manipulating outflow levels.

Thermal structure is important for biological productivity sedimentation, and management of downstream water characteristics. A general pattern for low elevation tropical lakes favours irregular circulation. During periods of stratification, the epilimnion is subject to minor internal stratification and remixing. Lewis (1973) terms this atelomixis (*atelos* is Greek for incomplete) and shows that it is due largely to short-term climatic factors. The frequent rain and cloud cover at the Wabo area is likely to have considerable influence over stratification.
Cooling and descent of littoral water masses is also an important mechanism of water movement in the tropics. Talling (1969) observed this in Lakes Albert and Malawi in Africa. Such a mechanism contributes to the exchange of surface and deeper waters. Reservoir basin shape and climate will influence the degree and frequency of this mechanism for water movement at Wabo.

The interaction of inflowing water density and the lake density structure will develop the general pattern of water replacement. If there is no lake stratification and incoming water is of the same general density as lake water it will merely displace lake water. Processing of inflowing water by reservoir communities will proceed in a roughly uniform manner, and outflow from all levels will have similar characteristics.

Inflowing water density will very likely be different from the main water mass. Inflowing waters would generally be cooler and contain higher dissolved mineral loads, making the water denser. A density underflow current would result. If the lake is stratified, this inflow may displace hypolimnetic waters which could create an upwelling effect. Release of hypolimnetic water would release water with a minimum of processing by reservoir communities (some processing by heterotrophs but no processing by autotrophs) while release of epilimnetic or metalimnetic water would allow differing amounts of processing. Release of hypolimnetic water may also pass more silt through the dam.

If inflowing water is less dense than lake water, utilisation of epilimnetic outlets would release water intensely processed by reservoir autotrophs and heterotrophs. Water high in reservoir organic matter would result. Release of hypolimnetic water would allow both autotrophic and heterotrophic processing. Water with both mineralised and reservoir organic matter would result.

From this discussion it is evident that outflowing will differ considerably from the
original riverine water by a change from the riverine community products to reservoir products which are largely autotrophic in the upper levels and largely heterotrophic in the lower levels with the concomitant loss of silt. The loss of silt is a key consideration in the Purari River system since it is important to riverine heterotrophic processing, light penetration, nutrient load and deposition and erosion of the delta. Silt will still enter the delta from the Aure River, but the overall input of silt will be greatly diminished. The silt budget will need detailed attention.

Another reservoir characteristic that would be ameliorated by short retention time at the proposed reservoir is the productivity pulse following inundation. As the land areas are inundated, nutrients become available from the soil, plants and forest litter. This results in a high initial productivity. Two such transitory peak phases were noted after the closure of the Kariba Dam (Cochet 1974). The first peak was right after closure and was related to quick inundation of rich terrestrial habitats. Dissolved salt contents doubled over riverine values and explosive growths of plankton and aquatic plants occurred. The latter peak was related to inundation of higher land areas. These transition periods are directly related to the amount of time necessary for filling the reservoir and the reservoir retention time. Both of these are short in the proposed Wabo reservoir, so the short retention time will greatly decrease the extent of any productivity pulse. Nutrients added during inundation and products of autotrophic production will be exported downstream by the rapid addition of new river water.

Aquatic Weeds

Aquatic weeds have become a problem in almost all tropical reservoirs. Explosive growths of *Salvinia*, *Eichornia* and *Pistia* in Lake Kariba have stopped navigation and made the construction of a barrier to protect turbines in lakes necessary (Balon and Cochet 1974). These plants are spread widely and easily. Water hyacinth, originally a native of South America, is now spread throughout tropical areas (Holm et al. 1971). The ecology of water weeds is not well understood (Mitchell and Thomas 1972) but their effect can be profound. They have been implicated as dispersal agents for disease vectors (Obeng 1969) and provide breeding sites for mosquito disease vector. *Pistia* is a preferred habitat of *Mansonia* mosquitoes on Lake Volta. These plants greatly increase evaporative water losses. The amount of transpiration is related to the humidity, but values of 3.2–7 times normal evaporative rates have been reported (see Holm et al. 1971). Water hyacinth and water lettuce are present in Papua New Guinea, although for some as yet unknown reason have not become a serious problem to date.

Fisheries

Potential fish protein production is particularly difficult to predict as indicated by Holden (1969). Lake depth, fertility, transparency, stratification, and presence of suitable species to fill new niches all influence the basic productivity that, in turn, determines the potential protein yield. High protein yield from a lake fishery should probably not be overemphasised as a cost benefit of the lake. In Lake Kariba, protein yields by the fisheries, if harvestable, are below those of wild game animals of the Gwembe Valley before flooding (Balon 1974). The usual pattern in newly created lakes is high productivity during the first few years of lake life, followed by a rapid decline as nutrients released during filling are exhausted and fish populations exceed the carrying capacity of the system. Exotic species introductions provide opportunities for management but may also prove undesirable. The introduction of *Cichla ocellaris* from the Amazon River into Gatun Lake greatly simplified the trophic structure, eliminating six of the eight previously common species. It also may have resulted in in-
increased *P. falciparum* infections by reducing populations of mosquito eating fish (Zaret and Paine 1973). Other introductions, *Sarotherodon macrochir* and *Tilapia rendalli*, failed completely at Lake Kariba, but the failure was followed by success of *Limiodon* (*Tanganyitean anchoveta*) (Balon 1974).

The fisheries composition changes followed after limnological characteristics of Kariba stabilised. If this proves to be the case in the Purari impoundment, riverine species are likely to remain important since the lake will retain riverine characteristics as a result of the short retention time.

**Wildlife Habitat**

Wildlife habitat will also be lost in the area covered by water. Operation Noah was a large and somewhat futile attempt to save wildlife stranded on islands as Lake Kariba filled. No such massive projects will be needed if the Purari River is developed, but unique wildlife, animals of value to the local people, and animals important to the tropical ecosystem should be studied and their conservation and management planned. Provisions for the preservation of rare species should be formulated.

No natural barriers to animal distribution exist in the Purari region, so severe impacts on the native animals is unlikely. Whatever habitat is inundated is likely to be found elsewhere. Interactions between the fauna and vegetation may be of importance, particularly near the proposed lake. Lake shore habitat will result in a different assemblage of organisms. The increased water edge area should favour the present riparian community unless food sources unique to flowing waters are lost.

**Delta Impacts**

Downstream areas will be greatly affected by any river impoundment. The Purari delta system drains 2500 cu km and involves the Ivo and Varoi rivers. This area contains mangrove and swamp woodland. Important plant genera include *Litsea*, *Cryptocarva*, *Artocarpus*, *Camphospermum*, *Callophyllum*, *Caryota*, *Pandanus* and *Endospermum*. Sago is important and cultivated in much of the area. Nipa palm mixes with mangroves as the salinity decreases and forms pure stands in some brackish areas. Much of the area is poorly drained, subject to flooding and constantly under shallow water. Drainage and salinity fluctuations are dominant factors in determining plant distribution. Altering flow regimes could adversely affect the hydrologic situation. Salt water intrusion would likely shift nipa zones further inland and extend mangrove areas, although the amount of downstream flow will not be greatly altered by a dam at Wabo except during filling.

The delta is dependent upon incoming silt to maintain its alluvial deposits. Decreasing the silt load in the delta could result in a receding delta. Kassas (1972) has reported the Nile delta to be receding since river control has taken place on the Nile by construction of the Aswan Dam.

The change in the organic matter pool due to the reservoir determines the impacts on the delta food chain. If inflowing waters continue to have similar proportions of particulate organic matter, from phytoplankton production in the lake, and conversion of dissolved organics to particulate organics in the reservoir and below it, filter feeders may not be deprived of a food source. The phytoplankton processing of reservoir waters may, however, lower its inorganic fertility by nutrient stripping. Laboratory studies have shown that particulate organic carbon, produced artificially from dissolved organics, can serve as a food source for brine shrimp, *Artemia salina* (Baylor and Sutcliffe 1963). Organisms that can adapt to using inflowing carbon that is not attached to silt particles will prosper, while those with stringent need for food ad-
The Melanesian environment

sorbed to silt will decrease. Areas of deposition would likely change since the buoyancy of detritus and silt differs. More organic matter may be exported to the Gulf of Papua if it is not deposited or used biologically in the delta.

If the turbidity of the inflowing waters is greatly reduced in the reservoir the growth of submerged and emergent aquatic plants may greatly increase. This could create a new nutrient recycling system and would be likely to provide additional aquatic insect breeding sites. If biological productivity is high and a large biomass is passed from the reservoir or grows quickly below it, turbidity may not be greatly altered and communities of periphyton and attached high aquatics may not develop.

Deltas and estuaries are very important nursery areas for fish and shell fish. The barramundi and the eel *Anguilla intermedia* of the Purari and coastal systems are both dependent upon the deltas and, of course, on lower trophic levels that may be affected by the conversion to reservoir community products.

Crocodiles (*Crocodylus porosus* and *C. novaguineae*) are present in the delta and are a valuable cash industry for local people. The New Guinea plateless turtle (*Caretocheles insculpta*) is also present, as are monitor lizards (*Varanus* spp.). Changed trophic structure will affect the populations of all these animals.

Gulf Considerations

The Gulf of Papua receives water and nutrients from a large number of rivers, including the Fly, Kikori, Purari and Vailala. The food chains in the Gulf are almost certainly dependent upon this inflow of nutrients. The decrease of nutrients born by the Nile River may have permanently altered the fisheries of the eastern Mediterranean (George 1972). The Gulf has both actual and potential commercial fisheries. The effects of decreased nutrient inputs from the Purari River should be evaluated for its effects on this protein resource.

Commercial fisheries resources exist in the Gulf but their utilisation has been hampered by lack of transportation and cold storage facilities. The Purari development would lead to capital and energy available for fisheries development. The preservation of this potential revenue and protein producing industry, which could be beneficial to local people, should be carefully planned. Secondary impacts of the industrial complex (pollution) should be carefully reviewed, as they could prove extremely detrimental to the fishery.

PUBLIC HEALTH

Hydro-electric projects can have tremendous public health impacts. For example, water impoundment and irrigation have increased schistosomiasis and in some areas, is leading to a high incidence of the more severe *S. mansoni* parasite (Hughes and Hunter 1972). Schistosomiasis has not been a problem in Papua New Guinea. Tuberculosis, malaria, hookworm and ascaris are the dominant diseases in the Purari delta (Parkinson and Tavail 1973; Malaria Branch 1970; Ewers and Jeffrey 1971; Wigley 1973). The change of natural water regimes, particularly by increasing the amount of standing water, could dramatically change vector ecology. *Anopheles punctulatus*, *A. kolicus* and *A. farart*, the main malaria vectors in Papua New Guinea, now reach-peak numbers at the end of the rainy season but also may form a peak as dry seasons create pools instead of flowing water (Van Dijk and Parkinson 1973). Any changes that would increase populations of *Aedes aegypti*, *A. albopictus*, *A. scutellaris* or *A. polynesiensis* may create a situation favourable to an explosive introduction of Asiatic haemorrhagic fever (see James and Harwood 1969). This could have disastrous consequences. As already noted, aquatic weeds form favourable insect habitats. Mansoni mosquitoes
have been found to breed in *Pistia* (Holm et al. 1971) as mentioned in the section on aquatic weeds.

Increased densities of people will affect tuberculosis, ascaris and hookworm infections. Amoebic dysentery is reportedly increasing in the area (P. Calvert, pers. comm.). The incidence of this disease is undoubtedly related to the practice of using the rivers for drinking water and waste disposal, and further increases will occur without changes in sanitation practices.

**Impacts from Access Roads and Power Lines**

The development of roads in areas where travel is difficult can quickly alter social and ecological conditions. The easier movement of people leads to more cultural mixing. Small groups that were dominant before roads were constructed can be reduced to minority groups by the influx of other groups. Economic advantages of easy access lead to settlement and commerce along the road as shown by Ward (1970) for the Rigo Road.

Roads serve as linear transmission routes for diseases, animal pests and weedy plants. Check points for aquatic weed control have been set up on roads in the Sudan (Holm et al. 1971). Hughes and Hunter (1972) describe the spread of trypanosomiasis in Africa by the movement of Kissi tribesmen along new roads. Disease focuses were created at each river crossing because the river provides a habitat for tsetse flies. Transmission of diseases should be considered as roads are built across Papua New Guinea. The control of diseases is very difficult, if not impossible, along roadways and will require very special consideration in their planning.

One of the greatest ecological effects of roads is the higher rate of erosion along their right of way. Road construction destroys natural vegetation and changes land contours. Soil is exposed and quickly eroded away by high rainfalls. Erosion rates may be particularly high in areas of alluvial deposition such as the delta.

**Impacts of the Industrial Centre**

Although many detrimental impacts of urbanisation are known, and usually emphasised, we should note the point raised by Wookey that ‘in the long term urbanization will probably lead to increased purchasing power, greater educational facilities, improved living standards and a more consistent food supply, so long as employment possibilities exist’ (Wookey 1973: 410). Focus on detrimental impacts will help prevent these impacts from having a large effect and should greatly lessen the probability of human suffering associated with the planned change.

A major impact of the creation of an industrial centre and port will be increased involvement of Papua New Guinea in world trade and politics. Actions in distant countries, which currently have little effect on Papua New Guinea’s self-sufficient economic base, will then have a much greater effect. The eventual involvement with world economics is inevitable, but the project should be viewed, realistically, as a step towards expanded international relations.

Urban populations should be viewed as two groups. Established urbanites exist, in general, in good living conditions. New urbanites bear the hardship of cultural shock, malnutrition and higher disease incidences (Wookey 1973). Diseases of mass contact, such as smallpox, tuberculosis, gastroenteritis, flu, malaria, etc., will increase with urbanisation, particularly where sanitation and nutrition are poor (Hughes and Hunter 1972). Urbanisation has already had noted effects on the incidence of tuberculosis: ‘The degree of tuberculosis infection amongst Papua New Guineans is directly proportional to the degree and duration of contact with European communities and
to the degree of urbanization and cultural change which has occurred in the indigenous communities' (Wigley 1970: 26). Venereal disease is also higher in urban areas and the highlands (Maddocks 1973), and higher rates along the coast can be expected with development.

Ports are sites for disease, animal pests and plant pest introductions. Constant surveillance and control must be exercised there to prevent the spread of rats, cholera, typhoid, etc. The pollution created by industrial development is known to all people. The example set by developed and overdeveloped countries, where industrial development was allowed to take place in an uncontrolled manner, should be valuable to all developing nations. Control of pollution, sanitation and working conditions is much easier if control measures are included in the early planning stages. Types of control measures will be specific for each industry, but should be formulated as each industry is proposed and developed. Proper industrial mixing will maximise recycling of materials and minimise pollution.

CONCLUSIONS
Development in the Purari River basin will result in a variety of important environmental and social impacts. Environmental impacts of greatest concern are those associated with silt, nutrients and organic production along the river course and in the delta and gulf. Sociological impacts will increase with increased development. Particularly severe impacts will be placed on those people living in the inundation area and in the vicinity of the port and industrial site.

The adverse consequences of environmental impacts can be lessened by proper planning, but this planning must be based on an objective scientific study of the problem areas. It is important for the scientific investigations to proceed in conjunction with engineering studies. Findings from ecological and social studies should carry as much weight in final decisions as the strict engineering considerations. The question on development must not be merely whether it is possible, but whether it is desirable, and under what well defined conditions it is acceptable.

APPENDIX
Analysis of water samples taken during a November 1974 field survey of the Purari River area confirms the importance of suspended sediments in the river and delta. Analysis results are given in Table A (all samples were taken from the surface).

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Phosphorus (ppb P)</th>
<th>Parameter Iron (ppb Fe)</th>
<th>Nitrogen (ppb NO₃-N) Dissolved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Dissolved</td>
<td>Total</td>
</tr>
<tr>
<td>Purari River</td>
<td>858</td>
<td>358</td>
<td>300</td>
</tr>
<tr>
<td>Wabo Creek</td>
<td>57</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td>Pie River*</td>
<td>804</td>
<td>32</td>
<td>1750</td>
</tr>
</tbody>
</table>

*Average of two samples

It is obvious from the great difference between total and dissolved amounts of phosphorus and iron that the suspended sediments contain the major portion (eleven times dissolved P and sixty-seven times dissolved Fe in the Purari River) of these nutrients. It is also evident that nutrient levels are very high and indicate a high probability that a productive reservoir will result. A similar proportion of dissolved and particulate nutrient factions is seen in the Pie
River. Construction of a dam would remove the major portion of P and Fe associated with the suspended matter. Downstream amounts could be reduced to one-tenth present P and one-sixtieth present Fe levels. Such changes will undoubtedly affect the ecology and fertility of the delta and gulf.

Comparison of Purari River water with water from Wabo Creek shows much higher nutrient levels in the Purari. The nutrients are highly associated with particulate matter in the Purari and this probably accounts for the major difference in major nutrient content between it and Wabo Creek. From the air, the ERA survey team found that the smaller tributaries appeared greenish while the Purari appeared very brown and turbid. The high sediment load carried by the river is responsible for this appearance.

From this data, we conclude that sediments carried by the Purari River contain the dominant nutrient fraction. Loss of sediments will greatly decrease nutrients to the delta and gulf areas, since only the dissolved portion will pass through the reservoir. Even these dissolved portions are high enough to produce the green water observed in Wabo Creek.

Analysis of nutrient loads throughout the year, assessment of potential algae and aquatic weed production, and an understanding of the importance of sediment bound nutrients in the delta and gulf is crucial to impact analysis and formulation of ameliorating measures.

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The Purari Scheme: Some Comments
J. KAIRI
for the Purari Action Group

The Purari River basin comprises an area of 33,670 sq km and has a population of nearly 12,000 people. The area of land stretches from the Highlands in the vicinity of Goroka to Chimbu to Mount Hagen and runs into the Gulf of Papua at Orokolo Bay.
near Ihu. The tributaries that all flow into the Purari are the Wahgi, Tua, Asaro and Pio Rivers. I must at the outset make it clear that I speak as an ordinary layman. In the pursuit of conservation we must recognise the intrinsic value of nature in itself, quite apart from any value it may have for future exploitation.

The drive for development must obviously mean a change in environment and the lifestyle of the people. It is therefore agreed that the protection of environment should be the principal aim of those who so desire developments on a large scale, such as the Purari development scheme. There are qualities and aspects of the environment that must be considered without reference to any increment to the gross national product or indices of economic growth.

For development in an untouched environment such as the Purari delta, it is important that investigations should be done in the fields of both civil and environmental engineering aspects. There is a need in the human environment for wildlife and other aspects of nature that are untouched, unappraised or little modified by man’s activities. It is therefore dangerous to draw the conclusion that the Purari scheme will affect only about 40 per cent of the population of this country; this is consciously to ignore the importance of the environment on which 90 per cent of the population of this country depend.

The Purari scheme will obviously allow rich foreigners, who have caused endless damage to their own environment and to most countries of the Third World, to make the indigenous people of the Gulf District totally and perhaps permanently dependent on foreign operations. This will also retard true development of the local people because they will be too busy slaving for the other people in order to earn enough just to keep alive on imported foods sold at inflated prices, and maybe to satisfy one or two ‘civilised’ vices such as cigarette smoking and beer drinking (which again make outside people rich). They should be self-employed, self-reliant and prospering from the fruits of their labour by engaging in food production, food processing and small industries, while enjoying all the essential services of a dignified society still living in harmony with a clean environment.

Any industrial development brings some degree of pollution to the environment. Most industrialised countries today fear that the problem of pollution is becoming one of the most frightful things in the lives of the people today. A country such as Papua New Guinea should not sell its valuable and pure environment to those who have polluted environments of their own and who want to share this burden by establishing enormous factories just because there is potential power available. It is rather unfair to the people in the rural communities, whose aim is to develop rural sectors, not to ‘catch up’ with western civilisation in the conventional way by building big dams.

The natural environment has much to offer to the people of the Purari delta, but there are only about half a dozen main sources of food available to them. These are sago, coconut, fish, crabs, prawns, birds and other catches. Building a huge dam will eventually destroy some of these food sources. With problems of population control, serious food shortage and malnutrition faced by this country today, the Government and people should focus their attention on self-help development, not massive environment destroying projects.

The Purari project has already created worries and confusion to the people, even those who cannot read the handwriting on the wall. Fear of the disturbances it will cause both to the people’s way of life and to their environment are elements the Purari project will contribute as certainly as pollution itself.

To a Papua New Guinean land is a valuable asset. There is often a fight over the
rightful ownership of land in this country. Undoubtedly there will be crises arising over the Purari project. It has to be realised that the people who are now living around and near Wabo site are not the only landowners. Some of the actual landowners, who are now claiming the rightful ownership of land around Wabo site, are direct descendants of the Iai, Koriki and Kaimare people who are now living some 25 to 30 km downstream.

I challenge the developers to give me clear answers to three simple questions:

(a) What will happen when our land is flooded?
(b) Where will our displaced people be resettled?
(c) What kind of employment will we have?

The answers to those questions—and there are many others—will show that we lose on all counts. Therefore developers should consider first how irreversible changes to land and environment brought about by such a project will affect the welfare of my people.

In conclusion, I emphasise this need to consider what so many experts have missed—the true Papua New Guinean views. There is one thing I am quite certain of, that my people's desires, their feelings, and their lifestyle are better known to me than to any anthropologist, because I am one of them. So much of what is said at the grass roots level is distorted on its way up to the decision making bodies. I hope some of our nationalists will realise that what we are really fighting against is the existing colonial bureaucratic network in which so many of us are tangled. The Purari Action Group, unlike some of these so-called nationalists, who have been assimilated by the colonial culture and no longer care for the ordinary Papua New Guinean, realises that we must speak for our people or not at all.

As Abraham Lincoln said, in another time and another place:

You cannot bring about prosperity by discouraging thrift; you cannot help small men by pulling down big men; you cannot strengthen the weak by weakening the strong; you cannot further the brotherhood of man by inciting class hatred; you cannot establish security on borrowed money; you cannot build character and courage by taking away man's initiative and independence. You cannot help men permanently by doing for them what they should do for themselves.
The extraction of minerals from the earth's crust and the conversion of these minerals into finished products has for years been considered an effective method for obtaining economic development. Our developing understanding of the environmental pollution caused by mining activities forces us to recognize that the total cost to society of these activities has not been accurately measured. The mining industry must now consider that it is dealing with two productive resources—the minerals and the rest of the environment—and it must expect that it will be judged not only on its efficiency in recovering the one but also on its effectiveness in protecting the other. Decision makers must consider the costs of pollution damage, pollution control and land reclamation. Pollution damage caused by acid runoff, by silt and sediment and by landslides involves costs including the loss of aesthetic values. An evaluation must be made of the relative costs of a variety of pollution control programs ranging from increasing the efficiency of existing processes to regional reclamation schemes or relocation of towns. Economies of scale that are obtained in waste treatment and land reclamation must be considered as well with the diminishing returns that enter as the effectiveness of restoration moves towards 100 per cent. Since mining is an interim land use, the final use to which the land will be put must be projected, and appropriate reclamation measures, including revegetation, planned. The planned future of the land will also determine how and where roads are cut before mining starts. Since traditional concepts of economics do not encourage private mining companies to take responsibility for external diseconomies governments must have clear policies and set conditions to ensure that environmental and social values are not eroded.

One of the most important ideas to emerge in the last decades with respect to man's use and abuse of the environment is the realization that man lives in a virtually closed resource system, a natural environment with essentially fixed dimensions of mass-energy and assimilative-regenerative capacity. Because of this realization it is becoming obvious to both developed and underdeveloped countries that the traditional concepts of economic developments have to be re-evaluated in order to protect the environment. The extraction of mineral resources from the earth's crust and the conversion of these minerals into finished products, though for years considered an effective method for obtaining economic development, is recognised today as one of the main activities with a high potential of environmental pollution. The purpose of this chapter is to discuss some of the techniques available to evaluate and reduce the environmental impact of one form of development, copper mining.

The conversion of copper ore into wire, sheet, or tubing involves costly and complicated technical processes. Since more than a hundred tonnes of ore must be mined to recover a tonne of copper, mining is the most expensive part of the operation, involving principally blasting, loading, and handling. After crushing and grinding, the ore is conveyed to a concentrating plant, where by chemical treatment the metal bear-
ing particles are concentrated to about 30 per cent metal. The very nature of these two processes, mining and concentration, make them the most important to consider in the analysis of the environmental effects of the conversion of copper ore into finished products. In many instances these two processes are geographically separated from the rest of the processes involved in the production of finished copper products, and only they will be considered here.

**Pollution Damage Costs**

As a result of changing attitudes towards the quality of the environment, the mining industry must understand that it is dealing with not one but two productive resources—the minerals and the rest of the environment—and it must expect that it will be judged not only on its efficiency in recovering the one but also on its effectiveness in protecting the other. The decision maker must recognise that there are some social costs or internal diseconomics, defined as all damages and harmful effects sustained by others (for which the private firms are not held accountable), that must be analysed and reduced to the appropriate level. The final goal of a planning process must be to minimise the total cost to society. In the case of copper mining appropriate waste management measures, although not privately profitable in the conventional sense because of the internal expenses, will minimise the total cost to society. This point is illustrated in Figure 34.1. It cannot be overemphasised that the final goal of

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**Fig. 34.1 Economic effects of environmental pollution**
the analysis is not to minimise cost of pollution damage but to minimise the total cost to society.

According to this approach the appropriate course of action cannot be determined until the costs of pollution damage are identified and correctly evaluated. This is a difficult task and one that is never achieved to perfection, but significant progress has been made in recent years; techniques have been developed to deal with the problem (Howard 1971).

The simple fact that wastes are present in the environment does not per se indicate pollution. The natural environment, although limited, has an assimilative-regenerative capacity, which has to be exceeded by an excessive amount of wastes before creating pollution problems. Similarly, it is seldom economically or physically desirable to restore land exactly to its pre-mining condition. Therefore, the first thing to do is to define the damage function, that is, the relationship between specific kinds and levels of mining activity and damages imposed on society. The benefits from any proposed environmental protection plan can then be calculated as the reduction in these damages.

The specific external costs or damages to the environment of surface mining and concentration are:

1. *Damage from acid runoff water.* In the process of mining and subsequent disposal of the ‘gangue’ or waste material, the exposed sulphide minerals react chemically with air and water to produce sulphuric acid. Additional reactions between the acid, water and minerals in the rocks cause other pollutants, such as aluminium and manganese, to be added to the water. Other forms of chemical pollutants include heavy metals and flotation reagents used in beneficiation; they are inadvertently lost in processing and reach streams by accidental spills, direct effluents, or overflow or natural leaching of tailings ponds and piles. Some chemical compounds in waste, such as phosphates, contribute to the abnormal growth of algae and other plants. Death to stream life may occur from oxygen deficiency resulting from this profusion of plant growth or from clogged gills or from toxic conditions.

2. *Damage from silt and sediments.* Erosion of the mining area or of the waste rock dump results in solid particle material, either mineral or organic, entering streams or impoundments. Usually this sediment consists of fine silt or coarser, chemically inert grains. However, particles can be radioactive or may react with the water or other substances in the water to form soluble chemical compounds. Sediments from these sources can have a highly adverse impact on both the quality of water and the costs of

<table>
<thead>
<tr>
<th>TABLE 34.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Representative rates of erosion from various land uses</strong></td>
</tr>
<tr>
<td><strong>Tonnes/sq km/year</strong></td>
</tr>
<tr>
<td>Forest</td>
</tr>
<tr>
<td>Grassland</td>
</tr>
<tr>
<td>Abandoned surface mines</td>
</tr>
<tr>
<td>Cropland</td>
</tr>
<tr>
<td>Harvested forest</td>
</tr>
<tr>
<td>Active surface mines</td>
</tr>
<tr>
<td>Construction</td>
</tr>
</tbody>
</table>

*Source: US Environmental Protection Agency 1973b*
water supply and storm water management. The water carrying capacity of streams is decreased and the storage capacities of lakes and reservoirs are reduced. The magnitude of the problem was acknowledged by a recent study by the US Environmental Protection Agency (1973b). It was found that active surface mines have a representative rate of erosion of 17,000 tonnes per sq km per year, the highest among most common land uses (Table 34.1).

3. Loss of aesthetic values. Surface mining has frequently been criticised for the destruction of aesthetic values of natural environment. To gain access to the minerals in the earth's crust vegetation has to be eliminated and the normal topography disturbed, thus creating visible defacement of the earth's surface. The US Environmental Protection Agency (1973a) has reviewed the methodologies for measuring or quantifying aesthetics and assessed the state of research in basic theory for understanding the unquantifiable.

4. Losses caused by landslides. The sudden movement of portions of the spoil bank down the hillside causes several types of damage. In addition to the loss of aesthetic values on the mining site, there is an increase in the barren area and inhibition of the growth of vegetation; the charges imposed upon mineowners should include estimates for damage from landslides. Landslides also impose other costs. In addition to increasing the flow of silt material from the mining area, a landslide may block or disrupt the water flow in a stream; the sliding material may cover a public road or highway. A comparatively massive landslide damages several acres of land below the mining area.

Recapitulating, it can be concluded that the costs of pollution damage of copper mining are highly sensitive to technological variables such as mining methods, to institutional variables such as population density, and—perhaps most important—to

### Table 34.2

Rating of environmental effects of discrete coal surface mining and reclamation operations

<table>
<thead>
<tr>
<th>Surface Mining Operation</th>
<th>Physical–Chemical</th>
<th>Biological</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Landslides</td>
<td>Slumping</td>
<td>Highwall</td>
</tr>
<tr>
<td>Access road cut and use</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Drilling and blasting</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Scalping</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Overburden removal and placement</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Coal removal</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
</tbody>
</table>

Net Environmental Effect of Surface Mining Operation: 3+ 3+ 3+ 4+ 4+ 3+ 3+ 2+ 2+ 5+ 1+ 4+ 3+ 2+ 3+ 3+

+ Adverse Environmental Impacts Aggravated
0 Negligible Environmental Impacts
— Adverse Environmental Impacts corrected

Source: US Environmental Protection Agency 1973b
geographic factors such as climate and hydrology. But if we wait for perfect information upon which to base the establishment of additional constraints or limits to protect the environment, we shall never have them. Enough information is known to establish several constraints, in addition to economic efficiency, which will greatly improve public decision making and will stimulate investigation and discussion, thus leading to still further improvement in the future. Techniques applied in the evaluation and quantification of environmental effects of other of man's activities can be successfully applied to copper mining. Table 34.2 shows the rating environmental effects of discrete coal surface mining. This technique can also be applied to evaluate the environmental effects of copper surface mining.

**TABLE 34.3**

*Total external costs arising from bituminous coal surface mining in eastern Kentucky, 1962-67 ($)*

<table>
<thead>
<tr>
<th>Year</th>
<th>$A_t$</th>
<th>$S_t$</th>
<th>$B_t$</th>
<th>$O_t$</th>
<th>$L_t$</th>
<th>Total Cost</th>
<th>Per ha disturbed</th>
<th>Per tonne mined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>95978</td>
<td>201813</td>
<td>3364</td>
<td>3000</td>
<td>4450</td>
<td>308605</td>
<td>36.70</td>
<td>0.048</td>
</tr>
<tr>
<td>1963</td>
<td>101028</td>
<td>212432</td>
<td>3541</td>
<td>5000</td>
<td>4700</td>
<td>326701</td>
<td>36.90</td>
<td>0.047</td>
</tr>
<tr>
<td>1964</td>
<td>71406</td>
<td>178095</td>
<td>2790</td>
<td>6000</td>
<td>4900</td>
<td>263191</td>
<td>28.30</td>
<td>0.035</td>
</tr>
<tr>
<td>1965</td>
<td>85591</td>
<td>213475</td>
<td>3344</td>
<td>7000</td>
<td>5900</td>
<td>315310</td>
<td>28.28</td>
<td>0.033</td>
</tr>
<tr>
<td>1966</td>
<td>64899</td>
<td>193059</td>
<td>3311</td>
<td>3000</td>
<td>5850</td>
<td>270119</td>
<td>24.48</td>
<td>0.028</td>
</tr>
<tr>
<td>1967</td>
<td>75014</td>
<td>223152</td>
<td>3827</td>
<td>3000</td>
<td>6750</td>
<td>311743</td>
<td>24.44</td>
<td>0.027</td>
</tr>
</tbody>
</table>

Source: Howard (1971). Units have been converted to metric.

Howard (1971) has gone further and quantified the external diseconomic associated with bituminous coal surface mining in eastern Kentucky. Table 34.3 shows the results he obtained, in modified form. The following nomenclature is used.

$A_t$ = external costs from surface mining operations in the time $t$ caused by acid runoff water.

$S_t$ = external costs from surface mining operations in time $t$ caused by silt material.

$B_t$ = external costs of surface mining in time $t$ caused by loss of aesthetic values at the mining sites by the general public.

$O_t$ = external costs from surface mining operations in time $t$ imposed upon owners of the land surfaces only.

$L_t$ = amount of external costs from surface mining operations in time period $t$ caused by landslides, in addition to any additional acid water and silt damages caused by landslides.

**Pollution Control Costs**

The other basic kind of information that is needed to minimise the total social cost of copper mining is the cost of alternative treatments or reclamation programs. Both operating and capital cost functions should be evaluated for a wide variety of techniques—ranging from those that require only increasing the efficiency of existing processes to those that call for regional reclamation schemes or relocation of towns. Even within a mine or a plant, there may be available different technologies that have
different costs. For example, changes in mining methods to reduce waste volume may be cheaper than treatment of a larger volume of wastes from existing methods.

In general cost functions for environmental protection techniques show two significant engineering-economic characteristics. First, the cost per unit of waste treated or land reclaimed tends to decrease significantly as the volume handled increases; this reflects economics of scale. Second, the unit cost tends to go up very steeply as 100 percent removal of some pollutant or complete return to pre-mining conditions is approached; this reflects diminishing returns.

In estimating the costs of environmental pollution control of copper mining, consideration should be given to the following:

(a) preservation and protection of appropriate cultural, recreational, scenic, historic and ecological values;
(b) control of erosion, slides, flooding, and pollution of water;
(c) prevention of air and noise pollution;
(d) prevention of hazards to public health and safety;
(e) harmony with the surrounding landscape; and
(f) the best long-term use of land so that restoration can be designed towards an appropriate end use.

On the basis of review and examination of these factors, a company may decide to forgo exploration or mining because the increased cost resulting from necessary conservation and restoration provisions may be too high. These costs or provisions are just as much a part of the total economics of the particular ore body as its grade or distance from a known market.

Abatement and control techniques used to minimise the effects mining and development operations have on water quality are generally applied to one of four areas: mine and plant development, source control, water treatment and water disposal. Pollution abatement and control of mine effluent have been successful when incorporated into the design of the mineral processing plants. Impoundment basins, settling ponds, precipitation and flocculation tanks, recirculation, aeration and, ultimately, an in-line facility for treating the water before it is released to the stream are common techniques.

The specific sources of waste water from mining and concentration of copper ores are:

(a) water treatment wastes, including filter backwash, and sludge from primary settling;
(b) sanitary wastes;
(c) process water including mine drainage, flotation plant discharge, scrubber water, sanitary waste, etc.

Data on the quantity of these individual wastes are not available. Table 34.4 shows the composition of raw waste from tailings ponds and of tailings ponds effluent for several mine-concentrator combinations (US Environmental Protection Agency 1973c). The waste water treatment practices in the copper industry for these types of waste are: recirculation with no discharge in arid climates; sedimentation in tailing ponds; neutralisation, flocculation if required.

It should be mentioned that treatment techniques are normally used in combination with preventive measures. Diversion of surface drainage away from the mining area is a positive step in preventing the formation of acid mine water. A secondary, but vital, result of this type of prevention is in the increased inflow of non-polluted water that is retained on the surface to dilute acid drainage.

Where water pollution results from the erosion of tailings or other waste piles,
TABLE 34.4
Waste water treatment methods and costs

<table>
<thead>
<tr>
<th>Amount Treated mgy</th>
<th>Treatment Method</th>
<th>Capital Investment $</th>
<th>Operation and Maintenance Costs $/3785 litres</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>Tailings pond</td>
<td>127000</td>
<td>0.017</td>
</tr>
<tr>
<td>500</td>
<td></td>
<td>50000</td>
<td>0.048</td>
</tr>
<tr>
<td>2500</td>
<td></td>
<td>208377</td>
<td>0.020</td>
</tr>
<tr>
<td>7000</td>
<td></td>
<td>10000000</td>
<td>0.007</td>
</tr>
<tr>
<td>1000</td>
<td>Settling(^a)</td>
<td>363000</td>
<td>0.097</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>25000</td>
<td>0.005</td>
</tr>
<tr>
<td>5</td>
<td>Sewage Plant</td>
<td>54000</td>
<td>0.11</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>53000</td>
<td>0.21</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td>0.82</td>
</tr>
</tbody>
</table>

\(^a\) Coagulating agents added

Source: US Environmental Protection Agency 1973c

reggrading the mechanically stable slope coupled with revegetation usually alleviates water pollution.

The US Environmental Protection Agency (1973c) has published a study about water pollution control practices in the copper industry in the United States. Of the fifty operations involved in the study, fourteen (or 28 per cent) reported zero discharge. These operations, all located in dry climates, employ tailing ponds to close the water circuit, with high evaporation rates and possibly ground seepage making discharge unnecessary. Included in these facilities with zero discharge of waste water were twelve mines and concentrators, one copper leaching operation and one smelter. All fourteen of these plants employed evaporation as a waste treatment method; its application is limited by geographical/climatrical considerations.

Tailings ponds were used by plants in areas of plentiful water for sedimentation of solids and in some cases as a reservoir for recirculation of water. These discharged about 1.44 billion litres of water per year or 67 per cent of the 2.1 billion litres of total discharge. Thus tailings pond treatment appears to be the most predominant practice, serving not only to provide evaporation and clarification but also to permit recycling of water. A compilation of waste treatment practices used in the United States in the copper mining industry is shown in Table 34.5. The specific cost data reported for waste treatment processes are listed in Table 34.6. Treatment in tailings ponds is the cheapest of the three treatments shown, costing from one to five cents per 3785 litres of discharge.

LAND RECLAMATION FOLLOWING MINING

Reclamation and/or rehabilitation of mined land is most important to the company and operator of a surface mine, since land use and possible environmental damage is widespread with surface mining in comparison with underground mining. With in-
Extracting minerals and energy from the environment

TABLE 34.5
Summary of waste water treatment practices

<table>
<thead>
<tr>
<th>Treatment Method</th>
<th>Amount Treated mgy</th>
<th>Per cent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings Pond</td>
<td>37984</td>
<td>69.2</td>
</tr>
<tr>
<td>Other Settling</td>
<td>2043</td>
<td>3.7</td>
</tr>
<tr>
<td>Dilution</td>
<td>2016</td>
<td>3.7</td>
</tr>
<tr>
<td>Neutralisation</td>
<td>25</td>
<td>0.1</td>
</tr>
<tr>
<td>No Treatment</td>
<td>12798</td>
<td>23.3</td>
</tr>
<tr>
<td>Total Discharge</td>
<td>54866</td>
<td>100.0</td>
</tr>
<tr>
<td>Evaporated</td>
<td>248</td>
<td></td>
</tr>
</tbody>
</table>

Source: US Environmental Protection Agency 1973c

TABLE 34.6
Compositions of waste waters from mine and concentrator operations (all analyses in mg/l)

<table>
<thead>
<tr>
<th>Components&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Raw Waste to Tailings Ponds</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discharge from Concentrator</td>
<td>Plant Drain A</td>
<td>Plant Drain B</td>
<td>Tailings Pond Effluent</td>
</tr>
<tr>
<td>As</td>
<td>0.01</td>
<td>0.09</td>
<td>0.03</td>
<td>0.006</td>
</tr>
<tr>
<td>BOD</td>
<td>5.8</td>
<td>164</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>Cd</td>
<td>0.01</td>
<td>—</td>
<td>—</td>
<td>0.00</td>
</tr>
<tr>
<td>CN</td>
<td>0.06</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cu</td>
<td>0.10</td>
<td>0.33</td>
<td>0.28</td>
<td>0.01</td>
</tr>
<tr>
<td>F</td>
<td>2.9</td>
<td>2.1</td>
<td>1.3</td>
<td>—</td>
</tr>
<tr>
<td>Fe</td>
<td>0.12</td>
<td>—</td>
<td>—</td>
<td>0.05</td>
</tr>
<tr>
<td>Mn</td>
<td>0.08</td>
<td>—</td>
<td>—</td>
<td>0.8</td>
</tr>
<tr>
<td>Pb</td>
<td>0.005</td>
<td>—</td>
<td>—</td>
<td>0.18</td>
</tr>
<tr>
<td>pH</td>
<td>7.3</td>
<td>7.0</td>
<td>6.7</td>
<td>7.64</td>
</tr>
<tr>
<td>TDS</td>
<td>3412</td>
<td>2810</td>
<td>3950</td>
<td>—</td>
</tr>
<tr>
<td>TSS</td>
<td>48</td>
<td>549</td>
<td>53</td>
<td>—</td>
</tr>
<tr>
<td>Zn</td>
<td>0.03</td>
<td>—</td>
<td>—</td>
<td>2.0</td>
</tr>
<tr>
<td>COD</td>
<td>—</td>
<td>343</td>
<td>106</td>
<td>—</td>
</tr>
<tr>
<td>Coliform</td>
<td>—</td>
<td>211000</td>
<td>20000</td>
<td>—</td>
</tr>
<tr>
<td>Metal Sulfides</td>
<td>—</td>
<td>0.23</td>
<td>0.18</td>
<td>—</td>
</tr>
</tbody>
</table>

<sup>a</sup> BOD = biological oxygen demand
CN = free cyanide
TDS = total dissolved solids
TSS = total suspended solids
COD = chemical oxygen demand
Coliform = bacteria per 100 ml

Source: US Environmental Protection Agency 1973c
creasing population and leisure time, tremendous pressures are being placed on existing industrial, residential, and recreational facilities. These pressures are leading to conflicts in land use. Since mining is an interim use of the land, it is logical to believe that when mining is through the land should be rehabilitated to a specialised land use.

Land reclamation normally includes three phases of operation: site preparation; backfilling and terracing; and revegetation. It is important to do a certain amount of planning and site preparation before major earth movement begins. Depending upon the intended use of the site, consideration must be given at this time to location of roads and any facilities that are part of the end use of the land. The degree of grading or earth moving that may be necessary for the reclamation of mined land depends primarily upon four factors: the method of mining; the cultural and topographic setting of the operation; the climate; and the intended end land use. In a region of sparse population and arid conditions, it may be acceptable to leave the mine site as it is upon completion of mining. Should a valuable natural resource such as water exist in the same area, it may be desirable to grade unconsolidated material to a stable contour to prevent water pollution. At the other extreme, where the site under arid conditions is near a high density of population, complete backfilling may be desirable. The success of revegetation depends primarily on terrain, stoniness, toxicity, moisture, and the microclimate of the site to be revegetated and the species of vegetation. It is important to establish a quick stabilising cover as soon after grading as possible. In recent years the practice of seeding a quick growing grass or legume in combination with reforestation has proven successful. Literature on the cost of land reclamation is abundant and it will therefore not be analysed to any extent here.

Neither the costs of pollution damage nor the costs of pollution control discussed here should be considered exhaustive. There are other factors, such as air and noise pollution, wildlife pattern disruption and change in value of adjacent land, that in some specific cases must be also analysed. However, the costs discussed are normally found in any copper mining and concentration operation and comprise the most significant portion of the total cost.

**Conclusion and Recommendations**

Because of the traditional concepts of economic development it cannot be expected that private mining firms will absorb the external diseconomics associated with copper mining. Even in countries in which the government or public policy makers have begun taking these factors into consideration, it has been only in response to public pressure. Moreover, because environmental pollution problems created by the actions of a given country might well affect other countries, it could be expected that pressure for environmental pollution control will also come from the international sector. Thus, for the welfare of the world community, every country, developed, underdeveloped, or on the way to development, should legislate for environmental pollution control. Guidelines are required for the particular actions to be followed by a government body in connection with the enactment of environmental protection from copper mining reclaims:

1. Recognition of the existence of external costs arising from the copper mining process.
3. Formulation of recommended procedures and regulations to internalise such costs within the industry, including estimation of necessary cost of pollution control or internalisation.
4. Recognising that the final goal is neither the minimisation of the external dis-
economics or cost of pollution nor the maximisation of the internalisation or the cost of pollution control, but the minimisation of the total social cost.

5. Institution of the pollution control requirements.

6. Measurements and comparison of actual cost increases and decreases after a trial period.

7. Further revisions of pollution control requirements.

References


Copper Mining on the Ok Tedi and Upper Fly Rivers

K.P. LAMB

The Fly River system, which is fed by the Ok Tedi flows for 1125 km through the Western District of Papua. It is the main source of protein (as fish and waterfowl) for the sparse population of much of the district. The proposed development of copper mining near the Ok Tedi will involve environmental changes from silt deposition resulting from construction and mining operations and from the addition of chemical and sedimentary wastes from copper processing. It is essential to establish standards and minimise deleterious effects that could be reflected in the fisheries of the lower Fly or the Gulf of Papua. Environmental impact studies, together with intensified study of the hydrology and biology of the upper parts of the rivers, are urged here. These will provide a basis for intelligent decision making.

From the eve of independence the Papua New Guinea Government has been considering several development plans that involve major river systems. I wish to consider one such project, which involves copper mining in the upper reaches of the Ok Tedi or Alice River, one of the tributaries of the Fly River. The mining site is in remote country in the Star Mountains in the very heart of the island of New Guinea, just south of the border between Papua and New Guinea and just east of the border with Irian Jaya.

The Ok Tedi is a fast flowing mountain river, which rises in the Star Mountains and falls almost 1500 m in 65 km. It flows through sparsely populated country with a very high rainfall (over 10 m per annum). There is no economic development and the small and scattered villages survive by hunting, fishing and taro staple subsistence agriculture. About 110 km below the proposed mine site the Ok Tedi joins the Fly River at D’Albertis Junction which is some 50 km west of Kiunga, the Subdistrict Headquarters.

The Fly River is the dominating feature of the Western District of Papua New Guinea. It arises in the mountains of the central chain and runs some 1125 km to the south coast, where it discharges into the Gulf of Papua. The estuary is 80 km wide at the mouth and the river is navigable for up to 1000 km. The main tributaries are the Strickland, which enters the Fly 350 km from the coast, the Ok Tedi, which joins it about 800 km from the coast, and the Palmer, which arises in the Blucher Range to the northeast. I should also mention Lake Murray of 780 sq km area, which has a catchment area of 7500 sq km and is well supplied with fish and crocodiles. This is connected to the Strickland by the Herbert River.

Thus the Ok Tedi River drains the sparsely populated northwest corner of Papua and joins the larger, slower moving Fly River near Kiunga where the altitude is only 18 m. The open rain forest of the north is replaced by closed rain forest around Kiunga and behind this are swamp forest and large flood plains. The Western District, which covers 95,000 sq km, is somewhat larger than Scotland or Ireland but has a population
of 68,000. There are large unpopulated areas and around Ok Tedi the population density is about 2.5 per sq km.

Although the Western District has been regarded as impoverished and hard to develop there are large herds of wild deer in the southwest. The coastal plain and middle Fly are very rich in waterfowl and fish (of which barramundi and catfish are mainly exploited). The crocodile industry is being re-established in the Lake Murray area. Large areas southeast of Kiunga have a high potential for tree crops. Agricultural development is in its early stages and has been hampered by poor communications and the scattered nature of the population. The discharge of the Fly River into the Gulf of Papua is of great significance, for here we find valuable commercial fishing grounds where a multimillion dollar industry is developing. These waters also adjoin the valuable fishing grounds of the Torres Strait and the north Coral Sea.

What is likely to be the effect of copper mining on all this? The benefits are obvious: a significant contribution to the national income, the economic development of a district that has lagged behind the rest of the country, opportunities for employment, education and health services for people who have not had these opportunities and many of whom are often short of food.

The cost of these developments is environmental change. In these days of ecological awareness it is becoming the practice to mount environmental impact studies before embarking on major development projects. It is then possible for the government to set limits within which changes can be tolerated without permanent damage to renewable resources. Let us now consider what kinds of change might be expected from a major development in copper mining.

Obviously there must be some road construction to give access to the mining site. Some means must be provided for obtaining machinery and supplies and for shipping out the concentrated ore. We might expect the construction of some sort of port facility above D'Albertis Junction, where the river is navigable by boats and barges for most of the time. The manpower must be provided for road and site construction and for the mining operation itself. Since there are fewer than 4000 able bodied men in the surrounding countryside, it would seem inevitable that extra labour must be brought in from elsewhere and fed and housed. An array of socio-economic problems must therefore be explored. Food must be found (or produced) for an army of workers in an area where food supplies are short. (This could of course be turned to advantage by forcing accelerated agricultural development in the district.)

But what of the physical effects on the environment? Inevitably there will be some pollution of the rivers from silt arising from construction activities, the erosion of deforested areas and the overburden from the ore. More importantly perhaps we shall want to know how the tailings will be disposed of after removal of the ore. In Bougainville we have seen the disastrous effects of discharge of tailings into a river. We shall want to be reassured that this does not happen to the Ok Tedi—and in turn to the Fly River, which is the main source of fish protein for the local people. We shall also want to be reassured that the continuous discharge of small or large amounts of noxious chemicals into the upper reaches of the river system does not have delayed, harmful effects in the lower Fly or in the Gulf of Papua.

Increased silt in rivers can be damaging to living organisms by reducing the light available for photosynthesis and bringing about changes in the food chains that are ultimately reflected in the fish population. It is also recognised that even small quantities of toxic chemicals are frequently concentrated by certain organisms in the food chain and, as a result, become poisonous to larger organisms feeding on the small ones. If larger concentrations of poisonous substances are released, all the living organisms
may be killed and we may be left with a stinking, slimy mess, as has happened to many rivers in Europe and the United States.

This is being rather pessimistic, so let us look at the situation more closely. If we are to plan sensibly and establish limits for pollution we must have a great deal of basic information about the mining and processing techniques, the hydrology of the rivers and their biology in the widest sense. At present much of this information is not available. With the collaboration of members of the University and others we in Papua New Guinea have started looking at the biology and hydrology of the Ok Tedi and related rivers and of the upper Fly River near Kiunga. As part of this joint investigation an expedition from Cambridge University spent three months in the field last year. We are still at the very beginning of understanding about the nature of these rivers and their living organisms. There is much essential research still to be done and it is hoped that this will receive substantial government support as a matter of priority.

There are two main species of fish used for food in the Ok Tedi and neighbouring rivers and these should be preserved if possible. The processing of copper ore involves a flotation process. The ore is ground up and mixed with water, compressed air and chemicals to assist flotation. The concentrated copper is removed from the surface and the remaining unwanted material is disposed of. This process should remove up to 90 per cent of the copper from the original ore. The disposal problem is a big one. About 30,000 tons of dry rock used per day will produce 500–600 tons of concentrate; 40 per cent is water and the remainder must be dumped. It is important that this material should not be dumped into the Ok Tedi or another tributary of the Fly. It should be possible to impound and precipitate the wastes as much as possible before release.

Concerning the chemicals used in flotation, some experiments are under way at the University of Papua New Guinea to investigate their toxicity to fish. This research is not yet complete, but the early results are encouraging in that the flotation agents we have studied decompose rapidly in solution and do not appear to be toxic to fish. We must also, however, consider the toxic effects of metals in the tailings. Copper is one of the most toxic metals for fish and other aquatic organisms. Concentrations of less than one part per million in water are poisonous to most species of fish. We do not know what other heavy metals will be in the wastes, but copper, mercury and silver are highly toxic, while gold, lead and zinc are almost as poisonous. These heavy metals do not undergo biological degradation and could therefore persist for a long time or for long distances in rivers; on the other hand they could be precipitated by the right chemical conditions.

The presence of excessive organic material undergoing decomposition can lower the dissolved oxygen content and raise the ammonia content of the water with deleterious effects. The nature of the suspended matter in the water—as well as the quantity—is therefore of importance.

Again, let us not be too pessimistic. Rivers can absorb a certain amount of abuse and recover from it. They play an important role in sewage purification in Europe and the United States. But this sort of use must be carefully controlled, as the consequences can be disastrous when rivers are overabused. I would suggest then that we need a lot more basic information about the hydrology of the rivers, their living organisms and food chains and the effects of site preparation and mining techniques on river quality. We need to know the distance of involvement for riverine changes so that the valuable lower Fly and Gulf of Papua are protected from damage. An early step would be to establish monitoring stations at say, Tabubil, Rumginae and Kiunga and obtain essential basic information on the chemical, physical and biological changes going on.

Progress inevitably brings about change. We want to avoid sudden, irreversible
changes to our renewable natural resources. Given co-operation between companies, Government and the people it should be possible to program these changes in a controlled manner and to set sensible limits to the nature and amount of pollution, to ensure adequate financial returns and also to ensure continuing food supplies and socio-economic development for the people of the Western District and Papua New Guinea as a whole.
Environmental Planning at Bougainville Copper

P. J. GILLES

Mining, almost by definition, has connotations of environmental disturbance. Additionally, when the rapid development of a large mine occurs on an isolated, tropical Pacific island, populated by Melanesian people traditionally leading a village style existence, a broader than usual spectrum of environmental problems arises. The development and operation of the Bougainville copper mine has caused both short-term and long-term environmental impacts. Some were a result of construction and have been eliminated whilst others, such as waste rock and tailings disposal, are caused by the mining operations. Dramatic technological breakthroughs are unlikely and reduced environmental impact will only be as a result of systematic research and planning. Waste rock and tailings disposal strategies that are being developed will provide optimum replacement environments for those that originally existed. Actions taken to minimise disruptions to the people of Bougainville include payments, including 5 per cent of the royalty paid to the Papua New Guinea Government; relocation to sites selected by villagers; agricultural assistance; and opportunities for participation in the peripheral industries generated as a result of the establishment of the mine.

In 1964, the presence of copper mineralisation was confirmed in the Panguna area of Bougainville Island. The next eight years saw the proving of an ore body, project evaluation and decision to proceed, construction of the mine and supporting infrastructure and the successful start of commercial operations. A development of this magnitude would rate as a major project anywhere in the world. Undertaking it in a country of rapidly changing political aspirations and sophistication and in an area of rugged topography and adverse tropical conditions served only to amplify the problems requiring solution.

This chapter examines the environmental aspects of the Bougainville mine development and outlines methods used to date to minimise environmental disturbance of current and foreseen environmental problems by planning.

BACKGROUND

The development of the Bougainville mine, particularly the planning, engineering and construction phases, has been adequately described. The Panguna deposit is on the western slope of the Crown Prince Range in the Kawerong valley. The area is surrounded by hills ranging up to 1500 m, while valley elevations vary between 600 m and 900 m. The terrain is deeply dissected, side slopes between 30° and 45° being com-
mon, and the whole area was originally covered with tall trees and dense jungle undergrowth.

The climate is tropical with mean maximum and minimum temperature of about 28° and 18°C respectively, mean relative humidity ranges up to 89 per cent and annual rainfall averages 4500 mm. Bougainville is a volcanic island with two active volcanos, one, Mt Bagana, being approximately 40 km from the mine. The area is subject to frequent seismic activity. Ore reserves were proven by drilling more than 200 diamond drill holes on 120 m centres to an average depth of 500 m. Reserves of over 900 million tonnes were delineated within a designed open pit at an average grade of 0.48 per cent copper and 0.56 g per tonne of gold. The sulphide orebody was originally capped with secondary mineralisation and overlaid with volcanic ash varying in depth from 0–60 m and averaging about 15 m.

Once the decision was made to proceed, the following work had to be completed before production could begin:

(a) constructing a permanent access road from the coast to the mine site;
(b) constructing the mine site town (Panguna) and the coastal town (Arawa);
(c) constructing a permanent power station and transmission lines;
(d) removing the overburden from the ore body, developing the pit haul road system, making all mining equipment and the associated maintenance and repair facilities operational;
(e) constructing and commissioning all concentrator facilities: crushers, screens, ball mills, flotation cells, pumps, concentrate thickener, pump station and pipeline, filtration and drying facilities, concentrate storage and loadout equipment;
(f) constructing adequate wharf facilities;
(g) arranging suitable waste and tailings disposal facilities.

**Sociological Impact**

During the exploration phase there was a steadily increasing but still relatively small number of people coming to Bougainville and a temporary access track was constructed from the coast to Panguna. The only local people affected were those living in the Panguna area or in proximity to the access track.

Once construction began, however, there was a massive influx of machinery, equipment and manpower, the latter peaking at over 10,000 during 1971. Suddenly Bougainville ceased to be one of the peripheral islands of Papua New Guinea and became the focus of modern engineering and economic development in the country.

A significant number of people in Papua New Guinea have been exposed to some sociological impact because of the mine development. For the majority it has either been minor or has increased the rate of change that was already evident. Villagers living in the actual lease area, however, have had to be relocated, compensated and assisted in adjusting to a new environment. Liaison with the local people is through the Village Relations Section, which co-ordinates the following payments and activities in relation to people directly affected by the mine:

1. **Payments.** Payments to the people owning land in the special mining lease, tailings lease and other leases held by Bougainville Copper Limited are made up of annual occupation fees, compensation for damage caused by the operations to improvements and to the land, and royalties for gravel removed from gravel leases. Additionally owners of land within the special mining lease receive 5 per cent of the royalty paid by the Company to the Papua New Guinea Government. By the end of
1974 a total of approximately K2.4 million had been paid out to the landowners, about 2000 men, women and children.

2. Relocation. Where a village is so affected by the operation that it has to be removed, it is relocated by the Company to an area selected by the villagers themselves. The new houses are built of permanent materials.

3. Agricultural assistance. The Agricultural Extension Section assists people displaced by the mining operation, particularly those affected by the tailings lease. Villagers are shown how to use their remaining land in a more productive manner. The Section has an agricultural station approximately midway between the mine and the west coast. Here, demonstration gardens are laid down and trials conducted to encourage better local production of fruit and vegetables; poultry, pigs and cattle are raised; and research is carried out to determine the optimum parameters for raising these livestock. Demonstrations and field trials are held regularly and stock, food and veterinary supplies are available at cost.

4. Business development. The Business Development Section advises people on the wise investment of their finances and assists them to participate in the peripheral industries that have been established on Bougainville as a consequence of the establishment of the mine. For larger business developments, which are financially beyond the scope of individual or small group entrepreneurs, companies have been formed under the sponsorship of a foundation and shares offered to the local people.

Thus people directly affected by the mining operation have had the sociological impact offset by financial compensation and assistance in adjusting to a new habitat. Moreover, on the credit side of the mining operation a wide range of education and employment opportunities have become available; the east and west coasts are now connected by road; and frequent shipping and air services now operate to and from the island. A modern hospital has been built in Arawa and the urban industries in the new towns provide additional employment and a range of goods and services not previously available. The mine training centre offers to employees tuition ranging from instruction in individual skills up to full trade and technician courses.

**Physical Environmental Disturbance**

The sources of physical environmental disturbance fall into two categories. Firstly, there are those that occurred during the construction phase and the measures taken to minimise disturbance. Secondly, there are sources of current and foreseen disturbance; these are documented here with the measures being taken or planned in the long term to handle their impacts.

**Construction**

1. Port-mine access road. This road provides the transportation link between the coastal port facilities and the mine. It is 26 km long, made up of 15 km of valley and swamp section and 11 km of mountain section across the Crown Prince Range. In the latter section there are large areas of unconsolidated soil and stability had been maintained only by the vegetation cover. Once this was disturbed the thixotropic properties of the volcanic ash together with seismic activity and high rainfall created instant instability. There was no economic alternative but to sidecast material into the upper Pinei valley and cut back to stable rock both at the road level and on the batter slopes and benches, which extend up to 120 m above. During this period the sedimentation load of the Pinei River was increased to a level that eliminated fish from the river. Compensation for loss of fishing has been paid at the rate of $20,000 per year for the five years 1970–4 inclusive and has been distributed amongst the people who have
traditional fishing rights in this area. Once road construction ceased, the sediment load in the river gradually returned to normal levels. The river today has rehabilitated naturally, fish are once more present and being caught.

The road construction left a narrow, bare swathe over the mountain section. Rapid revegetation was desirable for aesthetic reasons and also to stabilise the extensive batter system. Originally legumes were planted along the benches and regularly fertilised. It soon became evident, however, that wind blown seed from the adjacent natural forest was establishing at a most satisfactory rate and planting of introduced species was discontinued. Routine fertilising is maintained to promote growth of these natural species.

2. Pit development. Before the sulphide orebody could be developed, the overlying oxidised material and vegetation cover had to be removed. During 1969 the vegetation was poisoned and the trees in the pit area were removed, drawn into piles, and burnt. The volcanic ash overlying the orebody contained 30–50 per cent water by weight and was thixotropic (literally liquefies when shaken). Once this material was disturbed and exposed to rain it became a boggy mess and removal by conventional equipment was almost impossible. However this particular feature is beneficial in a hydraulicking operation and a technique was developed whereby monitors directed high pressure water streams onto the slope face while bulldozers above pushed material into the monitor area. In this way a total of 21.4 million cu m of material was removed. The hydraulicked material discharged into the Kawerong River, which flows into the Jaba River and thence to the west coast of Bougainville. This high sediment load had an impact on these river systems, and this will be discussed later as the same river system is used to transport the concentrator tailings.

Operations

1. Disposal of operating wastes. Two products, rock and concentrator tailings, are the major wastes produced by the operation of the Bougainville mine. Waste rock is the material that must be removed to keep the orebody exposed and maintain bench slope stability. Waste rock is mined by drilling and blasting and the broken rock is then removed and dumped. This material possesses conventional soil characteristics as it has only been disturbed and relocated and has not been subjected to any further treatment.

Tailings are the inert residual product resulting from the treatment of ore in the concentrator. Here the total mass is crushed and ground to the consistency of a fine sand, slurried with water and the economic minerals removed by the flotation process.

At Bougainville the average mining rate is about 155,000 tonnes per day. Of this 70,000 tonnes are waste, which is discarded directly. The remaining 85,000 tonnes are ore, which is processed in the concentrator to separate 1650 tonnes of concentrate from 83,350 tonnes of tailings. This means that almost 99 per cent of the material originally mined has to be discarded. The tailings leave the concentrator as a slurry of about 40 per cent solids.

In disposing of waste rock there is little alternative but to dump it. One method is to form a dump above the natural ground level. The stability and integrity of such a dump is critical. Another is to dump the rock into a valley, thereby building up the level of the valley floor. The problem here is to divert or control the valley stream and prevent erosion of the dumped material. The latter technique is currently practised at Bougainville. The waste material is dumped into the Kawerong valley and it was originally planned that, by armouring the river bed with large boulders, the river could be raised and controlled between dump faces. Unfortunately this scheme has
The Melanesian environment

proved unsatisfactory as an excessive amount of coarse rock material has been eroded from the dump faces, together with the fine material. Whilst this fine material is readily transportable by the river system the coarse material is moved only slowly and only during periods of high river flow and has caused excessive build up in several sections of both the Kawerong and Jaba Rivers. An alternative scheme is currently under construction; the Kawerong River is being diverted through a 200 m, concrete lined diversion channel around part of its original valley, this area then being available for waste dumping, and the river is returned to its original course downstream from the dumping area. In this way the coarse sediment in the river is reduced to normal levels and dumping will gradually fill up the bypassed Kawerong Gorge to the level of the diverted river. The flat land so produced will be useful for building homes on during the life of the mine and after mining has ceased it can be used for other purposes. The cost of the current phase of this project is in excess of $8 million and the diversion channel will need to be extended several times during the life of the mine. Agronomic research has already shown that natural and introduced plant species currently being grown in the Panguna area can be established on the dumped material.

Five alternative proposals for the disposal of tailings were examined in 1969. They included a conventional tailings dam, disposal into rivers, disposal on the Jaba lowlands and direct disposal to the sea. Mountainous terrain, high rainfall and seismic activity militated against dams and pipeline transport to the lowlands or sea and approval was given to discharge directly into the Kawerong River. A continuous high sediment load now exists in the Kawerong and Jaba Rivers, a coastal delta is forming offshore from the mouth of the Jaba River and the Pagana River, which flows into the Jaba River, has been isolated from the sea.

Tailings are basically freshly crushed and ground rock particles. This material bears little resemblance to a soil as it lacks microbiological fertility and soil organic matter. However, extensive agronomic research has been undertaken to determine the suitability of tailings as a soil parent material. Lysimeters have been set up on a concrete pad near the mine area. Whole tailings and sized fractions are exposed to normal atmospheric conditions. By varying the rate of withdrawal of leached rain water from the lysimeters, artificial water tables at various levels can be maintained. The withdrawn solutions and samples of tailings withdrawn from the lysimeters at various times are chemically analysed. One relationship originally studied with interest was the calcium oxide to sulphur ratio, which if below a value of 1.5 results in the development of marine clays that become highly acid when drained and prevent agricultural development. The Bougainville tailings currently show a calcium oxide to sulphur ratio of about 12 and this mineral composition seems favourable to the development of a well structured marl. Tailings pot trials, firstly with nutrient solutions and then with solid fertilisers, have established that a wide variety of plants can be successfully grown in tailings. Experiments with grass/legumes mixtures have been carried out to determine the rate of nitrogen accretion in tailings.

Having established that tailings have some desirable agricultural features the next step is to have them stored in a suitable location and physical state. This leads to the questions of where to place tailings so they will provide the maximum long-term economic benefit and how to measure the current deposition pattern. As part of the waste disposal agreement with the Government, Bougainville Copper Ltd was required to establish cross-sections along the Kawerong and Jaba Rivers and at six monthly intervals take vertical cross-sections of the material deposited on, or forming the bed of, the river. In practice there are thirty-five cross-sections, the first nine on the Kawerong River and the remainder on the Jaba River. Surveys are conducted of each
cross-section every three months. There is also a permanently manned sediment station at Mananau on the Jaba River between cross-sections 19 and 20. River flows are measured four times a day and water samples collected for sediment content and particle size distribution. Total analyses of composite tailings and water samples, representative of the three months, are also presented.

Therefore there is available every quarter an up to date picture of the deposition on land and, the input of tailings into the river system being known, the amount entering the sea can be calculated. After three years of operation there is sufficient data available to show a predictable deposition pattern.

*Environmental Planning*

Maximum planning effort is currently being directed to the tailings disposal area. Roads are being constructed or extended to provide better access to the area and detailed surveys are being made to confirm the feasibility of proposed strategies.

In broad outline, the scheme aims at developing stable and useful land surfaces both inland and at the coastal delta. It is possible that two distinct environments will become available for development and exploitation. Firstly, there are the land deposited sediments, which can be fertilised and revegetated. Secondly, there is the coastal delta, which has been built up by sediments deposited beyond the original coastline. It is expected that land deposition of tailings will take place on lowland swamp forest within the tailings disposal lease. Most of this area is totally inaccessible and not used at all. Deposition is expected to encroach on less than 25 per cent of this type of forest on the west coast, so it appears that no unique ecosystems will be destroyed.

Just as monitoring of land deposition has provided information for a tailings control strategy on land, it can be expected that routine measurements of marine parameters will provide data on deposition of the original coastline. Oceanographic surveys and marine biology studies are planned to start in the near future. Limited agronomic research to date on this material has indicated that naturally occurring and introduced species of mangroves are colonising and crustaceans and other marine life are becoming abundant.

Another important aspect of Bougainville Copper's Environmental Department's work is the routine sampling and analysis of waters and effluents. Drinking water and sewage effluents at all company installations are sampled and analysed weekly. The two process effluents, tailings water and filter plant effluent, are both originally concentrator process water. The latter is made alkaline by controlled lime addition to improve flotation efficiency. At the filter plant further lime is added as a flocculant. Tailings water and samples of river water taken along the Kawerong and Jaba River system are routinely collected and analysed for pH and heavy metals. The values obtained for copper, mercury, zinc, cadmium, lead and molybdenum are so low that special analytical techniques had to be developed to obtain quantitative values.

It has been suggested that the Bougainville operation may be causing heavy metal pollution of the rivers and sea (Brown 1974). Heavy metal hydroxides are insoluble in alkaline media and, as the lime (calcium hydroxide) keeps the waters of the Kawerong and Jaba Rivers slightly alkaline, it is impossible for heavy metal ions to remain in solution.

Acid pH and high copper values were measured in the Kawerong River during the exploration phase, both possibly resulting from acid drainage of rain forest humus. The alkaline river conditions, plus the fact that most of the heavy metal has been removed by an efficient flotation process—both a direct consequence of the mining
The development and operation of the Bougainville copper mine has caused both short-term and long-term environmental impacts. Some were a result of construction and have been eliminated, whilst others, such as waste rock and tailings disposal, were caused by the mining operations. Dramatic technological breakthroughs are unlikely and reduced environmental impact will be a result only of systematic research and planning. At Bougainville waste rock and tailings disposal strategies are being developed to provide optimum replacement environments to those that originally existed. Routine monitoring and analysis of process effluents is carried out as part of the company’s pollution control procedures.

References
Development of the Freeport Copper Mine

ROBERT D. MITTON

In the western sector of the Irian Jaya Highlands, near the Carstensz Pyramid, Freeport is mining Indonesia’s richest copper deposit. The company’s technological and engineering expertise has enabled it to overcome immense initial development problems and in this respect its record has been impressive. In other respects, however, the record has been much less admirable. The company, with the concurrence of the Indonesian Government, has ignored the rights of the local people to share in the benefits of the mine. It has disrupted the local environment and has employed western Indonesians in unskilled jobs rather than Irianese. It has imported goods that could be produced by the local people. It seems likely that, if these policies continue, conflict will ensue.

The Carstensz Pyramid, the highest peak within the New Guinea cordillera, lies in the western sector of the Irian Jaya Highlands. Four km due west of the summit, Indonesia’s richest copper deposit is currently being mined.

The permanent ice surrounding the peak was first recorded by the Dutch navigator, Jan Carstensz, in the early 1600s and the range was subsequently named after him. On a clear morning the range dominates the view from any vessel travelling the Arafura Sea close to the Mimika coast. Consequently, with the expansion of exploration in the early twentieth century, the Snow Mountains formed a powerful magnet for adventurers and scientific expeditions. A major expedition led by Wollaston in 1913 reached the ice, but failed in its attempt to climb any of the peaks. A second attempt was made by Colijn and Dozy (a Dutch geologist) in 1936. They also failed to climb the Carstensz Pyramid, but they returned with a report of a mountain of copper ore—the Ertzberg. This deposit has now become the focus of a major mining enterprise of which the technological and engineering feats have been awesome. However, Freeport’s social and economic relationship within Irian Jaya shows a dismal record. An overriding profit motive and a centralist government policy have resulted in a classic situation of colonial exploitation.

Physical, Cultural and Historical Perspectives

From the Papua New Guinea border to a point almost within sight of Teluk Sarera (Geelvink Bay) the dominant range runs as an almost unbroken spine of limestones and sandstones. Structurally the range is interrupted by the Paniai (Wissel) Lakes basin in the west, and centrally by the gorge of the Baliem. Geologically, the sedimentary sequence is disrupted by ancient volcanics south of Ilaga, and intruded by a dioritic mass near the Carstensz. The Carstensz intrusive is mineralised, and where it has had contact with the country rock some skarn enrichment has occurred. The Ertzberg is a chalcopyrite and minor bornite enriched body of magnetite associated with the skarn. The upper portion of this body has been exposed by glacial scouring in geologically recent times.
The deposit lies at a point where the Aghawagon valley, which drains most of the Carstensz ice fields, undergoes a major character change. North of the Erntzberg is the flat, swampy Carstensz Meadow. To the east is the steep wall of the truncated ridge line of the Pyramid, which throws its morning shadow across the mine. The alpine streams that flow sluggishly across the Meadow at an altitude of 3650 m converge at a point immediately north of the deposit and, cutting through a narrow portal beside it, rapidly plunge 700 m into the head of a modified cirque valley.

The Carstensz Range lies within the territory of the Damal people. The Damals south of the range refer to themselves as Amume. They are a physically short people, and in the steep southern valleys their numbers are low. Two villages, Waa and Tsinga, have direct access to the Carstensz grasslands. The main centres of Damal population lie north and east of a large, high plateau—the Kemabu Plateau—which itself lies directly north of the Carstensz. The grasslands of the plateau and the mountains have been used for hunting purposes for thousands of years; a rock shelter at 4000 m has produced a radiocarbon date for human habitation of more than 5000 years (J.H. and G.S. Hope 1975). Trails connecting the southern valleys with the Kemabu cross the range at low points between the permanent ice fields of the Carstensz and Idenburg Top. It was an undisputed fact that the mountain resources were claimed by the Damals. South of the Damal region the foothills are uninhabited. The coastal plain was the home of the Mimikas, a group culturally similar to their better known eastern neighbours, the Asmat.

When Colijn and Dozy reached the glaciers in 1936 the Mimika group had been subjected to mission and government contact for twenty years. The process that was eventually to destroy the people culturally, and turn them into a dispirited and apathetic group, had begun. The Amume were only known from reports of the Wollaston expedition. They had been mistakenly classified with the Kapauku, who were centred around the Wissel Lakes. The populations to the north would not be 'discovered' for almost another twenty years. The report on the Erntzberg, which was published in 1939, was of academic interest only: it was inconceivable that such inhospitable country could ever be commercially developed. The post-war demand for copper, however, resulted in a reappraisal of known remote reserves, and in 1959 the Dozy report was rediscovered.

In 1959 the East Borneo Company obtained an exploration permit to investigate the Erntzberg from the Dutch administration of West New Guinea. In February 1960 Freeport Sulphur agreed to undertake the permit area investigation. It is important to note that Freeport had had no previous experience in base metal exploration: the Company's origins and forte lay in the field of sulphur extraction in Louisiana and the Gulf of Mexico. The expansion into copper exploration was due to the forceful influence of the then exploration manager, Forbes Wilson, who foresaw the need for the diversification of Freeport's economic base. This lack of experience was partially responsible for economic problems that beset the project in its development stage, and it also explains, to a certain extent, their subsequent unsympathetic social and political role.

In July of 1960 Wilson led an exploration team into the Carstensz to sample the Erntzberg (Caldwell 1970). The Dutch New Guinea of this period was a region of greatly accelerated social and economic change. Indonesia was pressing its claim for the colony with increasing determination. The Dutch were pouring in unprecedented amounts of money: the Highlands were rapidly being opened up; mineral and oil exploration were encouraged. A northern route to the Carstensz from the Ilaga valley offered the easiest access to the ore body site. However, the airstrip which had recently
been built in the valley was controlled by a fundamentalist Protestant mission, which was fearful of the effects of ‘outsiders’ on their newly acquired charges. Consequently, Freeport’s application to use Ilaga as their exploration base was refused and relations between the Company and the mission were initially soured. Freeport was not the only group to be hindered by mission empire builders: a 1961 New Zealand expedition to the Carstensz was also refused permission to use the Ilaga strip (Temple 1962). Thus, even in the initial exploration phase, Freeport was alienated from the Highlands and developed a restricted south coast to the Carstensz outlook.

The results of the initial exploration were favourable, but before the project could develop further external politics overtook the scene, and in 1962 West New Guinea fell under temporary United Nations administration. In May 1963, Irian Barat became a province of Indonesia. The virulent anti-colonial stance and increasingly left leaning bias of the Sukarno regime resulted in an unfavourable climate for foreign investment. The attempted coup of October 1965 and its aftermath, however, completely modified Indonesia’s economic policy. When General Suharto eventually nudged Sukarno into political oblivion one of his main concerns was the control of Indonesia’s grossly inflated economy. In an attempt to attract overseas capital a new Foreign Capital Investment Law was enacted in January 1967. Freeport was the first company to sign a contract under the new law—a contract that was very favourable to the Company. Apart from an extensive tax holiday, Freeport was also granted immunity from royalty payment and land rent (Garnaut and Manning 1974).

**Exploration and Development of the Mine**

Intensive exploration of the ore body was begun in 1967. By 1968 it had been proved that the deposit contained 30 million tonnes of ore averaging a grade of 2.5 per cent copper, with additional values of 0.75 g of gold and 9 g of silver per tonne (Adams 1973). Although the mine was rich, the problems of development were immense. The top of the Ertzberg was at an altitude of 3713 m. The country around the mine is exceptionally rugged; the nearby summit of the Carstensz Pyramid soars to 4884 m. South of the mine the valleys are steep and narrow. The nearest port site, on an estuary of the Tipuka River at Amamapare, is 190 km to the south. In December 1969 a feasibility study was completed by Bechtel-Pomeroy and financing and construction went ahead in 1970–2 (Adams 1973).

The crushing plant was constructed on the edge of a precipice near the base of the Ertzberg (Figure 37.1). However, the concentration mill had to be sited in the deep valley 800 m below the crusher. The mill is connected to the crusher by a power line and three single span cableways, each 1500 m long (two are for transporting the crushed ore, the third is for the movement of personnel). A road connects the mill site (at 2900 m) to the town site (at 2000 m) 10 km to the south. At one point the road passes through the Zaagkam Tunnel, which is 900 m long. Beyond the town the road climbs to a narrow ridge, passes through a second tunnel (the 1500 m Hannekam Tunnel) and drops steeply on to the southern plains. The road does not connect directly with the port site: it goes as far as a barging point, after which river transport completes the link to the coast. Beyond the limits of the coastal swamp a 2 km long airstrip (Timika) has been constructed. This is sealed and capable of carrying DG9 aircraft; it serves as Freeport’s link with Biak and Darwin. The concentrate produced at the mill site is combined with water and slurried through a 10 cm diameter pipeline to Amamapare; there it is dried and stockpiled to await shipment.

The project was scheduled to cost $US150 million (Adams 1973). However, once it was operating, production was found to be below target; the original single ore
Fig. 37.1 Ertzberg project, Irian Jaya
cableway was operating at 50 per cent of expected efficiency. Consequently, a second cableway had to be installed at an additional cost of $US 10 million (Anon. 1974). This adjustment put an excessive strain on Freeport’s financial situation. Partly owing to an uncertain credit rating, they were having some difficulties in raising financial backing, and the high costs of development (especially in relation to problems encountered during the construction of the access road and slurry pipe) resulted in extremely austere budgeting. Money was made available only for objectives directly concerned with bringing the mine into production. The field of public relations was, unfortunately, relegated to the status of an unnecessary luxury. For Freeport this attitude was an economic expediency, but it has proved to be shortsighted.

In December 1972 the first cargo of concentrate was shipped to Japan. However, the formal inauguration of the project was not until March 1973 (Adams 1973). The mine was officially opened by President Suharto (a fact that underlines the importance placed on the project by the Indonesian Government); the company town was named Tembagapura—literally ‘Copper Town’—and Irian Barat was renamed Irian Jaya.

THE MINE IN ITS IRIAN JAYA CONTEXT

While the achievement of bringing the mine into production in conjunction with the overcoming of certain technological problems may be cause for admiration, it is but one aspect of the Erzberg history: the social aspect is not nearly as impressive. Although the project was to have an immense impact on the lives of the local Amume they discovered in the initial stages that they were to be alienated from it. A vast technological gulf separated the people from the Company—a characteristic of relationships between any exploration company and a pre-literate (and with the Amume, almost pre-steel) society. Few efforts were made by Freeport to bridge the gulf.

Freeport management dealt with the Indonesian Government; they took the pragmatic, but ultimately unrealistic, viewpoint that all social and economic problems concerning the local population should be dealt with by the Indonesians. Having spent more than two years in the general area I was aware that this attitude ignored certain basic, evident facts. Before Freeport’s arrival (and indeed well after it) the Government had no contact with the area. The nearest government station was at Ilaga, but officials would rarely move any great distance from the centre—certainly not to the remote valleys over the range. For local administrative liaison Freeport’s contacts were at Kokonau, the administrative centre of the Mimika. The mountain groups were beyond Kokonau’s sphere of influence: the Government was totally reliant upon Freeport for access to the Amume.

The only outsiders with a detailed knowledge of Damal language and customs were the Protestant missionaries but, owing to the initial lack of co-operation, Freeport were satisfied to ignore them. The people themselves had no spokesmen. The Irianese leaders chosen to represent certain regions in the 1969 ‘Act of Free Choice’ had no political influence and no power even to present a group complaint: their brief political role was meaningless outside their official function—to provide justification for the permanent inclusion of Irian Jaya into the Indonesian Republic.

Although traditional landownership is recognised under Indonesian Adat Law the all encompassing rights to the wider resources that are the mainstay of hunting-gathering societies are not recognised. Consequently, when the question of land payment arose it was only considered from the viewpoint of direct disruption of village gardens. Waa Village, close to the proposed town site, was the only group affected and was accorded minor compensation (Garnaut and Manning 1974).
The Melanesian environment

Freeport disregarded the morality of the government action, which they regarded as a carte blanche for development. Remote from criticism, they were able to proceed without environmental impact studies and the necessity for developing a social conscience. Fortunately, apart from the road construction, environmental disruption was minimal. Unlike Bougainville, there was no massive overburden to remove before mining could begin. The only river affected by waste products passed one village, Waa; it then emptied on to an uninhabited section of coastline. Freeport's lack of policy in dealing with the local people can only be summed up as 'If we ignore them perhaps they'll go away'. However, the people of Waa and Tsinga had no intention of moving, and the existence of the mine naturally served to attract people from other Highland areas. The initial enthusiasm for the Company soon turned to discord. There were major grounds for complaint: inadequate recognition of land rights, lack of material benefits to the villages, and lack of labour opportunities.

The question of land rights was brushed aside in an offhand manner by the Government. Subsidiary rights, such as access, were also ignored. Before development of the Ertzberg, hunting trails ran up the Aghawagon valley and on to the Carstensz Meadow grasslands. As the mine was developed sections of the trail were obliterated by rockfall and mudslide. Nevertheless, the trail was still used, and the locals even scavenged castoff nylon rope from the mine to make some of the more vertical sections a little safer. The development of the mine also resulted in the trail becoming a major access route from the north. The retreating glaciers had exposed a pass high on the north wall of the Carstensz — although it was possibly exposed in the early 1950s, it was first recorded by the New Zealand expedition of 1961 (Temple 1962). By 1972 it had become the most direct route from Ilaga, despite the danger of death by exposure (at its highest point the trail runs directly beneath ice cliffs and is 200 m above the snout of the Meren Glacier). From the pass the trail follows down the Meren valley and thence on to the Carstensz Meadow where it joins a second major trail coming in from the northwest (the northern access to the Kemabu River and Enarotali). Passing through the portal beside the mine the trail then negotiates the precipice below the crusher, dropping rapidly into the main valley. With the advent of the mine this route has been subjected to a new danger—blasting. Warning notices have been erected at the southern end of the Meadow, but even the mine management concede the fact that they are meaningless—the alternative route requires a detour of many hours, and many of the people for whom the sign is intended cannot read—and that it is only a matter of time before people are killed.

The mine has a projected life span of thirty to forty years, and with the development of subsidiary ore bodies possibly much longer. No general educational opportunities, even semi-skilled training schemes, have been extended to the local people: instead, at the insistence of the Indonesian Government, both skilled and unskilled labour are flown in from the western Indonesian islands. The Amume from the nearby villages have difficulty in obtaining unskilled positions, and they now have to compete with Irianese who have drifted in from other parts of the Highlands—Ekaris coming from Enarotali in the west, and Western Dani travelling from as far east as the Grand Valley of the Baliem. Small shanty towns have grown up close to Tembagapura. To the Highlanders the mine represents one of the few possibilities whereby they can achieve a cash income—from the earliest stages of development they have been aware of the mine's existence, even if Freeport was not aware of them. Disturbances that have occurred at Tembagapura have arisen from frustrations due to the inability to compete for economic positions and have invariably led to the mass layoff of Irianese. Among some of the European employees there is a substantial degree of sympathy for the
Irianese, and some of the geologists will work only with local labour, but the official Government endorsed position favours labourers from western Indonesia.

Tembagapura is an extraordinary anomaly. The town has a population of more than 2000, making it one of the largest settlements of southern Irian Jaya: its living standards are certainly the highest. A supermarket and a department store sell a huge range of American food and goods at subsidised prices. To step into the house of a senior executive is to step into another world—middle America in an Irian Jaya setting. Vacuum sealed from the world beyond the town’s roads, most of the inhabitants have no knowledge of, nor interest in, the wider context of Irian Jaya. Most have flown directly to Timika from either Darwin or Jakarta/Biak, and from there have gone directly to the town by either road or helicopter.

There is a substantial market for fresh food in Tembagapura, and the Highlands are capable of producing high quality fruit and vegetables. However, until 1973 no market developed between these two areas. Until 1973 fresh vegetables were either flown from the eastern states of Australia via Darwin, or shipped from Singapore. Eventually Freeport began to buy fresh food within Irian Jaya, specifically from the Baliem region, but this venture abruptly stopped in mid-1974 and the Company reverted to shipping in vegetables from Sumatra, via Singapore middlemen.

**Changing Policy?**

By 1973 it had finally become obvious to the Freeport management that they had a serious social problem on their hands. Overtures were made to missionaries for assistance in solving some of the problems. Obviously feeling the need to make some positive (and immediately tangible) developmental gesture, the Company supplied Waa Village with electricity. Eventually an anthropologist was hired and Freeport proposed the establishment of a trust fund for the local people. At this point the Provincial Government began to take an active interest in the welfare of the people and proposed that control of the money should be invested in the Government—Freeport declined the offer. Currently, the only positive step has been in assistance given to the local people in establishing commercial market gardens. This assistance also extends to a settlement at Timika where immigrants from western Indonesia are planting gardens. Apart from a professed policy of hiring Amume before other Irianese (but not before other Indonesians) the labour situation remains unchanged (Personnel Department, Tembagapura, pers. comm.).

The Provincial Government has established a police post in Tembagapura and also supplies customs officials at Amamapare and Timika; there has been no effort to set up schools or medical facilities for the local population. The army maintains an elite, well armed force in the town. Its only purpose is to protect the mine and town from the Irianese. If the combined Freeport/Government policies continue then it may eventually be needed.

**References**

The Melanesian environment


VI Forest resources and the environment
Papua New Guinea should look carefully at the economics of her current and planned forestry projects. Unless changes are made towards smaller-scale ecologically balanced practices and high enough prices are sought for timber harvested, Papua New Guinea runs the risk not only of losing increasingly valuable tropical rain forests but also of seeing projected economic benefits disappear. Tropical lowland rain forest is the world’s most complex biotic community, and its continuing loss is now recognised as one of the greatest conservation problems facing the world. The short-rotation monocultural crops that are planned as rain forest replacements, for example in the area of the Madang woodchip project, will probably be unstable, susceptible to fire, insect infestation, fungal diseases, and site deterioration due to damage to soils. Apart from the danger of destroying the productive potential of land, of losing native wildlife and flora, of forfeiting recreational opportunities, and of threatening the health of streams and watersheds, there are serious doubts as to the economic benefits to be obtained. Considerable evidence suggests that Australians are in fact subsidising big pulp and paper companies, and overseas consumers of their products, through the low prices charged for the raw material. To avoid following this model, Papua New Guinea should not undertake further massive forestry projects and current projects should concentrate on quality timbers where prevailing royalties are much higher than for pulp wood and withhold timber pulpwood until prices rise sufficiently to cover sound forestry practices and yield an adequate return. Low impact but not necessarily unsophisticated machinery should be used, only a small proportion of the forest should be taken at a time, and adequate buffers should be left around logged areas to conserve wildlife and flora. The switch to small-scale, low impact ‘village forestry’ will have to be accompanied by appropriate reorientation of forestry education, training and research. We should like to sketch briefly the Australian situation, and then to draw out some parallels between this and the situation in Melanesia. There appear to be many significant parallels. Many Australians are now seriously questioning the need for, and the benefits from, the factory type forestry now being foisted on them by the alliance of government, state forest services and the forest industries. There seem to be even more powerful reasons for people in Melanesia to question the alleged benefits from these sorts of operations.

**The Australian Scene**

Australian forests, like those of Melanesia and many other parts of the world, are now being seriously affected by the burgeoning timber export industry, especially the woodchip industry, and associated replacement of natural forests by plantations. Over the last six years four woodchip export projects, affecting about 2 million ha of forest, have been established in southern Australia, and many more are in the pipeline. In this period also forest management has become a major conservation issue and a
major source of confrontation between conservation groups on the one hand and forest services and forest industries on the other.

Australian forests were a small proportion of the land area before European settlement, but since that time have been reduced by two-thirds and now constitute only 5 per cent of the land area. The clearance, in the course of development, of many of the best forests—for example millions of acres of magnificent mountain ash forests in Victoria—to create marginal farming land now too often bracken covered or eroded, has come to be recognised as a tragic error. Australian forests are now seen by many Australians as highly valuable, not just as a source of cellulose, but also for protecting native wildlife and flora, for maintaining recreational opportunities and the beauty and character of the landscape, and for protecting streams and watersheds.

Except in the most rabidly 'pioneering' parts of Australia (like North Queensland) continued clearance of publicly owned forest is now becoming politically unacceptable. In Australia the export woodchip industry is not permanently clearing publicly owned forest, although it is contributing to the clearance of many areas of privately owned forest land. This private forest land constitutes about one-fifth of the total forest area.

But many Australians fear that the industry is destroying the non-wood values of public forests, and that it may even be helping to destroy the long-term capacity of the forests to produce cellulose. The woodchip industry has given a great impetus to 'tree farming' operations in our forests. These involve large-scale clear-cutting, and frequently the replacement of naturally occurring associations by planted or seeded monocultures of species more useful for wood production. The diversity of the natural forest, its wildlife and flora, and its scenic and recreational value, are all too frequently lost or greatly reduced in these operations. They can also involve serious consequences for watersheds, stream fauna and fisheries, through erosion and increased turbidity of streams, lakes and estuaries. There are also good grounds to fear that on many sites at least, soil fertility is being reduced through erosion and nutrient drainage, that yields will not be sustainable, and that the lack of diversity of the resulting even-aged stands will make them more susceptible to fire, insects and disease.

Australians are also concerned about the economic basis of this industry. Despite the confidentiality of many of the economic data, there is a considerable amount of evidence that the cost of regenerating the new forest exceeds the returns obtained and that the operation makes a public loss or at least unsatisfactory returns. Australians are, it seems, subsidising the big pulp and paper companies, and overseas consumers of their products, through the low prices charged for the raw material.

This fits in with the general economic picture for forestry. Generally the production of raw material is the unprofitable part of production, the highly profitable operation being the manufacturing part. When both operations are run by the one operator, a highly profitable amalgamated operation commonly results. But when the raw material production part is run from public forests at public expense, and the manufacturing part is in private hands, the picture is quite different. The profitable part is in private hands and the unprofitable and risky part is publicly borne. Forest services, which make large annual losses, are thus in the position of socialised losses for the large forest industries. Not surprisingly, this situation suits these industries well, and they are attempting to persuade governments to take over more and more of the job of producing their raw material, with some measure of success. The upshot is not only that forest industries are subsidised by the public, and wasteful and damaging excessive consumption of junk paper items—the major part of paper consumption—encouraged, but also that the excessively low prices paid for raw forest material
do not cover the cost of environmentally satisfactory forest operations or the cost of proper renewal of the forest. Environmental degradation is therefore encouraged.

On the public side of the ledger then there seem to be largely costs. The public is losing financially; wildlife, wilderness and much that is valuable is being destroyed; and the amenity and diversity of the forest is being lost. In the woodchip case the resulting products, which for the most part make no useful contribution to people's lives, are exported to benefit overseas consumers. There are, on the other hand, substantial benefits for large pulp and paper companies, which are among our worst polluters. It is no wonder that increasingly people are beginning to question the benefits they derive from such an industry and to ask some awkward questions about the distribution of these benefits, and the real contribution the industry makes to the quality of their lives.

On the wider political and ideological level, Australian environmentalists are concerned about the narrow and excessive orientation to wood production on the part of Australian forestry services, and their preoccupation with industrial growth objectives. They are concerned about the scanty research undertaken before enormous areas are committed to tree farming, the heavy promotion by forest services of these programs, and the playing down of their serious costs and risks. Australian forest services, they believe, are oversensitive to the needs and interests of big industry, which has far too much influence on planning and decision making. Forest services are hostile to environmentalists but have close connections with industry and consider their interests as against those of other groups. They promote the tree farming programs, which suit industrial interests, and attempt to obscure or rubbish alternative ways of managing the forests. There is suppression of information, secrecy in decision making and lack of public participation. Much of the destructiveness of Australian forestry can be traced directly to the overwhelming commitment on the part of forest services to the interests of big wood based industry, which interests dictate the large scale mass production forestry, and the heavy handed, capital intensive, factory style operations that are so destructive of forest values.

**Throwaway Rain Forests: the Melanesian Scene**

Australians may seem to have a lot to complain about. It might be thought that these are the complaints of an already affluent society. We want to argue, however, that the people of Melanesia have just as much reason for concern about their forestry operations, especially 'total logging' operations, which appear to be forestry of the most destructive sort.

The general outlook for Melanesia if present trends continue is for liquidation of all accessible lowland rain forest by the year 2000. In Fiji extensive forestry operations are proceeding on the main forested islands and all useful timber with diameter in excess of 33 cm is being extracted; no attempt is made to regenerate the original forest.

The policy, based on the known slow growth of indigenous forest and its heterogeneity of species ... is to regard the natural forest as a wasting resource and to plan to meet ... requirement(s) from plantation. (USP n.d.:1)

In the Solomon Islands extensive operations in the rain forest are expected to consume the known timber resource in 20-30 years. The regeneration alternatives being considered are restricted to monocultural plantings over a small part of the cut-over area, and there is no attempt to manage or sustain the natural forest. In New Caledonia and the New Hebrides what little natural forest of commercial value that remains will be exhausted in the next thirty years. And in Papua New Guinea a number of large-scale export oriented forest projects are predicted to make 'the
lowland rain forest as a feature of Papua New Guinea...a passing one' (White 1971). Apart from a number of smaller timber leases, woodchip projects are already operative in Madang in New Guinea and Open Bay in New Britain. Some five further large-scale integrated woodchip projects, and four others of intermediate scale, have been advertised (White 1975). These will affect most of the accessible lowland rain forest by the year 2000.

The more detailed picture is no less depressing. The rush to destruction¹ of the natural forests is perhaps nowhere more conspicuous than in Fiji, where

the Forestry Department believes that earlier exploitation of the indigenous forest down to 3 ft 6 in. girth [about 13 inches diameter] is very desirable, plus a maintenance of the present very active plantation programme. (Lembke 1971:57)

According to A.K. Oram, who bears the somewhat inappropriate title of 'Acting Conservator of Forests',

The balance of advantage would appear to be strongly in favour of felling and selling as much as possible. If it were possible to do so efficiently it is arguable that it would be desirable to fell all of the natural timber over say the next 5 years. (Oram n.d.4)

Since such a procedure is admitted to be practically impossible, Oram suggests 'a compromise between the theoretical desirability of felling the entire resource now and what is practicable having regard to harvesting and marketing constraints' (Oram n.d.:4). The compromise strategy is to spread out liquidation of the indigenous forests over the next 20–30 years (cf. Lembke 1971: 59). All the major areas of forest on the main forested islands of Viti Levu, Vanua Levu, Kandavu and Rabi have already been allocated to concessions, with the exception of an area in central southeastern Viti Levu which is probably being held as a future woodchip concession, and it is proposed that 'Pressure should be exerted on existing concessions who are not fulfilling their minimum cut conditions'. At the same time, to further the strategy, 'Maximum encouragement in the form of taxation allowances (i.e. accelerated depreciation allowances) and import duty reductions should be available to this industry ...' (Oram n.d.:8). In contrast, environmental constraints, which might reduce incentive, are definitely not encouraged. The result is that total logging of the natural forests (down to 33 cm diameter trees)—which will involve virtually complete site disturbance and interference with remaining poles—will be scarcely less destructive of the forests than clear-cutting for woodchipping.

Indeed by no means all of the destructive forestry in Melanesia will be for woodchips; so far, though destruction of forests has been extensive, only two woodchip schemes, both in Papua New Guinea, have begun operations in Melanesia. Total logging for veneer logs, saw logs and pulp logs, logging that takes all trees above a certain small diameter and results in almost complete disturbance of areas logged, can be just as destructive of the rain forest as total logging for woodchips.

In New Caledonia, only

10% of the land is covered by natural forest. This forest is receding as a result of bush fires and of mining exploitation and prospecting. It includes many species, but at present only about ten are known and exploited ...

It is estimated that the high forest resource (such as it is known at present) will be exhausted in 30–40 years time. (USP n.d.:2–3)

According to Thompson and Adloff (1971:396–8), who expand some of these points:

¹ The phrase is borrowed from Searle's (1975) critique of the proposed New Zealand South Island Beech Scheme. Implementation of this scheme has now been postponed—at least until after the November 1975 elections. In fact, however, several Melanesian projects surpass, in scale of environmental vandalism, schemes so far outlined in New Zealand.
Although the wooded area covers nearly a third of Grande Terre’s surface (250,000 to 300,000 hectares), it is largely composed of secondary growth. In many places the primary forest has been destroyed, and for this, man is far more to blame than is nature. The progressive deforestation of the Grande Terre has been due to erosion and abusive exploitation, and no attempts were made by the government to control either until after World War II.

Violent rains alternating with drought have eroded some areas of New Caledonia. The spread of erosion, however, has been the result of the bush fires set by farmers and herders as a quick and cheap way of fertilizing the ground, and of the wanton cutting down of trees either for export or to clear regions for mineral prospecting. Cattle and deer have also played a part in eliminating the vegetation that formerly protected the soil and covered much more of the island’s surface than it now does. Its disappearance has permitted lantana bushes and niaouli trees to proliferate in the denuded areas. The law of 1910, which provided a basis for New Caledonia’s forest regulations, was never put into effect, and a local ‘forestry service’ existed only on paper. Landowners, mining prospectors, and Australian lumber companies were allowed to fell trees without control or supervision and also without any obligation to replant.

... For lack of real support in the form of sufficient funds and technicians, the Forestry Service was not very effective until the 1960s. Then a Fonds Forestier was created to provide money for the conservation and better utilization of local forest products (1960), a reforestation program was devised for the replanting of 500 hectares a year (1967) ...

The measures described above were so belatedly undertaken that they can do little more than arrest erosion and conserve what is left of New Caledonia’s forest heritage by limiting the amounts of timber legally available for exportation and local use.

In the New Hebrides

High forest is seldom developed due to cyclone damage, shifting cultivation and paucity of species. It is unlikely that stands of timber which would interest a large scale commercial exploitation exist except on Erromango where they are at present being exploited ...

On Erromango a French Company ‘Société Agathis’ has begun a considerable operation to cut Agathis but this will probably not continue beyond 1976 by which time all the good logs will have been cut. (USP n.d.; cf. also Anglo-French Condominium 1973: 37–8)

In fact the company, which had a licence ‘to cut an unlimited amount of timber’ (Anglo-French Condominium 1973:37), ran into difficulties and export tonnage fell to a fifth of earlier levels in 1974 (from about 6000 to less than 1500 tonnes: see New Hebrides Condominium Statistical Bulletin, 10 July 1974).

Before 1970 there were no controls on logging, and no forestry inventories.

The Forestry Section of the Condominium Department of Agriculture was created in 1970 to control the logging operations of the Rougier & Fils subsidiary, Société Agathis, on the island of Erromango, as well as to carry out afforestation techniques with indigenous and exotic species, and to prepare an inventory of the forest resources of the New Hebrides. (Anglo-French Condominium 1973:37)

But the Section is scarcely adequately staffed for the tasks. Furthermore the ‘new licence permits Société Agathis to cut an unlimited amount of timber’.

In the Solomon Islands

The tracts currently under commercial plans will last about 10 years and then other areas would be called upon to play their part. These, it is estimated, will last a further 20 years–30 years in all ... It can be seen that the regeneration programme in the BSI must be given a

2 The four companies, operating in the Solomons in 1971 were: Levers Pacific Timbers Ltd, Kolombangara Is., United Kingdom owned and log export lifting to 113,000 cu m a year; Kalera Timber Co., New Georgia Is., Japanese, U.S. and Philippine owned and log export about 18 million s. ft. p.a.; 42,000 cu m a year; Allardycce Timber Co., Santa Isabel Is., Australian owned, log export about 26,000 cu m a year; Shortland Development Ltd., Shortland Is., Japanese and Australian capital and log export approximately 22,000 cu m a year (Lembke 1970:46; we have converted Lembke’s figures to metric units).
Forest resources and the environment

very high priority as the present cutting programme will consume all the known resource in 30 years. (Lembke 1970:46)

Fortunately this program—to cut through all the natural rain forests of commercial importance at a rapid rate, and to replant very limited areas with short-rotation monocultural plantations directed primarily at the production of pulp—has run into substantial local opposition. The opposition is effective, since approximately three-quarters of the country’s remaining commercial timber forests are on customary land.

In the view of the industry-forest service alliance

the first and most urgent problem is to secure cutting rights so that the present timber industry can continue when the present tracts are worked out in a few years time. (Kera and Maenu’u 1975:5; cf. also Lembke 1970:48)

At present remaining forests in the Solomons

are reserved ‘to meet the future needs of existing operators’ . . . the timber industry is fast approaching a stage where it needs positive assurance of future log supplies in specific areas if it is to continue development . . . There can be no doubt that the industry will not be prepared to implement any large new investment programme except on the basis of full security of raw-material supplies. (Lembke 1970:48)

The timber operators are entirely foreign owned and controlled, and most of their production is shipped to Japan. As we shall see, the local people are receiving little benefit and incurring many costs for the sale of their lands and forests. It is not surprising that they have objected.

After the purchase of the Vanganu Viru-Kalona and Allardyce tracts and one part of Santa Cruz, the landowners did not want to sell more lands to the Government so the Government tried to introduce firstly ‘long term lease’, secondly ‘profit agreement (timber right)’, but again these two systems were not successful. The third and last try so far is the ‘agreement signing between the land owners and the timber companies according to Forests and Timber Ordinance following direct negotiation by the timber companies themselves with the land owners’. This system is already showing signs of the landowners disliking it. In any case it is doubtful if this system gives sufficient security for the timber company’s investment. It remains very important to work out what will be the correct system that the landowners will agree to so that their forests can be worked so as to be of great benefit to them and their Government. (Kera and Maenu’u 1975:5; our italics)

Really, as in other parts of Melanesia, the main benefits accrue to foreign companies, to Japan, and to a small government elite.

In Papua New Guinea, where the pattern of distribution of benefits is similar, there are likewise difficulties arising with the traditional owners of the lands. There is some prospect that the distinctive Melanesian pattern of land tenure, so far from being a major drawback, will serve in Papua New Guinea also to block undesirable development and be in the interests of nature conservation.

By far the largest and best forests in Melanesia lie in Papua New Guinea, which has almost as much forested area as Australia, and in Irian Jaya. Substantial concession areas in Papua New Guinea are now up for offer. Apart from the projects in the Gogol (near Madang, with a concession area of 67,000 ha) and at Open Bay (183,000 ha) already taken up, major forest areas have been advertised at Sagarai-Gadaisu (120,000 ha), Kaumusi (85,000 ha), Kapiura (83,000 ha), Kapuluk (181,000 ha), and Vanimo (278,000 ha). And ‘other areas of intermediate scale promoted during this period included Kaut, Tonolei Harbour, Hargy and Bakada’. (White 1975:11; our italics.) These larger Papua New Guinea operations will be liquidation logging: they are designed to cut through the productive forest in the concession area in a fixed time (typically 10–15 years). A further 800,000 ha of forest is committed under log and sawmill concessions. These concessions, some of which are large, are likewise far from benign. (See, e.g.
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Jonas 1972. Some of the remoter operations, for example in the Nothofagus forests of the Highlands, are also apparently very damaging.)

D. McIntosh, Director of the Department of Forests, Papua New Guinea, recognises some of the dangers of large-scale log export projects such as are proceeding in Melanesia and adjacent Indonesia and Philippines:

We believe, however, that it would be wrong to allow this [i.e. large log export operations] to happen in Papua New Guinea. Log export operations, because of the nature of Papua New Guinea forests, yield minimum returns to the country and move through the country at a great rate, leaving behind a degraded forest and a multitude of roads and tracks to be quickly overgrown. (McIntosh 1971; our italics)

Surprisingly, McIntosh thinks that these wrongs would be rectified with large-scale integrated (log and chipwood) export industries, which subsequently, possibly, involve pulp mills. For such integrated operations, which characteristically involve clear-felling, if anything increase environmental degradation (and, as will become apparent, returns to the country are not much better than minimal). In fact

The clearfelling of large annual logging coupes will oblige the Administration to mount a massive reforestation programme. It is believed that in general, secondary growth will have little potential even for pulpwood and therefore plantation forestry will be necessary. (Endacott 1971:59)

Of course the massive reforestation program (which could be avoided by careful selection removal or small patch cutting) suits the industrial orientation of the Department of Forests:

It is only then [after almost 100% removal of the forest] that we can get down to the business of producing cellulose on a short rotation. Only then can the tropics play their part in the world forest products scene. (Colwell 1971:39)

The botanically and ecologically unknown rain forests of Irian Jaya are not to escape damaging exploitation. Large-scale woodchip export operations are now being planned, one of them by Conzinc Rio Tinto, the Australian subsidiary of the Rio Tinto Zinc Corporation. It seems extremely unlikely that Irian Jaya will escape the Indonesian Government's policy of massive forest exploitation of the outer islands, and the simple and effective idea of environmental destruction as a tool of social change.

It was explained to me that an important feature of Government policy is to develop the 'outer' islands (i.e. outside Java). Forest exploitation is useful in this because large-scale mechanised logging has a substantial social impact ... (McKelvey 1974:8)

It will evidently not be long before foreign companies move into Irian Jaya forests on a large scale (beginning with several large concessions already granted).

Foreign concessionnaires are exporting twenty million cubic metres of logs from Indonesia annually, an astronomic quantity of wood. The Indonesian Government is regulating foreign investment and exploitation of resources in many sectors but not in the wood industry where operations by overseas firms are allowed to proceed with little restriction ... logging of the natural forests is now proceeding at the rate of 600,000 ha per year and it looks as if the foreign concessionnaires have the bit between their teeth and the Forest Service has lost control ... It seems impossible for the current yield of wood to be sustained and the decline in productivity will almost certainly be steep, with unfortunate social and economic consequences. (McKelvey 1974:8)

McKelvey's comments might suggest that the destruction is due to the absence of forest services, or their lack of power and influence. However as the preceding account clearly indicates, in most other parts of Melanesia forest services are at best acquiescing in the destruction of the natural forests, and have in many cases encouraged and promoted measures that will result in such destruction, seeing their chief role evidently as agents in orderly marketing. The attitudes of forest services are of course not the only factors encouraging destructive exploitation. Nevertheless the reality of forest services
as actively promoting projects that will result in the destruction of these rain forests contrasts markedly with the self-image of the profession, as one of 'professional conservation'.

Finally, the exploitation and replacement of Melanesian rain forests will be increasingly directed to the production of low grade, and often undesirable, pulpwod products. Because of the diversity of species, rain forest material generally yields not high quality pulp suitable for writing paper, books, etc., but largely low quality pulp used primarily for packaging materials.

... indications are that the 'run-of-the-bush' mix is suitable at least for the production of packaging materials. This is confirmed by the Honshu Paper Manufacturing Co. Ltd., which, if its project at Madang is successfully launched, does in fact intend to use its material for linerboard. (Endacott 1971:54)

Subsequent plantations of kamerere (Eucalyptus deglupta), at Madang and elsewhere, will not produce high quality pulp, either, but primarily material for junk products. In this sense the rain forests are truly throwaway.

**Likely Effects of These Schemes**

We take as our discussion example the 'showpiece' Madang project, which is only the first of a series of projects 'about to lay waste' vast areas of accessible lowland rain forest in Papua New Guinea (Womersley 1974). This project, as presently planned and conducted, gives every sign of becoming an environmental disaster. The project is employing large-scale clear-felling in a valuable and fragile ecosystem, one far less resilient under this type of treatment than the temperate forests in which this controversial practice was developed.

Everything in the Madang concession from 20 cm diameter up is to go—most of it, including many saw logs, to the Jant chipper at Madang—with the exception of a few unsuitable species such as strangler figs, select food trees, and inaccessible trees on steep slopes. The life of the forest is estimated to be twenty years.

The Madang project as presently conceived does not meet the essential minimal condition for any non-destructive forestry operation, that of providing adequately for the regeneration of the forest, or at the very least for some other productive use. There is no evidence that the deforested land will, except in a few parts, be suitable for alternative agricultural ventures. It is not exactly news that primary tropical rain forest will not return on a short-term time scale, if at all, after large-scale clear-felling, and that widespread loss of forest is likely to occur. It is thought that if the destruction of primary rain forest seed sources is carried out over a sufficiently wide area, as planned in the projects, loss of the primary forest may be irreversible (Gómez-Pompa et al. 1972). Yet it is not apparently intended to replant or regenerate more than a fraction of the area cleared each year, and there is a far from negligible probability that much of the remainder will become an eroding and impoverished wasteland. It is the same elsewhere in Melanesia and Southeast Asia.

A common pattern in [these] countries ... is for a small part of an exploited timber concession to be developed for agriculture and another part, favoured with convenient location and topography, to be planted to exotic plantation. But always an area, usually the major part, is left fallow and relatively unproductive. (McKelvey 1974:5)

To a large extent, then, the Madang project appears to be a deforestation project. The effects of deforestation of hillsides in the humid tropics are only too well known—erosion, continuing landslides and landslumps (already evident in the Madang project), increased silting of streams and estuaries, and increased downslope flooding with adverse consequences for adjacent productive areas. Yet a considerable
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proportion of this deforestation program, again euphemistically referred to as employing ‘total logging’, will affect land that would by most standards count as rugged; half is hilly with steep slopes. The project does not meet, either, the important requirement that in tropical and sub-tropical areas with high insolation at least 30 per cent of the land should be left under forest cover to protect soil and water.

The actual commitment to reforest even part of the deforested area appears to be quite vague, and there are conflicting claims about who will undertake it. So far the responsibility has fallen on the Forests Department, and there it is likely to remain. In general in Papua New Guinea wood export contracts ‘the commitments on both sides, Government and entrepreneur are vague’ (Carson 1974:5). Carson’s claim is said to be readily confirmed by anyone with access to these confidential documents: the contracts are wide open, in far too many respects.

Replanting with short rotation tree crops, even if it were successfully carried out over a large area, would renew only the cellulose producing properties of the forest. The loss of other valuable non-wood aspects of the forest is no minor matter, especially in a country like Papua New Guinea where the forests are important to many of the people, and which has been described as having ‘for its size one of the richest, most diverse and most unique floras and faunas in the world’ (Schodde 1973:123). In fact

The principal threat to the perpetuation of the native fauna of New Guinea is in the alteration of the environment and more particularly the elimination of native forest. The latter is very important since a major portion of the fauna is strictly limited to the forest vegetation. (Gressitt and Zeigler 1975:117)

The rain forests are, of course, the main habitat of this biota, with, for example, 75 per cent of birds being essentially rain forest forms, and 65 per cent of endemic birds being confined to primary rain forest. Even in the unlikely event that regeneration of secondary forest were to be obtained over a substantial part of the area then, the results of deforestation are likely to be severe. For, as Schodde has pointed out, the flora and fauna of the secondary forest—already widespread in New Guinea where rain forest has been disturbed—is relatively poor.

For example, a recent avifaunal survey of the Lake Kutubu area … revealed that out of seventy species of forest birds recorded, only twenty, all representatives of widespread New Guinea forms, were found regularly in secondary growth (Schodde 1973:129).

Furthermore where a high proportion of the fauna is arboreal or dependent on the forest for shelter, even temporary deforestation can have severe effects.

Despite the high percentage of land area in forest, then, there is no ground for complacency about the effect of forestry operations on fauna, and certainly not for the complacency exhibited by the Forests Department—exemplified in K.G. White’s (1975:13) pseudo-ecology: ‘The modified forest should be an improved habitat for ground fauna and for much of the bird life; it is possible that it could be more productive in this sense than the existing forest’. Furthermore many of the areas to be destroyed are inadequately known botanically, thereby posing a major hazard for plant species (Womersley 1974). These areas include White’s ‘large resource of which we have a detailed knowledge’ (1972:61).

Continued destruction of the rain forest habitat in the style of the Madang project will certainly result in massive reduction in numbers of non-human species, and also very likely in considerable species eliminations. Animal species at the end of food chains are, reportedly, already showing decline. It is thought that areas of 1200 ha of suitable type and shape are needed even for temporary holding operations, and considerably larger areas for permanently viable faunal populations. By these standards the Madang project does not have a single adequate conservation reserve for flora and fauna.
Where so much fauna has primarily rain forest as its habitat, adequate reserves would be quite essential even if the natural forests were being managed and regenerated, which is certainly not the case.

By the same criterion, Papua New Guinea at present does not have a single adequate national park (neither of the two parks meeting the requirements). Much the same applies elsewhere in Melanesia. For instance, in New Caledonia, despite the fact that some of its flora consists of ancient and rare plants and trees, and ‘New Caledonia is unique in that 83 per cent of its species are not found anywhere else in the world’ (Thompson and Adloff 1971:2). there are only ‘13 reserves of various kinds which cover 95,000 hectares. Regulations appertaining to reserves are still unsatisfactory …’ (USP n.d.3) and in particular mining is not generally excluded. In the New Hebrides, few areas where the unique Hebridean kauri occurs remain undisturbed, and none are reserved. Yet—to understimate the matter—‘the New Hebrides flora and fauna are not well known’ (Leslie 1975:39).

Tropical rain forests are generally not stable under substantial interference of the sort that total logging operations impose. There are several reasons for this (see Gómez-Pamela et al. 1972). One is the short viability and short dispersal range of the seed of most primary rain forest trees. Another is the susceptibility of rain forest seedlings to ecological disturbance, especially to fire. A third concerns nutrient problems: … Tropical virgin-forest soils lack the most important nutrients essential plant growth … The nutrient content of soils is extremely low … A natural virgin forest, in which there is no exploitation man, is a self-sustained, closed system, including the soil. Such a system is in dynamic equilibrium. … The entire nutrient capital necessary for the continued growth of this lush type of vegetation is tied up in the living matter itself and in the small amount of undecomposed, dead, plant fragments … There are no nutrient losses under natural conditions … Only recently have large areas [of tropical rain forest] been destroyed by man … This destruction is probably permanent, because logging and burning of slash causes a sudden mineralization of the entire nutrient capital. Since such cleared and burnt areas are denuded of plants that could absorb the suddenly-released nutrient capital, it is leached out instead by rain. Only a small remaining proportion is held by cultivated plants and weeds. Therefore, cleared forest areas are infertile in the tropics. A second-growth of forest can become established on the fallow fields. But it will hardly attain the original vigour the virgin forest as a result of the reduced nutrient capital. After repeated use, the cleared areas are invaded by bracken (Pteridium aquilinum), or after repeated burning, by alang-alang grass (Imperata). (Walter 1971:91 ff.)

Tropical lowland rain forest is the world’s most complex biotic community. Its continuing loss is now widely recognised as one of the greatest conservation problems facing the world and one of the most significant and irreversible steps in its biological impoverishment. Melanesian total logging schemes, and Papua New Guinea woodchip projects in particular, will make a significant contribution to its loss. This is a loss to everyone in the world, now and in the future. But in the case of woodchip projects it is first and foremost a loss to the present and future people of Papua New Guinea, and especially to those whose way of life involves use of and presence of the forest. There is evidence that the full consequences and costs of the deforestation program have not been explained to these people, who apparently have been told (see, e.g. Department of Forests n.d.) that the forest, its wildlife and food supplies will return after cutting, when there is strong evidence that much of them will not. For example, not only is much fauna important to native economies unlikely to survive, but also isolated food trees left after surrounding forest is cleared are unlikely to survive for any length of time, and regeneration may be affected. Death of many isolated trees is already evident.
But it is not just the yield of forest values other than wood production that is in jeopardy—the sustained yield of cellulose itself is in grave doubt. It is intended to replace what is felled with short rotation monocultural crops such as kamerere (*Eucalyptus deglupta*), grown on 10–20 year rotations. Only someone with a highly overconfident view of the ease with which natural systems can be manipulated for human ends, who is prepared to ignore the conservation laws, or who has faith in the prolonged capacity of the soil to withstand abuse, can seriously believe that these short-rotation monocultural crops in the humid tropics will be permanently sustainable except under the most favourable conditions of soil with massive inputs of fertiliser. Even at present fertiliser prices heavy inputs of fertiliser are likely to have a serious effect on what economic viability there is. The best soils are commonly already in demand for agriculture, and total logging concessions are frequently on inferior leached soils.

But it is not just short-rotation and soil fertility problems that constrain such replanting projects. As Lamprecht (1969) has claimed:

> In spite of the enormous advantages [especially rapid growth and short rotations] which wood plantations have in the tropics and sub-tropics, indisputable proof exists that they lack biological stability.

Documenting the matter is not completely straightforward, since most plantations are fairly new, and forest services prefer to keep silent about failurs. As Lamprecht goes on to remark

> Lack of knowledge about large-scale damage in the tropics and sub-tropics does not mean that such damage does not occur. Visitors are usually taken to show-piece enterprises for obvious reasons. The same is true of the literature. We are not the only ones who prefer to keep silent about failures. And finally one should not forget that the majority of plantations are fairly new even when measured against the short rotations … usually less than 20 years. Lamprecht cites as causes of instability: fire; insect infestation (e.g. *Pinus merkusii* in North Sumatra and *Eucalyptus grandis* in northern New South Wales, see Carne et al 1974); fungal diseases and die-back; site deterioration, primarily through fertility reduction and damage to soils (e.g. nutrient losses, soil erosion, changes in soil structure). He might well have added other things, such as the short viability and limited seeding range of mature rain forest seed.

The problem of site deterioration is accentuated by short rotations. It is worth remarking on the decline in site productivity of coppice managed *Eucalyptus* plantations in Brazil. After the fourth rotation, at age twenty-eight years, wood production was too low to cover the cost of harvesting. Soil degradation occurs even under monocultures of teak, the one tree that has much success in tropical plantations (in monsoonal regions).

Many of the difficulties Lamprecht and others have documented in support of the thesis that tropical even-aged monocultural plantations lack ecological stability, have already surfaced in Papua New Guinea plantations. In a pleasant understatement, the Department of Forests’ glossy brochure *New Horizons* (produced in 1973 to advertise Papua New Guinea forests to overseas industrial operators and investors) admits that ‘Large-scale plantations of single species have many development problems’. In fewer than twenty-five years of plantation experience, all the problems Lamprecht cites, except site deterioration, are admitted as having occurred; attacks by insects, fungal rootrots, termite and weevil invasion, fire losses. It will presumably only be a matter of time before site deterioration is detected.

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3 The effect on the soils at Madang is severe; practically the whole logged area is run over and compacted by steel-shod machinery. According to reports it is the same with most total logging operations in Melanesia.
The fact of the matter is that the fundamental principles of ecology do not cease to apply in Melanesia. For example, the principle that, if the bulk of nutrients of tropical forest ecosystems are removed through forest removal, then the requisite nutrients are not available for a new forest surely does not admit of local exceptions. Lamprecht's thesis can be highlighted in this way: *extensive tropical even-aged monocultural plantations will only succeed in defiance of ecological principles.* The impression that one is successfully flaunting natural laws can, of course, be prolonged by much tending and by heavy use of fertilisers, herbicides and insecticides. There is, however, quite insufficient evidence that the use of these devices, often ecologically damaging, will ensure stability. There is a severe risk that they will not. There is, in short, the gravest doubt that the plantations will be sustainable, and certainly sustained yield over several rotations at acceptable costs appears improbable.

One should not need to stress the inadvisability of signing contracts and planning projects that depend on the success of such a risky venture. It is no good trying to dismiss these risks by saying that man is a risk taking animal, for it is quite invalid to argue that, because some risks are acceptable, any are. That is just an invitation to irrational decision making. Ecological risks of a large magnitude may perhaps be sometimes justified where the prize is suitably large, or to avoid some disastrous outcome. Such risks are not warranted for tiny speculative or unknown rewards. What are the economic rewards thought to be generated by the woodchip projects, and how are they to be distributed?

**The Economics: Who Benefits?**

On a world level the destruction of tropical rain forests for the woodchip industry involves trading one of the world's most ancient, complex and valuable ecosystems for one of the most worthless human consumption ends. In the New Guinea case for example, the 'low quality' woodchips from New Guinea's irreplaceable rain forests will go to produce low quality packaging paper, rather than high quality printing or writing paper. To those who understand the respective costs and benefits, this is hardly an attractive bargain. There seems little chance then of providing a convincing justification for the Madang project in terms of meeting important 'needs', providing important consumer benefits, and lifting consumer living standards. It will have to be argued that the process of converting 60 million years of evolution into worthless paper packaging, although intrinsically indefensible, creates, as a byproduct, wealth for the people of Melanesia.

However in Melanesia there appears to be a repetition of the Australian case; namely widely distributed, and largely intangible costs, as against a concentrated set of tangible benefits that accrue mainly to overseas interests and to a minute urban segment of local populations. In these circumstances, no matter how heavy the costs—and in total logging cases they are very heavy—a distinct political advantage lies with the beneficiaries, since they can readily quantify their benefits within the accepted commercial framework. How the costs and benefits are distributed we will see in the Papua New Guinea case.

Since even the royalties to be paid for Papua New Guinea projects appear to have a substantial measure of (legal) indeterminacy—the royalties are determined in the end by private bargaining—and since best instead of average royalties are usually quoted, economic benefits accruing from the projects are difficult to assess precisely. On the evidence available, however, one is bound to entertain the gravest suspicion that, from both public and local viewpoints, the projects are commercial liabilities. Important economic costs are not allowed for in the commercial accounting, for example the
severe risks of the projects (which can be assessed in terms of insurance), and the diminution or loss of environmental and social values of the forests. When these costs are added the outcome is plain: the projects are uneconomic in the wider sense. To make this point good it will suffice to point out the best marginal commercial case for the Papua New Guinea projects.

A first ground for suspicion is that the royalties paid (8c per 100 super feet or 34c per cu m at Madang, with a probable increase to 12c per 100 super feet or 50c per cu m over the next five years) fall far below those for Australian projects. Average Papua New Guinea royalties are less than one-half of average Australian royalties (see, e.g., Endacott 1971); and furthermore only 75 per cent of the royalties paid accrue to the public. Yet there is evidence that Australian woodchip schemes are operating at net public loss (see, e.g., R. and V. Routley 1974, Norman 1975). But this consideration is hardly conclusive, since although many of the costs appear to be higher in Papua New Guinea than Australia, not all are (e.g. labour), and the private companies are supposed to have some sort of responsibility to reforest some of the cut-over forest.

The inadequacy of the Papua New Guinea export prices is evident from Endacott's complaint (1971:57) that 'the Japanese domestic market is basically a buyers' market at present and the price of hardwood has been kept artificially low and does not represent fair value'; and that hardwood prices are kept relatively low by 'powerful pulp and paper industries'. In fact the export prices are so low that the Australian Forest Industries Journal, normally enthusiastic about any sort of forestry operation, however unsound, featured an article entitled 'New Guinea giving away raw material' (March 1972), which made the point that export (f.o.b.) prices from Papua New Guinea are only about 40 per cent of those sought by other log exporting countries in the region.

Compare, then—to obtain some idea of the public costs of a Papua New Guinea project—the total projected direct benefits of the Madang project over the first three years of operation with some of the costs. The total combined saw log and chipwood royalties amounted to $347,000, but the projected costs of reforestation alone for the 1800 ha pilot project is $709,000—leaving a considerable bill for the public to foot. This sort of elementary point is met by the claim which has some truth in it, that royalties will rise to a higher uniform figure and regeneration costs will fall when the project becomes fully operational. Let us concede a total annual saw log-chipwood royalty of $280,000, a figure sometimes suggested, but well above current company projections. The public return is 75 per cent of this, $210,000. Suppose reforestation costs fall to $270 per ha (from the present average of $385 per ha), and suppose that the public reforests only 800 ha of the more than 4000 ha cut annually. Then these costs, of $216,000, for reforestation already exceed public returns. Moreover it seems unlikely that reforestation costs, including line planting and tending costs and administrative overheads, can be reduced to $270 per ha, i.e. $108 per acre. Reforestation costs alone for part of the forest will, it seems, absorb all public revenue from the

4 An internal cost-benefit study of the Madang project (Ryan n.d.), which was supposed to show that the Forests Department would break even on the project, apparently allowed for the reforestation of only 320 ha. The study is classed as confidential, and we have not been able to see it to assess its adequacy. According to Endacott (1971), however: 'A study of the Gogol exercise indicates that a chip project producing 300,000 green tons of chips per year will call for a reforestation follow-up costing $170,000–$200,000 per year, exclusive of land purchase costs'.

5 Tending costs are especially heavy in the humid tropics. According to Florence (n.d.:28): 'The tending schedule on the tropical rainforest sites illustrates one major problem in tropical plantations: weeds have to be cut back four times in the first year, and three in the second. There are administrative overheads, which would add another 50 per cent or more to other regeneration costs.'
Madang project. And yet there are further purely silvicultural costs that have not been budgeted for, for example the application of fertiliser (on estimates for Australian plantations likely to exceed $75 per ha), the costs of pesticides, and fire protection costs. Nor are the very high risks of tropical plantation forestry allowed for. Nor are infra-structure costs, which will probably offset whatever taxation revenue accrues. Nor is allowance made for the additional costs of conversion of land to agricultural purposes, or of social or environmental costs. Yet the fact is that good management, which would help make woodchip projects environmentally and socially acceptable, tends to be expensive, and is in no way allowed for in royalties paid. There is typically an inverse correlation, a trade-off, between project acceptability and net commercial gain; that is, the more acceptable a project is made the greater are the public losses.

Recent losses of the Forests Department are indicated in their annual reports. Expenditure exceeds revenue by about 2.25 times (in 1972/73), $2.76 million as against $1.2 million. The pattern for Australian forest services has been for expenditure to increase more rapidly than revenue with the advent and increase of intensive forestry practices. A similar pattern should be expected for the Papua New Guinea Department, and has been predicted by recent foreign advisors. Indeed it appears that a substantial salvage operation will be required if the Forests Department is to meet even part of its responsibilities to reforest cutover lands. Thus it has been proposed not only that soft loans should be sought from various international banks to help with reforestation, but even that a value added or sales tax should be levied in forest development areas.

In the Solomon Islands the overall picture is similar. Forest service revenues exceed expenditure (by a small amount) only because regeneration is seriously lagging; thus 'the Conservator emphasises that replanting has not yet been built up to a level to keep pace with exploitation' (Commonwealth Forestry Review 51:273). Total logging operations succeed in making the marginal return that they do only by neglecting regeneration. The order by which regeneration costs will exceed timber revenue can be gauged from the following: timber revenue has reached an annual level of about $350,000 and it is desired 'to increase the replanting rate to over 5000 hectares per year' (Kera and Maenu'u 1975:4). However 1969 estimates were that replanting would cost about $100 a hectare (Commonwealth Forestry Review 1972, 51:87)—a figure that compares rather better with recent Papua New Guinea estimates when inflation is taken into account. But even at $100 per hectare regeneration costs of $500,000 considerably exceed revenue.

In Papua New Guinea two replies are commonly made to this sort of criticism, firstly that Papua New Guinea will benefit through taxation earnings on company profitability, and secondly that the projects, though they may operate at a loss for the first seven years or so, will eventually become profitable. As to the first point, since the company, Jant, is not operating at a profit and does not expect to break even before 1978, there are no taxation benefits at present. Nor are there ever likely to be. For the determination of the price at which woodchips are sold by Jant to its parent company Honshu are apparently to be determined by Honshu, and are likely to be set at a cost-plus price. This is the situation at Eden, New South Wales, where Harris-Daishowa (the equivalent of Jant) will apparently (should it eventually break out of its loss making pattern) operate on a cost-plus basis, the selling price being so determined by its parent company Itoh (for relevant details from the Harris-Daishowa company articles, see Norman 1975). In any case any taxation revenue that will eventuate is likely to be outweighed by infra-structure costs (cf. R. and V. Routley 1974: Chapter 13).
As to the second point, there is evidence that the projects will never become profitable. An FAO study of plantations following total logging operations by Dun and Fenton (1974), designed to sell Papua New Guinea projects to overseas investors (and accordingly seriously underestimating costs), revealed that a break-even price for kamerere plantations discounted at only 7 per cent, was about 48 cents per 100 super feet or $2.00 per cu m. But this is four times the expected better royalties, and is not likely to be achieved. (When it is, in the longer term, with inflation, costs will have risen correspondingly.)

The upshot is this: the woodchip export projects appear likely to operate at a substantial public loss. Apart from their environmental and social effects, the projects will serve as a drain on public revenue rather than increasing it; they will require funds that could be better invested elsewhere (that is, they have serious opportunity costs); and Papua New Guineans are doing what they can ill afford to do, subsidising large overseas owned pulp and paper companies. In order to obtain any public financial and other economic benefits from export woodchip projects it is necessary first to set a royalty price that gives an adequate return on public expenditure to regenerate the forest, provide the infra-structure, etc.; second to set a minimum or guideline price for the sale of woodchips, which ensures that some public benefit is obtained through the payment of company tax; and third preferably to ensure that the maximum amount of the profitable processing segment is locally undertaken (the latter of course often carrying serious pollution and environmental costs). None of these necessary measures appears to have been taken and no guarantees appear to have been given in the case of Papua New Guinea export woodchip projects; nor do they appear contemplated. Contracts can therefore be regarded as highly disadvantageous to the vendor (Papua New Guinea).

Especially conspicuous is the one sided nature of the risks involved in the projects. The foreign companies involved are prepared to make only relatively short-term commitments even for reforestation and normally write off their investment, plant, etc., over a period of fifteen years or less. When the forest is liquidated (in fewer than twenty years should the new crop fail or be made otiose by new technology), they can move on to a new source of supply or diversify into other areas. But it is the people of Papua New Guinea who will be left with the run down soil, unable any longer to support the cropping program, the eroding hillsides, the ruined forests, the disintegrating social structure, and industrial workforce made dependent on an industry whose resource base has been destroyed.

From the point of view of the local people who sell the timber rights, it may be doubted that the paltry initial per capita sale price and the royalty price of apparently less than $5 per head each year during the period of liquidation of the forest, provide adequate compensation for the hunting, fishing and other forest food and produce forgone, let alone compensation to them and their descendants for the long-term degradation and possible irreversible destruction of the forest and other adverse effects on their lives. It is hard to avoid the impression that this is an updated version of the traditional bead trade, which can be summed up in the magnanimous offer of the western entrepreneur: 'You give me that worthless ton of ivory and I'll give you this

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6 Thus McKelvey (1974:5) reports: 'Dr. Fenton [was] to carry out an economic appraisal of reforestation for FAO with the desired aim of making it look attractive to overseas investors.'

7 Work such as Liem (this volume) makes a valuable start on furnishing details for such costings. For example, in the Garu area megapode eggs alone were estimated to be worth K3000 in one season (30,000 eggs at 10 each).
immensely valuable string of glass beads.’ Nowadays, it seems watches and transistors substitute for beads.

There is clearly a trade-off between commercial benefits and environmental costs to the Papua New Guinea population. The Madang project, for example, will provide revenue for the Government—the main reason alleged for its existence—only if no attempt is made to reforest even part of the area or to impose adequate environmental standards. If projects are operated without adequate environmental safeguards, any wealth the project generates will be at the expense of local people. The project would, if conducted without adequate safeguards as a once only operation, redistribute wealth. It would evidently shift it from the local village population, to an urban, administrative and governmental elite. On the other hand, if it is conducted in such a way as to avoid or render negligible these costs to local people, it is difficult to see that there could, under present financial arrangements, be any significant benefits to the public treasury.

**Why Undertake the Projects?**

The idea that any exploitation of natural resources (‘development’) that is undertaken must always be beneficial, not just to the exploiters, but to most of those associated with it, is discredited in theory, but extraordinarily hard to dislodge as a working principle. Counter-examples abound. But it is still true that ‘nothing obscures our social vision as effectively as the economistic prejudice’—the ‘economistic prejudice’ being the view that any and every sort of development is beneficial (Polanyi 1945: 161). Current total logging projects provide good examples of developmental projects that have severe adverse impacts and result in negative net distributed benefits.

One would think that there would have to be some powerful, even desperate, reason for embarking on a course of action that seems likely to liquidate—over a fairly short period, for a paltry return at best—what is widely recognised as one of the country’s most important long-term natural assets, an asset that will probably be worth much more in the future than it is at present—the extensive and rich forestry wealth.

What reasons are advanced for forestry projects like the Madang one, which are not only environmentally but, it appears, socially destructive? The same sort of vague, un-quantified, and general developmental benefits are proposed as in the case of Australian projects: projects will make towns bigger (and therefore, it is thought, better), will provide some, admittedly low quality, employment, aid balance of payments, increase GDP, and so forth. One may doubt that these are reasons that—unless the case is very urgent indeed—would justify the destruction of so much of value. And the

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8 Development can be characterised in terms of positive increase of the main macroeconomic indicator. Thus ‘development’ is systematically ambiguous, varying as the macroindicator varies. This ambiguity impairs frequent assumptions such as that ‘people want development’. In particular, ‘development’ is ambiguous between commercial, or narrowly economic, development on the one side, where the macroindicator is GDP or an equivalent, and true development on the other side where the macroindicator is net value (or, on the welfare picture, net social welfare). While commercial development is often to be deplored, true development is not. The contrast between these different kinds of development of Papua New Guinea’s forest systems, and the respective extents to which they are really desired by local people, is brought out in Jonas’s excellent paper (1975). True development entails discriminating commercial growth. Undiscriminating industrial development (at least for an initial period) is in effect what is being advocated for ‘undeveloped countries’ such as Papua New Guinea by many western economists, who hope that the economies can thereby reach ‘take-off’.

9 Compare Carson (1974:4): ‘Lack of a sound definitive policy could lead to the liquidation of what is, probably, the most wide-spread and, possibly, the most long-term natural asset the country possesses.’
benefits frequently disappear on closer scrutiny or turn out to be outweighed by corresponding costs.

For example, with respect to provision of infra-structure benefits such as roads and the provision of community services such as hospitals and new schools usually advanced as a major reason for intensive forestry projects, one may be excused for asking whether for the very considerable public funds ploughed into providing these benefits indirectly—where they are provided—they could not have been provided much more cheaply directly (for example a few schools as against publicly financed multi-million dollar port loading or rail facilities designed primarily for woodchips). The employment case is scarcely better. Mostly there is a difficulty in obtaining appropriately skilled workers (cf. Jonas 1975). In the Australian case, for example, the quality of the employment is low, often dangerous and unhealthy, and the wages offered are not compensatingly high. The labour quantity in terms of capital investment is low. In fact, plantation forestry projects cannot support expensive labour—which is one of the reasons for planned mechanisation of plantation forestry both in Australia\(^{10}\) and Papua New Guinea. One may also query the wisdom of providing for a tiny fraction, 0.1 per cent of the Australian population, employment that helps to destroy the lifestyle or the amenity of the remaining 99.9 per cent of the population. In Papua New Guinea there is the further problem, that in forty years the forestry resource base will probably have been substantially eroded, but meanwhile, if successful in the short term, a cash economy will have been generated with numbers of workers dependent on its resource.

Similar points apply in the case of the balance of payments argument for destructive forestry. Firstly, the benefits will be short-term; and secondly, they will be most unfairly distributed. The balance of payments benefits, in the form of external funds and imports purchased at a heavy and subsidised internal cost, appear to be primarily in the interests of a westernised, and largely urban, elite. Thus insisting on those benefits amounts to making the interests of this elite paramount, far above those of the bulk of the population and future citizens whose resource base is going to be eroded. The economic answer, when the payments problem becomes serious, lies, of course, in import limitation and replacement, a tighter monetary policy and reduced government expenditure.\(^{11}\) It certainly does not lie in expanded forest export schemes.

Another reason frequently advanced for such development as woodchip projects, is the increase in choice provided for people both through economic growth, taken to equal GDP, and through further employment. However, to the extent that traditional lifestyles are adversely affected and rendered less viable by the destruction of the forests, a choice is being removed—choice between a traditional lifestyle and becoming part of the industrial consumer society and part of the cash economy. At the same time, if the forest resource is being destroyed or seriously degraded, choices for future people are actually being removed, as are the choices to opt for alternative lifestyles to the (characteristically western) industrial consumer one, by the imposition of the economic and social pattern of western civilisation. Choices are also being contracted by the insistence that a western style governmental infra-structure—which requires a substantial financial basis that a largely subsistence economy cannot afford—be fully maintained.

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\(^{10}\) In view of Australia's likely future difficulties in supplying labour, a point stressed in the Borrie population report, the employment benefits are of decidedly doubtful benefit.

\(^{11}\) Such an economic answer is obviously anathema to the Central Planning Office of Papua New Guinea, most of whose members, belonging to the urban elite, would find their relative standing affected.
For too many western commentators there would be one overwhelming reason taken to justify a development at any price approach, and to justify the environmental costs and the taking of enormous risks of the sort total logging projects represent; this reason is summed up in the word *underdevelopment*\(^{12}\) and the accompanying conventional picture. To too many westerners 'underdevelopment' conjures up a picture of primitive poverty stricken natives either undernourished or else lined up at soup kitchens. The picture is presented of environmental preservation as a luxury for rich westerners who selfishly want to maintain natural and historic objects for their own end and to withhold wealth from these people. But the picture is a thoroughly false one. It seems that the less wealthy countries can least afford to squander, or take enormous risks with, their natural resource base and liquidate natural assets, such as topsoil, upon which wealth depends—or to repeat the list of the disasters that are caused by ignoring the effect of environmental constraints that litter the history of development in the west (Lowdermilk 1943 and 1953). (These constraints are, of course, still largely ignored in official historical treatments, as the western nature dominance ideology dictates they must be.)

How far then, is the presupposed soup kitchen picture correct for Papua New Guinea, or for many other so-called underdeveloped countries? Not at all. According to Fisk (1966:23) writing on the economic structure of Papua New Guinea,

The overall picture that emerges is that of a low income country in which virtually all of the population have as much food as they want, are housed adequately by their own traditional standards, and have ample leisure for feasting, ceremonial and other pastimes. It is an economy that is potentially viable and self-sufficient at a level of primitive affluence. Of course this situation does not obtain in every region in Melanesia. It has been eroded by population growth in a few areas. And the overall picture will not be maintained indefinitely if present high rates of population increase persist. But remedies for these high rates of growth, which will eventually close off many options with respect to traditional and alternative lifestyles, are fairly clear. The problem certainly does not have to be met by adopting industrialisation.

Life at the level of primitive affluence is not necessarily unsatisfactory and to be supplanted by western ‘improvements’ wherever possible. Contrary to a common prejudice of western society, ‘life in the state of nature is not necessarily nasty, brutish and short’ (Lee and De Vore 1968:43, contradicting Hobbes’s famous political assumption). Many primitive societies represent ‘the original affluent societies’ with material plenty and ample leisure (see, e.g. Sahlin’s ‘Notes on the original affluent society’ in Lee and De Vore 1968:85–9, and subsequent discussion). The case for a desperate, development at any price approach just does not exist.

No doubt *some* development is genuinely needed, and desired. But any development undertaken should be genuine development (that is, increase of net social welfare) and should be based on and extend this primitive affluence, not erode it, or eliminate its base so that the people are brought into a dependent position, or close off options. Since sustained yield intensive forestry projects actually *absorb*, not provide, internal revenue that might better go into local welfare measures, such as schools and health centres, it is hard to escape the impression that such projects have been promoted by people who see the failure to lead a western way of life or to be part of an industrial consumer society as a sort of blight, the remedying of which justifies the incurring of very large costs and risks—a view western education fosters of pre-industrial societies

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\(^{12}\) Cf. Black (1970:19): 'It is a commonplace of contemporary thinking that the problems of the world are those of underdevelopment, and that they can be solved only by a measure of further development …'
generally. In part, then, the reasons advanced for the projects—in so far as they are at all clear or properly worked out in the case of total logging projects—seem to be those of westernisation by development.

More generally, much of the argument for the projects appears to presuppose the desirability of the objectives of setting up an indigenous entrepreneurial class, a class after the western pattern too often obtaining its privileged position at the expense of its fellow citizens and through the short-term exploitation of the natural environment—a pattern now coming into serious question even in its western homeland.

Who is behind the planning?

By contrast with the local people, overseas buyers from the developed countries and especially from Japan are eager to support the projects; the reasons are not so hard to discern. For the buyers they mean a very cheap and immediately available source of raw material, an advantage that flows on in a small way to other developed countries in the form of cheaper packaging materials, and more cheaply wrapped consumer goods. The projects also mean some further markets for export goods (transistors, tins and jeeps in exchange for forests), but more importantly they mean a spread of ideology, the commitment to the requisite sort of economic growth, a captive economy and transformation to an industrial consumer society.

Not surprisingly, then, the principles of ‘aggressive marketing’ of the forests without proper consideration for their renewability or the sociological and environmental effects and the promotion of woodchip projects, has been pressed by western (including Japanese) interests. Responsibility here falls heavily on the World Bank, which appears to have done much to encourage a get rich quick attitude to the tropical rain forests of the world and which recommended the Papua New Guinea forestry policy of aggressive marketing (see, e.g. White 1972:59), on the Australian Government, which accepted its advice, and on the FAO, which, often in co-operation with the World Bank, has done much to foster the projects.

A string of western advisers, often FAO advisers, often regrettabley from Australia and New Zealand, have helped to plan and advance these projects, usually without insisting on sufficient safeguards. These advisers carry a particularly heavy load of cultural baggage, and it is baggage that is already recognised by many in the places

13 While it is true that Japanese companies are heavily involved in total logging operations throughout Melanesia, and that most of the wood extracted is shipped to Japan, the exploitation is not, contrary to popular opinion, confined to Japanese firms. A number of companies from other countries, especially Australia, are also involved. Among the companies involved in, or interested in, total logging operations in Papua New Guinea are the following:—Open Bay Thiess Bros. (New Guinea subsidiary of Australian company), Sobhu Adachi; Madang Jant (subsidiary of Honshu Paper) and Wewak Timber (51 per cent owned by Fletcher Timber of New Zealand); Kumusi Pacific Forest Products, a consortium of Dravo, Planet Mining and Gibbs Bright (the latter two of Australia, the rival tender being from Sanyo-Kokusaku); Sagari-Gadaisa Sagari Lumber, of Hong Kong, and ANG Holdings (which controls Pacific Islands Corporation), now taken over by APPM of Australia; Vanimo West Sepik Timber (a wholly owned subsidiary of Plantation Management, registered in Australia and wholly owned by Savoy) and Ogi Paper, of Japan; in New Britain Shin Ashigawa, of Japan (which acquired F. Wakim), New Guinea Co-operation, of Japan; Mitsui Agri-forest Development, Amplex. Also in Papua New Guinea are Rheem Australia (which owns 80 per cent of New Guinea Industries); Placer Development; Tower Research and Development of Australia; and Parsons and Whitmore, of USA, a major pulp manufacturing and marketing combine.

14 It is claimed that the World Bank will henceforth finance only projects that meet certain environmental standards—an improvement which, if true, is long overdue.
they come from to contain some fairly shoddy goods, in the form of now dated and widely questioned developmental ideology and an overconfident attitude to the manipulation of nature.

A significant role in planning and promoting the Papua New Guinea projects has been played by the policy makers of the Government, and especially of the Department of Forests and the Central Planning Office; their pursuit of the objective of turning over the accessible rain forests to short-term industrial uses leaves them open to serious criticism. The governmental elite in Papua New Guinea evidently rates its own preservation, established standards and, if possible, expansion, far above maintenance of the Papua New Guinea environment and the primitive affluence of most of its people.

It is evident\(^\text{15}\) that the Department of Forests, like most of the visiting forestry experts, has fostered the projects and has tried to whitewash their deficiencies, failing to draw attention to the heavy costs and risks or to consider appropriately less destructive and industrially directed alternatives to the projects. The Department appears to have seen its role as a cellulose marketing agency, rather than as ecological manager of the rain forest. According to the Department, forestry policy includes ‘the desirability of “aggressive policy development”\(^\text{15}\) of the timber production potential’; and it is contended that strict application of the requirement of environmental impact studies ‘can well defer much needed investment’. In Papua New Guinea and elsewhere members of the forestry profession, a profession that is fond of presenting itself as ‘professionally conservationist’, thus appear not only to have condoned and helped plan projects that will be liquidating some of the richest and least known forests in the world for one of the most worthless and wasteful end uses—the junk paper and packaging industry—but are doing so without retaining so much as a single adequate conservation reserve. Moreover the Papua New Guinea profession failed to secure any proper environmental surveys in advance of the approval of major export projects, and is even resisting measures that might result in less unsatisfactory planning for future projects, such as environmental impact statements, on the grounds that these might frighten away overseas investors.

**What Are the Alternatives?**

There are, needless to say, various alternatives to the destructive forestry schemes. To appreciate the options, however, it helps to see the causes of destructive forestry practices. The destructiveness of forestry practices on non-wood values of forests is forced, firstly, by the industrial determination of these practices. For example, the methods and logging practices at Madang are apparently entirely dictated by the convenience and requirements of the Jant mill, instead of being geared appropriately to the ecological requirements of the rain forest. Volume throughput for industrial economies of scale determines the excessive size of projects and overambitious production targets, the large regular inputs, and the use of heavy, insensitive harvesting machinery. Generally it is true to say of Australian projects that it is the overgreedy setting up of projects that can only allow tiny and quite inadequate areas to

\(^{15}\) It is sometimes suggested, as it used to be suggested in New South Wales, that the Forests Department is not really in favour of these total logging projects but is forced into them by the desire of other sections of the Government to earn foreign exchange. This is far from the truth. Though no doubt, as in New South Wales, there are individual foresters who are opposed to the recommendations of ‘Head Office’, there is substantial evidence that the total logging projects were, and are, strongly supported by the Forests Department.
escape unlogged, the clearing regardless of suitability of areas that are much too large and the forcing of large-scale clear-felling of areas regardless of effect on other values, the destruction of species diversity, and the subsequent conversion to mass production monoculture of non-local species—all these undertaken in the interests of meeting allegedly inflexible industrial targets and quotas—that are responsible for the destructive character of much of Australian forestry. These procedures are adopted not always solely in the interests of profitability—not infrequently they are preferred over less destructive but just as profitable or more profitable alternatives—but sometimes in the interests of the processing industries.

A first requirement, then, for a solution to the problem of destructive forestry is evidently to sever the industrial connection, to alter the industrial determination and accompanying assembly line methods of accepted forestry planning and practices. A corollary is that future massive projects should not proceed and that current projects should be wound down to the extent that contracts permit. As a further corollary, a much more critical examination of FAO advice is wanted. FAO, the main provider of forestry advice and assistance to tropical countries, is by its constitution and in its organisation, dedicated to strengthening the industrial orientation of forest management, and apparently also to imposing the western industrialisation formula as the (magic) solution for the problems of 'underdeveloped' countries.

Secondly, modern mass produced industrially orientated tropical forestry is destructive because the ruling price paid is the 'liquidation' price, which fails to cover the cost of forest restoration, and hence does not treat forest as a renewable resource even from a cellulose producing viewpoint. A second requirement, then, is to concentrate forest removals on quality timbers where prevailing royalties are much higher than for pulpwood—by a factor of five or so—and to withhold timber pulpwood until prices rise sufficiently to cover sound forestry practices and yield an adequate return.

There is evidence that smaller-scale, less ambitious forestry, less determined by industrial targets and heavy handed mass production methods, could avoid many destructive features of prevailing forestry, and still enable utilisation of the forests. Rain forest, for example, can be logged as a renewable resource, in a way that can sustain most forest values—by careful selection silviculture. Harvesting under such selection systems would concentrate on high quality, mature logs, which, with careful handling, fetch a high price; it would proceed by a proper marked tree system (thus avoiding forest creaming) and would use low impact but not necessarily unsophisticated machinery and methods. It would take only a small proportion of the forest at a time, it would leave adequate buffers around the small logged areas, and it would make proper provisions for completely unlogged areas to conserve wildlife and flora. For example, reserves of the order of at least 1,200 ha of appropriate block shape and topography should be left in working areas as a wildlife refuge, and similarly designed areas of 2,800 ha or more should be retained for stable rain forest communities. Regeneration should be by natural methods, preferably obtained by removing mature trees only after they have set seed.16

There are two commonplace objections to the management of tropical forests by selection and natural regeneration methods: the slow growth of many of the main timber species and the problem of species diversity. These are, by and large, problems

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16 It should be remarked, however, that there remain some unknown constraints on selection silvicultural systems as applied to forests in the humid tropics. Working out these constraints will require much synecological and silvicultural research; but in the meantime at least, until constraints are better determined, practice should be conservative.
only for large-scale intensive operations. Primary rain forest trees are no more slow growing than many trees of the northern climax forests. Some northern hemisphere foresters, for example Germans, are now apparently successfully growing trees on long rotations of 200–300 years. A similar time scale could be used in Melanesia.

Smaller-scale selection forestry would blend well not only with the natural regeneration capacities of the forest, but also with the lifestyle of the local people; and it could merge with the small-scale timber production plantations proposed for villages in the recent *Strategies for Nationhood* (Cabinet Planning Committee 1974:44). Small-scale village forestry operations have already proved successful in Papua New Guinea (as in tropical Africa), and there is room for some expansion. For the time being, however, there remains the problem of where to market the surplus produce profitably. Several foresters (e.g. Westoby 1974; Leslie 1975) have suggested that special arrangements be made to market Papua New Guinea timber in the developed countries of the region, most notably Australia, better freighting arrangements being a prerequisite (see, e.g., Endacott 1971). That Australia and other developed countries should purchase timber produced by environmentally sound forestry practices at appropriate prices seems an excellent idea, but it will take much to convince Australian governments. In the longer term, of course, if, as seems likely, tropical and old growth forests elsewhere disappear, there should be little problem in marketing timber abroad for prices that cover all costs and yield reasonable returns.

The switch to small-scale, low impact, 'village forestry', would have to be accompanied by appropriate reorientation of forestry education, training and research. For example, it would combine well with the training of 'village foresters', a training perhaps along Chinese lines, less oriented to high energy bulldozer technology and more oriented to the continuing management and small-scale utilisation, in everybody's interest, of the existing forest resource, rather than to the undertaking of deforestation followed (in the ideal forestry world) by huge, socially costly, factory style plantation projects undertaken in the interests of big western industries. Forestry research, it almost goes without saying, would have to be oriented more towards investigating low capital ways of utilising and managing what is there, rather than towards capital intensive replacement of a tiny part of it.

The alternative sketched for sound forestry can be embedded in the larger socio-economic framework. The alternative pattern is that for which there is increasing pressure in developed countries: where economic growth is decidedly selective, where high energy using, or highly polluting, or environmentally destructive ventures are avoided in favour of lower impact alternatives. There seems to be no reason why the mistakes of western development, mistakes induced by the industrial consumer society, cannot be bypassed, as African models have tried to indicate. One such model is, perhaps, Tanzania (see, e.g., Omo-Fadaka 1972), but less authoritarian strategies have been glimpsed by other African statesmen. And the importance of avoiding at least the worst features of the industrialised west is likewise realised by some in Melanesia.

Forestry illustrates the options well, for in its case, at least, broad alternatives to destruction are fairly readily discerned—even if the details are inadequately researched in practice by industrially orientated forest services. Melanesia should adopt, instead of a program of deforestation followed by a program of partial reforestation of doubtful viability from both ecological and economic viewpoints, some less drastic methods of forestry that could be relied on to regenerate the naturally occurring forests. Forestry will have one of the major long-term impacts on the economy and on the social and biological environments of Papua New Guinea. It is a good place to start adopting a more discriminatory attitude to economic growth and development.
The Melanesian environment

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39 Constraints on Developing Forest Industries in Papua New Guinea

K. J. WHITE

While Papua New Guinea has large areas of forest, much of it is inaccessible owing to rugged terrain. Apart from such physical difficulties, the forests have other drawbacks such as the prevalence of very mixed stands with many kinds of timber and end uses, low volumes per hectare, and market acceptance problems. Additionally, for international marketing, large amounts of capital and technical and management expertise are required; this capital generally has to be imported and serviced. The industrialisation of the forest also poses social and political problems.

RESOURCES

The Papua New Guinea land mass covers approximately 46 million ha of which approximately 40 million ha are covered with forest. The remaining area is classified as swamps, waters, grasslands, and commercially unproductive savanna forests. Of the forest land, 21 million ha are inaccessible, 10.5 million ha are accessible but unsuitable for development, and 8.5 million ha are accessible and suitable for development. Papua New Guinea lies wholly within the tropics, but contains zones of a wide variety of climate, soil and altitudinal habitats. Broad forest types of mangrove, savanna, fresh water swamps, lowland rain forest, sub-tropical and montane are described by Womersley and McAdam (1957).

A great diversity of species exists, with some 200 tree sizes represented, largely in the lowland rain forest and passing as altitude increases through Araucaria forests to the Fagaceae and Nothofagus forests of the Highlands. A recent Resource Atlas (Ford 1974) illustrates this vegetative wealth. Its extent has been the subject of survey over a long period. The first comprehensive report was prepared by Lane-Poole (1925), who commented that ‘Australia’s tropical dependencies, while offering no prospect of immediate gain to large sawmilling interests, possess forest potentiality of a high order’. McAdam (1954), drawing on the work of the Army Forest Resource Survey of the war years, was able to generalise that there was a possible resource of 90 million cu m in accessible forests, and potential for expanding this figure.

In the post-war years (the 1950s) the Administration faced the massive task of reconstructing the destroyed pre-war townships and of providing the support for an advanced program of health, education and social development. The energies of the Department of Forests were involved in this work but at the same time policies were formed and accepted into national plans ‘to locate, assess and regulate the availability of the natural forest resources of the Territory so as to bring them within reach of development’. This was the main commitment of the Department in the 1960s, though at the same time complementary investigations were being carried out in forest botany, in wood qualities and in the training of Papuan and New Guinea officers. In
the period 1956–63 some 0.6 million ha were covered by conventional methods. From 1964–67 some 2.8 million ha were assessed. To date a total of 4.8 million ha has been investigated. Reports of the resource have been published in Department of Forests (1967); White (1972); and in considerable detail in Department of Forests (1973). The investigation confirmed that there is a resource of magnitude, and the areas considered suitable for development have been clearly identified (Table 39.1).

**TABLE 39.1**

*Forest resources of Papua New Guinea*

<table>
<thead>
<tr>
<th>Area</th>
<th>Merchantable area 1000 ha</th>
<th>Volume in million cu m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15–48 cm diameter *</td>
</tr>
<tr>
<td>Abau</td>
<td>87</td>
<td>3.5</td>
</tr>
<tr>
<td>Aroa</td>
<td>45</td>
<td>1.2</td>
</tr>
<tr>
<td>Sagarai-Gadaisu</td>
<td>58</td>
<td>4.4</td>
</tr>
<tr>
<td>Musa</td>
<td>80</td>
<td>4.7</td>
</tr>
<tr>
<td>Kumusi</td>
<td>28</td>
<td>2.4</td>
</tr>
<tr>
<td>Ioma</td>
<td>182</td>
<td>11.8</td>
</tr>
<tr>
<td>Mai-Ama</td>
<td>24</td>
<td>2.8</td>
</tr>
<tr>
<td>Open Bay</td>
<td>103</td>
<td>4.6</td>
</tr>
<tr>
<td>Ania-Kapiura</td>
<td>110</td>
<td>4.7</td>
</tr>
<tr>
<td>Kandrian</td>
<td>121</td>
<td>7.1</td>
</tr>
<tr>
<td>Arawe</td>
<td>157</td>
<td>8.3</td>
</tr>
<tr>
<td>Kapuluk</td>
<td>103</td>
<td>4.7</td>
</tr>
<tr>
<td>Melkoi</td>
<td>40</td>
<td>2.4</td>
</tr>
<tr>
<td>Nakanai</td>
<td>46</td>
<td>2.4</td>
</tr>
<tr>
<td>Kaut</td>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>Torokina</td>
<td>13</td>
<td>1.0</td>
</tr>
<tr>
<td>Vanimo</td>
<td>239</td>
<td>7.1</td>
</tr>
<tr>
<td>Middle Ramu</td>
<td>131</td>
<td>5.7</td>
</tr>
<tr>
<td>Giliwe</td>
<td>21</td>
<td>NA</td>
</tr>
<tr>
<td>Jimi</td>
<td>101</td>
<td>NA</td>
</tr>
</tbody>
</table>

*above buttress

The figures of Table 39.1 refer to areas not presently being developed. There are some 900,000 ha covered by existing industry operations. There are further large areas, for example in the West Papuan and Gulf District, of the order of 3 million ha but these are regarded as inaccessible at the moment; there are also numerous smaller areas that did not fit into the objective of assessing large blocks to attract large-scale integrated industries. The potential of the forest to assist in development is considerable but a number of factors reduce this potential.

1. *Diversity.* It is well argued that diversity brings richness to life in all forms but, in a forest industry, richness can be a source of embarrassment. The forests of Papua
New Guinea are complex and contain many different species. Survey results from a few selected areas show this representation. (Table 39.2)

**TABLE 39.2**

_Diversity in lowland forest areas_

<table>
<thead>
<tr>
<th>Area</th>
<th>Species Making Up 50% of volume</th>
<th>Species Making Up 20% of volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Rodney</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Sagarai</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Kumusi</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Vanimo</td>
<td>16</td>
<td>2</td>
</tr>
</tbody>
</table>

It would be very costly to log these numbers of species and yet leave some 50 per cent of the volume behind; in the forest there may be some 30–50 species making up some 80 per cent of the volume.

2. **Volume per hectare.** Low volumes per hectare will increase harvesting costs; illustrative approximate log volumes per hectare are: Cape Rodney, 26 cu m; Sagarai-Gadaisu 26 cu m; Kumusi 44 cu m; Vanimo 52 cu m. These volumes are at a minimum, half or less than those available per hectare in Indonesia, Malaysia and the Philippines (Department of Forests 1973). The lower volume increases roading network, haulage distance and other harvesting costs and places these forests at a disadvantage compared with those mentioned.

3. **Tree forms.** A wide range of tree forms is common to most Papua New Guinea forests; buttressing and bole fluting, bends, etc. adversely affect conversion processes (as, for example, in the manufacture of plywood from a round log). This reduces the standing capital value of the forest. In log classifications used in Southeast Asia it would seem that only 25 per cent of the Papua New Guinea volume would be acceptably classed as peeler logs.

4. **Wood quality.** The range of wood quality is as wide as is the species representation discussed earlier. Timber varies from very light balsa-like to extremely dense and heavy timber. There is a wide range of colours and of textures. There are relatively low percentages of woods with highly desired characteristics like Dracontomelum (walnut), Pterocarpus (rosewood) and Toona (cedar) that have gained cabinet timber status. The volume for these woods is low, as the percentages for a few areas show: Cape Rodney 4.0, Sagarai 5.3, Kumusi 9.3, Vanimo 2.3 (Department of Forests 1973). This great mixture obviously affects the value of the forest as generally it is easier to market a relatively uniform product, or one of intrinsic value. In comparing forests of adjacent countries the rain forests of North Queensland are much richer in cabinet timbers, while the products of the Indonesian, Malaysian and Philippine forests are much more uniform in colour, texture and wood quality.

5. **Infra-structure.** The forest resource is widely distributed and large blocks suitable for economy of scale and variety of product industries are in undeveloped rural areas. This means total lack of a servicing township, a local market of any size, power, communications, roads, an export centre, etc. A large amount of fixed capital must be invested to remove this difficulty and this greatly affects the profitability status for many years. These real physical impacts on the value of the resource are recognised and allowance is made in negotiation of timber sales for aspects such as the size of the
Forest resources and the environment

resource, stand quality, its access to market, climate, haulage distance, topography and soils.

6. Ownership. The lands of Papua New Guinea are vested in a system of traditional ownership. Direct and indirect use is made of forests by the traditional owners. Forests may be made available for development if the owners:
   (a) sell timber rights to the Government, which then arranges disposal;
   (b) arrange a direct sale to an industry;
   (c) develop their own industry.

This release requires the consensus of those people holding rights in the forests. As an industrial forest area is extensive it will frequently cover a number of ownership units, who must complete individual negotiations. The complexity of such arrangements is augmented by language difficulties; for example in an area of some 40,000 ha in the Gogol valley near Madang, there are some 1100 people and eight separate language groups; within these groups negotiations with over 100 ownership units were necessary. This ownership system is unique in the Pacific area and fragmentation of ownership can prevent industrial development if agreement cannot be reached.

7. Technology. The diversity of the forest and its wood has been noted. The mixed raw material is generally suitable for conversion by existing technology into a wide range of basic products (sawn timber, veneer, chips) which can be in turn utilised in structural, furniture, plywood and pulp manufacture. Constraints in use do occur but generally the properties and uses of the timbers are known. A recent application of technology has been in the use of mixed tropical hardwood for chips. FAO anticipates there will be a paper shortage and that the fibre resource most readily available will be the tropical forest. To date only one woodchip plant is in operation and this is of a somewhat pioneer nature. Further investments can be expected on full industry and market acceptance of this product. The forest industry—particularly in rural locations—is hampered by a lack of servicing technology.

8. Political uncertainty. In a world where investment can never be sufficient to finance all that needs to be financed, uncertainty about future political patterns increases risk, discourages investment and inhibits development (Colwell 1968).

9. Finance and manpower. The forest resources can be used by converting the forest capital into cash for both domestic and external markets. In particular the external market offers the opportunity to exchange the forest capital for cash or goods. The sale of timber on the export market places the industry in a competitive field and, to survive as an export commodity, it needs the continuity of large supplies, quality control and market promotion. This usually implies a large-scale capital and expertise intensive organisation. Investment in the order of K20 million may be incurred in a saw-veneer-chip complex; extension of this to a pulp factory stage would lift the amount to K200 million.

Large forest blocks are in areas of low population. Additionally this population has an educational and technical background below that of more developed areas. Further, Papua New Guinea as a whole is short of trained experienced technical and management expertise. This is being overcome by training and, in the interim, by importing expatriates. These drawbacks add considerable costs to forest industry ventures.

10. Markets. With its small population base the internal Papua New Guinea market is limited. It will increase with greater use of lumber, etc., in home and community construction. There could be industry expansion at the village level with increasing technical ability; the economic base may be of commercial or social nature. Lack of a large local market reduces the incitement to engage in manufacture of forest products
and promotes log exports. Demand in excess of supply occurs in international areas. Projections indicate a continuing need for imports into Europe, Asia (Japan, Korea, China) the United States and Australia. While the desire of importers for log exports continues, log exports are generally being phased out and timber in some converted form will be exported. The export market will require large volumes of standard qualities and this tends to favour the development of large-scale industries. Market opportunities will, however, continue for smaller operations.

The cost of transporting the product to the market is a vital factor. Transportation costs are rapidly increasing and there is no indication of pending stabilisation. The transport costs can be reduced if back-loading or import opportunity is available. The low Papua New Guinea import market limits this possible assistance. The product price is affected by imported inflationary costs in machinery, fuel, expertise, capital, etc., over which Papua New Guinea has no control; its export products have to absorb these costs in landing at the export market. As the product has many problems (already discussed), it is difficult to pass on these costs and the industry can be priced out of the market.

**CONCLUSION**

In brief, the forests are markedly heterogeneous and few areas show single species or genus dominance; there is a wide range of bole forms poorer than in other forests of the region; the timbers are widely different in end use qualities and appearance; few species have intrinsic high market values and many are totally unknown on international markets; the merchantable volume per hectare is considerably lower than Malaysian, Indonesian and Philippine forests, and in fact if it were not for the market deficiency in timber they would not attract much attention. Added to these disincentives to development are those of infra-structure, communication, land tenure and lack of technical expertise.

These then are some of the constraints on industry. Are they sufficient to deter industrialisation of the forest resources? I doubt it. There is a world demand for forest produce, of which Papua New Guinea has an export surplus. Commodity scarcity makes the previously commercially unfavourable forest of Papua New Guinea somewhat more attractive. The cost of marketing these forests does reduce their value. Care must be taken to maximise social and economic benefits to the people and to the nation of Papua New Guinea. Appendixes I and II spell out the Papua New Guinea Government's objectives; recently published guidelines designed to achieve these objectives are included in Appendixes III and IV.

**APPENDIX I**

**Forest Policy**

*(extract from Cabinet Committee on Planning 1974)*

8.71 Forests are one of the major natural resources of the country. The current timber industry programme has been based on the release, following worldwide advertisement, of a large number of timber areas. The development of these projects has aimed at the rapid expansion of the export of processed forest products through the establishment of large-scale integrated complexes which rely on private foreign capital and foreign expertise at least in the initial years.

8.72 By mid-1974 such projects were underway in the Gogol area of Madang, the Open Bay area on the north coast of New Britain, in the Kaut area on New Ireland and Mount Giluwe in the Southern Highlands. Also the Nakmai area of New Ireland was declared a local forest area under the Private Dealings Act and released during 1973-4.

8.73 Negotiations regarding the release of other new areas are underway. These include the Kapiura timber area near Hoskins, West New Britain (83,000 hectares), the Sagarai-Gadaisu
area in the Milne Bay District (145,000 hectares), Vanimo in the West Sepik (260,000 hectares),
the Kumusi timber area of the Northern District (70,000 hectares), and the Kapuluk area in West
New Britain (181,000 hectares). Other potential timber sources are being studied by the Forests
Department.

8.74 As a result of past policies concentrating on rapid growth of forest production and
exports, of about 75 timber operations in the country, only four are by Papua New Guinean firms
and in another five enterprises either the Government or government authorities have a
minority interest. During 1973–74 for the first time majority control by the Government or its
nominee in a reasonable time was included as one of the fixed conditions for the releasing of
large timber concessions. This is to be achieved by requiring that in addition to the option to
take up 26 per cent of the equity in the initial five years, an option to take up further equity after
about ten years leading to majority Papua New Guinea control within 15 years, is a standard
condition of timber agreements.

8.75 In negotiating new concessions, the Government also requires conditions in agreements
with timber companies for the encouragement of locally-owned business ventures associated
with the timber project. The permittee is obliged to encourage and assist the involvement of
Papua New Guineans in businesses connected with the main timber operations, such as log sup­
ply, felling, snigging, hauling, log preparation, and road construction. This assistance will be
provided through an advisory service in the company which will investigate business oppor­
tunities, make finance available on reasonable terms and assist with supply of spare parts and
repairs and maintenance.

8.76 Reforestation programmes have been planned for all major timber concessions. The
first of these will be implemented in the Gogol Valley where 2,000 hectares will be planted over
a three year period commencing with 250 hectares this year. A further 2,000 hectares will be
planted each year thereafter. Financing and operating management of reforestation pro­
grames sufficiently large to sustain the industry on a continuing basis will be the responsibility
of the developer. The terms of reforestation agreements will be negotiated between the Govern­
ment, the developer and the traditional timber and land owners.

8.77 Preservation of sawn timber and posts have been going on for some time. Treatment is
by means of dip-di ffusion and vacuum-pressure methods. At the moment there are 65 dip diffu­
sion plants located very widely in sawmills around the country. Most of the treated products are
exported. It is envisaged that with the establishment of a sawmill and a dip-di ffusion treatment­
plant at Open Bay this year, the volume of sawn timber treated will be considerably increased.
Further increases are envisaged as new areas are released for development. At present, there are
only three vacuum pressure treatment plants, established in Port Moresby, Bulolo and Banz.
Most of their treated products are locally consumed.

8.78 The social and environmental impact of forestry projects has been receiving much atten­
tion from the traditional resource owners and from the Government. Investigations into the set­
ing up of a timber enterprise and pulp mill at Ioma in the Northern District have been stopped
as a result of the opposition by the people in the area. It is clear that the environmental damage
caused by forest operations can be immense and permanent. Consultants have been employed
by the Government to advise on the conditions that should be incorporated in timber
agreements to alleviate damage to the environment either by logging or timber industry
development.

Appendix II

THE EIGHT POINT PLAN AND IMPLICATIONS FOR FOREST POLICY
(extract from Jephcott 1974)

1. A rapid increase in the proportion of the economy under the control of Papua New
Guineans.

Increased opportunities for local equity participation in forest industry and forest resources development.

2. More equal distribution of economic benefits including a move towards equalizing
incomes.

Directing earnings towards forest owners through a share in the royalty, business equity, and other
business and employment opportunities.
3. Decentralized economic activity planning and government spending with emphasis on agricultural development and village industry.

*Developing extension services to assist minor forest product industries and village participation in reforestation and forest industry activities. Involving forest owners in all phases of forest development.*

4. An emphasis on small-scale artisan services and business activity.

*Creating opportunities for contract workers and entrepreneurs in transport, logging, carpentry shops and other small industries.*

5. A more self-reliant economy less dependent for its needs on imported goods and services.

*Improving the competitive position of local timber products against imported substitutes.*

6. An increasing capacity for meeting government spending needs from locally raised revenue.

*Improving marketing and prices for export timber products to result in higher profit opportunities and thus greater revenue from royalty and taxes.*

7. A rapid increase in the active participation of women in both economic and social activities.

*In the general context exploring ways of increasing opportunities for women to participate in the forest activities.*

8. Government control and involvement in those sectors of the industry where control is necessary to achieve the desired kind of development.

*The Department to take overall management responsibility for the forest resources to assure that the national objectives are achieved and forest owners get a fair deal and at the same time to encourage forest owners and the industry to accept maximum responsibility for forestry activities, particularly in the fields of utilisation and reforestation.*

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**APPENDIX III**

**EXTRACT FROM POST COURIER, 23 APRIL 1975**

**FORESTS**

*Guidelines*

(1) As a general rule, no agreement between the Government of Papua New Guinea and a foreign enterprise will be by an Act of the House of Assembly;

(2) In the appraisal of investment projects a company's records of employer/employee relationships in other countries will be taken into account; and

(3) The technology utilised should be the most labour-intensive determined to be economically feasible.

**Minimum Terms and Conditions**

Any foreign enterprise or individual wishing to engage in an integrated timber industry must agree to:

(1) Comply with the laws of Papua New Guinea as amended from time to time;

(2) Permit Government or Papua New Guinean equity participation or options of equity participation to the extent determined to be practical and appropriate;

(3) Train Papua New Guineans for all levels of employment under a specific program approved by the Government;

(4) Within the framework of the industrial relations legislation, agree to involve to the maximum extent practicable, Papua New Guinean employees in decision making relating to terms and conditions of employment;

(5) Encourage and assist Papua New Guinea corporate entities or entrepreneurs in establishing business associated with the timber projects and directly connected with the main timber operations;

(6) Utilise sources of supply and services available in Papua New Guinea, preferably Papua New Guinean owned, unless adequate justification for not doing so can be provided;

(7) Operate within environmental guidelines established by the Government;

(8) Engage in reforestation programs as agreed with the Government;

(9) Provide required new infra-structure, or compensate the Government at an agreed upon rate or percentage for specific new infra-structure provided;
(10) Provide export marketing expertise or access to export markets, where the Government considers it appropriate;
(11) Agree to process all timber to the maximum extent practicable within Papua New Guinea, unless specific exemptions are made by the Government;
(12) In the drawing up of all agreements and arrangements for the provision of goods and services, utilise ruling market prices as the basis for determining cost;
(13) Keep all books of account and company records in Papua New Guinea and in the English language; and
(14) Abide by any additional terms and conditions imposed by the Department of Forests and/or as a condition for registration with NIDA.

Appendix IV

Resource Management Guidelines
(extracts from White 1974)

General considerations in forest development programmes require that:
• manipulation of forest resources should be based on ecological analyses and principles and the use of appropriate management technologies that result in a sustained yield from the resource, and which will cause minimum, adverse effects on the environment and degradation of the ecosystem;
• timber or other forest product management should aim to maintain the potential for maximum (optimum) sustained yields;
• critical areas e.g., catchment areas, riverina, and estuary zones, slopes and any areas subject to accelerated erosion be given special consideration;
• areas too steep or unstable for timber extraction should remain as protection forest and be managed for soil protection, water regulation and other values;
• appropriate areas be set aside for scientific, aesthetic and recreational purposes;
• where possible multiple purpose use be optimised.

The protective and social functions are becoming increasingly important in relation to the wood production function, though this will generally continue to be a primary one. Only soundly based combinations of the main functions, adapted to the medium and long-term needs of the country will achieve aims and provide near optimum benefits to the public welfare and the economy.

Forest management practice is applied through short-term operational plans backed by medium-term tactical plans and long-term strategic plans (15–20 years or longer). The long-term nature of such plans imposes management difficulties with future forecasts of inevitable social/political/technological changes. This does not mean plans should not be attempted but points to the necessity of allowing for a wide based inventory hopefully to give basic stability; flexibility in allocation and use of resources; the necessity of monitoring and modification of plans.

Environment considerations in forest management require that:
• forests be managed so that the composition and structure be altered no further than is necessary from that of the natural forests, for the achievement of the primary management plan objectives;
• operations should cover relatively small annual coupes with due care taken to limiting change to any one ecosystem in a working plan over a time period;
• the operation should provide a mosaic of coupes of varying stage (structures) and ages in each ecosystem.

Forest managers controlling appreciable areas of land should also ensure that:
• operations which they control do not lead to the regional elimination of any species of wildlife;
• any sites of particular cultural, historic or scientific significance are preserved;
• adequate areas of the native vegetation are retained, representing the range of environmental conditions present in the block and containing where appropriate scientific reference areas;
The Melanesian environment

- native vegetation is kept in strips along perennial watercourses and for landscaping purposes along certain roads and elsewhere and their program enhance wherever practicable the appearance of the landscape;
- the operations minimize any risks of stream pollution or any danger of harming non-pest wildlife;
- erosion faces are minimised and controls (drainage, revegetation) are applied;
- fire is excluded from the forest area.

Organizations involved in the conduct of clear cutting systems of forest management should adopt operational guidelines which take into account such factors as:

- adequate protection of soil and catchment values;
- where clear cutting is not essential for the regeneration of the stand, retention of belts of selectively managed forests in localities of particular visual significance and for purposes of environmental diversity; and
- where clear cutting is essential for the regeneration of the stand, retention of blocks of unlogged or selectively logged forest for as long as practicable, with some stands permanently retained to demonstrate dynamic of overmature, even aged communities.

Management requires the resource to be adequately protected from destruction (fires, illegal fellings) and very importantly to have strong Government backing in its efforts.

References


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McAdam, J.B. 1954. The Forests of the Territory of Papua and New Guinea, Port Moresby. Govt Printer, Port Moresby.


After a brief historical background of the area in the Northern Province where the Binandere [see Fig. 40.1] community has been fighting against imperialism to defend its land, this chapter gives an account of the way in which two of the many foreign companies have attempted to exploit forest resources in the area; the politicians' approach to the people, and the reaction and opposition of the people. It goes on to view the desperate attempts of the companies from the perspective of the world situation in which there is a shortage of natural forest resources. Papua New Guinea has to decide whether to adopt an improved subsistence society or to choose an impoverished industrial one based on foreign capital.

Papua New Guinea chose 1 December 1973 as the date for self-determination. At this time many foreign companies rushed to enter agreements with the Somare-led Coalition Government to exploit mineral, forest and human resources in this country. The passages quoted below show the haste felt by two such companies trying to get a foothold for investment in this country. Primary resources, open to foreign exploitation, are getting short with the colonial era coming to an end and multi-national companies hope to find in Papua New Guinea one of their last victims.

Both Mr. Tago (Sohe Open) and Mr. Wong (of Kawin Corporation Pty. Ltd.) agreed that time is the essence of all, firstly because the people in Ioma [sub] district want to see development as early as possible, and Mr. Wong had indication from Mr. Ho Yin that if they cannot accomplish anything by the end of 1973, they might as well get out and forget the possibility of investment in Papua New Guinea. In simple words by the end of the year they would be in a position to get on or get out. (H. Chow, Secretary, Peoples Progress Party)

Time is the essence of the [company's] interests in the establishment of [logging and saw milling] project, therefore I request that you [Mr. Tago] make every endeavour to persuade your people to agree on the establishment of this venture within three months [Oct.–Dec. 1973]. (Mr Wong's letter to Tago on 3.10.73)

Ioma area has massive resources which require massive investment for massive development. There will be massive exploitation of both material and people, and there will be massive destruction on land and environment. You [Waiko] are fighting a losing battle against massive international and national fronts: the struggle is too great for you and your people.* (Butler, DC for Northern Province to John Waiko)

In the Northern Province, the 4000-odd Binandere people have been defending

* The author is indebted to his colleagues M. Jiregari and R. Tamanabae whose determination and spirit of fierceness I shared in the struggle against imperialism, and acknowledges the use of the unpublished Sikuru Boe Report. But the author is responsible for the views expressed in this chapter.
Fig. 40.1 Binandere territory
their 2,500 sq km of land against such imperialism. Before discussing the way in which two foreign countries attempted to exploit forest resources in the area and the world shortage of natural forest products that prompted them, it is necessary to look at the background to the Binandere’s struggle.

BACKGROUND TO THE BINANDERE STRUGGLE

The Company was interested in an area stretching from Girua Creek south of Popondetta up to the Paiawa River north of Morobe in which the Binandere territory is located as well as the territories of other tribes.1 The area comprises some 76,500 ha, of which some 60,000 ha are heavily forested (see Fig. 39.2). It has a population of about 37,000. The location selected by one of the companies for a proposed town was on land belonging to the Binandere tribe. Totoadari Bay had been a traditional battleground between the tribe and one of its enemies, the Taian Dawari before the arrival of white men (see Waiko 1972). In 1874 the Binandere had opposed the landing of the first white man in the bay. This was Captain John Moresby who came to chart the Northern Coast of New Guinea in his ship Basilisk (Moresby 1909:369). Two decades later, the tribesmen fought with sticks, spears and clubs against the British colonial administration. In the struggle that ensued Binandere killed about ten white men who had come to prospect gold in the area. During the first three decades of this century Binandere resisted the colonial administration through cult activities which are an organised form of political resistance (Worsley 1970:76–7). These political movements provided the organisation and the leadership through which the Binandere defended its land in order to protect animals in the forest and fish in the water.

During 1971 a foreign company purchased timber rights around Douglas Harbour. This was the first time that any outsider was ‘allowed’ to come into the Binandere territory and acquire timber rights, alienating land from the people, apart from the acquisition of some land by the colonial administration to establish its station at Ioma. Had it not been for the District Commissioner the company would not have been able to purchase timber rights there. It seems that a representative of the company approached the official who, in turn, contacted a member of the Area Authority. Through this man the official picked three villagers who, in the opinion of the official, represented the landowners. These villagers were brought in by helicopter to identify the traditional boundaries from the air. How they marked the land boundaries, I cannot tell, but after this aerial survey the company ‘determined’ the boundaries and hardly a week passed before the officials of the company returned in the helicopter. They distributed compensation money to the villagers. Thus, before the people had time to realise what was happening and raise objections, the company had paid them to shut them up (this was said to me in interviews with the people).

This had three consequences. Firstly, the three picked men did not distribute the money according to the number of landowners in different villages; they shared it among members of the villages that they were most associated with. Secondly, the traditional boundary conflicts between the Binandere and neighbouring Dawari flared up. Some people approached an officer of the Land Titles Commission based at Popondetta to arbitrate and settle the dispute on the basis of the people’s traditions.

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1 During the same period when the Aega, Binandere and other communities were opposing the multinational corporations in the Northern Province, the Dzia, Yekora, Zinaba and others reacted against some foreign companies in the adjacent area of the Morobe Province. Students of the University of Papua New Guinea, especially those who come from the area, were the main spokesmen in the village oppositions.
Fig. 40.2 Timber rights sought by the company
This man was quoted as saying, ‘Forget the oral traditions, think only for economic development’ (Leonard Kawowo, pers. comm.). This dispute has not been settled as yet. Thirdly, the unprecedented approach warned other Binandere leaders to be aware of the intentions of the foreign companies with regard to the rest of their land.

As a result, some Binandere leaders were alert in 1972 when officers of the Department of Forests arrived at Bovera Village, Eia River. They were taking samples of trees, perhaps for the feasibility study that was to be undertaken by the firm of Parsons and Whitmore. Jigede, the big man of the village, threatened the officers and asked them to contact spokesman Jiregari, Tamanabue and Waiko, who were at the University of Papua New Guinea. Subsequently, a meeting was arranged in the University but nothing conclusive came out of it, except that it was noted that no one should enter the Binandere territory with the intention of alienating land from the people (Dept Forests Official File No. R10/87-6-28, of 27.3.72). Towards the end of 1973 Kawin Corporation attempted to buy timber rights through personal contacts with Mr Tago, Minister for Conservation and Environment. By then, however, the Government was negotiating with a bigger company, Parsons and Whitmore. John Stafford Karibe, one of the greatgrandsons of those who had opposed the landing of John Moresby, speaking of the land the Company had selected for its town site, said at Totoadari Bay in May 1974:

This land around the Bay does not belong to the white men and neither does it belong to the government nor can the government give it or allow the company to come here. If Mr. Tago and Mr. Daugi feel desperate to invite the company they can ask it to the land belonging to those politicians, not Totoadari Bay. We want to retain our land for gardening and maintain our forest for hunting purposes. (Unpublished Sikuru Boe report, August 1974)

For the Binandere, as for the major contenders, the events of the period from September 1973 to June 1974 were inextricably bound up with the history of the previous century. During the struggle of 1895 against the gold prospectors the Binandere had made their first great effort to defend the land bounded by Mamba River in the south, Wuwu River in the north, Owen Stanley Range in the west and the coastline in the east—an area of about 2500 sq km. During the first half of 1974 the Binandere made, hopefully, their last hostile effort to retain the land against the attempts to bring about its alienation and create landless labourers by imperialism.

The Struggle Against the Companies

In June 1973, Mr J. Chan, Finance Minister in the Coalition Government, personally approached a business group in Hong Kong to invest in Papua New Guinea (Chow n.d.). This contact resulted in the formation of Kawin Corporation Pty Ltd. At the end of September, because of party allegiance and through personal contacts, Mr Tago invited this company to establish a logging and sawmilling venture in the Ioma area in the Northern Province. On 4 October 1973 an aerial survey was made and the company immediately requested the parliamentarians to negotiate 150,000 acres (60,000 ha) ‘of the best timber land’ for them (F. Wong to Tago, 4.10.73). During the next month Mr Tago held six meetings, five of which were in towns and one in ‘his own’ village. All in all about 800 people took part in these various meetings. Mr Tago formed the opinion that, at all meetings, those attending ‘unanimously agreed’ that the Company ‘must’ be invited immediately. Mr Tago used the Tamata Local Government Council to gauge the feelings of the people in the villages along the rivers of Mamba, Gira and Eia; within a week he was informed of the ‘urgent need’ to bring Kawin Corporation into the area. On 28 November 1973 Mr Tago wrote to Mr Wong saying, ‘... on behalf of my people I formally invite and welcome the Kawin Corporation ... to
develop our timber resources for the mutual benefit of our people and your company'.

Realising the great potential for timber resources and the related products, another company, Parsons and Whitmore Pty Ltd, presented to the Government in August 1973 a feasibility study for consideration. Parsons and Whitmore, an American-Australian company, indicated to the Government its deep interest in the same area sought by the Hong Kong based Kawin Corporation. In December the Government warned Mr Tago that the area contained such great resources that the small company should be barred from entering the area, as the Government was considering proposals from the big company (Dept Forests Official File No. E1/153-0-0 of 13.12.73).

On 7 March 1974 the Director of Papua New Guinea Pulp Co. Pty Ltd wrote to inform Mr Tago of the intention of Parsons and Whitmore. By then the central Government had pressured Mr Tago to drop the proposal of the small company, and he was directed to negotiate with the people on behalf of Parsons and Whitmore. The people of the area were not informed of the decision to change from Kawin to Parsons and Whitmore, and were not informed about the differences between the former small and new big projects.

By February 1974 there were two issues concerning the people in the villages. One was that Mr Romney Goviro, President of Tamata Local Government Council, had arranged with the people to select ten men (including myself) to form a committee called the Komge Oro committee to represent the people of the Aega and Binandere tribes. Its main function was to liaise between the Kawin Corporation and the people, and to study any proposals in detail. Further the committee was empowered to negotiate on behalf of the people. The other issue was a growing resentment, especially in the Gira River area, about the way Kawin had approached the people. As pointed out earlier, the politicians held meetings in towns and the landowners in the villages were informed only by the one day visit of a group of hired people.

I was in my village on the Gira River, when a parents and citizens meeting was called at Saint Barnabas Primary 'T' School, Nindewari. At this meeting a motion was passed deploring the way in which they were approached to buy timber rights. I was asked to put their concern to the Government in general and the elected members in particular. By the beginning of March it became necessary for representatives of the Government and Parsons and Whitmore to fly to the Ioma area. On 14 March a brief discussion was held at short notice in the Department of Forests, Port Moresby. I was invited to attend on behalf of the people in the Ioma area. It became obvious in the meeting that Parsons and Whitmore wanted to go ahead with its operation, and that the project had reached an advanced stage without the people who own the area having heard anything about it, let alone being consulted! It was clear that the participation of the people at every point, a fundamental principle for negotiation, had been ignored from the outset. I had to decide whether to serve the interests of the Company and the Government or to represent the people as I had been asked to do. I chose the latter course. This choice was the basis of a division between the elected politicians, who

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2 Parsons and Whitmore Pty Ltd has about fifty-five mills in twenty-seven countries: twenty-three in Europe, eight in Africa, eight in South America, three in Southeast Asia, two in Canada and one in the United States. They were also involved in the disastrous extension of the Honolulu airport as the company carrying out both the feasibility study and the actual construction work.

3 People's Progress Party advanced K1000, of which K600 was used to gauge the opinions of the people (information based on various items of correspondence).
represented those requesting the Company to come, and students of the University of Papua New Guinea, who expressed the will of those opposing the Company in the villages. Mr Misael Jiregari, Mr Richmond Tamanabae and I were invited to go with the government team to the Ioma area for 'initial consultation' with the people, but we refused the invitation for three reasons.

Firstly, we did not want the people to see us with the Company as this would later have affected our relationship with the people we were trying to represent. Secondly, the feasibility study on the resources of the area, detailed proposals of the Company and other relevant information, technical and legal, were not made available to us. We felt that the invitation was another form of bribing us to serve the interests of the Company and the Government. Thirdly, politicians took a 'now or never' view with regard to Parsons and Whitmore, i.e. that it had to start its activities in the area then and negotiate with the people later, or there would be no 'development' for them. The priority lay in allowing the Company into the area, not in getting the people a good deal. We refused to abandon the interests of the people in this way.

After the briefing on 14 March we took several actions immediately. Firstly, an urgent meeting was held in order to inform the Aega and Binandere people in Port Moresby and to set up a relay network of personal communication between the capital and Ioma via the town of Popondetta. In the evening of the same day we arranged an emergency meeting to discuss the intentions of Parsons and Whitmore and to evaluate the opinions of the elected members concerning the proposal of Kawin Corporation. Mr Tago and Mr Daugi (member for Northern Regional) were invited to speak at the meeting. During the briefing on that day the aforementioned division was created—participants were divided into two opposing groups: a group who supported the proposals of Parsons and Whitmore and the politicians and became known as Gamana or the Government, and a group, including students and other spokesmen, who opposed the intention and the approach of the Company, and became known as Sikuru Boe or school boys (students).

It was explicit that politicians favoured Parsons and Whitmore instead of Kawin and that they were determined to invite this Company regardless of the people's views. As Mr Daugi put it, 'this is a huge project which would bring some revenue for the government. Whether the opposing group [Sikuru Boe] likes it or not the government has the final say in determining the issue at stake.' After the meeting the Sikuru Boe sent messages to the villages about its stand and the reasons for it. They took the view that the group represented those landowners who resented the way in which the companies tried to purchase timber rights from them. That night a political battle based on ideological differences began, and success or failure depended upon our ability to mobilise support for the people's cause against the determined companies and Government pressure.

On 6 April, for two reasons, another meeting was held. Firstly, we wanted to send a deputation to secure a voice in the Department of the Chief Minister. Secondly, we had to select four people to visit the Ioma area after the Gamana team returned to Port Moresby. This team, including the politicians, was visiting the area when we arranged with Mr MacIntosh, Director of the Department of Forests, and Mr T. Voutas, a representative from the Chief Minister's Office, to meet our deputation. It was agreed that no further action should be taken to negotiate timber rights until the three parties

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4 There were no minutes recorded in this meeting but I have kept my personal note of it. The meeting was held in Police Hall, Gordon Estate, Port Moresby.
5 This meeting was recorded and the tape is in my possession.
were satisfied. It was agreed also that the Aega and Binandere people should be properly consulted, and that, in the final analysis, they must decide for themselves whether they wanted to invite a company or not. Thirdly, it was agreed that the Government must be satisfied with the people’s evaluation of the proposals and conditions and that the Company must accept the company’s terms or be prepared to negotiate with them. Finally, it was agreed that the Company must be satisfied with conditions imposed by the Government. We were confident that at least the central Government was aware of the opposition group.

The members of the Gamana team were flown in a helicopter to Ioma for an ‘initial consultation’. Some councillors and village elders were chosen at Ioma. These men and other officials were flown to Bovera, Nindewari and Totoadari Bay only in the Binandere territory. Within two or three days the Gamana team had ‘consulted’ the people. In the opinion of the two politicians who accompanied the team, the people ‘wanted development’ and Parsons and Whitmore should start its operation. Further, the members of the team levelled many accusations against students and others who had organised the Binandere and Aega people in the city against the foreign companies. Most of the allegations had no basis at all, but some of them will be discussed later.

We made our own way to the land of the Binandere tribe on 25 April independent of the Gamana team, which by then had returned to Port Moresby. The aim was to visit every village on foot and discuss with the people what they knew about the proposals. We felt that informal and intimate approaches would enable us to gauge the opinions and feelings of the people. The arrangement was that the three man team should visit all the villages in the three rivers, Mr Tamanabae on the Mamba River, Mr Jiregari on the Eia and myself on the Gira. Later we met at Totoadari Bay, the intended town site for Parsons and Whitmore. Then the team went to Nindewari, Bovera and Ioma. We intended to discuss our findings with the Tamata Local Government Council before returning to Port Moresby. The plan was carried out as arranged.

Among other allegations, the members of the Gamana team accused us of being ‘educated big heads’ and ‘trouble makers’. Because of our education, it was alleged, we would get good jobs with high salaries, good houses and luxurious cars. These would pull us into towns and make us look down on the people in villages. They did not acknowledge that our determination to ensure the participation of the people and our refusal to participate in the Gamana team were, in themselves, a declaration of solidarity with those people. In a word the primary resources involved were the backbone of the great Binandere community, and we did not want them to be exploited and destroyed. Mr Tago alleged further that the amount of money that had been spent on ‘John Waiko’ to go to London for his education had cost the Government a fortune. This was not true as I was awarded a Commonwealth Scholarship, and the Papua New Guinea Government did not give a cent towards the education. It can be seen from these examples that the conflict on an issue of principle was continuously being personalised owing to the elected members’ fear of electoral competition.

In most villages the majority of the people did not understand the issues involved with regard to the Company. Seth Dadada of Manua Village, for example, gave his reasons for inviting the Company at the time when the Gamana team was visiting his village as follows:

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6 Unpublished Sikuru Boe report: this accusation was repeated when the teams confronted each other on 29 June 1974.
I was the first person who agreed that the American company should come. My reasons are as follows. Firstly, I spoke on behalf of the Binandere tribe. Small coastal vessels have stopped calling into Mambare Bay a few years ago. This means that the people bring bags of coffee or copra and wait at the bay, and they watch the boats pass by. They do not come in. So we put our cash crops on canoes so that we can paddle to either Dewade [a port of call] or Lae. If we manage to get to Lae we sell the cash crops, but the money we get goes towards the transport or food expenses we have already incurred. We pay these and return to our villages without any money. Secondly, these difficulties create burdens on us because there is a great pressure being put on us to pay various taxes—council tax, school fees, medical fees and mission fees. Thirdly, if the company came, it would have cut timber along the roads that it would have built, and the boat would call in here to load the timber. In this way, the land and sea transport would be made easier for us to sell our crops. These were the main reasons we asked the politicians to invite the American company.

In reply we pointed out several things. Firstly, the people only wanted the Company to provide roads, but the intention of Parsons and Whitmore was to clear all the natural forest of the allotted area. Secondly, the Company wanted 2800 ha of land at Totoadari Bay—the land used for growing taro, bananas, coconuts, betel nuts and so on, and partly occupied by two villages—for the town site. Thirdly, there was a map (produced by the Company) in which the villages were not indicated; nor was it clear where the residents would go if the company did come to build the town. Fourthly, there might be some compensation for damages done on the trees such as coconuts, betel nut and so on, but this meant that with the money from the compensation the people would have to buy taro, bananas, coconuts, etc. This would lead to loss of independence based on landownership and in its stead put dependence on money economy. These repercussions were not at all clear to the people. Mr Dadada stood up to speak again and pointed out that the description of the Company as given out by the Sikuru Boe team was beyond his understanding of the Company as explained by the Gamana team previously. He continued:

We were told that the Company chose this area to build its town: that it would erect its wharf and town between Manau and Mambututu Villages [a distance of about 0.6 km]. I did not agree to a Company that intended to take up all our land, and make us landless and drive us out to sea to live on canoes as the white man has done with native inhabitants in Port Moresby. I did not agree to invite a Company that would destroy all our coconuts, betel nuts and take up our garden land. We do not want to become buyers with money of all the things we grow on the land. The Gamana team came in haste and went with hurry and the intentions of the Company were not explained in detail. The land on which they want to build a town is not theirs. Who gave the Company permission to draw a map with the intention of alienating the land? They made the map without the people's knowledge. We call that sort of thing stealing the land. We authorise the Sikuru Boe team to tear up the map.

Leonard Kawowo summed up the attitude and the intention of the Gamana trip:

I refused to attend the meeting of the Gamana team, and these are the reasons. When a person is campaigning for an election, he walks to almost every village, even the garden houses in the jungle saying that the people should vote for him. But after he is elected, his feet never touch the ground at all. He sends messages on radio saying that he wants the people to gather together at several centres. He hovers in a helicopter and says that the Company is coming to bring money. I hate people who fly in the helicopters and do not walk on the land to tell us that the Company intends to steal the land... You have heard the sweet words of the two politicians already. Now we have heard the sweet words of the Sikuru Boe team. Now is the time to decide who is actually speaking on behalf of the people.

As for me, I have made my decision already. We have elected the politicians and they have done nothing in our interests until now. They want to persuade us to commit ourselves, our land and our future to the Company so that the politicians can say that they bring 'development' for us. But these are sweet words to secure votes for the next election. Secondly, the
students walk on the land and they do not get paid like the politicians. I support the Sikuru Boe team which represents our interests.

There were, of course, some people who were against the Sikuru Boe team. Laban of Mambututu Village asked this: ‘Who created this land? Who created man and his thoughts?’ Mr Tamanabae replied: ‘You want me to say God, so this land was made by God.’ And Laban continued: ‘So, the intentions of the Company and the Government are the fulfilment of God’s plan. Therefore the Company must come. You cannot stop God’s plan by stopping the Company. Americans [the Company] must come!’

After two weeks of discussions with the people whose villages were on the three rivers, we formed our opinion as to their responses. Firstly, there were some people who openly declared that they wanted the Company to come into the Ioma area, as is evident from the above quotation. Secondly, there were others who were in the middle or at least appeared to be neutral, but who were in fact on the side of the politicians. The Vice President of Tamata Council, Mr M. Bonga appeared to be neutral but attempted to persuade the Sikuru Boe team and its followers to ignore the differences and invite the Company. He said:

When I heard about the big Company I realised that this was the only opportunity for the Binandere people to see progress. I was not afraid of being exploited by the white men’s Company because there are educated men and women of the Binandere tribe at the University of Papua New Guinea. These men will draw up proposals together with the politicians. Further we have achieved self-determination already. I have been looking forward to the Company which could establish roads so that I can sell my produce. Do you Sikuru Boe want your people to remain in the jungle without seeing any progress? There has been no project in the council area and this was the cause of Mawae leaving the council; and now the Aega tribe is considering breaking away from us. We have a hope in the Company of seeing progress so that the council can unite the people.

Mr Bonga intended to persuade the Gamana and Sikuru Boe teams to make up their differences and invite the Company, but his attempt to merge the two groups failed because the differences were based on fundamental principles.

We felt that the third group, the majority of the Binandere people, opposed Parsons and Whitmore. Jigede, one of the strongest opponents, and a very important man, concluded in this way:

I did not ask members of the House of Assembly to invite a white men’s Company to destroy my land. I told the politicians to tell the Company that I only want a road outlet for selling cash crops; the trees near the road can be cut for the Company. Now I know that it intends to clear cut my forest. Trees do not grow in the air, but on the land. The forest is a source for my medicines, my wealth and my everything. Our ancestors own the place and we have the hunting rights. Not only will the ancestors curse me for accepting a few dollars in exchange for the irreplaceable resource, but also the younger generations will condemn me for my decision to invite the Company. Ancestors have lived here, I am living on the same land and I want the future generations to have good gardening land. I do not want the Company.

If it ignores my words, say to it that Jigede has said so, and if it ignores again I will impose this condition: that the Company must pay me, my wife and each member of the family and the extended family a sum of $1000 every day for ever. Every Monday, Tuesday, Wednesday, Thursday, Friday and Saturday they must all be paid $1000. Not on Sunday because it is God’s day of rest. My children and their children’s children must get this sum daily in order to live. These sums added together are nowhere near the price for my land and forest. If the Company is mean and does not want to give this token gesture for destroying my livelihood, not only mine and my family’s but also that of every single person in the village, warn the Company to forget about my trees on the land.

This quotation shows several things. Firstly, there was some misunderstanding as to
exactly what the Company intended to do. Secondly, politicians used the term ‘timber rights’ to avoid land issues, and to stop the people realising the inevitable consequences to the land and the wildlife. To the people, land and forest provide an independent means of living and in them lies the future for the unborn generations. Thirdly, they realised that only a continuous and perpetual flow of cash would replace it.

Before the Gamana team reached the Ioma area, Mr Tago wrote on 19 March to the Binandere: ‘Edo $120,000,000 [awa] kaenato yai piain jipapa etera’. This literally means ‘And [Parsons and Whitmore] want to give $120,000,000 to us [the people]’. At Manau Village, Gerald Boigo asked Mr Tago which of the two companies was offering big money. Austin Baiboe of Sia Village paraphrased Mr Tago’s reply: ‘... the Chinese company offered $40 million before, but now the American company intends to bring $120 million’. Mr Boigo then said that ‘since the American company is bringing big money, the people prefer the American to that of Chinese company. Further American soldiers fought against Japanese during the Second World War to protect the land, and not the [Hong Kong] Chinese.’ Mr Baiboe said that it was the amount of money that decided the issue as to which company should enter Ioma area. The Sikuru Boe team explained that the sum was the estimate of the total investment in the entire project: it was not the money that the landowners would get.

The Company had also argued that the establishment of the pulp mill would create job opportunities for the people, and the Government had accepted this argument. In fact, of the 37,000 people who stood to lose their forest livelihood (not to mention many more people whose land and fishing ground would have been indirectly affected by the vast operation), at most 1119 would have been employed, with the number decreasing as the establishment continued to operate. These 1119 were intended indigenous employees, the bulk of whom were said to be going to come from those dispossessed—just how many was left open. Moreover, according to the feasibility study, the salary paid to indigenes was to be K500–1000 per annum while the expatriate salaries would have been in the range of K10,000–14,000. A further claim was that the township would provide better facilities and easier lives for the people who would service it. We pointed out to the people that anyone who thinks that exchanging a viable subsistence life within his own territory, his own forest, and with his own social life intact for being the labourer, cleaner, or office boy for a town of transients bent on making money is ignorant or mad.

After we explained some of the issues, Edwin of Barara Village said:

I was a soldier in the last war and I fought alongside with American soldiers. My experience with them was very limited but it gave me insight into the American culture. Firstly, Americans were short tempered and their friendship was not very good. Secondly, their moral behaviour was bad. I had one incident which I witnessed myself. There was a native woman near Buna whose husband had been called up for war efforts. She married this man a month before he went. An American corporal was on duty and he was going to Eroro Village in a vehicle. He picked the woman up and promised that he would drop her at her request. But he did not because he drove the vehicle into the bush and entered sexual intercourse with her. After him, other soldiers had their turn, and the woman lay there, unable to move and the soldiers ran away. She was picked up later and then taken to the hospital. Some medical doctors sewed up the sides of the vagina that was torn by the soldiers’ penises. She had to remain in hospital for a month before she could recover. This is my experience with Americans and I do not like them nor their Company.

The final discussion was held between the President of the Tamata Council, Mr Goviro and other councillors and the Sikuru Boe team. We submitted to the Council that the majority of the Binandere people rejected the proposals of Parsons and Whit-
more. The most important thing that emerged from the survey was that the people wanted to remain owners of the land and wanted village development to build on what there was already—the people living in the villages. The people have a high level of organisational competence within the village unit and they are able to develop the infra-structure for feeding the available market provided transport to the market is facilitated.

We had identified some of the problems related to village development and we proposed to the Council some of the alternative ways to help the people to help themselves instead of inviting the Company to destroy the land resources. We suggested that the immediate answers to the problems were as follows. Firstly, the main population of Binandere and Aega tribes is concentrated on the river plains. Therefore, the river provides a natural means of communication and transport in the area. Road building would be a very expensive undertaking owing to large areas of swamps but organised water transport would be economically feasible. In order to facilitate this scheme, it would be necessary to establish a centre in Totoadari Bay, both for barge transport up the rivers and for a harbour for sea contact to Lae and to Oro Bay for Popondetta. With barge transport to the bay, the rich fertile flood plains will provide many agricultural products as well as those already established as cash crops. Self-reliant schemes for transport and market outlets could be organised.

The organisation of retail trade could be improved in the area. From our discussions, it seemed clear that the failure of individually owned trade stores was partly due to lack of expertise and transport difficulties, but mainly because such individualism, with profit accruing to one person, was disapproved of by the villagers. Furthermore, whereas one village can, among all its members, provide buyers, carriers to transport goods, clerks and counter sellers, no one person or family can provide all the necessary labour: the employment of fellow villagers is a political impossibility. Moreover, the size of the consumer market does not justify competition between various individually owned concerns. We proposed that each village should have one trade store owned by that village, set up and run by a village progress association. This proposal is much more in tune with the reality of the situation and with the aspirations of the people. Later these stores could belong to a co-operative wholesale society for the area, if and when the people ask for it.

These suggestions the people saw as meeting their needs. Thus, in our opinion, the next step in developing the area was in meeting the initiative of the people, with the people themselves giving financial and other support. This demands hard work, but only thus will the people develop their own area in the way they wish and with the self-reliance needed to make a success of their undertakings.

After presenting our findings to the Tamata Local Government Council, we returned to Port Moresby. We reported that the Binandere people did not want the Company. This was a great blow to the Gamana team. As expected, the politicians responded with 'never trust educated big heads' and arranged another trip to the area. This time we accepted the challenge and went with them to Ioma. The meeting was arranged in such a way that Gamana stood on one side, the Sikuru Boe on the other, and the people in the middle so that they could assess and evaluate arguments from the two opposing sides, and make their own decision. The meeting was violent and it became obvious that the majority of the people opposed the proposal of the Company. The project was then abandoned by the Government and the Company. The struggle had taken more than six months.

The successful campaign against the foreign companies and the final rejection of their proposals depended upon several factors. Firstly, Komge Oro Association
provided the leadership and the organisation in the campaign. Komge stands for Kumusi, Ope, Mamba, Gira and Eia Rivers. This association was formed in 1969 and, although it was not registered until December 1974, it became the spearhead for the people, not only in villages, but also at the regional and national levels. Its aims as stated in its constitution are very contrary to the intentions of the companies.

The association has three objectives. The first is 'to pursue cultural, social, educational and economic activities based on village community initiative and develop village resources with village leadership'. The second is 'to promote appropriate technology relating to village situations and requirements with the aim of training people within the communities in the use and maintenance of such technology, and to set up small village industries'. The third is 'to foster whenever possible the exploitation of all the primary resources of the area by the people of the area, and further, to protect exploitation of all the resources by outsiders until such time as the local people are in a position to exploit them themselves'.

The last objective was our primary concern during the campaign because without it the other two would not be possible. The President, Mr Henry J. Tabara, was adamantly opposed to the Company. He accompanied the Gamana trip and represented the association, and provided counter-arguments to the views of the politicians. At Popondetta town, the President and his executive committee provided a strong basis for leadership around which the support for the people polarised against the Company. This polarisation was one of the determining elements in the final rejection of the proposal.

The second factor was the Tamata Local Government Council. This Council was established in 1965 and it has been in operation for about nine years. The Council was responsible for Aega, Binandere and Mawae tribes, whose population may be estimated as approximately 10,000. Mr Romney Goviro was the President and he is a tough man. On some occasions he listened to the politicians, but often he was his own ruler.

Towards the end of 1973, Mr Goviro was instrumental in helping some leaders in a patrol to canvass the opinion of the landowners in the area. When it became obvious that the Government rejected the proposal of Kawin Corporation, he influenced most of his councillors to question the politicians and the Government. By April 1974 he had abandoned the Council Chamber at Ioma. He moved it to the coast at Totoadari Bay in the location where the Company proposed its town. This was a protest move as he did not like interference from the politicians and the Government and because the Chamber was close to the airstrip.

Mr Goviro defended his people and their land to the extent that he resisted taking part in any negotiation. Most councillors supported this cause and deplored the way in which they were approached to sell their timber rights. Caedmon Beu of Eia River even flew to Port Moresby. He was one of the members of the delegation that met Messrs McIntosh and Voutas. Indeed the Council was the backbone of the leadership in the villages and the Sikuru Boe team collaborated with many councillors in resisting the exploitation of primary resources and the alienation of land. During the final confrontation between the Gamana and Sikuru Boe teams, many councillors publicly declared their position against the proposal. The President, for example, refused to be the chairman of the meeting when Mr Tago asked him. Some other councillors equally declared their support for the politicians. The Vice President, Mr Bonga, whose opinion I have already quoted, was one of them.

Another factor in the successful campaign was the influence of the Anglican Church. The area has been under this church since 1899. Most church leaders in the villages ap-
The Melanesian environment

peared to remain neutral and most of them did not understand the complexities of the issues. In the late sixties the Right Reverend George Ambo, the only indigenous bishop in the Anglican Diocese of Papua New Guinea, advised Japhet Jigede, the big man of Bovera Village, to resist any attempt to buy timber rights because this was a stepping stone to destroying the land. Bishop Ambo must have seen the effect of timber felling on the land around the town of Popondetta, and his advice may have been based on that experience.

The Bishop of Papua New Guinea Diocese, the Right Reverend David Hand, came out very strongly against the Company and in support of the Binandere people. He wrote to Mr Tago on 15 April 1974, two days before the Gamana team flew to Ioma. Basically Bishop Hand was very suspicious of the intentions of the foreign companies and felt that their activities would undermine the Government goal of self-reliance for the village people. He pointed out that the politicians should avoid 'this open-slather development by these multi-million-dollar bracket companies' and that the Government should adopt and commit itself to 'a policy of gradualism [which] is safer for our country's real development in the interests of, and in justice to, ALL its people'. Further he stated that all the primary resources of the people should be '... carefully shepherded and not squandered ... ' The 'primary means of development', he wrote, 'is HARD WORK—by ourselves, not by some outside mob doing it for us ... ' The Bishop concluded his letter that the Binandere tribe should not be sacrificed on the altar of 'development':

I quite realise that the decision must be the people's. But I believe there is a great responsibility upon the people's advisors, to help them to see what is really truly in their best long term interests. We certainly do not want to witness the disintegration of the great Binandere tribe in the interests of a few quick dollars.

It is clear that the church supported the people in the campaign against the foreign exploitation.

A final factor was that the Sikuru Boe team was able to represent at the conference tables the people's need to retain their subsistence resources. But the mandate for this representation depended on two things. One is the fact that the Binandere language is our mother tongue and this gave us a great advantage. During our trip, we avoided formal meetings and held most of our discussions at night, and we talked to people. This enabled us to discuss the important issues in the most informal and intimate manner. The people listened attentively and asked very penetrating questions. We used Binandere analogies and examples to clarify some of the items in the 'utilisation schedule' and some of the effects on the environment and the people. Understanding the culture, therefore, is an important element in communication in villages.

The other base was that we have been maintaining a very close contact with our people, so much so that the people had confidence in us to represent the opposition side of the people in the villages. We were not rejected as 'educated big heads' as the politicians have accused us. During the last confrontation at Iaudari Village, for example, Jigede decorated himself with the traditional costume. He brandished his pineapple club in the air and chanted a war cry and gave it to the Sikuru Boe team saying, 'This is the power of the people, a symbolic power that you should continue to defend the land and the people and fight against the system of exploitation. Our ancestors have done it against any intruders. We must fight the Company in order to save the future of our grandchildren.' No one dared to speak after Jigede had spoken and the issue had been decided: the majority of the people rejected the intentions of the Company.
The desperate attempts of Parsons and Whitmore to buy timber rights in the Northern Province should be seen in a perspective that relates to the forest resources in the world. First of all, forest resources are finite and the capitalists of the so-called ‘developed’ countries have been ignoring this fact (Schumacher 1974). The result is that now there is a shortage of natural forest resources, especially trees for pulping, in most of the producer countries, notably in western Europe and North America. In actual fact the capitalists have badly mismanaged their timber resources in their own countries; having exhausted the resources and exploited the mass population there, they have gone on to destroy a great part of the timber resources in the tropical countries. Further they have miserably failed to replant most of the natural forest that had been cleared; and still further they have failed to recycle paper. There are evidences that they have overconsumed the sources of paper production, and this is why there is a world wide paper shortage (for figures see Schumacher 1974:20).

The ‘developed’ countries still have a few non-tropical forest resources in North America and the USSR, and no doubt they prefer to keep those for their future generations while they ruin ours. The excuse they offer is they find exploitation uneconomical owing to the high cost of labour: no doubt the stronger anti-pollution laws also affect them. The United States, having been forced to release its slaves, could not get timber because it had to pay its labour $500 a month; its businessmen therefore hoped to come here and pay $500 a year to indigenous labourers. But we do not want them in Papua New Guinea.

The ‘developed’ countries see the solution in extensively exploiting tropical forest in the so-called ‘developing’ countries. It is evident that the desperate situation in the ‘developed’ countries forces multi-national corporations to spread their tentacles of exploitation and to look to areas with natural forest so that they can go on in the same blatant, wasteful and immoral manner to destroy tropical forest in other countries. After they have destroyed their own forest as well as much of the forest of other countries, they now turn to destroy the natural forest in Papua New Guinea. Have the ‘developed’ countries learnt at all? No, they have not. Under the clear-cut operation tropical forest may never regenerate fully and techniques of replanting even the tree plantations over any length of time have not been established. Rene Dumont (1970:17) has said that ‘tropical farming techniques which can be applied without risk of soil impoverishment have not yet been perfected. It is high time that the enormous damage inflicted by the robber economy was repaired, and that the generations of the future should cease to be sacrificed on the altar of present-day convenience or self-indulgence.’ It is indeed high time! Rural populations who live in the traditional setting are much nearer to those techniques, but now they have to face the threatened wastage and rapine from overseas.

It is not yet understood that what happened in other countries devastated by imperialism will necessarily happen in this country. There are already signs that it is happening. Basically there are two divergent groups of people who do not seem likely to converge in the near future to put up a concerted front against imperialism: one, political parties, is more interested in state politics; while the other, emerging village organisations, is more concerned with village improvement. The latter may be used by politicians to get into national politics through elections but, once they get elected, politicians do not necessarily represent grass-roots movements.

The implication of the overthrow of Parsons and Whitmore is that, since the beginning of contact, Binandere society has never been shattered by colonial imperialism. On 29 June 1974 when the Gamana team and the Sikuru Boe team confronted each
other at Iaudari Village, several things were evident. To begin with, Parsons and Whitmore's attempt to alienate land aroused several categories of traditional and contemporary conflicts in the Binanderé community. From the traditional point of view the land customary titles had been based on communal ownership. Long-standing clan land boundaries and boundary conflicts, as well as traditional alliances, animosities and jealousies based on how the ancestors had come to acquire the land, were brought to the fore.

The traditional elements of conflict provided a setting for the contemporary situation—it could be treated as continuing the chain of traditional alliances and conflicts. For example, the Gamana team consulted only one clan whose members were predominant in the Bovera Village. This clan had migrated from elsewhere. The minority clan members in that village had most of its members in other villages. This minority desired to seek the opinion of the majority of its members before responding to the Gamana team, but the team only heard one view and flew away as the clan leaders were arriving at the village. As a result of this, the clan passed messages to all its members in the entire Binanderé tribe as well as outside it, to declare war against the clan that was consulted by the team. Owing to communal ownership of the land, all members benefited from the land and the forest. This was different from a distribution of the money within the clan; the money would have been too little to share equally among the members involved. Over a period of time this would have created tension among the clan members. The spirit of communalism would have disintegrated and in its stead individualism would have emerged. This would have paved the way not only for disputes about land confined to one village, but also for boundary disputes between villages, clans and tribes.

A further division was that between generations. Some elders argued that they would die sooner or later, and they wanted to get the few dollars given by the Company. Agreeing with this argument were those of the young generation who desired to be employed on the project, especially those who are currently employed in towns. The counter-argument was that the elders were going to die; they had lived on the land, and by the traditional standard were well off in terms of cultural activities based on the land. Once the land was destroyed it would be difficult to carry out ceremonial activities because of land shortage; but more importantly, the future generation would suffer because there was no land available to make gardens. Most of the young men who supported this argument felt that Binanderé society must not be disintegrated.

I want to stress that the attempt of Parsons and Whitmore to buy timber in the Ioma Area was the 'prime mover' to disintegrate the Binanderé community, whose land would have been alienated and whose people would have been forced to become landless labourers. Had the Company come, Binanderé society would have been destroyed as the land would have been, and shamefully destroyed to make outsiders rich, not to create a better society from it. Change must come from the people, not by their destruction.

Indeed there is some awareness of these issues among the third world peoples and in the 'developed' countries. Informed opinion is beginning to get momentum. Schumacher (1974:11) says:

"Every economist and business man is familiar with the distinction [between income and capital] and applies it conscientiously and with considerable subtlety to all economic affairs—except where it really matters: namely the irreplaceable capital which man has not made, but simply found, and without which he can do nothing...we are not in the least concerned with conservation; we are maximising, instead of minimising the current rate of use."

In fact, it is our traditional way of life that is much more conserving and more in har-
mony with the environment. This limits us and we are staggered by the seemingly unlimited wealth of the western world. But how long will it be unlimited, and at what price to human beings?

Realisation of the limits makes it necessary for us to join with the emerging saner elements of the ‘developed’ societies in the conservation of resources and recycling of materials. This will enable us to use our forest in our own time with consideration for the future of unborn generations. Any company that offers an intensive timber cutting project now is trying to exploit us in haste, to make a ‘quick profit and move out’. The national Government should guard against foreign exploitation through international corporations. Where the Government is blinded to the real interests of this country by its need to balance the budget for the next few years, and by its reluctance to cut down the expenses of the elite, it becomes the right and duty of the people to protect their own resources for themselves and their posterity.

There is unfortunately grave danger of the people being deceived. Kawin and Parsons and Whitmore give us a good example of how international companies approach the national Government to invest in Papua New Guinea. In the name of investment these corporations ask the Government, ‘Do you want development?’ Most politicians answer, ‘Yes, we want development’. The companies present their vague proposals saying ‘This is development’. It is a pity that the politicians ask the same questions of the people in their electorates, instead of presenting alternative choices and providing leadership to aim at goals that would be consistent with the people’s felt needs.

The underlying force in this approach is the western capitalist ideology. This ideology, propounded by agents like economists and financial advisers, says that there are three important keys to the kind of ‘development’ they were taught to practise. These are capital, technical expertise and raw materials. The foreign economic advisers believe that the multi-national corporations have the first two keys, and they say that it is necessary for the foreigners to invest money to extract resources. Further they say that this investment is good for the people who own the resources, and they tell the politicians that the third key is held by the people in the villages. Consequently, the politicians persuade the people to provide the last key by selling their resources to the foreign companies so that ‘development’ can take place.

The framework of this ideology allows for the capitalist to exploit materials and human resources in a way that coercively prevents active learning to take place between the foreign organisations and the people in the transfer of technological skills. The ‘level’ of technical competence required in the proposed establishment to remove resources for ‘development’ is far beyond the training of the people. This is a trick that encourages intensive exploitation of resources and discourages the people in the learning process. Further the trick is intended to exhaust the resources so that by the time the people have learnt the necessary skills, the resources have been destroyed and the money accumulated in the hands of the capitalists. This is the beginning of dependence: the people lose the primary resources that are the basis of the subsistence living, and the national Government starts to be dependent on overseas aid. In other words the foreigners use their ideology to enhance the exploitation of natural resources for they are interested only in the raw materials and not in transferring the skills required to start small-scale village industries. David Kaplan (in Sahlins and Service 1960:89) says that the colonial powers deliberately choose the level of industrial establishment because they have to safeguard their interests.

The great complexity of a highly evolved technological system has made it possible for advanced societies to discourage and hinder its spread ... All of the European colonial powers,
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for instance, used their political, financial and economic power to prevent, or at least slow down as far as possible, the spread of industrialism to the less advanced countries under their political control because they were primarily interested in markets and sources of raw material and not in creating manufacturing competitors.

We must make it clear that we are advocating that control of resources remains with the people so that they can develop them according to the needs of the people and not according to the selfish interests of foreign corporations and the luxury of governments.

We have pointed out how the politicians accepted, at least in principle, the vague outline of the proposals. This indicates that the way in which the ideology was presented makes the Government reluctant to lose a source of revenue and the possibility of employment created by high capital with foreign investment. This approach does not allow the Government to propose alternative ideology but it may indicate that there is no clear picture of national goals, at least no ideology that is geared towards consolidating the subsistence economy. The Government, by accepting the proposals, adopts an economic model that involves centralised budgets and foreign investment and makes people lose their ties to the land. The model is one that needs to be run and controlled by elitist leaders, whose view of raising revenue is geared towards excessive reliance on overseas interests. Further the model enables the central Government to determine 'an optimum level' of industrialisation and engineer the availability of the labour force.

In the Binandere case, the politicians were partly reflecting the illusion of the central Government; mainly they were motivated by self-interest. The mere mention of $120 million to the people made it look as though the politicians bring money to the people, and this idea is an attractive bait to win votes in the next election.

The important point is that the central Government expects to create the economic framework within which the people operate; because the Government is committed to 'development' and 'national economy' and adopts terms and concepts that are foreign to the villages, the people are confused and do not grasp the goals of the government. This situation produces the following effects. Firstly, the bulk of the funds for the Government comes from non-subsistence sources and the Government tends to depend more on outside revenues, extending this dependence to the people in relying on foreign corporations. Secondly, the resources of the people are sapped by the Government for foreign capitalists, and this makes the people more dependent on outside assistance and more vulnerable to exploitation by the international capitalist system. Thirdly, the situation creates social divisions in which the elite establish ties with multi-national corporations to exploit the natural resources while the 'half educated' and 'drop outs' aspire to attain the standards of the elite by migrating to urban areas and leaving the great mass of the population in the villages. Thus an exploitative class structure is well on the way in Papua New Guinea despite the entrenched egalitarianism of traditional Melanesian societies. Johnson (1971:3–10) makes it clear that:

Those who have had a political claim on the development process—the educated, the 'middle class', the established native capitalists, and the minority of labour employed in industrial establishments, not to speak of the politicians themselves—have done very well out of the development policy as it has been executed in practice, regardless of its efficiency or otherwise at the level of economic aggregates and averages. The rest of the population has not done well. For it, the visible economic development that has enabled the minority to regard itself as 'modernised' and able to deal with other national elites on equal terms has been achieved by a process of forced income transfer, not of shared economic progress. Fourthly, the Government continues to use effective mechanisms to keep the
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economic control in its hands and away from the people. One such mechanism is the term ‘timber rights’. In the western European countries the term means buying harvest and exploiting timber resources, but overlooking peasant ties to the land. In the Papua New Guinea context the term covers the same purpose: to alienate the land for timber exploitation without due regard to the people’s cultural and spiritual attachment to it and to the forest. Reafforestation is another example: given the fact that clear-cut forests in the tropics can never fully regenerate, it is deceptive to apply the term in Papua New Guinea. It is more realistic to adopt ‘monoculture’ or ‘tree plantation’ so that the people know that clear-cut operations leave no natural forest on their land (even these do not point out the consequences for the soil and the environment). It is no wonder that the people strive hard for goals that they clearly do not understand, and the central Government, providing neither leadership nor clear goals, gives no room to the people to define their own goals, which would be related to felt needs and immediate problems in the villages. Under these circumstances, it is only fair and proper that the people retain their resources at all costs, exploiting them by appropriate technology and in their own time.

In order for the people to remain in control of their own resources, however, the Government has to safeguard these resources against the western capitalist ideology. Revitalisation of subsistence living and the improvement of the subsistence way of life with the people controlling their resources are possible only if a sudden brake is put on the rate at which most leaders are selling the resources of this country. We must also make a radical break with the international capitalist system, which has been the principal means of exploitation in Papua New Guinea over the last fifty years.

Political leadership is required to take the stand consistent with the aspirations of the people. Politicians must decide now whether the society of Papua New Guinea can consolidate its subsistence living base or must choose another base. The advantages of the existing subsistence base are firstly that about 88 per cent of the population are in the rural areas and, secondly, that about 97 per cent of the land is under customary rights (i.e. in the hands of the majority of the people). There is every chance to evolve a new Melanesian society on this foundation, but we lack leadership to do so.

On the other hand, if the alternative is to have a society based on a cash economy, it is absolutely necessary to recognise the foundation of the subsistence society. Using this base, it is possible to propose a slow growth of industrialisation that would allow for a regulated utilisation of primary resources. This means that we must learn to establish our own manufacturing village industries and not to sell the country’s resources without consideration for the future generation. We can reasonably choose industrialisation only when it is run by us and for our benefit not that of foreign capital.

CONCLUSION

There are a number of factors that we can emphasise from the preceding pages. The first is that decisions arrived at by politicians in Papua New Guinea are made with only the short term view. There were several issues that were obvious during the struggles in the Northern Province. The elected members of the area appear to have been concerned with their immediate aim of being re-elected. Other government politicians, and indeed the Department of Finance, were concerned with making the budget look better; the Department of Forests was concerned with looking as if it was making use of the natural forest which would otherwise, in their limited view, be left standing idle. No one, in my opinion, who was involved in the decision making process was viewing the Ioma area project with regard to long-term results, of either an economic or social
nature. Indeed there was a lack of statesmanship; politicians were not expected or allowed by the political climate to think seriously in terms of basic values. It seems that the luxury of both of these elements of leadership was lost after the drafting of the eight point plan.

For someone like myself, who returns periodically to the scene of national politics from the bush, the continuing loss of morale is striking. More and more selfish motives are tolerated from our politicians and less and less statesmanship is expected. Lost in the sea of decisions based on expediency, many people seem to have given up their earlier struggles to give this country a direction aimed at the long-range future. In their own disillusionment they turn to more personal aims.

This is not what the people in the villages expect from their politicians. The people do not need politicians intoxicated with the idea that big business does exist and might admit them. The honour of being the last ex-colonial country to allow ourselves to be ‘underdeveloped’ by international capital is something we can do without. It is about time politicians judged their days by the opinions their grandchildren will have of them.

The second obvious factor was that ways for the people to express their wishes did not exist. There are several things that contribute to this. Firstly, there is a cultural and linguistic gap between the people in villages and their leaders in this country. Secondly, those who are chosen to bridge the gap (such as field officers, councillors, etc.) often turn out to be representatives of ‘progress’ and ‘development’. Of course these are the aims of the leaders and not of the people who elect them or the people whose interests they are supposed to serve. The result is that, whereas some people at the top may be under the illusion that the reports made available to them are the results of dialogue between the government representatives and the people, they are in fact hearing only the government voice and its own echo. The people are left in the worst situation: either totally uninformed, or (at best) informed but unheard.

The growing gap between the Government and the people who gave them mandate, the chasm with an elite at one end and the landless labourer at the other with the voiceless peasant in between, threatens to waste our country’s human and natural resources in bitter conflicts. In the Ioma area the Binandere elders have their own power; they have the symbolic war club that incorporates the fighting spirit of our people. The fight against imperialism was never regarded as over by these people. For many areas of Papua New Guinea, I think the spirit of independent pride, backed by fierceness of purpose, is much stronger than the people’s confusion as they try to grapple with new interpretations of progress. It is stronger than present observers believe. One of the issues facing this country’s policy makers is whether the pride and the fighting spirit of our people will be used to create an independent and strong Papua New Guinea where they and future generations can live with dignity or whether this same energy will be directed towards disrupting the country with civil war.

The third factor is that too many administrators and politicians hold the people in contempt, avoiding even a semblance of real consultation; only if there is opposition expressed through a sophisticated medium are they forced into initial consultation. The people of this country are seen not as builders of a strong Papua New Guinea, but rather as a nuisance to be ignored where possible and bought off where not.

It is high time the leaders of Papua New Guinea recognise that the wealth of our forefathers was derived primarily from the forest and land. Today the wealth of the bulk of the population stems from those areas of saved forest. The present generation has a moral obligation to the future generation to make a decision as to the base of Papua New Guinea’s society: subsistence has been the basis of livelihood for all its
communities over many centuries. To decide to recognise the subsistence base and to consolidate it with a regulated utilisation of primary resources will not only encourage a continuity of harmonious relations with the environment, but also guarantee a sound base for unborn generations.

The Binander people decided against the Parsons and Whitmore project because they wanted to maintain their subsistence independence and because they realised that the project would have a destructive effect on the environment. The rejection was also a rejection of the Papua New Guinea Government’s overindulgence in foreign investment. For such a struggle the people need reassurance that their subsistence way of living is not only saner and more pleasant but also does little harm to the environment. They need to be given back the feeling of the worth of their traditional responsibility to and relationship with the environment. Planners and academics should be talking to village people, the owners of the land and the forest, more especially to those who still have their emotional and spiritual base but whose confidence has been sapped by the hollow show of wealth of the multi-national corporations. That wealth is, in fact, based on overexploitation, indulgence and class inequalities and it is destined to collapse.

The people have fought against foreign corporations because they recognise the importance of the subsistence way of life and the potentialities of primary resources for improving that style of life. We have fought to prevent the exploiters establishing their foothold in the Ioma area. We must fight the exploiters and protect our primary resources and at the same time seek to incorporate technology that does little harm to the environment and creates little social division among the people.

Subsistence culture is a total way of life and itself provides an ideology for the subsistence population. What is lacking is leadership: the kind of leadership that can decide now whether the society, or the majority of its members, must live within a cash economy based on intensive capital from outside, or whether it can remain and revitalise the subsistence economy based on primary resources. The latter seems the best alternative for Papua New Guinea, though it is not the best for its elite, nor for the international corporations. We must look again to the framework for self-reliance set up by the Government through its eight aims and with its help consolidate the base for subsistence independence.

**References**


VII  Tourism and the environment
Tourism in Hawaii in the 1960s was a 'success story', success being measured in terms of increased numbers of tourists, consistently filling more and more hotel rooms and generating large profits while employing a rapidly growing workforce. The question is whether development of the industry in the 1970s can or ought to follow the same lines. The days of low cost energy, an essential ingredient in the high growth rate, seem to be over. Destinations like Waikiki are now seen to be badly planned and overcrowded. Big projects planned on outer islands will have pronounced demographic and social impact on local communities. The state will be hard pressed to provide essential services to a population swollen by in-migration due to tourism. Agricultural land is being permanently alienated, reducing the potential for even partial self-reliance in food. Still, tourism as a principal industry remains appealing to politicians and voters. Developers, who are increasingly mainland or foreign based, continue to be able to get what they want from state and county governments.

The record of the tourist business in Hawaii over the past fifteen years is one of spectacular success in conventional American economic terms. During the 1960s, the annual number of tourists rose 538 per cent, or 18.3 per cent annually compounded (Department of Planning and Economic Development 1972: 3); this unusually high rate of growth was maintained into the 1970s. In 1960, just under 300,000 tourists came to the islands. In 1973, the figure was 3,631,000, and they spent $US890,000,000 (Department of Planning and Economic Development 1974a: 136ff.). Projections at that point for 1974 were for 3,000,000 tourists who would spend $US1,000,000,000—an American billion.

Between 1960 and 1974, the hotel room inventory in Hawaii went up from 9522 to 38,675, and a further 13,507 rooms were planned, about half of them for 1974–6. The workforce employed in tourism went up from 4300 in 1960 to 18,000 in 1972 (Department of Planning and Economic Development 1974b: 9). Hotel operations, overall, were efficient. Room rates were lower than the national average, an occupancy rate higher than the national average was maintained, and gross profits were not bettered anywhere in the country (First Hawaiian Bank 1973: 1). In 1973, the tourist business generated, directly or indirectly, about 25 per cent of Hawaii’s tax revenues (Honolulu Airports Committee 1974).

All this is to say that tourism is big business in Hawaii. None bigger, in fact—it competes with federal spending, defence and other, as the biggest source of income in the state economy, and has far outstripped the basic money earners of the first half of the century, sugar and pineapple.

What is behind this success story? Ultimately, of course, the leisure revolution in the United States—increasing time and money for elaborate recreation. More specifically,
there was the coincidence in 1959 of two events—the granting of statehood to Hawaii, and the inauguration of commercial jet passenger service between the American mainland and the islands. Hawaii, in all its considerable attractiveness, suddenly became highly visible and at the same time easily accessible to the people of the richest nation on earth.

From that time on, Hawaii was sold to tourists in a continuous, well financed and aggressive marketing campaign. By 1973, the Hawaii Visitors Bureau, funded 75 per cent by state government and 25 per cent by interested business, was employing more than eighty people to spend an annual budget of $2,400,000, which, as the head of the bureau pointed out, came to less than $1 per tourist (Simpson 1974). At the same time, hotels, airlines, and the travel industry business generally were spending $25,000,000 annually promoting Hawaii.

State and county governments in Hawaii did their part to put in place the infrastructure demanded by the tourist business. Session after session, the state legislature voted enormous capital improvements budgets for airports, roads, utilities, golf courses, small boat harbours and so on. And the State Land Use Commission and county planning commissions were more than receptive to developers' proposals, generously rezoning land previously in agricultural, rural or conservation classifications to urban and resort classifications.

If the story so far reads like that of a bold, deliberate and successful attempt to seize a unique business opportunity, there is no reason not to accept it in those terms. Hawaii needed another big industry around the time of statehood in the late 1950s—and badly. The big economic inputs provided by World War II in the 1940s and the Korean War in the 1950s could not be depended on to recur (no one at that time would have predicted that the Vietnam War would be so lucrative for Hawaii). Most people in Hawaii were aware that the two long standing props of the economy—sugar and pineapple—looked at best unsteady over the medium to long-term future. The Hawaiian sugar industry, in a controlled world quota system, would never greatly increase its value to the state, and the Hawaiian pineapple industry was steadily being priced out of the world market. Hawaii needed another crop, ideally one that could be harvested on a large scale by the relatively unskilled work force increasingly being displaced from agriculture. So the tourist was cultivated assiduously, and he turned out to be an apparently perennial yielder, capable of continuous cropping. He not only sustained the Hawaiian economy, he transformed it.

So much for the background. Let us now look a little more closely at the tourist business of the sixties, to see what it bequeathed the seventies.

Early in the sixties the centre of tourism was Waikiki. It grew unbelievably fast, and by the later years of the decade was obviously turning into a high density, high rise resort of high energy and increasing tawdriness. With the prospect of this tawdriness turning to irredeemable architectural and environmental awfulness as growth continued all but uncontrolled, a comprehensive zoning ordinance was prepared, including moderate restrictions on building height and density. Intended as a control device, the ordinance had essentially the opposite effect—developers hastened to get their plans approved and start construction before the new restrictions came into force in 1969. The result was a feverish building boom—and a serious potential oversupply of hotel rooms in Waikiki.

History arranged for the rooms, old and new, to be filled from new sources. First, there was the Vietnam War's R and R program, which peaked in 1969 with 246,000 tourists, or 18 per cent of the year's total (Department of Planning and Economic Development 1972: 10). Second, there were Japanese tourists, a new phenomenon in
the business, who by 1973 numbered 300,000 or more than 10 per cent of the year's total (Hawaii Visitors Bureau 1973: ii)—and, incidentally, more than 100 per cent of the 1960 total from all sources. Third, the recent and celebrated energy crisis, at its height in the American winter of 1973-4, worked briefly to the benefit of Hawaii, leading cold Americans by the thousand to warm themselves briefly in Hawaii, an overseas trip within the United States.

But the Vietnam War wound down eventually. The Japanese underwent their own energy/economic crisis. By the summer of 1974, with the economy of the United States in ever worsening shape, the rate of growth of tourism in Hawaii had slowed considerably. The future of the tourist business in Hawaii is now problematical. It is already a truism that the 1960s low cost energy, high growth rate economy will not be back to bless Hawaii, the United States or the western world—at least in any time frame of interest for discussion of Hawaii's tourist business.

This is something no one really planned for, least of all in Hawaii, where growth in perpetuity was assumed. The 1960s were to go on forever. And in the 1960s, the tourist business could get anything it wanted from the state and county governments. Not until the 1970s opened was there anything like a serious effort to begin doing cost-benefit studies on tourism.

Only now that the seventies are more than half over, and it is obvious that the second half of the decade is not going to look anything like the 1960s in economic terms, have planners on the state payroll gone on record expressing concern about the possibility of the continued uncontrolled growth of tourism. In a set of scenarios for 1974–84, they discuss the undesirability of accelerated growth in tourism. This would, they say, offer attractive short-term employment possibilities, but in turn it would encourage increased in-migration, which, unabated, would double the state's population in sixteen years. The state would find it increasingly difficult to meet basic service requirements in housing, transportation and education. Rapid changes in land use would result in significant spoilage of the landscape and would lead to degradation of coastal waters through rapid soil loss. Air pollution would increase as airplane and automobile traffic increased. And accelerated growth in tourism would result in such an extreme concentration of employment in one business that in the event of an American (or a Japanese, or a world) recession, Hawaii would be very vulnerable to high unemployment (Department of Planning and Economic Development 1974c: 51).

Note that this is offered as an undesirable scenario for the next ten years. It would do very well for a synopsis of the last ten years—the cost side of the tourist balance sheet. Where the last ten years overlap with the next ten years is in several long-term, large-scale development projects associated with tourism. One or two are worth looking at.

First, there is the case of Honolulu International Airport. Throughout the sixties, it had a varied clientele, a complicated and essentially incompatible mix of private planes, military transports and tankers supplying the Vietnam War, and commercial jets in ever increasing numbers, especially after 1969, when a Civil Aeronautics Board decision allowed several more airlines to fly passengers from the American mainland to the islands. A new runway had been in the planning stages for most of the 1960s. The early justifications were on the grounds of noise control and improved safety (existing runways necessitated unsuitable flight paths over parts of Honolulu). When environmentalists challenged the proposed alignment of the new runway on these grounds, the justification essentially shifted to one of increased airport capacity, which meant capacity to serve the tourist business. When environmentalists challenged this
justification in court (along much the same lines as have since shown up in the planning document just cited—that tourism was a stimulus to undesirable population growth which would strain the state’s carrying capacity), the judge ruled that there was no proof of any connection between tourism and population growth through in-migration. The runway is now under construction, at what will be an ultimate cost of something like $100,000,000. It will greatly increase the airport’s capacity at a time when state planners, who now do see the connection between tourism and increased in-migration, are arguing against accelerated growth, and at a time when external constraints in the economics of energy are likely to spell an end in any case to accelerated growth in tourism, leaving the state with a sizeable debt that may be difficult to work off.

If the judge in the runway case could not see any connection between tourism and increased population through in-migration, there were others in Hawaii who could, as in the case of Maui County. The county consists of three of the eight inhabited Hawaiian islands—Maui, Molokai, and Lanai—which have historically been agricultural islands—sugar and pineapple on Maui, and basically pineapple on Molokai and Lanai. The pineapple industry is already being phased out of Hawaii, which means that the workforce on Molokai and Lanai faces unemployment. The response of Maui County and the state has been to encourage tourist resort and second home development on all three islands. The scale is massive. A single development in process on Maui will put in place a population bigger than Waikiki’s. This will effectively double the island’s population, which is currently about 50,000. On Molokai, which has a population of about 5000, a single development is planned for 30,000. On Lanai, which has a population of about 2000, a single development is planned for 15,000.

In each case, the nucleus of development, the prestige attraction, is a tourist resort, which becomes the leader for vacation and second home development. The customer and ultimate resident is the middle-aged, affluent white mainland American who emerges from the statistical profiles of the Hawaii Visitors Bureau as the typical tourist. The demographic forecast for Maui County, then, is that the local population (the usual ethnic mix of Hawaii, predominantly non-white) will in the foreseeable future be decisively outnumbered on their own islands. For the first time (and this will ultimately be true not only in Maui County, but statewide), there will be one ethnic group with an absolutely majority of the population, and it will be white mainland Americans, relatively recently arrived. What this will do to the social balance of Hawaii is anybody’s guess. But no informed guess is optimistic.

These massive developments in Maui County are avowedly to take up the economic slack as pineapple is phased out. Jobs mean votes, and the mayor of Maui County, a local man, a most astute politician, who is nonetheless engineering a medium-term demographic revolution that will work profoundly against the interests of his present constituents, is returned by record majorities, election after election.

But there are other things to consider as well, and they are not being considered. On Molokai, and particularly on Lanai, there are constraints of water supply and water service. Tourist resort, second home developments of great size effectively foreclose the agricultural option. A question very pertinent but never tackled head on by planners or politicians is whether it makes sense for Hawaii to be encouraging massive additions to population, using tourism as the stimulant, at a time when the world economics of energy and food argue against overload, and whether it makes sense to be siting these populations in such a way as to reduce the islands’ potential for even partial self-reliance in food.
This is a real question. Hawaii produces perhaps a quarter of the food it consumes (other than sugar and pineapple, and no one suggests that these make a balanced diet). The rest of the islands' food is imported from the American mainland. Hawaii has no source of fossil fuel; in fact it is as far from the sources of fossil fuel as any urbanised place on earth. Directly and indirectly, Hawaii's per capita use of fossil fuel energy exceeds that of the American mainland by more than one-third (Detwyler 1973). And yet the main planning and developmental thrust of the state is the perpetuation and expansion of the high population density, high energy use, urban affluent society that is running into such trouble on the American mainland and throughout the developed world. This is the lifestyle of continents. This is what is to be replicated in the islands.

Even if a few planners in the state administration have doubts about what they see coming, it is unlikely that they will prevail. There are too many ways for individual developers to be able to get what they want from state and county government. And increasingly, these developers are mainland based or foreign based, using Hawaii as just a branch of operations that must show a profit or be axed from the corporate system. In this volatile situation, it is not unlikely that the state and the counties will find themselves laying out enormous sums for a tourism infra-structure that will have no permanently useful tax generating structure built on it.

What will determine the future of tourism in Hawaii, of course, is the external constraint of the world energy industry. And the prognosis is not good. As Howard Odum (1974:17), one of the United States' most acute students of energy, ecology, and economics, has said:

If we may judge by the increase in tourism that followed the increased energy subsidy of our culture, tourism is a property that depends on high energies. As net energies go down in the United States, so must tourism. Political attempts to keep its priority over endeavors such as getting more food and fuel energies will fail... Whereas efforts to make transition slow and non-disruptive are needed, no one is doing anyone a favor by implying that tourism will not be declining.

This is, of course, unless there is some rich source of excess energy culture to draw tourists from—and Odum humorously suggests, as a stopgap to give time for new directions in planning, excursions for Arabs.

Thus in Hawaii, as elsewhere, jobs mean votes, jobs mean tourist developments, and tourist developments mean high energy use population growth at exactly the wrong historical and environmental moment. Planners are coming to realise this, but politicians and voters cannot bring themselves to acknowledge it. The only questions concern when the truth will become irresistibly apparent, and what will have happened to Hawaii before then, what patterns of population and land use will have emerged, and what their viability will be.

The history of energy use in the United States and Hawaii suggests that the only teacher who can command attention is crisis. And the difficulty with crisis as a teacher is that he tends to enter the classroom unannounced, to find his students inattentive, unprepared for the searching examination he sets—an examination that produces a high failure rate indeed.

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Tou rism, Land Alienation and Foreign Control in Hawaii

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In the century following colonial penetration [1778], the Hawaiian economy, population, social customs and way of life were rapidly devastated and ultimately destroyed. The remaining people together with the confiscated lands were incorporated into the world capitalist market system under US colonial jurisdiction. Today, Hawaii shows preliminary and many advanced signs of economic, political and social imbalance, environmental degradation, and threatened and possibly imminent collapse due to import dependency contingent on world conditions. Hawaii suffers from maldistribution of both wealth and power, typical of capitalist conditions, extreme absentee control, both economically and politically, owing to a one-sided service oriented economy in tourism and military, over which the people exercise little effective self-regulation. Indices of social disorder reflect mounting oppression, rising contradictions within the social and political spheres and incipient movements directed to basic structural change.

A completely self-sufficient, ecologically sound, pre-capitalist social order existed in the Hawaiian Islands for approximately sixty-five generations from around A.D. 500. The civilisation produced a technology and culture enabling it to expand gradually from small numbers of immigrants to about half a million people. Evidence suggests a balance between production and consumption, physical and social health, little if any wastage of labour or natural resources and perhaps as many daylight hours available for labour free activities and enjoyment of living as those required for sustenance. The population was distributed in coastal regions, plains and valleys without undue centralisation and no signs of congestion. The Hawaiians had a comprehensive knowledge of seamanship, navigation, skills in fishing, extended horticulture and aquaculture, hydraulics, animal and plant husbandry, wood and stone work. Exploitation of the majority (producers) by a non-producing minority caste of hereditary chiefs was limited by the consumption capacity of the chiefs, by the absence of external trade and a tradeable surplus, and by the capacity of the producers to retaliate. By all objective observations and records, the Hawaiians were a happy and compatible race of people.

Upon the arrival in Hawaii of the Resolution in January 1778, Captain James Cook accepted from the Hawaiians canoe loads of fresh vegetables, fruits, pigs and fish, for which he offered a few nails. With this exchange, the capitalist market system made its first penetration of the islands.

In pre-capitalist Hawaii, land was a use value without owners, as were air, sea and sky. All good things came from them (Malo 1951; Kamakau 1961, 1964). By the mid 1800s, pressure from foreign traders, merchants, bankers and missionaries resulted in the overthrow of the traditional communal land use and the transformation of land into a commodity, something to be bought and sold for money. This occurred in 1848.
under an edict called the Mahele. Nearly a half century later, in 1893, United States military forces overthrew the Hawaiian government. Annexation followed in 1898.

In Hawaii today both economic dependence on the world capitalist market system and integration with its political superstructure are nearly total. Hawaii is now the military, economic and political headquarters in the Pacific basin of American imperialism. On Oahu sits the commander in chief of United States Pacific military forces. (This is the same military that seized Hawaii in 1893.)

Hawaii has been the command and logistics centre for the Pacific phase of the inter-imperialist World War II and of the Korean and South-east Asian wars of intervention. At Hickham Air Force Base, Honolulu, is located the Directorate of Targets, 548th Reconnaissance Technical Group, central targeting office for the air wars in Vietnam, Laos and Cambodia (Lind 1975). The military own or control 25 per cent of Oahu lands. Many important incidents of the Vietnam war originated in Hawaii. Scott (1972) reveals the control Hawaii military headquarters had over Washington headquarters, and over the presidency and Congress regarding the Gulf of Tonkin and Pueblo incidents, invasions of Cambodia, Laos and others.

Hawaii has been and is a key training centre for counter-guerrilla training, nuclear submarine warfare, experimental defoliation, tactical bombing, offensive assault landing and naval manoeuvres. William Calley, one of the convicted war criminals of the My Lai Massacre, was physically trained and ideologically indoctrinated for that atrocity in military controlled forests and training camps in Oahu. A branch of the most sophisticated computerized world wide communication network—dubbed 'Project Aloha' (*aloha* means love)—is located at the University of Hawaii and plugged directly into the United States military command and control system of the United States National Security Agency, Department of Defense (Witeck 1975). Other research designed to serve military aims but carried out in the name of science includes that into vector borne diseases, deadly coral polytoxins, herbicides and others (Witeck 1975).

In the economic realm, Hawaii is the nerve centre for the analysis, planning, control and distribution throughout the Pacific and Pacific rim countries of a significant portion of the world's wealth, in the form of investment capital (HISA 1975), development loans, 'foreign aid', etc. The major sources of income for Hawaii's present de facto population of 902,000 show 80 per cent deriving from military and tourism (ODC 1972:11). With the closing of sugar and pineapple industries, a process now under way, Hawaii will be economically a wholly service-oriented, dependent colony (ODC 1972:2).

Hawaii was once the homeland of roughly half a million Polynesians. By 1878, its Hawaiian population had fallen to 47,483 (Schmitt 1968:13,69). Today, Hawaii is a scuffed road house for nearly three million tourists per year in addition to nearly a million residents. The Hawaii Visitors Bureau projects triple that number of tourists by 1990. Hawaii has the worst housing crisis in the nation in terms of cost-income, availability, dilapidation, vacancy rate, ownership and other criteria (Kaplan et al. 1971). The rate of inflation exceeds that of mainland United States, especially in land, housing and construction materials. The cost of living (consumer price index) is over a fifth higher than the United States average (Dept. Labor 1973). Wages are below parity

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1 Most United States 'foreign aid' does not leave the country, constituting credits abroad toward purchase of American manufactured commodities like military equipment, and usually carries international political strings.
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with national averages in many classifications. Nearly one of every ten residents is on welfare and the numbers are growing rapidly. Crime, prostitution, runaways, family breakups, alienation, racism and racial tensions prevail in Hawaii, especially in urban centres, focal points of the capitalist process of commercial exchange and growth, and are predicted to increase as urbanisation spreads (Fox 1973:255 ff.).

Tourist industry executives live in fear of the rising incidence of anti-tourism hostilities and promote image rectifying media presentations. Nightly bus tours returning from windward Oahu to Waikiki move in police escorted caravans as a result of repeated stonings by hostile residents. Transport congestion is at crisis levels in developed and developing communities while tens of millions of dollars in public moneys are spent on belt superhighways across lava terrain and agricultural lands to encourage land speculation and urbanisation.

A $400 million publicly funded trans-Koolau Mountains freeway (TH-3) is under construction to enable urban expansion of upper income housing and resort development along Oahu's rural windward coast; this will increase by ten times (to 300,000) the population of a primarily agricultural-rural area. Another third of a million new residents (one half the present size of already congested Honolulu), most of whom will be upper income mainlanders, are planned for in a 'new town' a few miles west of Honolulu in schemes prepared by landowners, developers and professional consultants (Wolbrink et al. 1974). A $1.7 billion publicly funded mass transit facility will provide cross-town transportation connections with urban and resort centres; this is also to encourage urbanisation (Daniel et al. 1972).

While politicians declaim against 'too many people', developers' reports show that crisis scale congestion enhances profits. Speaking for most of Hawaii's largest member corporations, the Oahu Development Conference (1972(5):4) states that 'concentration of population' creates 'a more intensive market'. The Royal Hawaiian Management Corporation, a mainland developer of Hawaiian and other lands, states (n.d.:7–8) as its 'basic economic philosophy' that 'When people arrive in increasing numbers, land in short supply becomes more precious', and "People Pressure" creates high values! Urban congestion and overpopulation are clearly shown to arise from the motive of private profit within the economic sphere—the market system of commodity circulation and consumption of land, labour, durable and non-durable goods (Brugmann and Sleteland 1971). Citing US Census figures ODC (1972(1):18) shows that the lowest income families are concentrated in the highest density areas. Census figures show that per capita expenditures for municipal services quadruple to nearly $500 in cities of one million or more from a little over $100 in cities of less than 50,000 (ODC 1972(3):9). Hoffman (1967) has shown that the highest effective tax rates in Hawaii are levied on the poorest segment of the population. Thus, the profit motive leads not only to the intensification of oppression of the broad masses of the people in regard to social and environmental conditions but also to the situation where they are made to pay for it.

A chronic deficit in public parks is concentrated in the high density working class neighbourhoods while the highest park acreages are found in the highest income neighbourhoods (Ching 1974:27ff.). As urbanisation proceeds, however, general standards fall. Honolulu's developed park space falls short by 1.88 acres or 0.75 ha per thousand people—63 per cent—of the needed and adopted standard of 3 acres or 1.2 ha per thousand. One of the results of deficiencies in recreational parks is that the population is driven into commercial amusement centres, movie houses, porno districts, bars and other traps for the tired, bored and distracted.
Immigration exceeds natural increase (the excess of births over deaths) as the primary source of population growth. Hawai‘i’s rising population and congestion are largely the result of selective advertising and sales promotions in high income mainland market constituencies. These pressures account for a continuous forcible eviction of communities such as that at Kalama Valley, Oahu, where in 1971 a small town of approximately sixty families of farmers and small tradespeople were thrown out of their homes. Two years later, a dense city of $100,000-plus homes, a golf course and marina had arisen over the former quiet rural town. Rich mainlanders now cruise to luxurious golf greens in electric powered carts where local working class children once played in a rural setting. The evictees of these relocations end up in the densely crowded low income ghettos, in driftwood shacks, or, in the case of the earlier 1950s evictions, in caves along the foot of Diamond Head. From among their ranks, especially among embittered youth, expressions of desire for revolutionary change began to appear in the early 1970s.

One of the effects of these developments is the destruction of the physical and environmental heritage of the Hawaiian people, a destruction that manifests itself in a profound identity crisis. Hawai‘i’s biggest and most intense demonstration by potential evictees—nearly 1000 farmers and their supporters—occurred in 1974 at a hearing to rezone two farming valleys, Waialohole and Waikane on windward Oahu, from agricultural to urban. The rezoning petition was advanced by a large landowner and developers who plan speculative, high-income housing. About 400 people—farmers and their families—face eviction. This farm community produces 80 per cent of Oahu’s sweet potatoes and a substantial part of its marketable fresh produce in fruits and vegetables. With eviction and urbanisation, this food market would fall into the waiting hands of mainland supermarket chains, the carrier, Matson Navigation Co. (owned by one of the ‘Big Five’) and large corporate food importers.

In 1970 and 1971, attempts were made by the state and federal governments, acting on behalf of Hawai‘i’s largest corporate developers and the tourist industry, to convert a several mile shoreline segment of coral reefs from fishing and recreational usage into fast land (via dredging and filling) for resort hotels construction, industrial warehousing and oil storage facilities. Led by youth, a vigorous Save Our Surf (S.O.S.) movement developed. With broad community support, a series of militant demonstrations at the state capital and community organising stopped over $400 million of destructive projects. The reefs were saved, but the pressure continues.

Not only undeveloped rural areas are targeted for urban development. Old and settled residential communities, large segments of downtown Honolulu, and even relatively new Waikiki hotels (such as the thirteen storey Waikiki Biltmore built in the late 1950s) are being continuously demolished to make way for new high rise construction. The smaller and weaker segments of the population, industry, finance, rural and urban areas are continuously succumbing to the larger and more powerful, thus narrowing the corporate-political power structure at the top and broadening the base of the alienated, disenfranchised and expropriated group below.

While unemployment lines increase, the number of low cost housing applicants (an applicant is a family or individual) exceeds 5000, with the waiting period up to five years (Hawaii Housing Authority, personal communication, 1975). Over 80 per cent of Hawai‘i’s residents cannot afford homes in the existing market (Kaplan et al. 1971) and the buyer income-price gap is worsening rapidly. In 1974, costs of condominiums and single-family residence units were escalating by $1000 a month.

Pollution of air, land and sea is now a chronic and worsening condition in and around Honolulu and is spreading to neighbour islands (SEA 1971). Every major har-
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bour, most small boat harbours and a number of bays throughout the state are now polluted and sources of pathogens to nearby recreational waters (Cox and Gordon 1970; Herschler and Randolph 1962; Bureau of Sanitary Engineering 1953; Gunderson and Stroupe 1967; Raymond 1972; Hawaii State 1953). Agricultural districts are sources of runoff waters into the rivers and the sea; these waters contain uric acid, nitrogen, nitrates, phosphates, ammonia, silt and other organic fertilisers in harmful concentrations, together with pesticides including rodenticides, insecticides, fungicides and weedicides (US Environmental Protection Agency 1971). Urban districts contribute carelessly disposed building materials, silt from earth and crushed coral stockpiles into coastal waters (SEA 1971; Smith et al. 1973). Power plants are sources of thermal pollution in receiving coastal waters (US Environmental Protection Agency 1971). Pearl Harbour contributes radioactive traces and oil wastes from ships and nuclear submarines (Mink 1971). Various pathogenic organisms are carried shoreward from sewage ocean outfalls by eddies and currents into the state's most heavily used recreational beaches (SEA 1971).

Hawaii's once famous marine flora and fauna are disappearing from many coastal regions as a result of stresses from urban development and this results in the permanent loss of livelihood to subsistence fishing villages. With tourist developments concentrating along the islands' best beaches and coastal areas, thousands of families have been forcibly evicted from traditional homelands by courts, police and government agencies acting on behalf of big landowners and developers. The first organised struggle against such evictions began in 1971 at Kalama Valley. In the past four years, some victories have been won in anti-eviction and urban rezoning struggles by the people's forces.

Over 70 per cent of the state's 1000-mile shoreline property is privately owned and being rapidly fenced off. Two of the eight major islands—Lanai and Niihau, with a combined population of 2500 persons—are privately owned. Half of Molokai, the fifth largest island with a population of 5600, is owned by one family, fenced off and patrolled against the entire population. A resort planned on the site by landowner Cook Ranch and developer Louisiana Land Development Co., if built, will increase the island's population of rich mainland newcomers by six times. The landowners have been publicly charged with planned ethnocide against the local non-white working-class population. A scarce fresh water supply to farms is planned to be diverted to resort use.

Government and industry economists publicly speculate that over 80 per cent of the tourist industry is owned overseas. Twenty-five per cent of Waikiki's largest hotels were recently purchased by K. Osano, a Japan financier, owner of Japan Airlines and corporate backer of Japan's recently deposed Prime Minister Tanaka.

A fairly reliable index of the state of health of an economy is the source and use of its energy; in this area pre-capitalist Hawaii was totally self-sufficient. Today, Hawaii is almost totally dependent on a precarious and limited supply of imported fossil fuels. In a noteworthy study, Detwyler (1973) has vividly documented the contrast:

Salient facts about the state of Hawaii's and Oahu's energy balances strongly suggest growing liability of the systems to severe upset... Hawaii has no fossil fuel resources, and, in fact, is about as geographically removed from them as is any urban ecosystem in the world. Before 1778, however, the ancient Hawaiians maintained an equilibrium system based upon solar energy.

With environmental degradation making the task increasingly difficult, Detwyler sees severe repression and social upheaval accompanying any reforms to create energy equilibrium in the worsening future.
In the related sphere of Hawaii's commodity (im)balance of payments, the value of commodity imports minus commodity exports rose fourfold to over one billion dollars per year from the early 1960s to the early 1970s, expressing the shift toward even greater service oriented dependency and away from production and self-sufficiency. With the emphasis on United States military adventures shifting from Asia to the near east and, in the light of inflation, the deepening depression — and with their effect on marginal income and savings upon which tourism depends — it would be difficult to overstate the fragility of the present economy. Yet both the corporations and their political stooges in government are building more tourist airports, yacht harbours and superhighways, rezoning valuable agricultural land to urban development and acting as though things were all right.

In the realm of land tenure, a neo-feudal system of oligarchic ownership is poorly masked by the trappings of a 'free market'. By 1967, 95.4 per cent of the total land in Hawaii was owned by seventy-four major landowners (individuals or corporations) comprising 0.009 per cent of the population (Horowitz and Finn 1967). This means the remaining 99.99 per cent of the population owns less than 5 per cent of the lands in Hawaii! The process of land consolidation in the hands of even fewer large landowners continues sharply. From 1950 to 1964, land transactions of the major landowners resulted in a net gain of 162,876 acres, an increase of 9.3 per cent in the process of concentration (Horowitz and Finn 1967). This near monopoly in land is part of the legacy of American colonialism in the 1800s and is firmly reinforced to this day by the market economy and political superstructure.

Concentrated and centralised land ownership and control (some lands are under lease from smaller to larger landowners) accelerates contractual and interlocking relations between large land rich and relatively capital poor local firms and collateral rich multinational conglomerates investing in Hawaii (such as Boise Cascade, Kaiser, Aetna, Consolidated Oil, world airlines, Japanese corporations and many others). When multi-national corporations invest locally, they do not usually put up their own front capital, but borrow from local banks (Stauffer 1975), in effect using the peoples' savings.

Deriving from a state constitution, Hawaii's local government consists of a seventy-six member, two-house legislature at the state level and four county governments. Studies of interlocking directorates and newly required statements of legislators' holdings reveal a web of corporate connections within law making and governmental administrative bodies. Front page stories in the local dailies cite polls showing suspicion widespread among a majority of the electorate of corruption, payoffs, crime in the suites, and corporate manipulation of high state and county officials.

In a recent widely publicised episode, three of Hawaii's leading construction firms were found to have stolen up to 13 ha of public submerged lands by illegally dumping industrial waste in former prime offshore fishing grounds at Honolulu. The illegal dumping had been going on for a quarter century with the knowledge and complicity of federal and state officials. No government action has been taken against any public official. State and federal agencies tried to whitewash the incident. The Oahu Grand Jury, a citizens' panel, after two lengthy investigations, handed down indictments of three top officers of Pacific Concrete & Rock Co., a mainland owned firm. They were charged with eight counts of criminal theft, criminal property damage, conspiracy, pollution and other crimes. Of the three officers, the president of the firm, R. Robinson, was promoted in 1975 to chairman of the board of the Hawaii Chamber of Commerce to polish up his image; the company's chief engineer, H. Cerny, is a member of the pollution control committee of the General Contractors Association;
and the vice president of operations, A. Suga, is a member of the State Board of Paroles and Pardons. The former head of the Public Defenders Office was hired for $10,000 to defend the corporation and its officers. A gubernatorially appointed judge subsequently dismissed the case on a technicality.

A newly created state environmental 'quality' commission is packed with representatives and officers of the tourism industry, the state's largest bank, developers, corporate attorneys and corporate planning agencies, together with a token member of a sheet metal workers union, all institutionally development and profit oriented.

Over widespread public protest, Hawaii's only natural and accessible lake (101 ha), a prime environmental asset and Hawaiian cultural heritage resource, was filled in last year by a millionaire developer with the permission of the governor appointed state land board, purportedly to build a golf course. The developer, C. Ching, served as 'bagman' for the governor's previous election campaigns, raising over a million dollars in 1970.

The recently ended twelve-year administration of Governor John Burns was surrounded by similarly exposed scandals of corruption of public officials and agencies. The chairman of the state land use commission, which has zoning and use jurisdiction over all lands in the state of Hawaii, was recently publicly exposed for illegally advising the nation's tenth largest home builder in the selection, from a stable of hand picked local attorneys, of preferred individuals to represent the builder in zoning applications before the commission. In secret corporate memoranda to the firm's Florida main office, made available by unknown informants to the press (Slater 1974), it was revealed that individual attorneys' fee quotations to handle the presentation before the commission ranged from $60,000 to $500,000. The commission chairman is an international representative of the once militant International Longshoremen's and Warehousemen's Union, whose leaders are now deeply enmeshed in the affairs and schemes of the tourist industry, developers, landowners, agricultural employers and government agencies. (The ILWU represents workers in sugar, pineapple and longshore industries and in about sixteen hotels and some miscellaneous shops.)

Following tumultuous public hearings fairly recently in a five-year boundary review of the state land use commission, the state administration and land use commission chairman introduced and the legislature passed legislation to limit all testimony at future land use hearings to landowners and parties of direct interest. This would screen out public participation on land use in Hawaii—one of the highest priority issues of public policy.

In the area of jobs and labour, conditions reflect a high rate of exploitation of labour and the instability and one sidedness of the economy as a whole. Owing to the short-range character of most construction projects, the inability of the economy to absorb youth entering the workforce, the importation of cheap labour from overseas and deficient training for higher skills, unemployment grows faster than the workforce, both relatively and absolutely. In the thirty-four years to 1974, the workforce doubled to 358,000. In the same period unemployment quadrupled to over 28,000. Actually, the picture is far worse than these government figures show. Thousands who work part-time or as unpaid domestic or piece workers or who have given up the search for jobs are not tallied as unemployed. Even the workforce itself is a narrow definition constituting less than half of the working age population.

Even so, state Labor Department figures reveal the lopsided shape of the economy. Monthly job reports (January 1975) show a total of 337,500 in the state workforce, of whom 205,600 are in trade, finance, transportation and services and 80,100 in government employment. Only 51,800 are in manufacturing and construction. Declining
agricultural employment now totals only 9700 of whom 7200 are in sugar and pineapple for export.

Wage levels reflect the areas of highest profitability and unionisation and the most overheated zones of the economy. December 1974 figures (rounded) show average weekly earning of $296 in contract construction at the top for an average work week of thirty-nine hours, and $87 in laundries for thirty-four hours in the lowest category. Hotel wages are second from the bottom at $95 a week for twenty-seven average weekly hours of work. A comparison of wages in agriculture and hotels shows the profit incentive underlying the flow of capital away from plantation agriculture and into tourism. In 1972, for example, average weekly wages in sugar and pineapple were $145 but $79 in hotels; both industries were unionised, although hotels not fully. U.S. Department of Labor studies show that a Honolulu working family of four needed $287 a week for a 'moderate' living standard in 1973.

When occupancy of hotel rooms falls, workers are laid off, thus bearing the brunt of hard times and seasonal fluctuations. Meanwhile, industry owners benefit from many public subsidies. Included are annual funds from the state to the Hawaii Visitors Bureau—these totalled $17.8 million for twelve years to 1973, mostly used for advertising (Donahue 1973)—and untalled hundreds of millions of indirect subsidies for the tourism infrastructure, including airports, highways, yacht harbours and other facilities and amenities designed to enhance operating profits and resale value of hotels. An example is $95 million in tax money budgeted for fourteen major yacht harbours each of which is at or planned to be built at an existing or planned private resort complex. Yacht harbours are destructive of local lifestyles, fishing grounds, reefs and other marine resources and of Hawaiian historical sites (House Resolution No. 468–1973).

A study of the 434 boat owners at Ala Wai Yacht Harbour (near Waikiki) showed that 90 per cent were male, 80 per cent white, 75 per cent had university degrees or equivalent, average annual income was $30,450 and average initial expense for recreational equipment was $29,900 (Raymond 1972). (The median income for Hawaii in 1970 was $12,035.) For this wholly unrepresentative and rich segment of the population, the state spent in 1973 $9 million for harbour improvements at Ala Wai Yacht Harbour or the equivalent of over $31,000 for each of 289 new boat-owners (0.03 per cent of the population).

While hidden and direct public tax subsidies have been provided to Hawaii's sugar and pine barons through the years, it is clear that today, all things considered, the rate of exploitation (the rate of paid versus unpaid (Marx 1906:241) and tax-reclaimed labour) of the workforce is higher in the tourist industry than in Hawaii's traditional large-scale agriculture.

Hawaii employers recruit cheap overseas labour for Hawaii tourism establishments. A strike of Fijian workers at the Mormon operated Polynesian Cultural Centre (a tourist trap) revealed that overseas workers were brought to Hawaii under false promises and deceptive contracts for the purposes of exploitation. A restaurant at the Dillingham owned Ala Moana Hotel recently imported an entire work force of 140 service employees from South Korea at sub-standard wages and working conditions while thousands of unemployed walk the streets of Honolulu (Knight 1975). Administrative staffs of hotels and tourism agencies are usually recruited and trained in mainland head offices and shipped to Hawaii.

Two events suggest the long-range planning that entered into tourism developments in the islands. At the turn of the century, Waikiki was a site of extensive aquaculture, with numerous shoreline and inland fishponds, duckponds, taro and rice fields.
Waikiki supplied a substantial part of the food for Honolulu's population. Fresh waters from mountain streams flowed through shady groves. So pleasant was the Waikiki environment then, that King Kalakaua, Queen Lilioukalani, Princess Kaiulani and other Hawaiian royalty had their beach homes in Waikiki.

In 1896, the Dole republic, which three years earlier had overthrown the Hawaiian government, mandated the board of ‘health’ to fill in ‘any tract of land … deleterious to the public health in consequence of being low, and at times covered or partly covered by water.’ This Act was carried over word for word as Section 1025 in the Revised Laws of the soon annexed Territory of Hawaii. On February 21, 1906, L.E. Pinkham, head of the Health Department (later appointed Governor), declared, with the approval of the board of health, ‘after months of study’ that ‘the Waikiki district is at the present time “deleterious to the public health”—“is low, covered and partly covered with water”—is not drained at all—“is incapable of effectual drainage” and is “in an unsanitary and dangerous condition”’ (Pinkham 1906:3).

Based on their spurious claim, the document, titled ‘Reclamation of the Waikiki District’, outlined the aims and the methods of ridding Waikiki of its food producing capability and residents and substituting a new elite alien population, ‘culture’ and city. Pinkham’s words (1906:7) show the colonial mentality:

Honolulu deserves a population of persons and residents of private fortune, who seek an agreeable climate and surroundings, and who expend large already acquired incomes rather than those who expect the community to furnish them the opportunity of earning a livelihood and even that of the accumulation of wealth. Such persons as we seek desire to find attractive and charming residential districts free from all objectionable features and neighbors.

In supplementary remarks, Pinkham wrote (p. 29), ‘Cities, whose citizens, officials and legislators wisely anticipate the future are able to accomplish great public works with little ultimate cost to the government and much profit to property owners’.

Following the plan, Dillingham Co., Hawaii’s biggest construction company, with the islands’ only dredging equipment, was paid in the 1920s from public tax funds to dredge a canal several miles in length along the inland portion of the Waikiki district. The canal destroyed the age old aquaculture of Waikiki. The dredging spoils were used to fill in the fishponds, and taro and rice fields, creating fast land for future construction. The dredging and filling, in the name of a sanitation project, provided the excuse for getting rid of ‘objectionable neighbours’, the fishermen, farmers, workers, their families and their lifestyles. By squeezing out small landholders with high tax assessments, land ownership was consolidated in the hands of a few large landholders. The canal dredging provided Dillingham with large profits from public funds. By 1966, Dillingham was Hawaii’s biggest multinational corporation with a commanding influence over the entire economy and political superstructure. Much of its growth was based on public funded projects, which, together with other developments, contributed to the present nearly total dependence on imported supplies.

Following the Waikiki project, large numbers of evicted Hawaiians were forced to live in cardboard shacks on the slopes of nearby mountains and in caves along the base of Diamond Head, where I played with the children in the 1930s. The Hawaiian people became outcasts in the homeland they had discovered and nurtured for centuries.

William Helton, Honolulu Advertiser writer (21 March 1971), describes Waikiki today:

Here lies Waikiki, 450 acres of concrete and humanity crunched between an Army fort, a park, a canal and the ocean … It mixes in all the ingredients of an urban eyesore in the middle of paradise: Easy money for thugs and prostitutes, a festering jungle for dope addicts and pushers, traffic madness, parking frustrations and gallons of noise. Donald A. Bremner, full-
time executive vice president of the Waikiki Improvement Association, talks about his troubles ... they all boil down to a previous lack of planning.

In this manner tourism engulfed Hawaii, greatly accelerating land alienation, absentee ownership and control.

In the 1930s, sugar and pineapple employed approximately 33,000 workers in Hawaii. The Mahele had placed at the disposal of the colonial forces most of Hawaii’s arable land in huge estates which became the basis for large-scale agricultural production. By the 1950s, competition had forced Hawaii’s sugar and pine producers to cut the labour force down by over two-thirds, using harvesting machines that replaced workers by the thousands. Parent banks and holding companies of the sugar and pineapple producers began comparing profit rates with urban development and overseas investment opportunities in cheap labour market areas.

By the mid 1950s, the Korean war had fattened international air carriers. New routes, airfields, and world-wide international air arrangements were established. These were further extended by the Vietnam war and other United States interventions in Southeast Asia. Investment capital and military funds flowed westward. With Hawaii as its hub, tourism in the Pacific took off.

Governor John Burns, his administration and corporate backers, launched the war born ‘Era of the Pacific’. They turned the state treasury into a horn of plenty for the promoters of tourism. Statehood in 1959 provided direct access to federal moneys and levers of power over military appropriations and a bonanza of publicity for Hawaii of benefit to big investors and power brokers.

By 1970, profits in tourism were estimated to exceed well over $100 million per year, based on per room profits, the highest of any United States geographical area (Harris et al. 1971:33). The aforementioned differential in profit rates and runaway shops (exodus of capital) means permanent loss of jobs for thousands of Hawaii’s pine workers, their families and dependent small town tradespeople and shopkeepers. Entire island economies face total collapse (Lanai, Molokai, and districts on Hawaii, Oahu and Kauai). An emergency state task force was formed to attempt to find alternative employment in diversified agriculture. What the future holds for diversified agriculture in Hawaii under the present system is foretold by its own history. Formerly supplying a substantial part of the food supply of the islands, it now exists on a very small scale and even this is only marginal because of heavyweight competition from food importers, large landowners, feed and fertiliser suppliers, etc. Even during World War II, when enemy interception threatened Hawaii’s food supply, large landowners interlocked with Matson Navigation Co. (the prime carrier), banks and the corporate power structure refused to provide land for home grown food supplies in order to protect profits and monopoly controls.

**Prognosis**

Future prospects for Hawaii point to increasing dominance of old local capital agencies and the economy as a whole, together with its dependent political power structures, by overseas-based multinational corporate units and the military.

Motivated by profits in land, construction and other commodity exchange, urbanisation, with ever higher population densities and congestion, will continue the invasion and desecration of older communities. Rapid destruction of the remaining ‘Hawaiian lifestyle’—quiet, rural, partially self-sustaining sharing of locally produced foods and services—will continue. Small local production and marketing distribution will continue to be replaced by the output from large-scale remote production centres distributed by national and international supermarket systems.
The resulting, clearly evident pyramidalisation and delocalisation of power and control, accompanied by the abandonment of the last vestiges of plantation paternalism, will further alienate broad segments of the working people of Hawaii from old allegiances to the system.

The course of the rising conflicts between these two forces—the people and the remote power centres of the system—will be influenced by economic and political events on the national and international scene.

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The features of the natural environment of coastal Fiji significantly affected by tourism are: land, foreshore, fresh water supplies and the capacity of the environment for waste disposal. Coastal tourism development is discussed here in terms of these demands. In the past, the absence of clear policy objectives and stringent physical development guidelines enabled developers to disregard Fiji's long-term environmental and social welfare. Today applications for development are subject to stricter conditions. The recent incorporation of the concept of compensation for lost marine resource rights into the foreshore lease application procedure sets an encouraging precedent. Further progress may be expected as the necessity for minimising reductions in biological productivity becomes accepted and co-ordinated land use planning in the public interest becomes government policy. Research into coral reef ecosystems is still needed, as is study of soil stabilisation and other requirements for restoring environments to balance following construction site works. Much also remains to be done in the areas of administration, legislation and manpower training in order to implement successfully sound tourism policies.

Natural resource allocation for tourism is ideally made in the context of a balanced appraisal of alternative potential uses by assessing costs and benefits in economic, social, political and environmental terms. In this chapter the focus is upon environmental considerations, though inevitably these have economic, social and political implications (see, for example, Samy 1973). For the sake of brevity and relative simplicity, these ramifications are not discussed. Features of the natural environment on which tourism in coastal Fiji makes significant demands are: land, foreshore, fresh water supplies and the capacity of the environment for waste disposal. Development of coastal tourism is discussed here in terms of these demands, their implications for alternative uses of the natural resources in question and the extent to which planning procedures and legislation in Fiji may or may not be evolving towards a rational system of coastal resources allocation for tourism.

The scale and density of development are obviously critical factors in assessing environmental demand. The environmental demands of an unsophisticated bure\(^1\) style tourist resort may be no greater than those of today's Fijian village, with its mix of traditional and imported products and technologies. However, at the other extreme, what might be termed the Waikiki style of high density development can seriously disrupt the environment and, in this way, destroy the bases of local communities (see Chapter 41). This extreme type of tourism development does not exist in Fiji and, according to present planning guidelines, is not intended.

\(^1\) Bure is a Fijian word for a traditional village house and is used to describe small cottage tourist units, often incorporating traditional building materials.
DEMANDS ON LAND

Land selected for tourism development may have potential for agriculture or forestry. It also may be advantageously located for urban development or for industry. In some cases it could reasonably be argued that communities in Fiji would derive greater net benefit if a site selected for tourism development were left in a nearly natural condition for community recreational and educational purposes. There is no integrated national inventory of Fiji's land resources that might be used as a basis for wise allocation of areas for tourism. Some of the elements of such an inventory do exist, however, in land use and agricultural maps (Twyford and Wright 1965) and in a subsequent survey of the forest potential of the main islands, Viti Levu and Vanua Levu.

A report on prospects for tourism also exists (UNDP/IBRD/Government of Fiji 1973a) but the tourism development regions it proposes have not been accepted. Ad hoc decisions continue to be made as to which land is pre-empted for tourism development, with limited knowledge of possible alternative uses, no guidance from a regional plan and in the context of an urge to encourage overseas investment in a country short of capital and having increasingly large numbers of unemployed. In such an unfavourable decision making climate have the demands on land for tourism development given rise to conflicts in potential use? The major areas of present development are along the Coral Coast of southern Viti Levu and along the western coast and offshore islands of the Mamanuca group (Figure 43.1). Land along the Coral Coast is characteristically hilly, with only small areas of agricultural potential. The
The Melanesian environment

Seaside sites favoured by tourist hotel developers generally do not include the better agricultural soils that might be desired for use by village communities. Further, Fijian villagers and Indians from towns and small farms in the area constitute the labour force for tourist resorts in the area, deriving economic benefits that reduce the need for agricultural land.

The large Pacific Harbour luxury tourist villa development near Navua is a different case. It is based on land with potential for large-scale agriculture, land that lies adjacent to an ambitious 2032 ha rice irrigation scheme now being developed. The Pacific Harbour land was not of good agricultural quality in its original state, however, and would have required an elaborate drainage scheme if it were to be developed for cultivation. Resorts in the Mamanucas occupy small vegetated sand cays or scenic corners of larger islands with resident native owners who, while some of their agricultural land has been allocated to tourism, are able to continue to live on and farm the remainder.

Approximately 83 per cent of the land in Fiji (about 1,520,000 ha) is Native Land, which cannot be bought or sold. Some of this land is available for leasing through the Native Land Trust Board, a statutory authority that administers all such lands on behalf of the Fijian owners. Of the remaining land, about 10 per cent (180,470 ha) is freehold while 7 per cent (129,200 ha) is Crown land, administered by the Ministry of Lands and Mineral Resources.

Up to the present the diversion to tourism development of some land administered by the Native Land Trust Board with agricultural potential appears not to have altered seriously the land base of local communities or threatened seriously the important social structures that derive from the land base. So far, the greater threat to Fijian communities comes not from leasing parts of their land in this way, but from involvement in the tourism industry. However, freehold land prices have been forced to such high levels by speculators that non-indigenous communities have been deprived of potential housing and small-scale agricultural land.

This is a different situation from that of Hawaii described in Chapter 41. The relatively small impact, to date, of tourism on agricultural land in Fiji derives from the facts that there has been much less development, that most of Fiji’s land is not available as freehold, that the coastal sites sought by tourism developers have not been prime agricultural land and that these sites are not, with the exception of Suva, in densely settled areas. However, the figures provided in Table 43.1 for tourist units not yet in existence but approved or under construction reveal that there will be a much greater diversion of land for tourism in the near future.

The conflict free situation is unlikely to last. At least one village community on Suva’s urban fringe has experienced pressures to relocate because it occupies a site of considerable tourist hotel potential. Speculators have paid relatively high prices for farm land backing Natadola Bay, one of Fiji’s most attractive beach areas. This area may be developed as a large-scale tourist resort. Some environmental implications of such development are discussed later. On Fiji’s ‘garden island’ of Taveuni (Region 3), much of which is freehold land under coconuts, plantations are being eagerly sold to tourist resort developers by owners facing an uncertain future in the copra industry. If this trend continues, large areas of good agricultural land will be diverted to tourism. At present the only tourist units on Taveuni (population 1645) are forty-one hotel rooms. Units approved or under consideration, however, are three hotels, 105 bures and 3324 villa lots (Table 42.1). The 777 ha of Wakaya Island (Region 2), freehold and formerly a copra plantation, have been subdivided into 753 exclusive high class residential lots, a significant diversion of agricultural land.
### Table 48.1

Existing, approved and proposed tourist accommodation in Fiji at 15 April 1975

<table>
<thead>
<tr>
<th>Region</th>
<th>Hotel Rooms</th>
<th>Bures + Cottages</th>
<th>Villas</th>
<th>Apartments</th>
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<td>existing</td>
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*Source: Directorate of Town and Country Planning, Suva.*
The public recreational value of some of the land and adjacent beaches already developed for tourism has been reduced owing to the past inadequacy of legislation and planning guidelines and to the disinclination of tourist resort developers to consider the public interest. Though all terrain below mean high water mark is publicly owned, the presence of a building close to the shore, particularly one occupied by a group of foreigners behaving in a manner alien to the traditions of Fiji's communities, intimidates those of the public who would otherwise wish to use that area for recreation, study, fishing or right of way.

Fiji has few good beaches and some of these have already been alienated in fact, if not in law, by tourist resort developers. Public access to beaches and foreshores is not stipulated in any legislation. The problem is, however, recognised by Fiji's Directorate of Town and Country Planning, and in areas that come under their jurisdiction, powers derived from the Town Planning Ordinance of 1966 enable them to set conditions. Legally, in all except the smallest of subdivisions, developers are now required to provide public reserves representing a minimum of 5 per cent of the land being subdivided. In the case of land adjoining the sea coast this is normally required on the coastal frontage, with good public access to it (Ministry of Urban Development, Housing and Social Welfare 1974).

Incorporation of the concept of the 'setback line' into planning legislation would ensure that coastal areas are accessible to the public. The landward distance of a setback line from mean high water mark would need to be varied in accordance with the type of coast, particularly in respect of its stability. Seaward of this line no alterations should be made, except those consistent with natural processes in the area or facilitating beach access. Such restriction would prevent the erection of buildings at the water's edge, a process that has consumed the choicest stretches of coastline in places like Hawaii and some Caribbean islands and has taken some attractive sites on Fiji's Coral Coast. An additional argument in favour of the setback line is that, in some areas, buildings constructed close to the shore are in danger from storm seas and tsunamis. Recent evidence for this is contained in a report on the destruction of village houses on this coast by storm seas generated by a distant hurricane (Fiji Times, 8 April 1975). Some damage was also done by this storm to Coral Coast tourist resort buildings. There is a distinct possibility of severe damage some day from tsunamis generated by submarine earthquakes in the vicinity of southern Fiji. The wisdom of setback lines is now, belatedly, appreciated in Hawaii, where the Department of Planning and Economic Development is using up to 91 m as a recommended limit to the encroachment of buildings on shorelines; the tourism development program for Fiji advocates 30 m. Recently, Fiji's Directorate of Town and Country Planning has begun to enforce a 20 m setback.

The undisturbed area between shoreline and setback line would not need to remain as natural wilderness. It could be managed to some extent, though less emphasis should be given to exotic plant species and more to Fiji's poorly appreciated native flora. Long stretches of coastline could be made accessible to walkers by the establishment of foot trails through the protected strip.

The first and in many cases the greatest environmental impact resulting from tourist development is associated with the construction phase. Sites are levelled by earth moving equipment and access roads cut. Large areas of vegetation cover and topsoil are removed and heavy tropical rains soon cause piled topsoil and substantial amounts of clay subsoil to be transported into drainage channels, thence to streams and the sea. Some of these soils are particularly difficult to stabilise on moderately steep embankments and cuts, providing a continuing problem in the current construction of a new...
Nadi-Suva highway. Nevertheless, much can be done to minimise the loss of soil from a site and its potentially disruptive appearance in aquatic ecosystems. This requires sensible planning of temporary drainage systems for each project, the use of sediment ponds for trapping transported material in drainage channels and the sealing of waterways.

Planning legislation does not deal directly with control of site works erosion, though the Town Planning Ordinance does give the Director of Town Planning scope for dealing with this and a number of related problems. Legislation exists from 1966 for the establishment of a Land Conservation Board. This would have the power to intercede in matters of site works erosion. Little has been done to date, however, because of lack of expertise and of personnel to plan, inspect and police erosion control measures. This is a serious weakness in planning for tourism development and detailed proposals for improvements have recently been made by Swartz (1975).

The Foreshore

In the first instance, foreshore areas are affected by development in terms of sediment transported from construction sites. This can seriously disrupt foreshore ecosystems. Recovery after the cessation of construction derived sedimentation may or may not occur. Along Fiji’s Coral Coast, foreshore areas consist of fringing coral reefs averaging 500–700 m wide. Coral communities of the reef flat are not spectacular. Those of the ocean slope are impressive, but not easily accessible to tourists. On the biological, rather than the scenic, value of this fringing reef, the effects of sediment could be more serious by virtue of a drastic lowering of primary productivity of the reef flat through marked reduction of solar energy. One consequence would be a reduction of the yield and quality of food species utilisable by village communities along that coast. Fortunately, strong longshore currents prevail along the Coral Coast and these aid in the dispersion of sediment. While this minimises the problem, it does not eradicate it. Immediately west of the Qaraniqio River which, over a recent five-year period, carried considerable amounts of sediment from site works for the vast Pacific Harbour scheme, many coral colonies on a small attractive fringing reef were killed. Differences in the vulnerability of different coral species to sediment has caused shifts in species composition and induced ecological instability. Although regeneration of some coral species has occurred within the last two years as suspended sediment loads have subsided, it will be many years before the coral community will resemble the original one.

Foreshore areas below mean high water mark are government owned and controlled and no rights to such areas accrue to developers or owners of adjacent land. If a tourist resort developer wishes to use a foreshore area for any purpose, whether it be the removal of boulders for construction purposes, the blasting of coral heads to clear boating or swimming areas or the infilling of an area below mean high water mark in order to extend the land surface, an application for a Foreshore Lease must be filed with the Director of Lands. Comment is sought from fisheries, marine, planning, tourism and public works sections of government. The public is also invited to comment, the application being advertised in the daily press. Increasingly in recent years, objections have been made by village communities concerned about the possible loss of marine food resources (see the Fiji Times throughout 1974).

It is now a well established fact that foreshore areas, particularly those carrying stands of mangrove species, are of high biological productivity. Whereas in Florida this has been quantified (Heald 1971), no such data exist for Fiji. Decisions have been made, therefore, either on unbalanced economic grounds or with political considerations paramount. Adequate cost-benefit comparisons have not been possible.
An important precedent was established in 1973 when a prospective resort developer agreed, though he was not legally bound to do so, to pay compensation to a village community for shellfish beds (compensation was based on a marine resource survey by Squires et al. 1973) which would be adversely affected by the construction of a marina proposed for a tourist resort. Subsequently the Foreshore Lease application procedure administered by the Department of Lands was modified in such a way as to require, as a first step, the payment of a compensation sum based upon an assessment of the value of marine resources to be lost as a result of coastal alterations. Only after this compensation is paid is the application considered further. If it is subsequently rejected, compensation money is refunded. This is a procedural development of great significance for other areas of Melanesia.

The sand and rubble coastline characteristic of all tourist resort sites in Fiji are constantly being altered by natural physical processes. Seasonal alterations may be apparent in terms of shifts in areas of deposition and erosion on a beach. These are easily recognised. What is usually not appreciated by resort developers or allowed for by government planners is the vulnerability of these coasts to catastrophic events of low and unpredictable frequency—tsunamis derived from submarine earthquakes, and storms.

The responses of a coastline to natural physical processes may be dramatically altered by the construction of artificial offshore structures or the dredging or blasting of channels and boat basins. Prior studies of coastal hydrography backed, where appropriate, by experiments with models should be required as part of an environmental impact statement to accompany each application. Only very recently has this been required, and only to a limited extent. There is no supporting legislation and no organised procedure for handling impact statements. There are, however, positive moves to rectify this situation.

Construction of a groyne, an artificial island or a passage through a reef may drastically alter coastal water flow patterns, which is likely to cause a shift in the distribution of reef organisms. By altering flow velocities this will cause a change in sedimentation patterns, which is likely also to be of biological significance. Existing knowledge of coral reef ecosystems is limited; they are complex and undergo fluctuations in composition and structure seasonally and over periods of several years as a result of variations in the natural environment. Thus it is difficult for environmental scientists to determine a reference base against which changes expected as a result of coastal alteration can be measured. However, in stressing the biological complexity and the interpretive difficulties involved I do not wish to create the impression that preliminary studies and the deduction, from these, of possible ecosystem changes are meaningless. Every effort must be made to seek some answers in advance. The accuracy of the answers will improve as experience accumulates.

Fiji has a number of small-scale offshore artificial structures, which, though they may be aesthetically objectionable, have had an insignificant influence on coastal processes. There are, however, other structures, the effect of which has been marked. A Foreshore Lease was granted in 1977 for the creation of an artificial island on a reef flat offshore from a resort hotel on the Coral Coast. At that time no study of the expected role of this island in modifying coastal processes was called for. Before construction of the new island, sediment from a stream entering the coast at this point was dispersed by a westward flowing longshore current reinforced by ocean swells from the southeast refracted through a reef passage. The artificial island subsequently built was so located as to absorb a substantial amount of the energy of swells passing through the reef passage and to weaken longshore currents at the foot of the beach. As a result,
water currents landward of this island were much reduced and the sediment brought
to the estuary by the stream was no longer transported away. Between the artificial
island and the resort hotel a thick layer of very fine sediment has built up on the
original sand base. The physiochemical environment so created is ideal for the
development of a mangrove community, an effect probably not part of the resort
development plan!

**Fresh Water: A Scarce Resource**

One of the dangers of making commitments to tourism development without a com­
prehensive understanding of available natural resources is the difficulty of seeing
beyond a specific project to the wider environmental and developmental implications.
Fiji is a country of high rainfall. Nadi, a centre whose climate is representative of
western areas of Viti Levu, receives an annual average rainfall of 1852 mm. Much of
the Coral Coast receives rainfalls similar to that of Suva (2954 mm). Yet in terms of
water resources available for development these high figures can be misleading;
ground water supplies are not extensive, prospects for reservoir storage of runoff are
limited and reservoir construction and water reticulation are expensive.

A water shortage already exists in Region 5 and it is difficult to imagine how the ex­
isting number of hotel rooms in that region (1425) can be increased to the 7225
already approved by the Government. As well, there is a planned addition of 1400
tourist villas and 700 apartments. Existing communities can be expected to grow, not
only in terms of population but also in terms of per capita water usage. Increased ur­
banisation and the expected associated development of industries will make even
greater demands on water resources. If approved, the proposed Natadola Beach
tourist resort development (UNDP/IBRD/Government of Fiji 1973b) of 3000 bedroom
units (a capacity of up to 6000 tourists), to be associated with a supportive new town of
20,000 people, is likely to prejudice alternative forms of development of the southwest
corner of Fiji's main island. Its golf course alone is calculated to require over 22
 tonnes of water per hectare per day and total water requirement for the completed
scheme, which includes small commercial and light industrial areas, is projected to be
over 21 million litres per day. At present the main use of the Natadola area is for
sugarcane and vegetable production. Both are important crops for Fiji. An ambitious
plantation soft wood forestry scheme is being developed in the hinterland and impor­
tant developments in the beef cattle industry are also possible. The coastal area could
be further developed for agricultural settlement and port and processing facilities rele­
vant to the forest and cattle industries, while the beautiful Natadola Bay beach area
could be zoned for the primary use of the people of Fiji.

**Environmental Tolerance of Wastes**

The disposal of fluid wastes from a tourist resort depends usually on atmospheric and
aquatic mixing processes. Thus, smoke or invisible gases like sulphur dioxide or
carbon monoxide from diesel generating units are dispersed by the mixing action of
wind. For the small amounts of gases produced by resorts in Fiji this is quite adequate.
Liquid wastes, however, may be problematical. These are made up primarily of sewage
effluent, which, while it may be treated to remove any hazard to health, continues to
be an ecological hazard until such time as it is effectively mixed with and dispersed by
sea water.

The capacity of natural waters to dilute and disperse liquid sewage effluent is great,
but it is not unlimited. Fiji's Coral Coast waters, offshore at most resorts, are actively
mixed. However some bays, particularly if they are shallow, have very limited circula-
tion. Here, sewage effluent, if not effectively dispersed, causes nutrient enrichment and this results in explosive growth of bacterial and algal populations whose subsequent decay utilises dissolved oxygen, thus promoting unfavourable, sometimes fatal, conditions for aquatic fauna.

There is a classic example of this effect on a coral reef fringed bay in Hawaii (Banner and Bailey 1971). The combined effects of sewage nutrients and sediment have caused the death of corals and many associated species and the dramatic proliferation of an alga, Dictyosphaera cavernosa, which, as on Fiji’s reefs now, once occurred in Hawaii’s Kaneohe Bay only as small, isolated and inconspicuous growths. The waters of Kaneohe Bay are not well mixed. Even if present plans to treat and reduce the amount of sewage drained into this bay are successful, sediment on the reefs may not be dispersed. Since coral planulae need a solid substrate for attachment, regrowth of corals may not be possible.

The health of tourists and the public in Fiji is zealously guarded by strong policing of the relevant legislation by the Ministry of Health. Until the Ministry has approved sewage treatment proposals of a resort developer’s plans the development cannot proceed. This legislation does not, however, protect the environment from unmanageable levels of nutrients and sediment. The ecological hazard is beyond existing government controls except insofar as, in drier parts of Fiji, the Ministry of Health encourages resort developers to utilise liquid sewage effluent, after appropriate treatment, for garden and golf course irrigation.

The amounts of solid waste generated by tourism can be considerable. Much of the food consumed by tourists is, even in fertile Fiji, imported and, because of containers, its solid waste has a low biodegradable component. At 1.1 kg per head per day it is greater in weight than the 0.8 kg presently produced by urban populations in Fiji (UNDP/IBRD/Government of Fiji 1973b). Amounts of solid waste from the bigger resorts pose serious disposal problems. An annual figure of 22,400 tonnes of this material is projected for the proposed Natadola project. For this scheme it is proposed that waste be dumped into mangrove ecosystems in the area. This cynical approach to the use of mangroves reveals a continuing denial of the existence and significance of these valuable marine resources.

The Lesson for Melanesia

Ad hoc decisions on tourism development projects in the absence of a comprehensive regional plan and the inadequacy of legislation relating to tourism’s environmental demands mean that Fiji is far from controlling tourism. For years past, in the absence of clear policy objectives and stringent physical development guidelines, Fiji was regarded by overseas tourism developers as, environmentally, a ‘soft option’, a country in which developers could exploit the environment to suit their own needs. They now find that this is no longer the case. A reasonably enlightened application of legislation means that the potential environmental impacts of development proposals are now more carefully evaluated. The recent incorporation of compensation for lost marine resource rights into the Foreshore Lease application procedure is an important example of this and is of particular significance for other countries of Melanesia.

Good guidelines are not, in themselves, enough. Effective implementation and policing is necessary and the expertise necessary for this is not readily available. More comprehensive legislation is needed and it is encouraging to note that new bills on water resources management and environmental protection are now being drafted. In spite of these encouraging developments, however, it is disturbing to note the extent of the commitment to future tourism development, as indicated in Table 43.1. These
Tourism and the environment

figures are not final; some of the proposed developments will not find financial backing and some will not be approved. However, a proportion of them is likely to become reality and this has enormous environmental and sociological implications. Piecemeal decisions on tourism development applications mean that nobody has any concept of their collective impact.

Clearly, the rest of Melanesia can learn much from the Fijian experience. It is to be hoped that other countries will, in advance, establish clear policy objectives, that they will plan their tourism developments, that they will zone tourism areas in the light of natural resource, environmental, sociological and economic factors, that they will establish comprehensive legislation and sound planning guidelines and that government agencies will be adequately staffed for effective implementation and policing of this legislation and these guidelines. No major commitment to tourism should be made until this is achieved.

References
VIII Health and the environment
A variety of definitions of health are possible, depending on who is doing the defining, where and for what purpose. Looking at health in the changing environment of Melanesia today it is important to distinguish which traditional habits and settlement patterns may have health promoting aspects and to discover why the beneficial effects occur. An interesting relationship may for instance be present between hookworm infection transmitted by faecal deposits, and betel nut chewing, the latter acting as antidote to the former. Discontinuation of traditional breast feeding of infants has disastrous results. Changing settlement patterns allowing greater access to aid posts may facilitate prevention of such diseases as gastro-enteritis and pneumonia, while opening new paths for other communicable diseases. Although life expectancy is higher in towns than in rural areas of Papua New Guinea the very rapid rate of growth of population in the towns introduces such new problems as coronary artery disease. Inadequate, overcrowded housing, with little or no sanitation, occurs in squatter settlements on the urban fringes where the incidence of tuberculosis is high, and where ‘new’ communicable diseases such as dengue may proliferate. It would seem that while some very simple training and supplies could go far in preventing disease, careful attention must still be given to the overall problem of health and to the kind of physical and cultural environment in which health is likely to flourish.

**What is Health?**

A traditional Melanesian villager may think of health as living in harmony with his community and with the spirits of his ancestors. Do we have a better understanding of health? Intuitively we think of health in terms of wholeness, bodily soundness or good function and we may have some concept that other dimensions of mental, moral or spiritual soundness are involved. However, from the scientific point of view, health is very difficult to define and even more difficult to measure. The World Health Organisation has said, ‘Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’. This is excellent propaganda but it is such a Utopian definition that few of us reach such a state except perhaps for a few days on our honeymoons. It is more realistic to think of health in dynamic or adaptational terms. We may think of a person’s health in relation to his ability to perform his tasks and function as a member of his family and community. Audy (1971) defines health as ‘A continuing property, potentially measurable by the individual’s ability to rally from insults whether chemical, physical, infectious, psychological or social’. We can appreciate that health is constantly present from birth to death, but at changing levels. Any stimulus or insult can lead, either temporarily or permanently, to a lower level of health; after recovery health may actually be enhanced, as when a person recovers from a mild attack of poliomyelitis and is immune to further attacks.
Any expatriate in Papua New Guinea who, whilst climbing a hill, has been overtaken by a Highland woman carrying a huge bilum filled with kaukau will acknowledge that there is more than one viewpoint on health. He may be better nourished and have fewer intestinal parasites and skin diseases, but there is no doubt who is the more healthy if health is measured by the ability to climb a hill. Similarly a Melanesian village may be unhealthy in the sense that many children die in infancy and there is much preventable disease, yet in a biological sense the village may be healthy in that the adults are quite capable of performing all necessary tasks and the population is increasing because there are more births than deaths.

HABITS AND HEALTH

Perhaps the greatest environmental influences on the child come from the habits, both good and bad, of the family and community into which he is born. The importance of prolonged breast feeding for the nutrition and safety of the young child and the disastrous consequences of attempts at artificial feeding by unsophisticated people are well known.

Hygiene has been well defined as the separation of man from his excreta. Many Melanesian villagers still defaecate indiscriminately in the bush and the chief agent of faecal disposal is often the pig. In the villages one can see a pig following someone into the bush in the early morning hoping for a meal. Hookworm infection is spread from eggs passed in the faeces. From these eggs minute larvae develop in the soil; they can then penetrate the bare skin of any person who walks barefoot over the soil. Hookworms are known to suck blood from the intestinal wall, yet surveys in Papua New Guinea (Bearup and Lawrence 1947; Vines 1970), which showed that hookworm infection is very common, did not demonstrate any definite relationship between hookworm infection and anaemia. Heavy hookworm infection over a long period of time is needed to produce hookworm anaemia unless the diet is also iron deficient (Gilles et al. 1964). We still do not know how important hookworm infection is as a cause of anaemia in Papua New Guinea, but we do know that it is a significant cause among Highland labourers working on rubber estates near Port Moresby (Douglas and Taminika 1973; R. Knight pers. comm., 1974). Each labourer taps his own group of rubber trees for latex and he may therefore defaecate and work in the same area day after day. If he begins with a light hookworm infection the conditions under the rubber trees favour the development of hookworm larvae and he soon becomes heavily reinfected until he may have a sufficient hookworm load to cause anaemia from blood loss. Perhaps the absence of pigs in the rubber plantation adds to the hazards of promiscuous defaecation.

Betel nut chewing is another very common habit especially in the coastal areas of Papua New Guinea. In many respects this habit may be less harmful than the western equivalents of cigarette smoking and the drinking of alcohol. It has, however, often been associated with the high rates of mouth cancer in Papua New Guinea (Atkinson et al. 1964). Oral cancer was for some years the most commonly reported cancer there, although it has recently been overtaken by cancer of the liver (G.H. Aiken pers. comm., 1975). Oral cancer is commonest in the lowland areas, where betel chewing is most prevalent. In Asian countries there is also an association between betel chewing and oral cancer, but many investigators think that it is the tobacco contained in the betel quid that is the greatest danger (Muir and Kirk 1960; Omar-Ahmad and Ramanathan 1968). Tobacco is rarely if ever included in the betel quid in Papua New

* Kaukau are sweet potatoes.
Guinea, but we do not know what parts of the betel quid, the nut *Areca catechu*, the lime, or the betel pepper *Piper betel*, are important in causing cancer. Betel nut has some action against intestinal worms. The Chinese have used extracts of the nut against tapeworms for many centuries and the alkaloid Arecoline contained in betel nut is widely used to treat *Echinococcus* infections in dogs. Does the chewing of betel nut give some protection against heavy intestinal parasitic infections in Papua New Guinea? We do not know, but perhaps these examples will serve to illustrate the need to look for possible health promoting aspects of habits as well as their ill effects.

**Isolation and Health**

The relative isolation of many communities in Melanesia is important for health in two main ways. Firstly isolation helps to prevent the spread of communicable diseases. Papua New Guinea has been fortunate in the absence of epidemic diseases such as smallpox, cholera and plague for many years. But isolation is a fragile barrier, as the repeated outbreaks of El Tor cholera in Irian Jaya over the last ten years should remind us. The second major effect of isolation is the difficulty of maintaining even simple medical services for scattered populations in remote areas. In the Western District for example, over 11 per cent of the population live more than four hours' travelling time from the nearest aid post (Department of Public Health 1974). The infant mortality rate in rural areas is thought to be almost double that in the towns. As so much of the fatal illness in this country is due to readily treatable communicable diseases such as pneumonia and gastro-enteritis, even humble medical skills and equipment can save many lives. It is clear that the expansion of government medical services cannot meet all the needs of isolated groups and that the development of roads and simple training for some members of the communities to treat their fellows will be equally important.

**Urbanisation and Health**

Although life expectancy is higher in towns than in rural areas of Papua New Guinea, the very rapid rate of growth of population in the towns, around 17 per cent per annum, introduces new health problems. Some of the problems are the familiar ones of 'developed countries' such as road accidents and the appearance of coronary artery disease among town dwellers (Aiken et al. 1974). Other problems are due to the development of a septic fringe around the towns, where new migrants are forced to live in inadequate, overcrowded houses with little or no sanitation. Mylius and Wigley (1971) showed that the prevalence of tuberculosis was two to three times higher among people living in the squatter settlements of Port Moresby than among those living in the old established settlements. There is also a real risk of the introduction of 'new' communicable diseases in the towns. Dengue, a virus infection spread by *Aedes* mosquitoes, has been known in Papua New Guinea for many years and there has been at least one major urban outbreak in Rabaul (Zigas and Doherty 1973). Classical dengue is unpleasant, but the patient survives; over the last twenty years, however, there have been epidemics of a different and more dangerous syndrome, haemorrhagic fever associated with dengue, in most of the major cities of Asia. Dengue haemorrhagic fever is spreading and there has recently been an epidemic in Fiji. There can be little doubt that the towns of Papua New Guinea are also at risk, at least as long as *Aedes* mosquitoes are allowed to breed in their environs.

In conclusion, Papua New Guinea’s chief health need is the control of common communicable diseases both in isolated rural areas and in the mushrooming towns. It must also tackle the background of poor nutrition and sanitation that breeds these dis-
eases. Many diseases, both new and old, depend upon personal habits and we must monitor both the good and bad results of these habits and educate people to be aware of their effects.

REFERENCES


45 The Evolution of Traditional Medicine in New Caledonia

D. BOURRET

Traditional medicine in New Caledonia consisted of several distinct kinds of remedies, each directed at a certain class of illness or physiological-psychological state. A complex system of beliefs determined when a person needed treatment and whether commonly known remedies or secret practices were to be used. A variety of plants, and in earlier times some animal species, were important; but at all times the power of the healer was necessary, either to release the special qualities of the plants involved, or to administer them with the proper rituals. Some kinds of traditional medicine, including sorcery and white and black magic, are particularly difficult to investigate currently because of the fears and superstitions surrounding them. Modern civilisation has inevitably affected all traditional practices, often weakening confidence in the old ways, but at times producing a movement towards increased use of black magic and rendering a frightened people susceptible to the influence of powerful individuals working for their own ends. It is to be hoped that, before the positive aspects of traditional medicine disappear, the value of traditional healers and their remedies will be recognised and used alongside European medicine.

‘For the natives of our islands guard jealously the secret of their beliefs and superstitious ceremonies. Unless one makes a special study of the subject one can live amongst them for fifty years without finding the key.’ (Lambert 1900).

Traditional Melanesian medicine in New Caledonia, like most ‘primitive’ medicines, uses simples. In earlier times some animal species, principally marine, also played their part in the native pharmacopoeia (Lambert 1900); prescriptions of this sort are still found in the New Hebrides, where they may be of Polynesian introduction, but they seem to have disappeared from New Caledonia. These treatments were intended to be used for illnesses which are conventionally called ‘totemic’ and it is necessary to distinguish between illnesses of a natural kind and those of a socio-magical order.

For the Melanesians few illnesses are natural and death, except occasionally that of young children and of very old people, never is; fatal accidents, such as motor and airplane accidents, are usually considered to be the consequence of ill will. Chills, digestive complaints, certain urino-genital troubles (Métais 1967), tiredness and some other ordinary complaints belong to the field of family medicine called in New Caledonia ‘la petite médecine’. The remedies for these illnesses are known to everyone, they are not in the least mysterious and in general it is unnecessary to ask a ‘specialist’ for help. However certain people, particularly women, attract by their

I thank Madame Danon, the interpretive philosopher of Maurice Leenhardt who was visiting Noumea, for helping me to state precisely certain aspects of my thought, and also my friend Helen Reeve-Brinon, formerly ethnobotanist at the Australian National University, Canberra, whose English translation is certainly the best that I could have hoped for.
knowledge and availability a clientele in proportion to their reputation, which is based as much on the efficacy of their remedies as on the massages that they also give. The plants they employ, to which we will return, are not always inoffensive and their administration by those less knowledgable would not be without danger (cf. SPC 1973).

Certain states that appear physiologically normal to us, such as puberty, pregnancy or the fragility of the newly born, are also called illnesses. These episodes in human life represent for New Caledonians periods of uncertainty, as if an individual is suspended, passing from one stage of his evolution to another. He is then an easy prey for evil powers, which are able either to kill him or to take possession of his mind, and it is only proper to protect him: there is a group of remedies particularly intended to ease these transitions.

The specialists whom we find at this level in the village are known to all the adults, that is to say to all those who have already passed through the different stages of their evolution. Each event at each stage uses a different therapist. Thus, for example, the midwife’s role stops immediately a baby is delivered. The care to be given after birth, on the one hand to the mother and on the other to the newly born infant, is the business of several other women, whose field of action is also strictly delimited.¹

Each of these specialists, whether man or woman, possesses secret remedies, which in principle can be passed on only to members of his or her family; under certain conditions they can be acquired by exchange of custom. The administration of these medicaments is apparently not accompanied by ritual, any more than is the gathering (although the place, time and procedure of collecting may be subject to certain obligations).

Before starting on more esoteric levels of New Caledonian medicine, it is appropriate to pause and look at the plants used in the first two categories and, as a preliminary, define the semantic content of the word ‘medicament’, a term maladroitly translating the indigenous concept.

In the northern part of New Caledonia at least (Leenhartd 1930), a medicinal plant is the vehicle of a ‘power’ known as mana, but the plant itself does not possess or even transmit the power. The ‘medicament’ must therefore be understood as an intermediary; the therapists who possess the power are able to transmit it to the plants of whose latent virtues they are the trustees. In general it has been transmitted to them by an ancestor, direct or collateral. The intuitive dream that designates a plant suitable for a particular treatment also often comes from this privileged ancestor.

Thus one informant uses *Piper austro-caledonicum* (Piperaceae) against coughs. He has received from his father the ability to administer it, compounded with the bark of *Ficus proluba* (Moraceae) and the stem of *Oxera robusta* (Verbenaceae) as a ‘fortifying purge’ for boys who lose their virginity, but its use must then be surrounded with some few precautions. The mother of another informant (who observes the traditional rule of being no further identified than by her social position—‘mother of’—and speaks to strangers of traditional matters only when the chief authorises it) is the midwife ‘qui prend l’enfant’ (‘who takes the child’); her cures have been transmitted to her by her mother. In common with other pharmacopoeias, many of her prescriptions are founded on a superficial likeness; thus the cotter-like buds of *Hydrocotyle asiatica* (Umbelliferae) symbolise the ‘closed’ intestine of the newly born, and are used in massages to evacuate the meconium, that is to say to ‘open’ the digestive tract.

¹ The specialists associated with childbirth and post-natal care are disappearing. The lure of maternity and family allowances pulls almost all the expectant and young mothers to the dispensaries and the mother and child care centres.
In the same way a third informant uses the roughly peeling bark of *Xylocarpus granatum* (Meliaceae) as a depurative (blood cleanser); this recipe came to her from her aunt who also passed on to her the ‘strength’ that renders her massages efficacious. In pointing out to the author the benign use which she makes of *Sporobolus indicus* (Gramineae) has ‘given’ this grass to her: the author in turn will be able to use it and the plant ‘will work well’ if she concentrates all her attention and ‘good heart’ on the act. This same informant, tormented by the depression obsessing her husband, dreamed about the leaves that have cured him. The first informant has confided to the author, under the seal of secrecy, the use, which he alone knows, of *Semecarpus vitiensis* (Anacardiaceae); this was likewise revealed to him in a dream.

Examples are plentiful. If one considers them on a sufficiently grand scale it can be seen that the vegetable species chosen are not always common: botanically speaking they may be pantropical and ruderal, for example *Hydrocotyle asiatica*, or much more strictly localised and endemic to a variety of degrees, for example *Piper austrocaledonicum*. Chemically the analyses and tests made give variable results, not always uninteresting even if the alkaloids one first looks for are fugitive, as in *Piper austrocaledonicum*, or absent as in the genus *Xylocarpus* which contains some tri-terpenic compounds (Bouquet and Debray 1974) and in members of the Anacardiaceae which contains some phenolic compounds (Paris and Moyse 1967), or if the common usage of the plant does not in fact depend upon its chemical properties, as in *Hydrocotyle asiatica* and *Sporobolus indicus*.

Informants cited are traditional people, who are at least 50–60 years old, but the transmission of knowledge to the younger generation is still made even using modern methods such as writing.

The levels of therapy that are discussed next are not actually any more difficult to define than the preceding ones. They are, however, much more difficult to penetrate, partly because they touch still secret fields that may be perilous to reveal from numerous points of view, and partly because they refer to a system of understanding of the universe that is totally different from ours, one that involves ‘la pensée magique’ defined by Lévi-Strauss (1962).

The significance of totemic maladies was well disentangled at the beginning of the century by the Pasteur Leenhardt (1930). In an overall sense, simplifying while enlarging his interpretation, one can say that these maladies overtake those who, consciously or not, infringe a social law. They are expressed in morbid long lasting or recurrent states, often poorly defined, in which the issue is not necessarily fatal. In the Hienghène region in the northeast of New Caledonia, for example, one of the totems most often cited is that of the Lizard. In fact there are at least two Lizard totems in which the representation and the responsibilities are different. To the Lizard most frequently implicated are owed itching skin diseases located on the forearms, forelegs, and at the waist.

Traditionally, the diagnosis must be made by a devin (soothsayer). In this particular case the relation of cause to the effect seems well established in indigenous thought. The processes of divination are varied: palpation, which determines if an illness is ‘hot’ or ‘cold’, the examination of oracles (leaves, woods, fruits, ants, anything that may be a sign) or a revelatory dream. The offended totem discovered, the patient is addressed to its possessor who is the only one able to cure the imposed ailment.³

² In fact Melanesian thought does not separate the mind from the emotions.
³ Totemic ancestral connections are in principle secret and the line can be traced only by grace of the intervention of the devin.
Today, with the rendering commonplace of certain totems such as the Lizard quoted above, one would expect to find that these processes of divination are disappearing, their symptoms and their familiars being sufficiently well known. If the remedies employed, such as *Acronychia laevis* (Rutaceae) alone or compounded with *Agathis moorei* (Gymnosperm, Kaori) and *Davallia lorrainea* (Fern, Davalliaceae), or *Glochidion? caledonicum*, (Euphorbiaceae), have not fallen partly into the public domain, it is because to be efficacious they must be obtained from those who know how to say the right 'word'.

A whole category of ill defined complaints, as much physical, for example headaches, as psychical, for example 'la poisse' (bad luck) are thus the doing of non-respected totems. The healer, after getting himself into a receptive state and wrapping himself and his patient with him in precautions that can be said to be psychologically antiseptic, often progresses warily, alternating several different five-day treatments with purifying and neutralising baths (Leenhardt 1930) based on *Erythrina variegata* (Leguminosae) before an amelioration is felt. If the illness resists all medication the practice of sorcery, 'emboucannement' (drugging), is probably involved.

It is then necessary to find a counter-measure for the sympathetic magic, which is traditionally of three sorts: one 'tapped', another 'burnt' and the last 'sent'. In the first case evil leaves or woods are tapped on a stone to the rhythm of malevolent words. In the second case smoke of chosen plants is the vector of the imprecation. In the third and last case the simple handling of plants accompanied by 'utterances' will be sufficient to destroy the bewitched. The three processes do not exclude some material support, a 'magic packet' concealed along the victim's path, or, more simply, slow acting poison slid into his food.

At the beginning of the century Pasteur Leenhardt noted the ever increasing extension, from an origin apparently in the Solomon Islands, via the New Hebrides and Lifou (Loyalty Islands), of the baneful influence of the Doki or 'red devil'. In contrast to the action of traditional *boucans* (drugs) which is long and oppressive, that of the Doki, presently feared throughout New Caledonia, is brutal and fatal in a brief period of time.

Nearly all the criminal magic of old times often works at the psychological level by morbid auto-suggestion, and is therefore able to be circumvented. Antidotes exist; there are even, for those who have some reason to be on their guard 'protections', usually in the form of leaves (for example *Glochidion* sp.—Euphorbiaceae) 'activated' by a 'good' healer. The essence of his art consists above all in his ability to give back self-confidence and taste for life by means of exorcism. Against the sudden attacks of the Doki, New Caledonians are defenceless and scared. From this has recently sprung a real black magic, which serves the basest interests and which owes nothing to tradition.

Besides the sympathetic magic concerning individuals, crises of collective possession were witnessed up to the 1940s; it is not known whether the motivation was ritual or simply orgiastic, or by what means they were provoked (there is a possibility that the genus *Datura* (Solanaceae) was involved). The severe repression that followed the last bacchanalies has left a feeling of fear amongst the tribes concerned, which renders all inquiry difficult. This level of indigenous medicine is without doubt the most difficult to investigate. Two of the causes are quite evident, being two pressures of civilisation, justice and religion.

In all countries with missions 'sorcerers' were rapidly tracked down. It is only fifty years since real *auto da fes* were organised in religious boarding schools with the aim of eliminating all plants, other than comestible, that the young pupils had received from their families in the bush. The eradication has certainly been incomplete: some native
priests have a zealous dogmatic faith in Satan and his works, while the secular popu­lation, poorly catechised, live in a constant state of superstition. (This is perhaps less evi­dent in a Protestant environment).

At the judicial level the supposedly criminal activities of the healers and druggists have been the object of denunciation and pursuit. Since many denunciations sur­passed the hopes of the denouncers themselves in their far reaching conse­quences—principally concerning land tenure—the indigenes have now taken the wise decision to regulate this sort of litigation amongst themselves.

A third cause of distrust is less obvious; it resides in the traditional belief that a magic revealed or discovered will turn against its owner, who then has no possible recourse against it and is irremediably damned. This explains the reluctance of informants to speak of such dangerous things; if druggings are mentioned, one never knows from whom they emanate nor, a fortiori, which plants are used. Remedies are more easily identified because it is important for an informant to show that he is not one of these evil-minded people who poison their neighbours. The medicaments are named according to the kinds of illness they are supposed to cure. Thus the ‘remedy of the ill that torments man’ is composed of the grated bark of Homalanthus nutans (Euphorb­iaceae) rolled in a cornet made from a leaf of Meryta ? pallens (Araliaceae), a tree with a mythological connotation; the patient drinks the cold lixiviation. A mixture of the grated bark of Dizygotheca sp. (Araliaceae) and Oxera robusta (Verbenaceae) presented in the same way can also be used. The ingredients are picked at arm’s length and by the left hand, and the plant is respectfully solicited to do its work. In earlier times a customary offering was made to the ancestral spirit materialised in the plant.

This concoction of grated barks lixiviated in a cornet of leaves is characteristic of the treatment of ‘bad’ spells. Another way of treating the medicament is to wrap it in little packets of leaves or buds, rolled and attached by vegetable ties specific to each packet; this is a common way of conserving or transporting medicines. The medicine is ex­tracted by filtering or by shredding and macerating in water at one end. In these two cases prohibitions are frequent, for example fire is prohibited and food must be taken without fat or salt.

Prohibitions are still more severe at the level of white magic, the last kind we will look at. Its ‘medicines’ are transmitted along the paternal line. White magic serves to release thunder, rain or drought. It is also a magic of propitiation for cultivation, fishing, war, etc. The owners of the medicaments have, by the fact of their ownership, a certain social position, and they undergo a period of initiation into the magic, which lasts five years. The adolescent who undergoes it is chosen (from the direct or indirect family line) for his particular qualities. Adopted children appear to be excluded. During the long initiation period the young boy will be more or less isolated and in­structed in, among other things, plant nomenclature, genealogy and the mythical tradition. At the end of his initiation, which certainly involves other secret aspects, his father will give him a leaf to masticate and swallow; its properties will seal his memory. From this moment he will be capable, when it becomes necessary (for example at the death of his father), of using the magic of which he has become the owner.

These magic acts are effected in solitary places such as mortuaries or high valleys, and are accompanied by prohibitions, by ritual gestures, and by words usually spoken in an archaic language. They are always based on plants, of which the medicinal properties are of secondary importance; for example in the case of thunder magic.

* So far no informants have shown the leaf to the author or given her its native name.
Broussonetia papyrifera (Moraceae), Glochidion sp. (Euphorbiaceae) and Macaranga vedeliana (Euphorbiaceae) are used.

This social side of the arsenal of New Caledonian magic medicine is disappearing rapidly. The tribes do not go to war any more and the thunder does not obey the prescriptions as promptly as it used to: without doubt men have lost faith. Perhaps only the magic of cultivation, hunting and fishing still survives discretely. The isolation of the initiate, moreover, is difficult to reconcile with the needs of the modern world, in particular that of schooling.

Black magic, in contrast, prospers. Long stabilised by the ordinary interplay of customary institutions, it has expanded during two periods: slowly at the beginning of the century and rapidly after the war. Some have seen in this expansion a psychological transfer, tending to externalise anxiety (thus giving it an objective material manifestation and creating a possibility of escape) and due to pressure first from colonialisation and then from industrialisation. However, the facts must not be neglected: as far back as the end of last century New Hebridean workers were conveyed by ‘blackbirders’ through New Caledonia and the Loyalty Islands. There is no doubt that they brought with them medicines of which the action, the magical context and the antidotes were all unknown to New Caledonians. If one considers that the New Hebrideans seemed on the whole to New Caledonians unsophisticated creatures, still very little ‘civilised’, close to nature, and endowed with powers of which the famous Doki is only one example, one can imagine the fear that they inspired (perceived, as they were perhaps, as a kind of living image of the ‘vieux’—the old ones, ancestors of the New Caledonians).

Asiatic workers and the European and Réunion colonists also brought with them their remedies and magic. But ethnic barriers came into play and exchanges were cautious, above all between Asians and Melanesians. The isolated colonists were more susceptible to influence because they were in the minority and, more to their detriment than to their advantage, there were more than one who, in fear and admiration, were persuaded of the power of native ‘medicaments’.

A dozen years ago an ‘anti-sorcery league’ composed of known native healers was formed. The influences that presided at its constitution are little known. Recognised under the Act of 1901 as a non-commercial association, it has sought the support of official European medicine and is at present tolerated to the point where, in the country dispensaries, certain of its members are occasionally called into consultation with European doctors, in particular when the illness appears to be psychosomatic.

Co-operation between indigenous and European medicine is, aside from these appeals to the league, one-sided, clandestine and patent. Indigenous medicine is of course not recognised, and European medicine still represents for many Melanesians, along with the priest and the gendarme, a certain order of things. It is indispensable to take precautions not to run counter to this order: dispensaries, clinics and hospitals are therefore well attended. But the patients who enter them are never abandoned and throughout their treatment and convalescence they remain under the responsibility of a healer, an anonymous visitor who, in addition to ‘good words’, occasionally brings some drug that is administered without the knowledge of the nursing personnel (whose complicity, however, should not be neglected). Beside these visits one of the principal activities of the league is the practice of exorcism, individual or collective (the latter being demanded by a whole tribe). The last manifestation of this sort took place in 1971 at Koné in the central west of New Caledonia.

Nevertheless, acts of sorcery committed for political ends above those of the narrow tribal compass have not been found. Some threats of possible recourse to powerful
destructive spells seem to have been uttered at the time of the preliminary investigation of an action against a group of autonomists, but so far the threats have not been carried out.

At a more unconscious level, such magic is able nevertheless to sustain demands of a social type. Thus during 1970–1 the arrival of large numbers of New Hebridean workers was resented by the great majority of the native urban population as an aggression. The immigrants were feared and hated partly for their competition—as much in the field of employment (a large number of workers tied to poorly paid contracts) as in the social field (single men without family attachments)—and partly for the cultural content of which we have already spoken.

A large number of New Hebrideans have returned home. Some of those who have stayed in New Caledonia have established profitable importation businesses in boucans between the two territories. The retailers are discrete, but they have a sound commercial sense: it is necessary to pay dearly for the satisfaction of being relieved of an embarrassment or of gaining the favours of one who has been indifferent. The reputation of their drugs has already reached a large section of the countryside and, alas, the law courts.

Martiniquais, Madagascans, Comorians, and still others also make a more than negligible contribution to the folklore magic of Nouméa. However the influence of these groups is minimal outside the urban limit. The efforts of researchers in this area remain poorly recompensed.

Such then, rapidly sketched, is the present balance of traditional New Caledonian medicine. Obsolescence appears at first sight to be its most immediate and significant tendency. But it has been seen that as yet only the social magic is profoundly affected, it being in jeopardy at the same time as the tribal structure that it has helped to maintain. All the same, in the fields of folk medicine that do remain alive, it is the knowledge of traditional and customary causality that is in danger of disappearing. Already its integrity for some pharmacopoeia has been reduced to appearance protecting a superstition.

The place is open, then, for the most baneful magic, and this is a vigorous tendency expressing a formidable mental confusion. The borders between ‘nature’ and ‘culture’, between the world of the dead and that of the living (Haudricourt 1964), between ‘illness’ and ‘health’, were products of an equilibrium consciously maintained in earlier times but now displaced or bent more or less gravely by introduced pressures. The ‘medicaments’ are no longer efficacious, except on certain rare occasions, despite the efforts of the healers to adapt new models to the ancient framework, (alcoholic delirium to traditional totemic possession, for example). One hope, however, remains for safeguarding the better part of this New Caledonian medicine: the reluctance of informants to overstep a certain limit of disclosure proves that the acculturation is not yet total. Our task is to prevent these secrets from dying with their last masters.

References


The Melanesian environment

This chapter provides the historical background to tuberculosis in Papua New Guinea, 1871-1971, and a report of the epidemiology of infection, including an outline of some basic infection rates. Baseline statistics are given as well as indications of strategies and tactics for fighting the disease. In the past, study of tuberculosis in Papua New Guinea generally failed to consider the implications for the spread of infection of external and internal labour trades or the prevalence of the disease among expatriate segments of the population, and observations were distorted by focusing on unrepresentative samples usually confined to Papua New Guineans living in expatriate settlements. The distinction between infection and disease in tuberculosis was not clearly made, and this, combined with attention to individual treatment rather than a public health approach, did little to check the spread of tuberculosis. Post-war studies have been more thorough and have led to a primary conclusion that infection with tuberculosis amongst Melanesians is directly proportional to the degree and duration of their contact with European communities, and to the degree of urbanisation or culture change experienced. The growing points of the disease today are: the urban areas, particularly Port Moresby; the institutes of tertiary education; the Highlands areas. Growth in urban areas is associated most seriously with the physical and cultural deprivations of squatter settlements. Concern for high rates within institutes of tertiary education is particularly acute because the young people affected are a key to the country's future and they could be agents of further infection as they continue their careers as teachers and medical people throughout the country. The case of the Highlands is different. Here infection had been virtually non-existent until recent years and its introduction and spread due to increased contact has provided an opportunity for the study of the evolution of tuberculosis in a virgin community and a unique chance to apply the principles of prophylactic management of a community health problem on a grand scale.

The antiquity of tuberculosis in New Guinea is not known, but there are reasons for believing that the disease had been introduced into the country at some time before the advent of European settlement. It can be assumed, however, on reasonable grounds relating to the general epidemiology of infectious diseases, that it was not a problem in the pre-contact era. If the disease had survived the epidemiological conditions prevailing at that time it is probable that tuberculosis and man coexisted in a way that was acceptable to both and that cost neither more than it could afford.

Over the greater part of the last century certain other influences have been operating to define the immediate picture of tuberculosis in New Guinea, and a proper appreciation of the present position can be obtained only by putting these into the time perspective.

**The External Labour Trade**
The first of these influences was the labour trade, both external to New Guinea and
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within it. Commercial Germany began to take an interest in New Guinea in 1874, with the establishment of Godeffroy (Hamburg) at Mioko in the Duke of York Islands, and in 1878 some labour had been enrolled from its small sphere of influence for work on the German Samoan plantations. This recruiting became serious in the 1880s, and continued until 1910, two vessels being used continuously and specifically for the purpose. This is interesting historically, but the critical date for New Guinea was 1883, which marks the first recorded visit to New Guinea of the blackbirders manning ships engaged in the labour trade, providing workers specifically for the Queensland sugar plantations. These men were of unsavoury reputation, notorious for kidnapping and their inhuman treatment of native labour who worked in and were recruited from the Bismarck Archipelago, the Trobriand and D'Entrecasteaux Islands, and the islands of the Louisiade Archipelago (Docker 1970).

In the fifteen months from May 1883, the date of the first arrival of the blackbirders in the Bismarck Archipelago, until the prohibition of the Queensland labour traffic in the area, thirty ships took away some 2600 natives to the sugar fields. Between the years 1869 and 1906 some 60,000 natives from the South Seas islands were recruited to the sugar fields. The small number of New Guineans was due to the fact that they died too readily on the plantations, and that New Guinea was closed to the colonial labour vessels in 1884, following a royal commission of inquiry into recruiting in the New Guinea area, where some of the worst atrocities of the Queensland labour trade had been committed. Working and living conditions on the sugar fields were appalling. Mortality rates amongst the workers were astronomically high. Thrice in the seventies they reached eighty-five per 1000, and in 1884 it was 147 per 1000 in an almost entirely male population, 70 per cent of which was 15–35 years old. It was usually only in the final year of a three-year contract that the labourer was acclimatised and fully hardened to the work. If a labourer fell ill he usually succumbed quickly. The mortality rate was three times higher than the highest recorded death rates amongst Europeans at the time, and death was due, according to contemporary reports, 'To an inability to adapt to a different environment, to strenuous and continuous work, and inadequate medical care' (Parnaby 1964). The reported mortality rates were less than the actual death rates, and between 1896 and 1906 approximately 25 per cent of the recruited labour was totally unaccounted for.

Work conditions on the sugar fields were analysed in the report of a Board appointed by the Queensland Government in 1880 to ascertain, if possible, the cause of the excessive mortality of the South Seas islanders in the sugar plantations of Maryborough, Queensland. The Board found that the labourers were in general too young for the work, of which the amount and duration were excessive. 'It was too long for all, and certainly excessive for those new recruits who had but lately left an existence of savage idleness'. Accommodation, water supplies, diets, medical attitudes and inspection of labour were all attacked scathingly in the report (Qld V. & P. 1880). No certificate of death was issued, nor was any report made to any authority. Money owing in the case of death 'went to profit and loss. The planter had the profit and the unfortunate labourer the loss.' Dysentery was a primary sickness, according to the report:

A vague term which seems to include various diseases. Cases of consumption where diarrhoea occurred were described as dysentery. On some plantations where the epidemic nature of dysentery was admitted it was denied that it was the chief disease, pulmonary consumption being more common! (italics mine)

The external labour trade is important in the context of tuberculosis in New Guinea because the Act controlling the recruiting of labour did not require returning
labourers to undergo medical examination. Thus they took back to the islands, with disastrous results, diseases they had contracted in Queensland, including tuberculosis and venereal disease. When sixty-five recruits were returned to the Louisiade Archipelago in 1897, for example, six were found to be suffering from the ‘venereal’. Tuberculosis is not quite so easily detected as the venereal, otherwise the tubercular members of the group would have suffered the same immediate fate as their venereal colleagues, summary return to Thursday Island, there to rusticate until the disease was deemed cured—a life sentence in fact. If they had done so, however, it is possible that a Mr David White, writing in the 1893/94 British New Guinea Annual Report and discussing native words in common use to describe some twenty-seven sicknesses on Sudest Island, might not have been able to include the following: ‘Native name—LOO: a violent cough accompanied usually with spitting or vomiting of blood and wasting away of the flesh—very fatal’.

THE INTERNAL LABOUR TRADE

It must be said at once that labour employed locally in the Old Protectorate (German New Guinea) was little better off than that employed in Queensland. Villages were overrecruited and depleted of young men lured to the plantations by false promises, force and deception. The men constituted as often as not an involuntary labour force recruited for work in Rabaul from as far away, for instance, as the inland Sepik. It is hard to distinguish the contract labour system from a system of forced labour (Docker 1970).

Tuberculosis was common amongst the indentured labourers. It is not proposed to say more about this here than that the prevalence of tuberculosis amongst them was high and that this in turn ensured that at least some of the surviving labourers would take infectious tuberculosis back to the villages when their times of indenture were completed. The German policy of recruiting labour from the most distant parts of the Protectorate ensured that, from the turn of the century at least, Rabaul was the centre from which tuberculosis was being introduced into the remotest parts of the Protectorate.

The historical background to tuberculosis in New Guinea is well documented in many reports. They include those of Her Majesty’s Special Commissioners to the Protected Territory of British New Guinea, the Papua Annual Reports, the Reports of the Development of the German Protectorate in the South Seas to the German Colonial Government, and Reports to the League of Nations on the Mandated Territory of New Guinea from 1918 to 1940.

They are remarkable for several things: firstly, the evidence they disclose of the amount of tuberculosis in the expatriate population, particularly amongst the European community, where minimal prevalence levels of 0.3 and 0.4 per cent were the rule—death from tuberculosis amongst Europeans was not uncommon; secondly, their revelations of the amount of tuberculosis prevailing amongst the native New Guineans living in proximity to European settlements; thirdly, their disclosure of how little was known about the prevalence of tuberculosis beyond the settlements; and finally, the complacency with which the known inroads of tuberculosis amongst the native people were viewed by the medical officers who made the reports.

In 1871 the London Missionary Society established itself in Papua, in Daru, and in Port Moresby in 1872. The evangelical and educational aspects of its work were aided by the use of South Sea Island Mission teachers introduced in increasing numbers from that time. The total intake to 1888 was 200 Polynesians of both sexes. In 1888 it was reported that in the fifteen years 103 of these South Sea islanders (Rarotongans,
Tahitians, Samoans, Nuieans, Tongans, and some others) had died. They had succumbed to disease or the hostility of the natives, twelve having been massacred. However it was estimated that only seventy had died from purely local malefic causes and the matter of the mortality rate amongst them became an alarming one.

A. Musgrave (1889), in a memorandum on the mortality occurring amongst the Polynesian teachers in British New Guinea, and the alleged dangerous unhealthiness of the climate, gave details of the mortality of the teachers and other members of the expatriate community and stated that the conclusion was inescapable that there must be some special features in the lives of the teachers or defects in the system for their care and control that had operated prejudicially, and that overall there were notably more cases of fatal illness in the mission teachers’ families.

The Reverend S.M. Macfarlane in a letter to the editor of The Times (11 July 1875) said: ‘It is true that a few had disease in their systems which this climate rapidly developed and brought to a fatal conclusion. Humanly speaking they would have lived longer in their own country.’

In May 1887, the Reverend W.G. Lawes, writing in the Australian Medical Gazette on the effects of the climate of New Guinea on exotic races, discussed the fate of the South Sea islanders between 1872 and 1887, and said that most of the deaths had occurred within two to seven years of their arrival in New Guinea. The crucial statement in the article reads as follows: ‘The immediate cause of death has not always been given. There have been some cases of Phthisis ... and some cases have been obscure and difficult to diagnose.’

Phthisis in the context of nineteenth century medicine meant far advanced pulmonary tuberculosis. It is clear from these letters and the reports of later medical officers that the South Sea island families must have been heavily infected with tuberculosis and, when it is considered that by 1886 these teachers were located at all LMS stations from East Cape to the Fly River and west of it, one wonders if it is not more than coincidence that the centres of tuberculosis along the south coast of Papua correspond to the sites of LMS mission activity in the late nineteenth and early twentieth centuries.

Add to this a lack of knowledge of the cause of tuberculosis and its transmission (Robert Koch had announced the discovery of the tubercle bacillus only in 1882) and a lack of appreciation of its extreme contagiousness, and it is apparent at once that the potential importance of the disease in the medical history of New Guinea was not appreciated at the time. It is clear to us that the South Sea islanders carried more than the message of Christ to ‘a savage race of inhuman murderers’ and the village names Mwada, Tureture, Manumanu, Hanuabada, Pari, Kalo, to name only a few, have a *déjà vu* flavour to those who are today responsible for the management of tuberculosis in New Guinea.

Most of the reports mention tuberculosis in greater or less detail, and not always consistently. Lupus was recognised particularly in the west and in the Purari River villages. Several times it is reported that tuberculosis was on the increase and what was almost certainly tubercular polyserositis was reported from Samarai in the British New Guinea Annual Report for 1904/05; it was reported also that amongst the Rarotongans who lived there localised tuberculosis is ‘found in the form of tuberculous abscesses’.

Some insights were displayed, but most reports were marked by the complacent tone of the Papua Annual Report for 1917/18: ‘Phthisis is seen to be the cause of a few deaths but not to be a factor threatening the existence of the Papuan Race.’ Experience has shown both in Papua and elsewhere that it is only when a native race takes to wearing European clothes that phthisis really decimates them. This matter of
fact depending on direct observation is independent of any special opinion which may be advanced to explain it. ‘Phthisis does occur but it is not a common cause of death.’ (At that time 2–3 per cent of the deaths amongst indentured labourers were due to tuberculosis!) ‘Cases are seen from time to time but the increase is not marked. It is a disease to be watched.’

Venereal disease, hookworm, and that dread tropical disease, beriberi, engaged most attention at the time. The Chief Medical Officer’s report for 1927/28 strikes a reminiscent note:

With regard to tuberculosis I should like to add that every medical officer when he arrives in the Territory seems to take it as almost axiomatic that tuberculosis is going to be the great health problem with regard to the natives. I thought so myself, 23 years ago, when I saw cases in the villages, and that a high proportion of mission teachers showed significant signs of tuberculosis.

He said that he would do all he could to diminish the probability of what he called massive infections, but tuberculosis was regarded inevitably as a cause of death and morbidity all over the world, and it was accepted with some resignation that it is often regarded as a threat to native people. He did not regard tuberculosis as a very great threat to Papuans as a race.

It was only in the late 1930s that there was any indication that the complacent attitudes of the past were being shaken. The Lieutenant-Governor’s report for 1937 said:

Anxiety has been felt of late years on account of the prevalence of tuberculosis in the Port Moresby villages, and the number of deaths due to this cause. The population in these villages is increasing, but it would increase more rapidly if we could check the tubercular trouble which is responsible for half of the deaths.

Money was provided in the estimates for the establishment of hospitals for the treatment of natives suffering from tuberculosis and leprosy. Gemo Island Hospital was established in 1937. Its aim was to remove sources of infection from the villages. It is clear, however, that the position in the villages was not greatly affected by the activities on the island, and the circumstances that surrounded the treatment of tuberculosis on Gemo were such that the hospital did virtually nothing to check the spread of the disease in the villages, especially in the ‘big village’, Hanuabada. The position there had been clearly presented by Clements (1936) when he made the first real attempt to assess the situation in the course of a clinical tuberculosis survey in which he estimated the prevalence of tuberculosis in the village to be at least 2.1 per cent.

On the New Guinea side, reports over the same years indicated that the prevalence of tuberculosis was increasing and the disease was rising steadily on the morbidity and mortality tables. By 1939 it was fourth on the list of total mortality, and it was clear that tuberculosis was well established in New Guinea by that time. The position had been summarised in a 1937 report to the League of Nations, which stated that tuberculosis was widely spread throughout the more settled parts of the Territory without any suggestion of any special endemic focus.

The only measure which offers a solution [to the problem] is the continuance of the present policy of gradual improvement of the living conditions of the native people, the introduction and extensive cultivation of the best native foods, and the development of an incentive towards the attainment by these primitive natives of a higher racial status.

A very sad report is available (Sister Adele 1969) of an epidemic of tuberculosis in the early 1920s at Vunapope, which gained a hold on many young sisters in the convent before it was recognised. In 1925 the mission doctor was convinced that the disease was the dreaded tuberculosis and not malaria as thought.

One after another the Sisters contracted the disease, specially the younger members of the
Community, and in the ensuing ten years more than 22 Sisters died of the disease. Later the case of the outbreak was thought to be the infection of open Tb. in a young Daughter of Mary Immaculate Sister appointed in charge of the Novitiate. Her case was not discovered until the dread disease was well advanced among the junior Sisters. (Sister Adele 1969)

No apology is necessary for dwelling even briefly on the early contemporary history of tuberculosis in New Guinea. It is easy to be critical of what went before, with the aid of hindsight and from the standpoint of modern knowledge of the pathogenesis of tuberculosis, its extreme contagiousness, and the importance of the community approach to the control of the disease. We tend to forget that although the causal organism of the disease was discovered in 1882 it was not until the 1930s that the full pathology of tuberculosis had become common knowledge amongst physicians, and the full force of logical community management of the disease has been applied to it only over the past quarter of a century. The men in charge of the health services in New Guinea in the period under discussion were all men of their time. They apprehended the problems of tuberculosis in the light of contemporary attitudes which saw the condition primarily as a problem of the medicine of the individual. Only occasionally were they concerned with the public health aspects of the disease, and only rarely did they consider the implications, for instance, of the labour trade, or the prevalence of the disease in the expatriate segments of the population, in respect of the transmission of tuberculosis in the wider scale amongst the native population of the country.

The internal labour trade was probably the major vehicle for the dissemination of the disease in the country, and still is in the Highlands of central New Guinea. The disease had its major origins amongst expatriates. By and large, opinions about the disease were gained from the study of native people who lived under the very artificial conditions of the European settlements. They knew next to nothing about the situation in the remote villages, although they speculated about them occasionally in a detached way. In Papua, for instance, there is no record before 1937 of any tuberculin skin testing having been done at all on a wide scale, and the very meagre reports from New Guinea were confined to the selected settlement situations.

Genuine facts were distorted by what appears from our loftier viewpoints to be a large body of nonsense and a concern for trivia in arriving at attitudes towards the disease, and speculations about the resistance of the native people to it. Dysentery, malaria, pneumonia, anaemia, and malnutrition all played their parts in producing the picture of tuberculosis as it was seen, for instance, in Rabaul, and the dramatic clinical picture obscured the fact that even in Rabaul many were infected but relatively few succumbed to the disease (even after X-ray examinations had cast doubt on the original pessimistic assumptions about the inherent lack of resistance to tuberculosis displayed by the natives).

The concern with the effects of imitation of European lifestyles and the wearing of European clothes as contributing causes of tuberculosis ignored the fact that these things and the tubercle bacillus came, so to speak, in the same pipeline. There was a refusal based on prejudice and presumption to apprehend clearly and thus to separate cause and effect. The expatriates, Europeans, South Sea islanders, Malays, Filipinos, Asians, all brought tuberculosis with them. Amongst them the prevalence of the disease was high.

Prejudice, preconception, complacency, a sense of hopelessness perhaps, and resignation in the face of tuberculosis cultivated over years of experience of the disease for which little could be done actively even in the developed parts of the world, combined with a lack of knowledge of the state of affairs existing in the country amongst
the native people (and the budgetary constraints that obtained at the time, limiting what could be done anyway), ensured that tuberculosis had gained a strong hold on the native people by the end of the 1940s, and set the stage for the post-World War II attack on the problem, in which for the first time attempts were made successfully to measure its extent.

**THE PRESENT POSITION**

Tuberculosis is not new in New Guinea, but the conditions under which the disease can spread and perpetuate itself are. The country is undergoing its own form of industrial revolution. In the remote past the tubercle bacillus and man lived together at little cost to either. Man paid the occasional penalty. Bacilli died by the millions but the species survived to provide man with immunological experience, which may have helped in the maturation of his defences against infectious diseases in general as well as against tuberculosis. Man developed a *modus vivendi* with the tubercle bacillus throughout the centuries, until he himself upset the balance by his socio-economic developments—epitomised in the western world by the industrial revolution, leading to urban population osmosis from rural areas, urban overcrowding in unfavourable circumstances, the disruption of established patterns of community living and family ties, and isolation of individuals and microcommunities in radically new environments.

In New Guinea the organised social change of the past century, accentuated over the past thirty odd years, has produced a change from what was at most a minor endemic disease to an epidemic one. Once this change has taken place the survival and perpetuation of tuberculosis are assured. Tuberculosis needs only zero population growth to perpetuate itself over the time span between generations. It has only to ensure that one infectious patient infects enough people to guarantee that one infectious patient emerges in the next generation.

Today the epidemiological situation in New Guinea can be summarised in the following firm conclusions, which are drawn from the results of many investigations into the prevalence of infection over the past thirty years. The first is that infection with tuberculosis amongst Melanesians is directly proportional to the degree and duration of their contact with European communities, and to the degree of urbanisation or culture change that has occurred in the Melanesian communities. In these respects the Melanesian communities can be grouped into four loose categories:

(a) highly urbanised, high grade of contact;
(b) moderately urbanised, low grade of contact;
(c) little urbanised, low grade of contact;
(d) not urbanised, contacts few and far between.

The categories are loose ones, and not clear cut, but they are still useful, despite some recent changes. Representative baseline infection rates in these communities are: (a) 60–70 per cent; (b) 40–60 per cent; (c) 20–30 per cent; (d) up to 10 per cent.

In Port Moresby, where the community has had long contact and the degree of urbanisation is high, the base infection rate was 66 per cent. In category (b) the rates average 55 per cent, in category (c) 25 per cent. Two examples from category (d) show infection rates of 5 and 7 per cent. The association between infection rates and contact and culture change reaches its logical conclusion in the New Guinea Highlands where at the present time amongst communities numbered in thousands the rates range from a virtually irreducible 0.2 per cent to a maximum at Goroka township of 2.0 per cent.

Age/sex analyses of the four representative communities show quite clearly that as the degree of urbanisation and contact increases infection rates rise and the curve
tends to spread at the base (that is, the infection is more diffusely spread in the community) and it is equally evident that in the rural communities infection becomes localised more and more in the older age groups, and that in the remote areas it is largely confined to the adult males.

This localisation reflects two things:

1. Those who are infected are predominantly those who have left the rural communities to work in the heavily tuberculinised coastal areas, and in many instances they have done so in an unprotected state.

2. The period of time spent on the coast is long enough for these adult males to become infected but not for infection to be seen to need treatment, or to heal spontaneously before returning. Therefore at least some of these labourers return to their homes in an infectious state. They may not be and usually are not ill. Thereafter the groups in the community most likely to become infected are those with whom the adult males will have the most intimate contact, the women. The infection will filter down through the community, affecting the adolescents more than the children and infants initially because they are more numerous and perambulant, and their contacts with potentially infectious people are more frequent than those of the small children. One other thing is clear from the studies. The major pool of infection in the community is in the groups aged fifteen years and older. The proportion varies from about 70 per cent in the urban areas to over 90 per cent in the lightly tuberculinised communities.

The statement that the prevalence of tuberculous infection in Melanesians is directly proportional to the degree of their contact with European communities needs some clarification. It is not suggested that the disease has been deliberately introduced into the communities. That tuberculosis has been brought into the country by Europeans is certain, and it still is being brought in. (Anyone who is familiar with the romantic literature of the South Pacific cannot help but be struck by the appearance throughout these stories of the men who came to the tropics because of a weakness of the lungs, in search of cure. ‘R.L.S.’ is probably the best known of these.) The evolution of tuberculosis amongst Melanesians has been an accidental byproduct of the development of the country.

This development necessitates the building and growth of towns and cities, and these, although they sometimes appear to be the growing points of civilisation, are more often the focuses of social disease. The towns provide the very conditions that favour the dissemination and perpetuation of tuberculosis. The sheer rapidity of their growth, the result of inexorable urban migration of people drawn from the rural communities to the towns by the arid attractions of an alien culture, overwhelm the capacity of administrations to provide services to cope with them in a way conducive to good health. Tuberculosis is pre-eminently the disease of the *milieu intime* and, in the final analysis, is dependent on the infection of an individual by the tubercle bacillus. The claim for a single cause for tuberculosis cannot be upheld, despite the paradox that without the single cause there can be no tuberculosis. Other environmental factors including social stability, nutritional states and cultural factors all play their parts in determining whether or not infection with tuberculosis becomes tuberculous disease. The towns, unsettled, unstable, uncertain, neurotic, are the places where the traditional social stabilities are shattered, roots are loosened, and balances upset.

The urban Melanesian has left the old subsistence economy and the traditions of reciprocal giving that underlaid and supported the traditional social systems. He lives on a cash income, which is dissipated largely on imported goods and services. His
nutritional standards are low, his house is overcrowded and underventilated, and he is subject to endemic sickness and repeated epidemic illnesses, all of which tend to sap his resistance to any disease, let alone tuberculosis. His rural counterpart, by and large, still lives in the stable environment to which he is accustomed. These disadvantages ensure that the townsman’s reaction to tuberculosis is more out of hand than that of the rural dweller.

What is striking about the epidemiological picture of tuberculosis in New Guinea is the wide range that it covers from the firmly established pattern in the coastal areas, exaggerated in the towns and approaching saturation in certain small and isolated communities, to the virtual absence of infection in most of the Highland communities. Because of this extreme diversity there is no such thing as a national average infection rate. One can only attempt to categorise certain groups on a basis of contact and culture change and in each there is a small range of infection rates characteristic of the group.

All the accepted indices of change run in the direction of improvement in the tuberculosis situation in New Guinea. The dilemmas of control lie in the recognition of significant growing points of tuberculosis over the recent past. These will have to be restricted if the favourable trends of the past decade and a half or so are to be maintained. The growing points are, in order of importance: the urban areas, in particular Port Moresby; the institutes of higher education; the highlands area; central New Guinea.

The Urban Areas
Port Moresby is selected as the prototype of the urban situation because it is the biggest of the towns, it is expanding more rapidly than other towns, and the tuberculosis problem is more acute there than elsewhere. The town exemplifies to a high degree the general urban drift from rural populations. The urban community is in ferment.

Port Moresby has roughly one-fiftieth of the total New Guinea population but in 1971 was providing facilities for the management of one-eighth of the tuberculous population of the country. The prevalence of tuberculosis is approximately 1 per cent, but in the ‘squatter’ settlements in the town may be three to four times higher than this. A small idea of the problems of management of the tuberculosis problem in Port Moresby can be gained from consideration of a study of the tubercular patients admitted to the wards of the Port Moresby General Hospital. In the years considered, 213 patients were admitted with a diagnosis of tuberculosis.

Of these, 102 were new admissions not previously known to have the disease. The others were readmissions for assessment of progress, or disciplinary reasons, or they were admitted for the management of relapse of disease, or for the treatment of some condition other than tuberculosis.

Of the 102 primary tubercular patients, 35 per cent were urban dwellers, coming from villages within the radius Porebada to Pari, or were rural inhabitants employed in Port Moresby, or were members of the families of these; 65 per cent of the patients were from rural areas. This is a low figure because, clearly, some of those classified as urban workers were typed thus only as a courtesy; the evidence that they worked in the town was minimal.

The significance of this 65 per cent lies in the facts that:
1. Almost invariably they have large families.
2. Accommodation for them is hopelessly inadequate.
3. There is no work available for the heads of the households, or they are employed as casual labourers in jobs with no real earning power; nor is there any job security.
4. They come from areas poorly equipped to provide either in-patient or out-patient treatment services for tuberculosis.

5. They resent bitterly and actively protest against any attempt to divide the family by hospitalising only the affected members. This is an intolerable situation if the father is the affected member of the family and only a little less so if it is the mother. Protest takes the form of default and absconding from hospital and must be regarded very seriously in the light of apparent recent improvement in the epidemiological situation in the town.

These people are further handicapped by the general retreat from the old social systems designed to lighten the community burden of caring for the sick in all circumstances and to ensure the continued inclusion of the sick and their families within the community. The urban community is less willing than formerly to accept the burden, and for obvious and valid reasons. The social and economic circumstances operating in Port Moresby, inseparable as they are from development, are operating to maintain and perpetuate tuberculosis and could easily increase an already heavy case load.

Towns and cities are never prepared for significant population increases. Population growth always exceeds the ability of the towns to provide facilities for the larger populations. This is obvious enough in the great metropolitan cities. In Port Moresby the population increase over the past two decades has outstripped the provision of basic facilities. Housing is substandard, overcrowding is common. The transfer from rural subsistence to cash economy has led to nutritional deficiencies, and respiratory infections, often epidemic, are commonplace. These are transmitted freely in such a community and have a detrimental effect on a population suffering from the accumulated effects of other conditions—malaria, anaemia, diarrhoea, and parasitic bowel infestations to name a few.

Hanuabada Village illustrates the endemic situation very well. In 1966 a tuberculosis survey was done in the village and by coincidence this was exactly thirty years after the first survey by Clements in 1936; 2300 people over the age of fourteen years were X-rayed. Twenty-four were found to have lesions in the lungs, which were regarded as tuberculous in origin, and were judged to be active and to need treatment. All but two had minimal to moderately advanced disease, and all were non-infectious in that sputum smear examinations for the tubercle bacillus were negative. The morbidity rate for tuberculosis in this group was thus a shade above 1 per cent. The average age of the male patients was fifty-two and that of the females forty-four. All patients completed a full course of treatment, and there were no deaths from tuberculosis in the group.

It is interesting to look at the situation in Hanuabada thirty years before at the time of Clements’s survey. Amongst 2000 people Clements found forty-three patients, of whom 45 per cent were excreting tubercle bacilli. The death rate from tuberculosis was 14–15 a year—one-third of the deaths from all causes; statistically it amounted to a rate of 700 per 100,000 per year. Tuberculosis was the greatest killer in the village.

Tuberculosis is still an important disease in Hanuabada, but its quantity and quality are clearly much reduced from those of thirty years ago. It must not be forgotten, however, that the prevalence of tuberculosis in the village, and in the town of Port Moresby, is twice that of the most severely affected rural areas.

The Institutes of Tertiary Education

In the centres of tertiary education in Port Moresby the prevalence of tuberculosis has been up to five or six times higher than that in the most severely affected rural areas (0.5–0.6 per cent). In 1968 the figures from four such institutions were: Papuan
More important than the level of infection in relation to the general prevalence is the fact that these patients come from the late adolescent age groups. The average age of patients in Hanuabada Village is forty-five years. In other rural communities the average age of patients lies somewhere between forty and fifty years. In other words, there is nationally a high percentage of patients in the middle and old-age groups. The prevalence of tuberculosis amongst the late teenagers of the educational institutions must be many times higher than the national prevalence in this age group. (How much higher it cannot be said because the service has not achieved a level of sophistication that would enable the delineation of accurate age specific morbidity rates for tuberculosis.)

It is disturbing that the group involves those from whom the future leaders and teachers of the community will emerge. It is particularly disturbing in relation to the prospective school teachers. In view of the epidemiological implications of the lightly tuberculinised under fifteen, the tubercular trainee teachers, of whom there were forty-two registered in 1970, can only be regarded as the most dangerous threat of all to efficient control of the disease in the community.

The students are working hard in an environment essentially unfamiliar to them, and a highly competitive one. They have lost the protections of the primary and secondary schools. The environment is one for which some at least are ill equipped to manage and they are exposed to infectious tuberculosis in the highly tuberculinised urban community in which they live. There are thus considerable physical and psychological stresses imposed on them, creating a favourable climate for the development of tuberculosis in susceptible individuals. Particular attention must be paid to them at case finding, prophylactic and therapeutic levels if an excessive loss from this valuable section of the community is to be avoided.

Their plight is part of a larger one that will involve bigger communities as the pace of culture change increases. In New Guinea tuberculosis is one of the problems confronting communities living in an alien environment divorced from the old certainties of traditional village life. Problems that arose in the old cultural situation were met by ready made solutions peculiar to the animistic society in which they lived. The alien culture provides new problems, but no protection, because the new problems had no counterparts in the old culture.

The Highlands Area

In the epidemiological shape of tuberculosis the Highlands region of New Guinea is unique; 900,000 Melanesians live in the interior of New Guinea in what until the very recent past has been almost complete isolation from the coast. This exuberant people was full of vitality, and protected from epidemic situations by isolation and lifestyle. They achieved a measure of social and political stability superior to that of the more fragmented coastal society (Souter 1963).

Up to World War II, which had very little effect on the area, infection was minimal, and the area could be regarded as virtually free from the disease. Subsequently modern communications broke down the isolation, the vast populations were recognised as an important source of labour and population movements into and out of the Highlands increased.

Now the natural evolution of tuberculosis in a hitherto tuberculosis free community
is being observed there. The early cases, derived either from expatriate coastal or repatriate Highland labourers—the exogenous sources of infection—were sporadic and isolated. Each, however, created his own unit of infection around him. The exogenous source infects local Highlanders, who in their turn become potential endogenous sources of infection. Initially the units are few and far between, but as the twin influences of time and intensity operate, some units in close proximity overlap and coalesce to give rise to microepidemics of the disease; there have been two important examples in the Highlands over the past ten years. An extension of this process with more numerous units coming into close proximity leads eventually to the epidemic situation familiar in its various forms in the heavily tuberculinised coastal areas in New Guinea.

Hopefully we shall not see the full expression of this experience in the Highlands, despite the slowly increasing incidence of tuberculosis in the area. The natural order of events has, it is believed, been interfered with substantially by the great mass BCG vaccination campaigns conducted there over the past eighteen years. New infection in this community should excite a sufficiently high degree of anamnestic immunity response to damp the whole process down and lead to a less formidable expression of tuberculosis in this vulnerable community. (This general trend of evolution of tuberculosis in a tuberculosis free community can be and is being reversed in New Guinea. This leads, however, to the appearance of microepidemics amongst susceptible groups previously diffusely affected, but now under the influence of vigorous control measures less heavily tuberculinised. Examples of this have been two school microepidemics amongst children in contact with tubercular teachers in Madang.)

**Conclusion**

Tuberculosis has defied containment for centuries and it displays an unrivalled capacity for adaptation. The important clues to its management are to be found in the close study of the characteristics of the disease itself, those of the patients and of the attendants. In the developing countries our concerns are largely with the latter. In Papua New Guinea the characteristics of the disease are known, its distribution and quality are apparent, and the problems it presents are clear. The characteristics of the patients are sufficiently well known and it is accepted that many of their beliefs are circumscribing management quite seriously, as is the apparent indifference and apathy with which they have accepted the ravages of tuberculosis in the past.

The study of epidemiology should lead to the successful application of the appropriate administrative measures in logical sequence designed to reduce the disease to unimportance. The gap between the statistician's dream and the realities of control, however, is often a wide one. We are dealing with biological systems; the disease is one of human beings, with all that this implies in terms of the difficulties in controlling it. Appropriate administrative measures are essential to the success of a control program, but control is not simply an exercise in administration or logistics.

Tuberculosis was a disease of Europeans' greatgrandparents, their grandparents, their parents and themselves. Happily their children and grandchildren will escape it, ours being the first generation that has been able to live comparatively safely with the disease. It was not an important disease to Melanesian greatgrandparents; it became one in a dramatic fashion to the grandparents, and it is still one to Melanesian parents and their children. It is possible to ensure that their children's children will escape it. This can best be done by ensuring that what we know today is applied logically to the solution of the problems of tuberculosis, and that tuberculosis control does not remain an illusion.
In the natural order, over a period of time measured perhaps in two or three generations, a process of selection occurs in an infected community; it results in the community being rid of its highly susceptible members, the residue possessing either a high grade of natural immunity or a better capacity to develop secondary resistance to the disease. In these circumstances the elimination of actual or potential sources of infection by the use of chemotherapy and chemo-prophylaxis and the elevation of resistance to tuberculosis by biological prophylaxis could theoretically lead to the elimination of tuberculosis, that is a reduction beyond the threshold of the disease in man, the continued presence of the organism being compatible with the absence of disease. This is not eradication—the extirpation of the causal organism finally and irrevocably. The elimination of tuberculosis in New Guinea is even further away than control of the disease, where its prevalence is reduced to a level acceptable in the community, but both are possible. That there has been a reversal of the trends of the past in New Guinea is clear from studies done on school children in 1871.

In Port Moresby the prevalence of infection amongst primary school children has been reduced from 59 per cent in 1958 to 22 per cent in 1971, and in the Gazelle Peninsula from 30 per cent to a little more than 10 per cent in the same time. Infection rates amongst Madang children are now 5–10 per cent as opposed to 31 per cent in 1959, and in Bougainville the reduction has been from 38 per cent to about 10 per cent.

It is clear that the peaks of the epidemics have been passed in the coastal communities in New Guinea. A peak was reached some thirty years ago along the south coast of Papua. Elsewhere in New Guinea, excluding the Highlands, the peak was passed in the late fifties. Increasingly children are reaching adulthood without having had a natural infection with tuberculosis. In the Highlands the peak has not yet been reached but it should be possible to prevent a high peak ever being reached.

This means that the process of natural selection of the population by tuberculous infection in the uncontrolled situation has been interrupted; groups that would have been eliminated in the past now survive. There will be a net genetic impoverishment of the community at the level of ability to resist invasion by the tubercle bacillus. This presents problems for the future protection of the community with chemical and biological prophylaxis until the stage of elimination has been reached. Tuberculosis is no longer sorting out people with the same intensity as it did in the past. Theoretically susceptibility is being perpetuated by control intervention. This in itself is not a bad thing provided that we are prepared to provide artificial protection where it is needed. That this must be done is mandatory. Tuberculosis is such an insidious disease that even after its elimination it could, undetected, regain a firm foothold. We should not get the erroneous impression that, because there has been a reduction in the number of cases, and because the treatment of the disease is so comparatively easy, tuberculosis is only mildly infectious. In reality its contagiousness has not decreased. The global experience, and that in New Guinea, of explosive microepidemics bears witness to this indisputable fact.

References
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The symposium discusses themes relating to health oriented and environmental sciences, within the context of a Melanesian human ecosystem. These themes include epidemiology, the natural ecosystem, nutrition, and socio-cultural change, including genetic factors. The symposium considers such effects of socio-economic change as broader disease patterns, gene pool shifts, macro-directions in regional change, new micro-habitats, and psychological and socio-cultural implications; concern is also directed to achieving viable contemporary definitions for health and environment, and to their changing interface.

LEONARD KAUPA
I would like to consider ‘health’ as it is applied in a Melanesian environment, and give a brief account of the education and expectations of a UPNG medical graduate. Much of what I am about to say is a personal opinion.

I take health as the ability to cope with the physical, mental and social dimensions of existence, and the ability to perform a role in the day to day activities of a community in a given environment. Health status can be looked at on an individual level as well as on a community level. A Melanesian’s life is dependent on intimate interrelationships with the surrounding ecosystem; his basic structural and functional unit is the extended family, his day to day activities like fencing, gardening, fishing and game hunting are carried out on a community basis. It is therefore of great importance that we assess his health status on a community level, even though it is individuals that make up the community.

People become unhealthy from many causes, but for a Melanesian the ultimate cause was sorcery, magic or witchcraft. Accidents, snake bites, headaches and so on were analysed in terms of why rather than how, and a traditional village ‘doctor’, who received informal education, whose magical possessions were inherited from the previous generation and whose knowledge of the surrounding botany was very superior, was the only healer. Today’s young medical doctors are very expensive. In 1974 it cost the Government and the taxpayer K70,000 to take a medical student through a five year course. Those who make the investment therefore expect something in return and rightly so. They may be dismayed therefore when we appear to belong to the western world: our training has been western oriented, applying scientific method to the study of diseases. About 90 per cent of our teachers are Australian, English, Indian and Filipino; they go directly into their postings without much introduction to the Melanesian environment and its indigenous health practices.

Our training has been geared to a modernised, well equipped and well staffed
hospital and on graduating we tend to remain in urban general hospitals, where we appear to serve a minority. The sophisticated Melanesian attending a hospital clinic would prefer a western doctor, while at the other end of the scale the traditional Melanesian would give first preference to the traditional village doctor. The unfortunate UPNG graduate doctor is left in the middle, very much confused but realising that he has to reconsider his role in the Melanesian community.

Professional medical training in PNG is only recent: in 1951 the first Papua New Guinean doctor graduated from the Fiji School of Medicine; in 1960 the Papuan Medical College was established; in 1964 the first graduates emerged from the Papuan Medical College; in 1967 UPNG was established; in 1971 its Medical Faculty was established; in 1972 its first bachelor’s degree status doctors graduated. We are very inexperienced. The number of national graduates is increasing each year. What we lack in experience we can make up in number. In present Melanesian society, the traditional village doctors are leaving hardly any trace of their medical practices. The expatriates are leaving the country. We UPNG graduates belong and will stay. All we require is that the people give us time and confidence. I am sure that today’s students will be tomorrow’s teacher-doctors.

**PATRICIA JOHNSTONE**

During the year 1970/71, the annual percentage increase in the population of Papua New Guinea was 3 per cent. This rate of growth results in a population doubling in twenty-three years and is fairly high in comparison to that of some other developing countries. For example, for the period 1960–70, the average population growth rate for Asia was 2.5 per cent per year and for Africa it was 2.4 per cent (Cabinet Committee on Planning 1974).

In Papua New Guinea the birth rate is much higher than the death rate. For example, during the year 1970/71, the birth rate was forty-four per 1000 while the death rate was only fourteen per 1000. This resulted in a net increase of thirty per 1000 that year. In 1971 the population of Papua New Guinea was estimated at 2.5 million. At an annual 3 per cent rate of population growth, by the year 2000 the population will be over 5 million, and by 2023 it will be over 10 million. Moreover, if the growth rate increases, as it has been increasing, these population estimates will be low.

The high rate of population growth is fairly recent. Twenty-five years ago, in 1950, the annual percentage increase in population was 1 per cent, the population doubling in seventy years. Although there was a fairly high birth rate, there was a higher death rate than now, owing primarily to high infant mortality. This was probably caused by the same infectious diseases that kill infants today in Papua New Guinea—lower respiratory infections, gastro-enteritis, malaria, etc.—yet are susceptible to medical treatment and environmental improvement such as malaria control programs.

In 1950, infant mortality ranged up to 350 deaths per 1000 live births in rural areas of the country; the lowest figure, in a few relatively settled towns was 100 per 1000 live births. By the mid-1960s, with health services in many areas and malaria control programs under way, the average infant mortality for the nation was 100 per 1000 live births—a figure matching the low urban mortality recorded for 1950. In 1971 with further improvements in health care, the average infant mortality in rural areas was seventy per 1000 while the urban average was thirty per 1000 (Bell 1973). (This rural figure is inflated by a few remote areas that still have a fairly high infant mortality of up to 140 per 1000.) The infant mortality in Papua New Guinea is still relatively high compared with mortality in developing countries that have been exposed to medical
care and malaria control programs for longer periods. Infant mortality should thus continue to decrease following further expansion of maternal and child health services and environmental improvement programs.

As well as lowering infant mortality, improved health services have also increased maternal fertility. Another factor boosting fertility in the last twenty-five years is the gradual abandonment of traditional contraception measures, such as long periods of sexual abstinence following childbirth and during lactation, and men and women living in separate houses. Thus factors that in the past have depressed the rate of population growth have declined in recent years and infant mortality has decreased while fertility has increased. This means that today families in Papua New Guinea have large numbers of children and the country as a whole is faced with a rapidly growing population.

The high rate of population growth is a problem in Papua New Guinea, for both medical and socio-economic reasons. Medically, repeated closely spaced pregnancies are a drain on the health of the mother. Moreover, with higher numbers of pregnancies, there is an increased risk in giving birth: among women giving birth to the fifth or further child, there is higher probability of emergency deliveries, Caesarean sections, post-partum haemorrhages and twin pregnancies. In Papua New Guinea the average number of children per mother is six (Muirden 1973). Short intervals between pregnancies decrease the time during which the infant can have breast milk, which predisposes the child to malnutrition as the mother attempts to feed it artificially. Finally, because children are less likely to be immune, a high proportion of children in the population increases the risk of epidemics.

Socio-economically, the population of Papua New Guinea is young because of the high birth rate and better child survival. In 1971, 45.5 per cent of the population was under fifteen years of age and, given present trends, this proportion is expected to increase (Cabinet Committee on Planning 1974). These young children contribute little to the workforce. The adult workforce is proportionately smaller in Papua New Guinea than in developed countries like the United States and Europe, which have lower birth rates and thus proportionately fewer children; in Europe only 24 per cent of the population is under fifteen years of age, while about two-thirds of the population are in the workforce and thus able to be economically active. Papua New Guinea has a high ‘dependency load’; that is, a high proportion of people are dependent on the rest of society.

With proportionately large numbers of children, proportionately more resources must be set aside to the care and primary education of these children. This puts a strain on the economy of the country, and means that less capital can be spent on developing industries and programs that will develop the country. It also means that less capital can be spent on secondary and tertiary education to train the young people in technical skills and as administrators. In addition, individual families may not be able to provide adequate food, clothing, and other necessities for a large number of children, especially in urban areas where the family is on a fixed wage. Finally, all the problems related to public health—provision of sanitary facilities, supply of pure water, and adequate nutrition—are aggravated by a rapidly increasing population.

Today, Papua New Guinea is at a relatively early stage of economic development. If the population growth rate exceeds the rate of economic growth, there will be no overall economic advancement and it is likely that there will be economic retreat. If the population doubles, the country will need to double food production, available jobs, school facilities, housing, basic services to the people, and medical facilities and care to maintain approximately the same standard of living. Yet most people in Papua
New Guinea are hoping not just to maintain their standard of life, but to advance it. It will be expensive to supply the material needs of the rapidly growing population of Papua New Guinea, and it is imperative that government plans for the future accommodate or alleviate the present growth pattern.

**SUE SERJEANTSON**

As we have seen, the socio-cultural changes current in Papua New Guinea are resulting in a changing population demography and, as demographic structure changes, so also does genetic structure. For example, as the distance and incidence of migration increase, the genetic differences between groups decrease. It is obvious to even casual observers that there are genetic differences between Papua New Guinean groups—there is a great range of skin colour, hair texture, facial features and body build—and by the study of blood groups and the inherited variation in serum proteins and red cell enzymes, geneticists have demonstrated that not only are there genetic differences between language groups, there are often significant differences between villages within language groups. This is not unexpected, for there is often a strong preference for marriage between persons born in the same village.

Are marriage patterns currently changing? Ryan (1973) suggested that, in some Highland groups, people may not travel as far to marry now as they did in the past, owing to a reduced need for marriages of alliance with reduced warfare. However, in the three lowland groups studied by the Institute of Medical Research (Serjeantson 1976), it was found that young people migrated further to marry than did their parents. These three lowland groups included Kiunga, with administrative contact since 1951; rural Madang, with a series of administrations since 1884; and the indigenous urban population of Madang township. Marriage patterns, fertility and mortality were examined in the three populations.

In Kiunga, there was a strong preference for men to marry someone born in the same village and, in fact, 87 per cent of all marriages were contracted within the village. In rural Madang 49 per cent of marriages were between people with the same birthplace and, in 85 per cent of marriages, husbands and wives were from the same language group. However, among urban English speakers, in 46 per cent of the marriages studied, husbands and wives had a different first language and the mean distance between their birthplaces was nearly 400 km. Nevertheless one-third of urban English speakers still married someone from the same village. For each population the proportion marrying within the village had not decreased in the younger age groups, but those who did leave the village to marry migrated further and transcended former linguistic barriers.

A genetic consequence of this migration and intermarrying is the reduction of genetic differences between groups. Another important consequence is a reduction in population inbreeding. Although most Papua New Guinean groups have strong injunctions against marriage between relatives, in small communities with preferential within-village marriage, husbands and wives may have as many genes in common as if they were first cousins. In general, this has not been deleterious in Papua New Guinea, presumably because those carrying harmful genes have had a high mortality rate and harmful mutants have been kept at low frequencies. Only in a few language groups have deleterious genes reached significant frequencies (e.g. Icthyosis congenita in a few villages between Kaiapit and Wantoat, and spotted albinism in the Giri language group). With increased migration, inbreeding coefficients will decrease and harmful recessive genes may spread through the population.
Fertility and mortality rates are also currently changing in Papua New Guinea. Urban and rural Madang women aged over forty years averaged 6.5 live births, with fertility twice as high as that in Kiunga. Mortality differences between the groups were most marked; in rural Madang, child mortality was twice as high as in the urban group, and in Kiunga three times higher. Women aged 20—29 years reported 7, 13 and 21 per cent of live born children dying in the urban group, rural Madang and Kiunga respectively. In 40—49 year old mothers, the corresponding percentage child mortality rates were 11, 22 and 30. These differences in fertility and mortality largely reflect the availability of health services, although environmental differences may also be of importance.

A genetic consequence of these fertility and mortality differentials is that certain socially advantaged groups in Papua New Guinea are contributing more genes to the next generation than others. For instance, the total population size of Kiunga has changed little since the first census in the early 1950s, whereas Karkar Island has more than doubled in population since 1950. An example of how differential fertility can change population gene frequencies is provided by Fiji where, owing to the higher fertility of Indians, Fijians now make up a minority of the population.

Another genetic consequence of high mortality is that natural selection has considerable opportunity to operate. In a genetic sense, the Kiunga population with its high mortality rate may be better adapted to its environment through the principle of survival of the fittest than the urban group. Haemophilia, for instance, was known in Papua New Guinea but was very rare, since many of those affected could never have survived the rigours of rural life; with urbanisation and increased health services, a number of haemophilia cases have now been reported. With increased health care we may well see an increase in the number of persons affected with other rare genetic diseases.

In conclusion, socio-cultural change has resulted in increased migration, with a reduction in genetic differences between groups and a reduction in population inbreeding. There will be changes in the nation's average gene frequencies owing to the greater fertility of some groups, and there may be an increase in the incidence of rare genetic disease as improved health services permit the survival of those who would have succumbed at an early age to the physical hardships of rural life. If the breakdown of isolates proceeds, one day it may be impossible to distinguish between a Highlander, a Bougainvillean and a Papuan.

**ROLFE KORTE**

Some years ago the term 'primitive affluence' was used to describe the socio-economic conditions, including food availability, in Papua New Guinea. Many research workers have studied nutrition in this country during the last three decades. As there has been an emphasis on biochemical and physiological research, nutritional problems have not been well described in epidemiological terms.

More recently compiled evidence suggests that nutritional problems in Papua New Guinea are very similar to those of other developing countries in the tropics. These observations throw some doubt on the concept of 'primitive affluence', a pre-contact optimum or nearly optimum state. Vast differences in socio-economic development within Papua New Guinea offer opportunity to analyse the relationship between nutritional status, demographic parameters and a number of development indicators to test the validity of the concept of such a putative 'affluence'.

It was found that those districts that had the highest road density and agricultural production per capita had a relatively low rate of malnutrition in children under five
years. Interestingly, other development indicators such as cattle projects, primary school attendance, Development Bank loans and health expenditure do not show a relationship to the prevalence of malnutrition on a district by district basis. Moreover, population density does not relate to the malnutrition problem. On the other hand, definite correlations were observed between the accessibility of health facilities and the percentage of children enrolled at maternal and child health clinics. As might be expected, districts with the highest childhood mortality also had a high prevalence of malnutrition.

From this, it is evident that malnutrition is particularly prevalent in areas that have seen little or no development. This suggests that economic development is associated with improved nutritional status. The fact, however, that this relationship cannot necessarily be extrapolated to the higher levels of economic development, i.e. urban centres, is exemplified by the case of Port Moresby. Some 34 per cent of the population of Port Moresby are working in some form of employment for more than thirty hours per week. In contrast, the range for the remainder of the country is only 5–22 per cent. Yet the malnutrition rate in urban Port Moresby, almost 50 per cent, is as high as those of the most undeveloped districts.

The effect of urban migration on the nutritional status of the population in urban centres is obviously detrimental, but just how the drain of manpower from the rural areas affects agricultural production and nutritional status in rural areas is not very well known. Demographic data on the age and sex distribution in some rural areas in Papua New Guinea show a drastic reduction in the young male population, who traditionally play an important role in land preparation and fencing. Rural-urban migration on a larger scale is a relatively recent development and the full nutritional impact is likely to be felt only after some time. It is in effect a reduction of the manpower available for rural activities.

We can therefore conclude that, with the development of communication facilities, economic enterprises and basic health services, there is a nutritional improvement and, secondly, that improved nutrition must also be considered a prerequisite of national development. Beyond this there is, however, a pressing need to forestall the detrimental effects of socio-economic change, including rural-urban migration, which has led to a renewed increase in the prevalence of malnutrition.

ROBERT JENKINS

It has become apparent to many persons in the western world that men and women alike experience intense feelings of being alone. These feelings, variously described as being 'cut off from a meaningful existence', 'alienated from society', 'trapped in the triviality of everydayness', generally involve the feeling of isolation from the surrounding environment. Mental depression and suicide are often the desperate answers to these feelings of aloneness, cognitive solutions succeeding alcohol and other drugs, and such feelings are becoming increasingly prevalent among the 'silent', also considered the 'normal', majority.

Why is it that citizens of the west experience these unhealthy feelings of aloneness? In essence I believe that it results from a failure to understand ourselves as an inseparable part of the biological, social and physical system; it is a failure to understand man as part of a field. The impetus for this attitude I see in a conception of science by which man considers himself the observer, whilst nature is the observed. Secondly, the attitude stems from man's desire to conquer the environment, to prove his cosmic superiority over the earth. Thirdly, it results from social institutions, language and
philosophy that have encouraged an attitude of independence. These encourage man to be independent, yet at the same time social institutions give him anxieties and so he feels caught in a trap.

Man in the west has come to view himself as ‘I’, independent and separate from other physical, social and biological systems. He views the Ego or ‘I’ as being within his body. His notion of the Ego is skin encapsulated. ‘I’ is seen as a little man, dwelling inside, something separate from his own physical self. The task of psychotherapy, then, is mainly concerned with the liberation of the individual, in solving the problems of the individual relating to his integrity and contributing to his authenticity.

Turning briefly to the east, eastern cultures too are concerned with liberation from egocentric styles of consciousness, as in Taoism, Buddhism, Vedanta yoga, meditations: ‘occupied’ states of physical aloneness. In general I believe that eastern man sees the social patterns of language and thought not as ultimate truths, but rather as social conventions. He doesn’t make the mistake of seeing his language or his institutions as being the ultimate reality. He sees them as rules that change, and the problems and anxieties that arise out of social events are not seen as paramount—nature is. In examination of the eastern cultures, it becomes apparent that the dichotomy between the subject, man, and the object, environment, is not as marked as it is in the west.

My own experience in the field of Melanesian mental health gives me the opinion that Melanesian man is not yet experiencing the feelings of aloneness and separateness that man in the west has been and is experiencing. The Melanesian, in my opinion, is not yet alienated from his environment. Why? Firstly, I believe, because he gains his primary identity from a strong, traditional extended family system. Within this his social role expectations are made very clear. Secondly, the satisfaction of his needs is obtained primarily through working with others in a relatively natural preserved environment. He is a grower of crops, a fisherman, a hunter. He works with nature, and is intimately dependent upon his natural ecosystem for the satisfaction of his needs. Thirdly, western science and social institutions have not yet subjugated him to an artificial system of responsibility. With inevitable cultural change, however, the environment and people’s social roles also change. I believe I am already beginning, with my colleagues, to see individuals who are in conflict with their responsibilities to extended wontoks (specifically kin, more generally those speaking the same language or living in the same place), to their more nuclear families, and to themselves as individuals. If the questions of science and social institutions are imported from other cultures without sufficient consideration of context, in the words of Alan Watts ‘like bales of hay’, then Melanesian man could suffer the undesirable effects of social role change. Many people in responsible positions are only too aware of the danger of importing some social institutions from abroad, of the dangers of inappropriate application of the competitive individualistic ethic in Papua New Guinea.

Will this be the base for Melanesian man becoming more alone than he is at present? I believe he can cope with change quite adequately, if he is encouraged to preserve his traditional belief in the non-material influences on his life. For I believe that Melanesian man’s present belief system is in some respects conducive to mental health: his Ego is not regarded as ‘skin encapsulated’, he is not incorrectly regarded as the initiator of all his behaviours. I am of the opinion that traditional Melanesian man sees himself as part of a gestalt of physical, social and conscious interaction. His actions are not always seen as having their genesis within himself or in his Ego; he is the subject both of material and of non-material influences in the world.

It is this traditional Melanesian belief that I hope will be preserved throughout cultural change. For then man, although he may be more alone, will not feel lonely. It
is through such traditional realisation and through future encouragement that man’s inner potentials and spiritual search can save him from aloneness in an environment unavoidably involving more and more material factors as part of health and prosperity.

**PETER PANGKATANA**

I should like to consider what people tend to overlook or forget when they are discussing general medical issues, the setting of the actual family in a Papua New Guinea village. Consider the situation of a hypothetical family: one child is sick, and the family is concerned about it. This family consists of two children, a father, a mother, two uncles, two aunts and their three children, a grandmother, and a grandfather. The grandmother is also sick, and the witch doctor has just arrived and is going to another part of the village to discover who is responsible for the child’s sickness. The family is discussing the one ‘long-long’, or mentally ill member of the village, whom they suspect may have something to do with it. This is their situation and they are taking care of it their way.

The village is four hours walking distance from the nearest aid post, their only medical service facility. Of the two children the one that is not sick, the younger, is malnourished (a third was stillborn). Clearly our discussion must concern itself with all the factors, all the problems of such a family and their village. The family is a very large one, part of a community, and we must consider this when we try to provide medical services.

We must also consider the motivations of the village. Of course any layman can say that there is no need for outside interference, they can assess their own problems and call out when they need help. Yet with the introduction of medical aid, of aid posts, and of medical education, the local community is clearly undergoing extreme changes if not some sort of disintegration. The introduction of the ‘kiap’ administrative system, the communications system, the aid post system and new diseases has affected the pre-existing disease and health pattern.

With the introduction of the aid posts, which are the backbone of the medical service system in Papua New Guinea, and of orderlies who act as local doctors, many (though certainly not all) children have been vaccinated. New health patterns have produced profound changes in the general environment. These changes are felt not only in the rural areas, but also in the urban areas. Younger people living in both isolated community systems and newer urban systems find great difficulty in coping with all the parts of this changing national pattern; a good example is provided by the Highlands labour scheme which brings Highlanders down on contract to work in the lowland and coastal regions.

Why should these changes be directly associated with health? Most people will say we have to have health centres, but these might turn out to be another agent in the modification, the destruction if you wish, of the pattern of life of the people.

Health must be planned beyond health centres and accordingly the various problems have been considered and incorporated into the design of Papua New Guinea’s overall national eight point improvement plan. That is good in terms of paperwork but what does it mean in terms of practicalities for the people? The aim of the improvement plan, and also of the five year national health plan of the Department of Public Health (1974), is to improve the quality of life for all Papua New Guineans, to promote the security of the Melanesian people. We know, for example, that there are high malnutrition rates in various parts of the country, and we know that
if we focus on a complex health issue like malnutrition, we can improve the overall health level and quality of life for the people.

These plans are not going to succeed unless they have the support of the people and their leaders at local levels. These people are not immediately involved in carrying out the master plans, but yet their knowledge and their co-operation are essential for success; if they are *not* involved, then all the words and all the plans become, in the Pidgin term, so much *maus-wara*: verbal spray.

**K.J. PATAKI-SCHWEIZER**

In summary, I should like to note particularly three of the constant concerns of this symposium: nutrition, psychology and health delivery services.

A strong concern for the nutritional effects of social change and technological development has been evinced. Since malnutrition varies in the severity of its effects, it is hard to pinpoint relations between social, environmental and economic factors, in part because much of the relevant information is still unavailable. There are evident extremes of malnutrition at both ends of a rural-urban continuum. There is also a relation between nutrition and infection, and we can to some extent influence the nutritional level by reducing susceptibility to infectious diseases. Of course the reverse effect of nutrition on infection would also hold: improved nutrition reduces susceptibility to infection. Although the former is the less dominant aspect of the two, it does have its place in health care programs and health assessment.

A strong interest is also evident in the relation between psychological alienation and the physical environment. While alienation involves the failure or incapacity to communicate, it is not uniquely the property of an easterner or westerner; it has to do with the particular institutions of a culture. Man is both an individual and a social product, and in cases where social institutions begin to break down or cease to serve their original functions, the sense of aloneness and alienation is increased. Since communication occurs in many ways, this may be extended to exchange with the environment, especially in times of rapid socio-cultural change.

In more specific terms of communication by health services, quite often people in trans-cultural situations, and in alien environments such as hospitals, misunderstand and feel they are being spoken to rudely. Part of the solution is to use local people such as midwives and translators and to set up training programs where necessary to promote communication and to minimise misunderstandings.

It is particularly important that realistic and sensitive attention be given to all aspects of health delivery. Because of the difficulty of defining health, and because man everywhere perceives himself somehow in relation to the environment around him, more and more research has recently been done on incorporating traditional medical practices and attitudes into modern education, since as methods they have in part been proved over time. Many realise that these channels and methods exist in villages and can be tapped, yet they call for more efficient and sensitive administrative organisation and for local doctors to co-ordinate them (Pataki-Schweizer 1975). At the same time we must face newer problems such as overpopulation and malnutrition already evident in certain areas; studying regional contrasts may produce good comparative data and methods. Clearly the problems also call for education at all levels and for a continual feedback of education and information to the people. Department of Public Health policies have to be tailored to local needs and expectations as much as overall plans, and this requires local data and continuing reassessment; there is the dual need for general educational philosophy and specifically tailored departmental
policies. Students in medicine at UPNG are therefore regularly and increasingly exposed to medical work as they go through their training, in various parts of the country from coastal regions and islands to the Central Highlands.

Health aspects of traditional practices, such as livestock running freely and faecal contamination, are also factors. Here the solution lies not in eliminating the original practices but in restraining or redirecting them so that the benefits do not involve immediate health hazards. Both economics and logistics are involved in promoting health services, but of equal or greater importance are the attitudes of the people, which take longer to change. The plan now in effect for Papua New Guinea states quite clearly that priorities will be given to children and to people in the rural areas.

Much interest has been shown in the possible use of traditional healers in contemporary health delivery schemes. The example of the Navajo tribe in the south-western United States is informative here (Bergman 1973). These North American people are trained in selected medical-clinical methods and provide rapport between traditional and modern healing. They refer patients to western medical facilities when western medicine is called for, and to traditional Navajo methods when they believe that it is necessary. The success of such a venture depends partly on government support and funding, and in the Navajo case these have tapered off somewhat. It is difficult to generalise from culture to culture, especially since the Navajo have a very strong and elaborate culture and very developed methods of healing, but there is no reason why such an imaginative approach could not be tried in Papua New Guinea (Burton-Bradley 1969).

The task involves availability of traditional medical practitioners, their willingness to learn, a high degree of village co-operation and universal willingness to respond. In effect the idea is so novel that a program must be formulated to put it into practice. The program might achieve considerable success, however, because, while attitudes learned early in life are not easily changed, such ‘parallel learning’ could be more effective and possible than relearning, especially if it incorporates creative dimensions such as art and therapeutic self-expression. As throughout this symposium, immediacy and mutuality of meaning are more than evident issues, and equally so is their need.

References


IX Planning and the environment
This chapter looks at ways in which technology can be used to achieve self-reliance. Two themes emerge—that no meaningful progress can be made without genuine consultation with the people at grass roots level and that modifications of certain traditional ways of doing things are often more satisfactory than imported conventional technology.

JOHN TO VUE

Of the Government’s eight aims, self-reliance, ‘not depending on others for help’, is the most central one. Self-reliance in this context is impossible, because complete political, economic and/or technological independence for any community is impossible. Nevertheless it is an ideal state towards which a community could strive if it so desired. I have decided to add four words to the dictionary definition—self-reliance is ‘not depending on others for help’ as much as possible.

By far the most important requirement for self-reliance is, of course, the psychological acceptance of one’s own way of life during the process of change. A community has first to accept the realities of life. It has to realise its own resources and capabilities and their limitations. At the same time it should have the determination to master its own affairs on the basis of its own capabilities. That is it should be ready and willing to take its own initiative—to conduct its own political, economic and social affairs in its own way. By doing things thus, the community would be liberated psychologically, which in turn would generate determination to become more and more self-reliant.

Assuming that there are checks and balances existing within a country to maintain community mindedness and interest among members, the degree of self-reliance could almost be controlled and regulated—like water through a tap. But it could only be made possible by regulating and controlling foreign technological inflow, that is by curbing the demand for imported goods and services. This, in my view, would be an appropriate step towards the use of appropriate technology for self-reliance. By restricting foreign technological inflow a community would find the time to apply traditional technology; to use existing appropriate technology; to modify any imported foreign technology; and to decide on the type of foreign technology to be imported.

Various mechanisms can be used as control measures:
(a) an industrial development policy that could emphasise the use of appropriate technologies and restrict those that are not appropriate (it is understood that the Papua New Guinea Government is already looking at this);
(b) control of foreign investment, which would restrict inflow of technology through the various production means and through imported commodities (I believe NIDA is already working along this line);
(c) employment control to restrict the inflow of personnel oriented towards the use of modern complex technologies;
(d) rapid localisation of ideologies, which would play a supporting role to (a), (b) and (c).

JOHN WAIKO
This comment arises out of the difficulties that some of us are facing in the village and consists of some thoughts on the possible alternatives that face villagers of this country. The obvious question in regard to appropriate technology is: appropriate for whom and for what? This is not a technological question at all. It is a political and ultimately a moral and philosophical question as well. My own answer is to maintain autonomous subsistence life as far as possible. Subsistence living is the foundation because it is based on the resources we have—our land with its riches—without being geared to destroying those resources. It is the only long-term independent way of life available to us. It is autonomous and sufficient unto itself. In my view cash needs should be kept to a minimum and the methods of obtaining the cash should be those disrupting the subsistence economy least. Replacing imports with home manufacture is important because it increases independence from outside pressures. Further manufacturing for internal trade (a traditional Melanesian activity) disrupts the subsistence base less than selling vast amounts of our primary resources. Eric Wolf describes the effect of western economic behaviour in some areas in this way, ‘Where previously market behaviour had been subsidiary to the existential problems of subsistence, now existence and its problems became subsidiary to marketing behaviour’. I regard this change as being destructive because it means that existence gets less and less pleasant while entrepreneurs get richer and because it points along a road of progress that does not lead to a good life for our people.

This is not to imply that we have the perfect life now but only to suggest the road to take. Subsistence farming as practised may not necessarily meet the aspiring needs in the villages; therefore we must look further, not to the outside, but to resources within the village. What sort of things can we use for a happier life within the village? Ideally indigenous technologies should be enhanced and evolved. I am thinking, for example, of the traditional system of trading stone tools, which could be adapted for metals that can be extracted here and do not have to be sent overseas. The point is that introductions must stem from what the people have at the moment; only then can they involve the people and give them control over the technological progress. Thus for metals we need to have a drum forge that can be worked in the village. In many places in the world people still work their metals by hand and in all metal cultures they once did. Australia today does not happen to be a country of blacksmiths and so we in Papua New Guinea have gained the impression that worked metal requires heavy machinery. We have to learn that man makes and shapes metals and we are men.

Looking at the same issue from the national point of view it is ridiculous for us to be selling copper, and for that matter raw timber, to the monopoly capitalists to such an extent that these raw materials are not available to the urban centres of this country. It is even more ridiculous that, by putting together the money earned by selling off vast quantities of primary resources, we can buy from the same capitalists very small amounts of goods that they manufacture from our raw materials. This hardly looks
like a sane economic policy (except to the capitalist we deal with). It certainly is the opposite of self-reliance.

What then of appropriate technology? Given a will to give the rural dwellers of this country a range of skills enabling them to meet many of their felt needs and to keep subsistence viable in the new situation, how do we achieve it? If technologists are to help in this they must develop their responsiveness to the villagers' needs and requests. It is important that people feel they are making new things as they have before made the things they needed. The power regained by making and then using one piece of new equipment is everything; the status felt by owning ten pieces of bought new equipment is nothing. It is because it is nothing that the villager has to buy more and more. It is not objects that are wanted; it is the power of making them. The message to the villagers that they are to take responsibility again has to be very strong. Ideas are needed, not loans.

Melanesians are very good at getting a new crop, or a new technique or a new ritual form from a neighbour they see using it. They are not very good at sitting and listening to explanations of how they could do such and such or even watching demonstrations out of context. The introduction of a new technique has to come from people who use the technique in the context of their everyday lives. Techniques always come surrounded by other bits of culture and the culture of the western school room is not a very suitable one for the Melanesian village. Thus the role of the instructor technologist is that of technical adviser and inventor but he is useless without assistance from an individual who would use the technique while living with the people. It is not always reasonable to demand that the same person be both.

We educated Papua New Guineans, who have been partially taught by the dubious method of listening and watching, not doing, may be able to bridge the gap. This will not be easy because we will first have to understand the new ideas fully and then live in the villages. If we persevere and succeed in really making them part of our own repertoire, then and only then are they in a form in which they can be absorbed into the culture of the village. This brings us to the problem of people returning to the villages. The flow to the urban centres will, if continued, do much to kill Papua New Guinea. Only a radical change in the values of this country as expressed by its politicians, media, education system and other institutions would give any hope of changing the pattern. While an elite believes that town is better than villages, people will continue to come to towns. It will take some time before the migrants who remain in poverty will hate the elite enough to fight them. Only if Papua New Guinea's leaders really decide that they want an improved subsistence society, not a poor version of Australian or Japanese society, will people return happily to their villages, and only then will the villager learn to feel his own strength to the full. Whether they learn to feel this strength with the central Government or against it, depends on the central Government.

We also need something from the universities in our villages. The increased demand from the Government for managers and plantation technicians (foresters and agricultural scientists, who are heavily armed with monoculture techniques) and for lawyers, doctors and economists will saddle us with university products we do not want. These are all people who will aid the cooperation between the central Government and the outsiders, the internationalists. Why will they do this? Because that is all that their training equips them for. They will do absolutely nothing for the relations between us in the villages and the Government.

In the technological fields we need a much lower and more useful level of competence. The few specialists needed in these fields do not justify an emphasis towards more such graduates. What we in the villages need are people of vision, with a
knowledge of historical change and understanding of philosophical issues and social theory, people with a depth of understanding of the basic alternatives that face us. We need people who can understand the implications and the meaning of the choices we must make. We need thinkers, not blind technical executors of policies made without the depth of knowledge to act in wisdom. Much of this needed wisdom is in our own traditional culture, though some we must get from the thinkers of the west and the east who are more conversant with the problems of a pluralist society.

Finally might I say that women are coming to take more and more responsibility in the rural life as men absent themselves; women are less caught up in the high living and the status of the elite life. Perhaps the strongest hope of this country lies with its women and it is about time that we found some ways of lightening their load so that they can make themselves heard not only at the village, clan or tribal level, but at the national level as well.

**PETER FITZPATRICK**

Very generally, alternative technology can be described as technology over which an individual or a small community can exercise comprehensive control and which relates harmoniously to the natural environment. At first sight alternative technology may seem just right or natural for Papua New Guinea. This country remains largely divided into those small communities that the utopian advocates of alternative technology see as necessary. Furthermore, Papua New Guineans usually have a creative but conforming relationship with the natural environment:

Alongside a river in ... (Papua) an old man sits and stares at the water. A tree trunk drifts past: at certain intervals it rises to the surface and then sinks again, always with the same motion. The old man reaches for his drum and softly takes up the rhythm that he has discovered. While he beats the drum, the image of a dance takes form in his mind. So the Orokaiva ... express the process among themselves. The rhythm must be discovered; then the dance arises, which imposes it on the environment, thereby drawing the environment into the movement as well. (van der Leeuw 1968: 15)

More particularly, alternative technology fits the eight aims and national goals; it would promote national and communal self-reliance and decentralisation; it fits in with small-scale enterprises and it would accord more with Papua New Guinean forms of social, political and economic organisation than does complex technology; it entails the conservation and replenishment of natural resources and the environment; and, since existing inequalities can be seen as reliant on complex technology (Singer 1970), a countervailing emphasis on alternative technology could well lead to greater equality.

Perhaps most significant for the aims and goals is that alternative technology can involve greater participation of the people generally in economic life. Systems based on imported complex technology have abysmally failed to provide an answer to the employment problem in third world countries (e.g. Arrighi 1971: 116) and nothing seems to indicate that the position will be otherwise in Papua New Guinea (Central Planning Office 1974: 19). Although adequate prediction in this area is difficult, it is hardly daring to suggest that the employment problem in Papua New Guinea will be an enormous one and one—it could be added—with political implications great enough at least to concern the Government. Here alternative technology can create widespread productive activity by means that are relatively cheap and closely adapted to the resources and skills available to Papua New Guineans. At this ideal level, then—at the level of aims and goals—alternative technology is clearly very apt. Why has it not caught on in Papua New Guinea?
Some technological change is manifestly called for in Papua New Guinea. Several closely related factors—increases in population, internal migration, shortage of resources and various ‘demonstration effects’—have created needs and desires that cannot be satisfied within the existing or traditional technological system. Generally, these forces for change can, broadly, have one of two results: there can be a self-reliant expansion of existing technologies to meet the challenge or, alternatively, there can be a breakdown in self-sufficiency and a dependence on imports that is in turn balanced by specialised production for export (Wilkinson 1973:104). In Papua New Guinea, as in Africa (Goody 1971), local technologies were incapable of accommodating these forces for change and so Papua New Guinea was forced into cash crop fetishism.

An option to employing alternative technology as the basic one is to use it to supplement European technology. With such use typically people would resort to available alternative technology when forced to by the disadvantages of the imported system; but alternative technology would then be something to emerge out of in climbing the overcrowded ladder to the ‘modern’ sector. Thus the ‘second best’ nature of alternative technology would be affirmed and the focus of aspiration would remain the technologically complex system. But if alternative technology is not to be used in this purely supplementary way, then one has to confront the conflict between alternative technology and technologically complex systems.

Technologically complex systems destroy popular technologies that oppose them. As Frank has pointed out (1971:31):

the metropolis has always suppressed the technology in the now underdeveloped countries which conflicted with the interests of the metropolis and its own development, as the Europeans did with the irrigation and other agricultural technology and installations in India, the Middle East, and Latin America; or as the English did with industrial technology in India, Spain and Portugal. The same is true on the national and local levels in which the domestic metropolis promotes the technology in its hinterland that serves its export interests and suppresses the pre-existing individual or communal agricultural and artisan technology that interferes with the use of the countryside’s productive and buying capacity and capital for metropolitan development.

Other writers have used a similar argument to show that structures of oppression and of inequality in third world countries are largely reliant on imported European technologies and thence reliant on the links with so-called developed countries that result from this importation (Singer 1970; Dickson 1974:165–7). This is to describe the relation between these structures and technology in very general terms; ultimately it results in the imprisonment of the individual imagination and the channelling of lifestyle implicit in Illich’s description of ‘the social workers [who] had to socialise tenants [in Venezuela and Brazil] who lacked sufficient schooling to understand that pigs may not be raised on eleventh-floor balconies nor beans cultivated in their bathtubs’ (Illich 1973:63).

The resolution of this conflict may suggest a radical change of direction in Papua New Guinea, but any such change should be relevant and here it must be emphasised that the conflict is not confined to capitalist style development. China, for example, recognises and seeks to accommodate the conflict as an aspect of its philosophy of ‘walking on two legs’—one leg here being complex technology and the other alternative technology. But the success of this balance in China is now very much in doubt and even so the balance is supported by strong and comprehensive controls and by an ideology that is (or at least used to be) sympathetic to alternative technology. In Papua New Guinea controls on a developing complex technology and its effects are not likely to be adequate and the only alternative then would be to prohibit the import and
further development of these technologies and to phase out the bulk of those operating at present.

It is probably fanciful to expect this approach to be adopted yet. But if we accept that things remain open-ended enough in Papua New Guinea to justify some optimism, then the foregoing analysis does suggest some particular courses of action perhaps worth considering:

1. At the village level, to help existing forces—such as Yangpela Didiman (Hemmes 1974)—which promote that liberating educational process described earlier. This help could include urban based work in setting up an alternative technology resource centre.

2. At the governmental level, to work, through relevant research and assistance, with those bodies that have or will have some power to restrain complex technologies such as the Ombudsman and the National Investment and Development Authority.

JANE COOKE

In our country we all talk about village development—development of the average citizen—and about trying to avoid producing an educated elite. But then we meet in fancy big rooms and say big words to each other. I will try to use words that all my friends can understand. Talking about appropriate technology, I would like to ask the question ‘appropriate for whom?’ For the individual person, or for the economy of the country, or for those big people who like to invent all these things? I have a feeling that the big people sit in their big offices and decide what sort of economy or business our people should have and then ask what the appropriate technology for it is. I suggest that our big people must get out and meet the people and talk with them—and even live with them—and find out what they are really thinking, which of these new ideas they are really interested in. I have heard some people say that if they ask the villagers what they want they will answer that they want a road, or a bridge or some big thing. I think this is what the big people call the ‘road and bridge mentality’. Well, if I came to your door and, when you asked me why I came, I said, ‘I have a million kina and I want to give you something—what would you like?’, what would your answer be? Would you be able to give an answer quickly?

What does this have to do with what I am meant to be discussing, women’s tasks that can be improved with appropriate technology? Let me explain my point. Recently, when discussing the problem of malnutrition someone said that unless the people recognise the problem themselves there is no problem. He meant that if mothers do not realise that their children are not as strong as they might be, they are not going to be interested in new ideas about foods and cooking. It is the same with appropriate technology—if people don’t feel there is a need for these things they will not be interested in them. It is a problem for the women I work with to get firewood for their cooking, since they have to go a long way. The alternative is to use imported kerosene, which is expensive. What we should have is a small charcoal industry in some of the villages around Port Moresby which could then sell charcoal to my women—appropriate technology!

But let us go back and sit with the women for a while. Once or maybe twice a week they must get firewood. It is decided to go today. Everyone gets dressed and puts flowers in the hair and sings while waiting for a PMV to come and they go out to Brown River or somewhere and get their firewood. If we have a charcoal industry I wonder if the women will put flowers in their hair when they go across to the trade store? Obviously the present arrangement gives some of them satisfaction. True, the
women have a social outing. But, the experts say, the smoke from the wood fires in the houses causes some sort of trouble with their lungs so there is a problem and we should change something. Well my point is that we must sit with the women—and the men—and explain that the smoke causes sickness. Not give them a lecture, but spend time with them until they can understand about respiratory disease and how smoke can cause this. Then the mothers will be concerned and perhaps start trying to use kerosene—or smokeless stoves—or bottled gas or something. But they might find that this is too expensive. Then is the time to start thinking about a charcoal industry, when the problem has become one for the people.

I am being idealistic, and my example is not perfect, but this does not deny my point that we must help our people understand the things that are behind these new ideas as well as to worry about which is the most appropriate solution. This is the community development process; our educated people must learn to sit with the people and help them understand. Then they must help the people choose which of the many problems they want to solve. Only then should we start to worry about which is the appropriate technology.

Please do not misunderstand me—I am very much in favour of an appropriate technology as opposed to the machines and processes that many of our planners now talk about. But if our people do not understand the reasons for introducing some of these changes then any technology is inappropriate. Perhaps the solution to what is appropriate lies as much with improving the human skills of those introducing the technology—or those choosing what is appropriate—as with teaching people to accept appropriate technology rather than ask for big things like trucks or tractors. So while we educated Papuan Australians must familiarise ourselves with what appropriate technology can offer, let us not stay in our carpeted offices, but rather let us organise ourselves to have the time to discuss these things with our people. When we have come to understand the worries of these people, then let us try to discover the appropriate technology.

MEG TAYLOR and ROSEMARY HEMMES

Yangpela Didiman is a grass roots rural development movement, started by the Lutheran Church in the Southern and Western Highlands, but very much a people’s movement in the rapidity with which it has spread (150 clubs and over 5000 members), and the enthusiasm and success of various projects. It is an excellent example of what appropriate technology can achieve if appropriately introduced.

Essentially Yangpela Didiman encourages the ideology of self-reliance, yu-inap, specifically with reference to the $50 million food imports of Papua New Guinea. The emphasis is on ‘Yumi kirapim kaikai bilong yumi yet’; new crops have been introduced—buckwheat, oats, rye, sorghum, soya bean, sunflower and silkworm, bees, goats, pig and poultry projects are also popular. Water buffalo are being introduced in lieu of tractors.

A film available of Yangpela Didiman activities makes very clear the use of appropriate technology. It is not just a matter of factor proportions, capital v. labour intensive, or economies of scale; appropriate technology is access technology as opposed to artifact technology. The people can grasp the technique and make it their own. It is a people’s technology, it enables development on their own terms, and without dependence on bank loans, extension officers and technical expertise, all of which turn people into clients.

In other respects Yangpela Didiman is more ‘Melanesian’. Its all round approach
incorporates sports, competitions, string bands and sing-sings as well as agriculture instead of bisis or cash crops. It stands as an example to Papua New Guinea of how a rural community can successfully live a traditionally oriented life in the twentieth century.

LEO HANNET

On Nissan Island we are presently carrying out a project on ecodevelopment, development that takes into account the various factors in our society or in our life, the economic and political situation as well as cultural values.

In the Bougainville District, as well as major works, we have village improvement projects. The assistance money is used on a kina for kina basis, except in areas where people have been the victims of the vicious circle of poverty and there is a need to inject some money to get them off from first base. In this program our main concern is to:

(a) improve the quality of food and protein intake in the village, that is diversify the types of crops;
(b) improve the water supply systems in the villages through small hydro schemes or supplying pipes and extending water to a particular village;
(c) improve the standard of housing in village areas, perhaps through better use of timber resources; the provincial government is trying to set up a sawmill which will sell timber at strategic points and is making bricks from coronus or cement;
(d) improve the supply of electricity to rural areas through hydro schemes; we have put aside K60,000 for these schemes.

In Bougainville we have a big dilemma: highly industrialised technology was introduced willily to our island whose people are essentially struggling peasant farmers. Without closing our eyes to the realities that are on Bougainville, we have minimised bad effects of the copper mine and other types of development through the Bougainville Development Corporation, which tries to hive off any enterprises started by big foreign firms or at least complement or take over their work or business. So far there are four subsidiary companies: the Bougainville Air Service to improve communications; the beer shops in Panguna (which we took over); a shipping enterprise servicing the outer islands and transporting fish and copra; and a catering business for Bougainville Copper Limited. Bougainville Development Corporation is being created in part to take control of these big businesses; perhaps it is appropriate that a body acting on behalf of the district should take care of and eventually distribute the shares to each of the 30–40 village governments.

We plan to cope with our present problems by attacking each at its source, at grass roots, and to this end we have undertaken a pilot project to create an integrated form of rural development. We have taken on Nissan because it is a place that has been considered by the previous administration as beyond possibility for development. The people are told that they cannot improve themselves; they have internalised this and bit by bit lost any initiative. This area, which refused two years ago to have a council or pay tax, managed in 1975 to raise K10,000 to buy its own boat. And it now has something like K2000–3000 tax money for self-improvement.

Nissan Island, 7.7 sq km and shaped like a doughnut, has an extensive lagoon. Its 4000 people (projected to be 15,000 by the year 2000), are primarily dependent on agricultural products, mainly coconuts, taro, sweet potatoes and bananas, as well as sea products such as fish, oysters, prawns and crayfish. The plan aims to help the people of Nissan become self-reliant by operating at a level of technology more in
tune with the capabilities and resources available to them in their rural environment; it offers an environmental or ‘integrated farming system’ as G.L. Chan has described it. The concept involves an ecosystem built around the principle of the methane gas digester, utilising human or animal wastes to produce a water-waste-fuel-food-minerals-materials cycle. The plan recommends that no change be made in the traditional sanctioned pattern of village residential development, which demonstrates the remarkable initiative of Nissan Islanders to exploit local resources of materials and manpower. Active steps are being taken to encourage these qualities; for instance, people have used scrap material from World War II, together with stabilised corocon blocks made from crushing local coral and cement. Agriculture forms perhaps the most important basis for ecodevelopment on Nissan. The most economic farm unit recommended is a cluster of eight families (or multiples thereof) each of whom could farm land of approximately 0.75–1.00 ha.

Where possible improvements are to be financed locally. Outside assistance will be necessary initially until the integrated farming system gets into gear. Local financing could be promoted by establishment of retail, agricultural and fishing co-operatives and of a village government council, which could apply for economic development loans. It will be interesting to see whether Nissan Island will provide a model for other rural Papua New Guinean communities.

M. SIMPSON, A. POINTER and H. WEBSTER

Left to itself any society will produce an appropriate technology, one directly related to its environment, and to materials available within that environment. The Eskimo produced a snow block technology and the Egyptians on the banks of the Nile produced a mud brick technology for their building requirements. And Melanesia, too, produced an appropriate building technology. In traditional Papua New Guinea society timber was, as it still is, available in abundance. You cut down a tree, built your house and, when in ten years the house required replacement, you went out and cut down another tree. If you replanted as you cut down you had a renewable resource. These buildings had various advantages: they were abundantly available; they were cheap; they utilised traditional skills; they were weatherproof; they could be decorated; they were relatively durable; they did the job required of them. No policy decision was made to use the timber resource, yet no better example of an appropriate material and an appropriate technology for it could be offered. And the technology reached a high degree of sophistication.

Doubtless if Papua New Guinea society had remained static traditional technology would have been sufficient to cope with any requirements it was called upon to deal with. However, it has not remained static and, following the 1962 United Nations report, a rapid program of development was undertaken. Unfortunately much of the policy seems to have been based on expediency. With the built environment the long-term effects of such a policy can be visually, socially and economically disastrous. It has been expedient to bypass traditional lifestyles, it has been expedient to rely on imported technology, and saddest of all it has been expedient to rely almost totally on imported building materials.

The nation requires an expanding construction program, but inflation in the countries that presently supply Papua New Guinea with building materials is pushing up the costs an alarming rate. It is a case of increasing demand accompanied by decreasing funds. At present building costs are kept down by the simple expedient of designing smaller and smaller buildings—which cost progressively more and more money.
Thus the results of relying on expedient technology are all about us. The ‘ticky tacky’ boxes erected throughout the country bear no relation to the needs of Papua New Guinean society; they are but dreary models of European buildings, frequently totally unsuitable for their environment, designed to be erected quickly with a minimum of labour, relying on imported materials, techniques and philosophy of lifestyle. The real tragedy is that the present technology has become in the minds of many a status symbol. What the architect Robin Boyd described as the Australian Ugliness is not only alive and well in Papua New Guinea—it is flourishing.

**Hap Skinner**

As an example of alternative technology, I should like to explain how to excavate, transport and deposit large amounts of fill without heavy mechanical equipment. Essentially the method is based on principles that have been in use for centuries by gold prospectors. The two basic principles used to separate gold from soils can be applied to the movement of large amounts of fill: running water will keep soils suspended in it; running water slowed or stagnated will let the soils settle out. The process is as follows.

1. A channel is dug through soil that has to be moved. The channel must be deep enough to carry a sufficient volume of water to move loose soil.
2. Water from a point above the excavation site is diverted from a stream or river into the channel.
3. Soil is loosened from above the channel and dumped into it. When the cutting face or excavation site is more than 3 m away from the channel, a new channel may be dug at the bottom of the cutting face.
4. As the muddy water reaches the dumping area where the filling is required, the water must be slowed down so that the soil can settle out. To accomplish this the water must be allowed to spread out over relatively level ground.
5. Fences or barriers made from local materials, for example bush timber, bamboo, pit pit, leafy branches, kunai and soil, are constructed at appropriate positions. The water passes through the first fence but the heavier soil is trapped and retained until the desired level is obtained.
6. At this stage the next fence is blocked off and the process is repeated at the next highest level until here also the required level is obtained.
7. After sufficient time to allow the ground to dry out, the fences are removed and the terraces or steps levelled. On steep slopes and areas where there is no need to remove the large fences, the stakes can be anchored back into the hillside for extra strength.

If adequate levelling pegs are installed and correctly observed, the cutting and filling may be achieved in such a way that little final levelling is required. Proper control of water is essential at all times, as too much water can wash out many hours of work; it is for this reason that water is sometimes discharged parallel with a fence and not at right angles to it.

The method has been successfully employed to build airstrips at Naniwe and Langimar in Papua New Guinea. At Langimar, during a total of nine weeks working with the local people, three Summer Institute of Linguistics volunteers were able to:

(a) move 10,700 cu m of earth (approximately 125,000 wheelbarrow loads);
(b) gain 189 m of new airstrip;
(c) remove a dangerous dip.
(d) gain the necessary flyovers;
(e) have the airstrip approved for commercial use.

The entire project at Langimar was completed without any heavy equipment and for a minimal capital outlay for labour and simple tools.

The process requires water above the excavation site; a proper ratio of water/volume/slope; and readily available unskilled labour. In addition to airstrips it could be used for constructing roads, levelling sports grounds, terracing gardens, levelling village sites, and any other movement of earth.

**E.J. HOVEY**

In the past people have talked about low key technology, low impact technology, intermediate technology. We now have people talking about appropriate technology. I personally prefer the term appropriate technology, but they are all forms of technological development or technological transfer, and the questions that should always be asked are:

(a) appropriate for what?
(b) appropriate to which situation?
(c) appropriate for whom?

Two basic areas that require comprehensive technical assistance and development in Papua New Guinea are: community quality of life and community productivity. Community productivity, my principal concern, relates to the development of commercial or industrial items, that is, of cottage and small industries. If we then consider the problems of the definition of ‘what is appropriate technology?’ we should have parameters for technological input. Basically I believe it boils down to two other questions: ‘does it work?’ and ‘is it needed?’ If these two questions are answered in the affirmative then we should use it.

There is a tendency for a great number of people, especially non-technologists, to think of the technology as used by the developed or industrialised nations fifty or sixty years ago or highly simplified jam tin type mechanical devices. I believe both these themes to be fundamentally incorrect and I ask the question whether it is more difficult for a Papua New Guinean to learn to use the most modern technology available, or an obsolete technology of fifty or sixty years ago. With any commercial or industrial endeavour to be competitive and to survive it must be based on the most modern appropriate technology available, not on an obsolete idea or methodology. The basic assumption then is that the appropriateness of the technology depends on the ability of a client to understand, assimilate, operate and maintain that technology; hence the concept that appropriateness is dynamic and varies according to a mixture of factors, that is:

(a) community needs;
(b) the level of sophistication of the client community;
(c) the availability of maintenance support;
(d) the interstructural support;
(e) the physical environmental factors;
(f) the economic factors.

The success of any technology or technological transfer depends on the acceptance and confidence of the client community and it must be meaningful in terms of the community’s aspirations.

Too often we find that, in order to gain acceptance for a project, field staff make statements as to performance, productivity or other benefits to be derived from a
technologically oriented project. This all too easily creates unrealistic expectations, which invariably lead to disappointment and in many cases to the rejection of the technology and the project. To avoid failure or rejection the following guidelines should always be followed:

(a) identify the community’s aspirations;
(b) derive a range of alternatives;
(c) test to determine the most appropriate input and consider all the possible disruptive effects of the introduction of the technology on traditional social and economic structures;
(d) test the general feasibility of the technology before making promises to the client group; and
(e) confine the performance statements to conservative levels.

In Papua New Guinea too often the choice of equipment has been made by people with no specialised knowledge of the options that are available or with no experience of machinery or even with no real understanding of the physical, social or economic circumstances of the client group. This leads to inappropriate technical inputs and failure. Many technical errors of this nature could be avoided by consulting experienced technologists. Again, inappropriate equipment is often purchased because of cost considerations. The new-car-every-year concept is inappropriate in Papua New Guinea. Equipment of a disposable type presumes certain operating criteria in order to perform satisfactorily for its planned service life. In the rural areas of Papua New Guinea, owing to the environment and the shortage of skilled operators, design criteria of this nature are seldom obtained, with the result that great amounts of machinery do not survive designed lifespans. It is probably wiser to select machinery that is over-engineered and to disregard the marginally higher cost factors. Papua New Guinea’s relative isolation from the mainstream of modern technology imposes restrictions on the types of equipment that are generally appropriate. Some of the desiderata for appropriate machinery or equipment are:

(a) it should be over-engineered and therefore durable;
(b) it should not require extreme accuracy for alignment or heavy foundations;
(c) it should not be affected by earth movement;
(d) it should require simple routine maintenance and a minimum of in-service adjustment;
(e) it should not require specialised lubricants, tools and gauges;
(f) it should not be sensitive to voltage fluctuations in electric supply;
(g) it should be protected against the environment in which it must operate;
(h) it should not use or produce toxic, noxious or dangerous substances;
(i) it should have no significant effect on the environment;
(j) it should have an adequate spares back-up supply organisation;
(k) it should provide direct feedback to the community in terms of productivity;
(l) it should have no effect on the environment;
(m) it should be reliable.

In conclusion, there is one final need to assure the success of approved technological projects: that there is a co-ordination of effort and information. It is surely inappropriate that we have different groups attempting to promote a similar project without the knowledge of and consultation with each other, or different groups making ad hoc decisions on what is appropriate and attempting to introduce methods and equipment again without consultation with each other.
References


In developing countries, a concern for the appearance of the built environment—what the cities, towns, villages, roads, bridges and harbours look like—is often neglected. Priority tends, with good reason, to be given to profound issues dealing with policies for promotion of food production, utilisation of energy resources, control of foreign investment, urgency of education, inadequacy of employment, decentralisation, law and order and protection against pollution. It is true that the mere presence or absence of a building such as a community centre may be so strong as to generate or prevent significant community activity. Of deep importance on another level in Papua New Guinea today is the way that the structure, design and materials shaping the built environment will help both to structure and to reflect this country’s emerging identity. The examples of China, Israel, Hong Kong and Malaysia show something of the variety of ways that character can be expressed or eroded by buildings. The fact that the perception of ‘beauty’ is subject to a complex interplay of external and internal symbols and influences should not deter people from striving to create a built environment that will contribute to national goals. Papua New Guinean aesthetics are being given increasing attention, as evidenced for example by the University of Technology’s progress towards an architectural archives. The challenge is to proceed from an awareness of cultural resources and traditions towards a practical and socially responsible and responsive future.

In developing countries, a concern for the appearance of the built environment—what the cities, towns, villages, roads, bridges and harbours look like—is often neglected. Priority tends, with good reason, to be given to profound issues and policies concerning promotion of food production, utilisation of energy resources, control of foreign investment, urgency of education, inadequacy of employment, decentralisation, law and order and protection against pollution.

Policies are pronouncements on paper. Often it is not until human activity becomes noticeable, especially in the form that leads to the construction of buildings, that the consequences of a policy can be assessed. The mere presence of a building such as a community centre may be so strong as to generate community activity. The absence of that community centre building may prevent any significant community activity. Buildings are not, however, usually the prime causes of personal or social actions. The built environment is rather the effect, the end product, expressed in tangible form, of the thoughts, values and aspirations of human beings.

The mental energies of the politicians, managers, advisers and report writers in a developing country may well be directed towards policies of national control and development. But there is another major theme that keeps emerging and that comes from farmers, villagers, fishermen, artisans, clerks and students as well as the decision makers. This is the quest for an obvious national identity that can be seen, described,
appreciated and criticised and that functions as both a philosophical symbol and a physical reality.

There is an inevitable national identity in the legacy of the natural environment, from tropical rain forest to kunai grass valleys, palm fringed shores to meandering swamps, torrential rivers to misty highlands. But this countryside existed before national awareness and national independence and hopefully will continue to exist. The landscape is circumstantial, not symbolic. Mankind is the only conceited animal; nothing convinces men more of their own importance and identity than the things they do themselves—from chopping down a tree, building a *kundu* or a Concorde, a canoe paddle or a Parliament House, poetry or painting. Mankind is also the only creative animal. The appearance of things built by man can endorse, encourage, supplement, deny or destroy the formation of natural character. If we accept that the appearance of the built environment matters, and that the groping for national identity is both real and desirable, then we must explore further, by considering visual perception in the light of cultural traditions and innovations.

In the end, we are seeking reliable ways of committing ourselves to assessment of the man made environment that will allow us to say such things as ‘keep it there’, ‘destroy it’, ‘modify it’, ‘let us have no more of it’ or ‘do it again’. Out of these assessments we would like, for the nation’s sake, to anticipate a policy that would guide the actions of ourselves and others so that a satisfactory, even an exciting, response from the community to things built in the near and distant future is, if not guaranteed, at least highly probable.

**Visual Perception**

We do not see clearly; our visual perception is prejudiced. Our eyes look at our environment and the messages filter back not only through lenses and nerves but through the whole mental and emotional pattern of our being. We tend to see only what we want to see, and what we expect to see. We have preconceived notions of what is going on. We need to have some preconceived notions, otherwise the millions of signals the eye receives would remain as formless as a lump of sago. The patterns we use to order the visually perceived environment are patterns learnt, or perhaps merely acquired, from the trial and error experiences of childhood, from the behaviour of parents, other adults and peers. Everything I have seen before, and everything that has been said to me about what I have seen before affects what I shall see next.

Some black people find it impossible to imagine that a white person could ever be beautiful. Some white people could never acknowledge beauty in a black person. Some people manage to cast away the blinkers of prejudice and trust their eyes to judge black and white, beautiful or ugly. Nevertheless, being racially unprejudiced cannot guarantee, by itself, the ability to make visual discriminations related to beauty, any more than intellectual brilliance can. More than a few distinguished scientists are aesthetic morons. We need to want to see. If never used, the sense of looking and appreciating can soon shrink and atrophy.

As well as the accidents and particularities of our personal and shared histories, the circumstances of the moment of observation may also affect our appreciation. For instance, on a cold rainy day at the Acropolis in Athens, it may be difficult even for an enthusiast to work up to a high pitch of architectural appreciation; to a man whose wife has just run off not with his best friend, but with someone he hasn’t even met, the smile on the face of Da Vinci’s Mona Lisa may be more infuriating than sublime; to a tourist stricken by a massive bout of malaria, the Haus Tambaran at Maprick may appear as something less than magnificent. Paradoxically, some people would argue that
a degree of physical discomfort and psychological tension is desirable for a creative artist. I believe that this view is mostly put forward by biographers, bureaucrats and businessmen and is motivated by their own sense of inferiority and inadequacy when faced by the creative act. So they plot a revengeful payback myth that seeks to promote suffering as a necessary condition of work for those whom they grudgingly admire but cannot emulate. But there is even some truth in what they suggest; a creative response can be the cathartic product of conditions of stress and duress. The artist saves himself by leaping, with his active imagination, out of unendurable personal crises and social disasters. He may also happen to create a few of those problems too, on the way out.

This sounds like a very confused state of affairs. If assessment of the visual aspects of the built environment depends so much upon quirks of personal fate, the whole cultural heritage to which we are born and the physical and psychological states of the moment, how is any kind of stability, reliability and independence of judgment possible? Are we trapped by the tyranny of time, place and personality?

Although we cannot expect to find universality of opinion amongst individuals, groups or nations, what is remarkable is that a concern for the visual environment is universal. Each human society has words and phrases that are used to describe aspects of the environment in terms of approval or distaste, and to express a preference for one artifact (anything made by man) over another—whether it is a planted arrangement of flowers or the painting on the outside of a building. The highest accolade is usually expressed in terms synonymous with or an equivalent counterpart of the English word ‘beauty’. Aesthetics is concerned with the study of beauty. In the western world aesthetics has become such a precious study that it has almost refined itself out of existence. Certainly the goal of beauty, with all it implies of a rather remote, exquisite and balanced quality, is a goal that attracts very few artists, sculptors and architects these days. And so aesthetics has come to involve itself with a wider range of perceived expression than the simply beautiful or the beautifully simple.

Those who are alert in the world of the arts recognise the very special traditional sensitivity of Papua New Guineans to concepts of form, design and ornament. It is a sensitivity that begins quite literally skin deep, in body painting and tattooing, extends to body decoration in the forms of flamboyant costumes, masks, head dresses, necklaces, arm and footbands, beyond the immediate personal adornment to shields, drums, implements of war and agriculture, beyond this again to buildings, village design and landscape and into the art of the human being in space—the theatre of mime, song and dance. The whole conspectus of human aesthetic endeavour is encountered, but it is not as art for art’s sake. It is part of a whole set of social, mythical and cultural values that were firmly held by each particular community. When these values change, as they are changing now, the creative impetus fades. And although it wounds me to say so, and will wound some of my friends, one has to be honest enough to admit, in the words of Professor James Weaver, an economist from the USA: ‘The American Indians and the Australian Aborigines stand as constant reminders of what happens to a technologically backward society when it is confronted by a technologically sophisticated society. They got zapped.’

Of course, we can preserve to a certain extent. We could say, for instance, that Red Indian war dancing is alive and well and living in Disneyland, where for a few dollars every afternoon painted redskins with pale-face values perform a weak mockery of their culture before an international audience of thousands. Culture is a living thing, and if its sustenance is removed, it dies. The tourist agencies are, of course, adept at giving a senile culture the simulation of life by keeping it in the aesthetic counterpart of an iron lung. Sometimes I feel I prefer cultural euthanasia.
Returning to the consideration of traditional aesthetics in Papua New Guinea, we must realise that much that has been written about ‘artifacts’ consists of physical descriptions, attributions of locality and usually rather vague references to the purpose or significance of the article; there is even less reference to its intrinsic qualities as design. Of the large inhabitable artifacts we call buildings, the evidence and documents are even more fragmentary. Rather late in the day we at the School of Architecture and Building at the University of Technology at Lae are endeavouring to assemble an architectural archive consisting of historical photographs extracted from a variety of sources, reminiscences and field visits to extant examples. In this we have had tangible support and encouragement from the Institute of Papua New Guinea Studies. In fact, in the opening issue of the Institute’s magazine Gigibori are three articles that are amongst the first of their kind to take Papua New Guinea aesthetics seriously.

The first article, by Sir Albert Maori Kiki, begins with a terse and vital paragraph:

In 1939 Christian converts burnt down the eravo, the big men’s house in Orokolo. Even though the Christians were a tiny minority then, the elders decided not to rebuild the house. They had already lost confidence in the culture of their forefathers. The old ways had failed to protect them against the white man’s power and their traditional world view did not enable them to interpret some of the rapid changes that had overtaken them.

The article goes on to describe the continuation, almost as a subterfuge, of the art form expressed in the marapai: ‘a dwarf coconut that has clan designs incised on it with a shark’s tooth’.

The second article ‘Suau aesthetics’, by Cecil Abel, mentions three main characteristic responses of the Suau people to an artifact that is regarded with admiration; these are the phrases ‘it’s so beautiful’ (ta’i iloro); ‘his hand is very gentle’ (nimana ibiga ariri) and ‘heat’ (gigibori, power, authority or prestige, ‘... a power the carving derives from the ritual that has been performed on it after it has been carved’).

In the third article Ulli Beier discusses aesthetic concepts of the Trobriand Islands and distinguishes three qualities: beauty, ‘it moves my inside’ (kakapisi lula); a quality of good design and craftsmanship, evenness (kala migileo) or clarity (sena boena), and the expression migila, ‘... a magical quality ... [that] depends both on the carver’s knowledge of magic symbolism, which he incorporates into the design, and on the magic ritual with which the finished object has been endowed’.

Bringing these last two descriptions together we find, despite differences in nuance, that they have much in common—an emotional appeal called beauty, for want of a better word; appreciation of skill and good craftsmanship; and an awareness of an ineffable ‘magical’ quality that resides in the context—the story and ritual behind it—rather than the physical properties of the object. Even making allowances for the possibility that these descriptions have been strained through the sieve of the translators’ own linguistic meshes, the kinds of preference being declared are close to the artistic virtues of classical western art. The real range of expression in the observed object, however, is quite different from the ‘classical’, and the quality of magic is a different ingredient again. Yet this quality too has its counterpart in modern day hip-talk (itself a bit old-fashioned now) in turns of expression like ‘I dig it’, ‘It moves me, turns me on’, ‘Has the right vibes’.

What I have been attempting to illustrate is not that there is continuity of value judgment between all nations, but that there is, in all societies, a deliberate concern with the appearance of man made things. There is a difference between the kind of statement that says ‘I like that’, which is a personal judgment, and the kind that says ‘I would like everyone to like that’, which seeks to establish criteria for the community. More ambitiously, there is the kind of didactic, preaching statement, to which the
earlier modern architects were prone; it says in effect ‘men would live better if the built environment was like so and so’, where so and so was the architect’s private vision. We have been trapped already by this sort of manifesto—for instance Le Corbusier’s belief that cities should consist of widely spaced tall towers located in parklike surroundings. This elegant prospect has proved socially disastrous, financially dubious and practically unrealisable in most of the European and American cities that have tried it out. As far as I can tell, it seems that the new building developments at Waigani are being guided by this same futile image.

Personally crafted artifacts engage our minds with thoughts of the object, its creator and its frame of reference. On the larger scale of buildings and landscape, where many people contribute to the construction, where expenditure in either money or physical energy is relatively vast and where the environment is not merely a reflection of society, but one of the determinants of society, aesthetic judgments are not enough. Buildings give us clues, hints and direct evidence of the sort of people we are, the sort of people we depend upon and the sort of people we would like to become. Like an archaeologist deciphering disinterred bones that have been buried for hundreds of years, we can do some detective work on a nation’s architecture, with at least this advantage over the archaeologist, that our clues are for the most part already above ground.

**Environmental Examples**

Let us look briefly at some examples of the built environment in other countries. In Peking, the buildings around two sides of Tien Ah Min Square show all the traces of the neo-Russian phase of Chinese communism. The Russian effect is monumental, un-inventive, dull, with traces even of ancient Egyptian details in the column capitals. It is a severe architecture, grandiose and unsympathetic to individual human beings. On a third side of the square is the Palace Museum, once called the Forbidden City, a relic of the aristocratic dynasties and a symbol of their lavishness, viciousness and lack of concern with people who did not belong to the lordly classes. And yet, these are beautiful, magnificent buildings, superb spaces and landscape; visiting them is one of the most popular weekend pursuits of the Chinese proletariat. The people appreciate the architecture. How is the clash between the values that the traditional imperialist palace represents and the current values of the republic resolved? The party line is that of course the emperors did not actually build the palace, the real construction was done by the slaves, serfs, workers and lower middle classes. So the palace is, if not exactly sanctified, at least sanctioned.

In a more recent phase of Chinese architecture, the urge to have a displayed connection with a national identity that has lengthy roots in the past led to the design and construction of buildings that were basically formalist modern. The roofs, however, were traditionally Chinese in shape and material. The effect is sometimes a harmonious blend, sometimes weird and comical, where for instance, a pagoda roof perches uneasily atop a high rise block. Very recent buildings, such as the Trade Fair Hall and extensions to the Peking Hotel, are routine modern buildings, with no classical, traditional or neo-Russian allusions and no decorative ornament. They are austere, not entirely graceless, and quite typical of the style of building that was most fashionable in the west about twenty years ago. Workers’ housing, built close to places of employment, is in appearance quite similar to that of Housing Commission flats in the various Australian states. The amount of space per family and the provision of toilet facilities is, however, much less. The simple brick walled, tile roofed and courtyard houses of the urban areas persist—the form is functional, attractive and
agreeable. Similarly in the rural communes, even new houses are built in the basic vernacular that has lasted for so many centuries.

With labour intensive cultivation and with so many people to feed and such a long history of civilisation, there is not much of the Chinese natural environment left. One simple and beautiful landscape device, attributed to Chairman Mao during the Red Guard phase, has been the planting of thousands of trees. Along roadsides and in left over spaces unsuitable for building or cultivation, trees grow now in dense clumps, groves and avenues. There has been no messing around with the odd specimen tree here and there—the approach has been large-scale and intense.

The Israelis, no less ferocious in their national pride than the Chinese but in quite a different political and geographical situation, are not desperately trying to get an Israeli quality into their architecture. Very confidently, they build to the limit of their technological and imaginative resources. The result, whether it be a tall office building or a library in Tel Aviv, a university campus building in Haifa, or a long established kibbutz in the north, is architecture of exceptional quality. Even in the area being rebuilt and reorganised near the Western Wall in Jerusalem, the new buildings are so delicately designed to merge with the fabric of the old that any break in architectural continuity is difficult to discern. This is architecture of a community self-confident in its ability to create and survive.

The competition for space in crowded, compact Hong Kong has produced a visual environment that is to some people terrifying, to others enormously stimulating. Here, multistorey dwelling is obvious in the extreme, but the density is horizontal as well as vertical, on the waterways as well as on the slopes. The living conditions of the poor, the middle class and the wealthy are often clearly juxtaposed. The signs of life like washing on poles projecting from each apartment add to the vivacity of the environment. One doubt remains in our perception of this busy scene—from the hillside cemeteries overlooking Chaiwan, it is hard to separate the pattern of the terraced tombs for the dead and the layered rooms for the living.

Malaysia has seen the influence of many cultures—the indigenous village life around the Kampongs, the religions of Buddhism and Islam, the Christianity and commercial enterprise of the west. Many Malaysian architects feel very intensely the need to combine these influences somehow in their new work. Demonstrating traces of the past is a difficult exercise—often leading to farcical mixtures, such as in the tourist hotels around Penang, and only rarely to an architecture of any dignity. The government buildings in Kuala Lumpur draw their inspiration from sources as diverse as Islamic architecture and the US Air Force Academy in Arizona, bringing these images together in an architectural confection that is controlled by sufficient design discipline not to become too sickly sweet. The dilemma of the Malaysian architect is familiar to architects in many of the developing countries, including Papua New Guinea.

A question that I am frequently asked goes something like this: 'How are we going to develop a uniquely Papua New Guinean style of architecture?' Or, since I am engaged in the training of Papua New Guinean architects, it is sometimes assumed that I know how, and the question becomes 'When are we going to see a uniquely Papua New Guinean character in our new buildings?' Both of these are intriguing questions. The answers I give to them depend on at least two factors—the sincerity of the person asking the question (for some clearly do not wish there to be an answer, or reckon that they already have the answer) and my own state of mind at the time.

If I'm feeling a little bit rude I may reply 'If you can tell me what you think a Papua New Guinean style or character is, then I'll tell you how to get it. I'm a designer, not a social psychoanalyst.' If I'm tired and dispirited and feeling evasive, I may reply 'Ask
my students, they are Papua New Guineans and they are the ones who should know, not the expatriate academics.' If I'm feeling really nasty I'll reply 'A whole range of Papua New Guinean styles exists already. Open your eyes and take your pick. The range existed traditionally and it exists currently, right now. In the range are the spontaneous, slap-dash, vigorous and scruffy constructions in self-help settlements. They are not beautiful, they are often not comfortable and they're sometimes unhygienic, but they're yours. They are a very real expression of what part of urban Papua New Guinea society happens to be now, not what it might be, or what it ought to be.' My hypothetical questioner returns to the attack: 'But', he says, 'we can have no pride in them. These buildings are poor and mean and ugly. They lack good craftsmanship (some of them) and provide no sense of community.'

Again I might reply 'Is not this the question you really want to ask? When is an affluent style of Papua New Guinea building going to come? It will, when you have enough money, but it mightn't be full of pride.' The answer really is that when the community wants it badly enough a distinctive Papua New Guinean appearance will evolve. When nobody feels the need to ask the question any more, it will have come, but it may not look like what we expect. The expectation is of visible reminders of the traditional environments of the past. There is no doubt that the spirit of the man made environment should be rooted in the traditions of the past. But at the same time it must be looking to the future as an exciting and challenging prospect. Behind this approach must be the will of a people prepared to innovate and bring new responses to new circumstances, maintaining a keen practical sense and social responsibility and informed by ingenuity and creative imagination.
50 Appropriate Technology in Papua New Guinea

A.P. POWER

The basic thesis in this chapter is that development, amongst other things, means increased demands on the environment as the material wants of the people increase in the face of the modern economy. For social, technical, and ecological reasons these demands cannot be met by a linear expansion of the traditional production system. They can be met only by the introduction of new technology. The relationship between technology and development is explored by examining traditional and colonial production systems in Papua New Guinea. The conclusion reached is that technologies appropriate to both the cultural and the physical environment are needed for development. The beginnings of a philosophy of appropriate technology are outlined by establishing several basic criteria for appropriate technology. In the light of these criteria, technologies appropriate for rural development are suggested. Finally a case is made for the establishment of an appropriate technology development organisation and a tentative structure is briefly outlined.

The history of the development of the modern affluent nations is immensely complex and the cause of lively dispute amongst historians and economists alike. No attempt will be made here to enter into this debate other than to claim that the evolution of technology into the form of modern scientific industrial technology is absolutely central to this development. I shall not even attempt to give an adequate definition of development as it tends to embrace all aspects of society. In this chapter I am deliberately concentrating on technology in society.

Development in crude quantitative terms seems to refer to the amount of goods and services extracted from the environment by the production system of any particular society for consumption by that society. Clearly we can talk with some sense according to this measure about developed or underdeveloped or less developed or overdeveloped or never-to-be-developed nations.

The most striking characteristic of the production systems of the highly industrialised modern states is the immense quantity of energy and materials extracted from nature to provide the goods and services consumed by their populations. For example, America, with roughly 6 per cent of the world’s population, consumes roughly 40 per cent of the world’s wealth in the form of things won from nature like metals, energy, etc. (Jenkins 1971). Conversely, the so-called developing nations on a gross and a per capita basis produce and consume a mere fraction of the world’s production. The traditional consumption patterns of the developing countries are directly related to their technology and their production systems. These production systems are, on the whole, relatively labour intensive and not capital intensive. The technology employed is relatively low level, traditional and empirical, as compared with the high level, scientific and industrial technology of the developed countries.
There seem to be quantum jumps between the levels of technology employed by different kinds of societies to provide them with their needs, and there seems to be a corresponding quantum jump between the levels of consumption of goods and services provided by this technology (Figure 50.1). It follows then, that it is impossible to increase production beyond a certain limit using one kind of technology as all kinds of limit problems set in. A society must employ a more sophisticated technology or give away the idea of producing more.

The extreme differences in styles of technology existing between the developing and the developed countries are reflected within the economies of the developing nations themselves; all of them have, to a greater or less extent, begun to transplant high level technology from the technologically advanced nations to which they are related by a history of colonialism and/or neocolonialism. This transfer of technology has begun to introduce new production patterns, and more notably now, new consumption patterns whose influence has begun to spread throughout the developing country. Hence the economists speak of the ‘dual economy’, with the ‘traditional sector’ and the ‘modern sector’. When people refer to generating development or development programs they mean, in part at least, increasing the production of goods and services in a particular level beyond what is already produced. Implied always is the idea that this increase is to be achieved by some form of new and introduced technology from technologically ‘more advanced’ places. The relationship between the two sectors of the dual economy is crucial to any discussion of development and it is constantly explored by social scientists of every persuasion. I wish to concentrate on one aspect,
namely, technology and the two economies, but occasionally I shall point to implications in other directions.

**The Dual Economy in Papua New Guinea**

The presence of the dual economy in Papua New Guinea is obvious to all. Vast inputs of Australian grant money, foreign loans, and foreign investment have established such substantial elements of an expensive modern infra-structure as highways, telecommunications, airlines, and hydro-electric power. Elements of a modern manufacturing sector have also been established: the list would not be complete without mention of the copper mine at Panguna (presently getting its third computer).

Most of these enterprises have sought to employ the latest in high level, capital intensive technology, requiring the skills of large numbers of expatriates for their establishment. For their continuing operation they require a minimum number of almost never-to-be-localised positions (multi-national companies always fill the top positions with their own people) with the remainder to be filled with an increasing proportion of specially trained nationals of varying skills. Their capital intensive nature is maintained and their utilisation of the local workforce will remain relatively low. The result is that these enterprises, which have relied so heavily on foreign technology for their establishment, will for a very long time to come be dependent on the same foreign technology for their maintenance.

Although the enterprises, both government and private, employ nationals at a salary about one-fifth of the Australian rate, the goods and services that they produce are, with a couple of notable exceptions, priced according to the expensive modern world economy. This effectively means that Papua New Guineans have become poor men in their own country. Even the top bracket Papua New Guineans employed in the modern sector are under severe strain if they assume consumption patterns consistent with the affluent countries as represented in Papua New Guinea by the modern sector. The urban worker, not to mention the urban unemployed, must forever eschew such predilections or aim to get them by means other than working for a wage. The villagers outside the main towns likewise on present indications can never earn enough to afford more than an occasional visit to town with modest purchases of necessities. This situation is flying in the face of self-reliance and must be a matter for concern to the Government.

Apart from the modern sector of the economy there is the so called ‘traditional sector’ or ‘subsistence sector’, embracing the rural villagers who make up close to 90 per cent of the population of Papua New Guinea. They too are becoming increasingly dependent upon the modern sector, so much so that the term is inaccurate when applied to the rural economy. It is abundantly clear that for most people in the rural areas economic development means an increase in their ability to earn cash. Their preoccupation is to engage in some form of bisnis. To a certain extent this has always been the case but it is more obvious today, and it is spelled out by grass roots development organisations. Even ideologically inspired schemes must begin to pay their way or fail.

I have dealt at length elsewhere (Power 1974) with the impact and the extent of monetisation of the rural economies in this country, and will recall only a couple of points here. Past development, with its one dimensional dependence on cash cropping to produce some export commodity, has made inroads into the subsistence sector without greatly stimulating economic activity revolving round the villages themselves. These inroads have led to land shortages in some areas and, indeed, have been directly
responsible for increased tribal fighting.\textsuperscript{1} In all areas it has led to increased demands on the environment. In other words the traditional production system must produce more than it has done in the past. I think that it can readily be shown that this cannot be achieved without a significant input of new technology if the physical environment is not to be degraded. Wherever any significant amount of cash cropping has begun in Papua New Guinea, there has been a shortening of the fallow, be it a classical swidden or intensive highland system employing mulching and rotation tree crops. If this tendency progresses too far the natural result would be a depletion of soil fertility and ever shortening of the fallow with ultimate breakdown of the environment.

A feature of traditional agriculture not often stressed is the heavy reliance on the work of women, especially for the care of the garden and the day to day provision of food for the household, including domestic animals. This is to say that not a great deal more could be expected of a major part of the workforce if efforts were made to increase output. Thus a linear expansion of the traditional agricultural production system is not possible and therefore will not meet the demands of development. I would argue that the rural areas need a quantum leap in the level of agricultural technology so as to increase agricultural productivity and meet the demands of rural development.

Thus in the modern sector and in the transitional subsistence or rural sector there are problems of development, not least that of ensuring the meaningful participation of Papua New Guineans in a way that is related to the general productivity of the country as a whole. I understand that this is the economic principle underlying the present national wage policy. The principle of distributive justice demands that there be some kind of equality between the earning capacity of the urban worker and that of the man on the land. As we have seen the urban worker in Papua New Guinea is struggling to subsist, let alone to partake of the benefits of the high level economy of the modern sector. Therefore any policy that seeks to upgrade urban incomes would act against efforts to raise rural incomes, which are lagging far behind. Efforts to bring down the cost of living, on the other hand, would aid both sectors, especially since the only way to do this involves development of economic self-reliance, which in turn depends on the contribution of both sectors towards what I have called a genuine Papua New Guinean economy. If the eight point plan is any indication, the meaningful resolution of the relationship between the two economies is seen correctly by some national politicians as being of the utmost importance for the secure emergence of Papua New Guinea as a nation.

An understanding of the role of technology in the two economies is essential for the establishment and the management of a beneficial relationship between the two economies. I am assuming that the mixed economy will be here for some time to come—in fact for the foreseeable future. Conversely this assumes that moves will not be made to eschew all modern technology or to return to a pre-colonial economy and that the other extreme, the rapid conversion of Papua New Guinea into a modern industrial state, will not be pursued.

It seems to me that the eight point plan spells out in clear terms that the present Government does in fact desire some economic and therefore technological middle road. Many of the important phases from the eight points—more equal distribution of

\textsuperscript{1} Meggitt (1972:118) speaking of one Highlands area says: 'during the past 2 or 3 years, there has been a striking resurgence among the Central Enga of interclan violence (fighting, killings, and arson), which can be directly attributed to the growing pressure on land resources stemming from population increase and the spread of commercial agriculture and animal husbandry'.
economic benefits, decentralisation, agricultural development, village industry, small-scale artisan, activities, more self-reliant economy—have direct implications for the transfer or development of styles of technology appropriate to Papua New Guinea.

There is a need for a closely integrated rural development program and for diversification of the economic activities of farm, village, and rural town in such a way that they complement each other and provide a level of regional economic activity which would lessen the crippling dependence on the world export market and at the same time contribute in real terms to economic self-reliance.

**Social and Environmental Problems of Development**

An awareness of the close relationship between technology and the cultural and physical environment of traditional societies is tremendously important for an understanding of the impact of colonialism in Papua New Guinea. More importantly it is essential for any evaluation of culturally and environmentally appropriate technology for development.

*The Impact of Colonialism*

Past development in Papua New Guinea, when evaluated from the point of view of technological transfer of expertise to the local people, leaves a lot to be desired. Different colonial administrators have been aware of the problem, but no coherent policies have emerged to emphasise technology transfer other than the short-term training of Papuans and New Guineans to be useful in the job of administration and development. The skilled developmental work is largely being carried out by expatriates, albeit for the local people. These expatriates, largely Australians, got on with the job of development in spite of the fact that the local people were only superficially involved. Huge roads were cut and blasted through grassy valleys and forest clad hills. Helicopters planted high frequency transmitters on remote hill tops often sacred to the village people. The people learned practically nothing in the way of technology from the experience.

Some forms of development concentrated a fair amount on the transfer of technology, in particular the efforts to promote cash cropping of plantation crops. Even here much of the success sprang from the particular aptitude of the Papua New Guineans as agriculturalists; in terms of numbers of people involved they were the main agents. New crops were spread in traditional fashion and were followed up by government efforts at regularisation. In some areas quite a high level of sophistication was achieved in crop processing for export, particularly of coffee, cocoa, and copra. What is notorious is that none of the skills associated with the processing of these products for home consumption was transferred and, indeed, there were positive steps to discourage this at certain stages. I have heard this said, for example, of processing for home use of coffee and oil palms, though it is of little importance since people probably did not then want or need the products.

In a sense much of this development has merely creamed off the surplus of the primitive affluence of the traditional production system by converting it into a one-dimensional reliance on export commodities; the basic production system and the pattern of production remained unaltered. There was no real success in imparting fundamental technologies that would have increased the production or decreased the work load. Papua New Guineans have not learned to use pack or draught animals, waggons, or ploughs, though all these were introduced on missions and plantations a hundred years ago. None of these comments seeks to lay blame for bad policies. The complexity of social and technological change in the multitude of diverse and relative-
ly tiny societies characteristic of Papua New Guinea cannot be overemphasised. The situation is the same today.

Contrary to popular belief the tropical rain forest is not an ideal place to practise agriculture. As a very complex climax ecosystem, mostly in areas of severe sun and plentiful rain, its cultivation raises a host of management problems. Any management solution is going to be wasteful, especially in terms of leached nutrients and lost top soil. Classical swidden agriculture is no exception and it is sustainable only under a relatively low population density.

In comparison with Australian farming, the energy relations of such a system are very interesting. According to one study of the swidden agriculture of the Tsembaga people of the Highlands, the farming system returns twenty-five food energy units for every one energy unit expended by the gardener (Rappaport 1971). A similar figure for an Australian farmer is three food units (Rural Research, CSIRO journal, September 1974).

However the fertility of the soil in the Tsembaga system is maintained by burning twenty-five years growth of forest to release the stored nutrients, wasting enormous quantities of energy in the process. If this energy is counted, then the Tsembaga spend twenty energy units to get one back. Of course, if the system does not break down, the Tsembaga’s energy is renewable, while the Australians spend irreplaceable fossil fuel both to work the farm and to provide the fertiliser. It is well known that the dense populations of the Highlands are maintained by a much more intensive form of agriculture with much shorter fallows but these systems still depend very much on the fallow.

The advent of cash cropping has had several important ecological effects upon the traditional gardening system. Apart from the sweet potato gardens in the Highlands, traditional gardens contained a multiplicity of species, which made for more efficient exploitation of the microclimates so created and also tended to provide a more stable ground cover. Cash cropping tends to call for monocultures with attendant ecological hazards, though I would imagine that mature plantation crops with complete ground cover and closed canopy, while they may be bad risks from the point of view of pests and diseases, do constitute a great threat to the environment. The important thing about cash cropping is that the surplus produce that was traditionally consumed by the group or cycled in a regional trade exchange system has begun to give way to a situation that bleeds off the gris or surplus from the land into exports and it is not replaced in any way at the moment. The growth of cash cropping leads to a much greater demand on the environment because people want to produce more. Therefore the way cash crops are produced and the amount of them produced constitute a threat to the physical environment that must be met by technological adaptations which are ecologically sound.

Technology and Traditional Society
The general level of sophistication of traditional technology in Papua New Guinea was capable of enabling the population to extract their requirements from the environment and achieve a fairly enviable standard of living in terms of their ability. However, it is true to say that the so-called primitive affluence of the traditional societies is very much related to the low level of material demands on the environment. What is more important from my point of view is not that the level of material wants was low by comparison with a modern industrial society but that the technology employed to provide the wants was evolved within the societies and was integrally related to them. Hence it stands to reason that any technological innovations within the societies will have immediate social effects and, conversely, that any change in the level of material demands placed on the environment will have technological implications.
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Traditional societies in Papua New Guinea were and still are basically agricultural societies with a very high percentage of the population engaged in agricultural pursuits for some or all of their working time. There were many specialist technologies employed specially for production of exchangeable commodities like salt, oil, axes, pots, shell products, weapons, and capital items like fish traps and canoes. The important thing is that these societies were basically self-sufficient in their technology. Even where there was dependence upon trading partners, sometimes this seems to have evolved to satisfy social and political needs rather than because of economic or technological deficiencies. As Harding (1967:246) says: 'Production is wed to exchange by the material demands of social ritual ... which directly or indirectly raises the level of regionally specialized production above what might be stimulated by the demands of utilitarian consumption alone'. The non-specialist members of the community were not far removed from the skills of the specialists and some could replace them in an emergency. The specialists and the generalists worked closely in projects such as house building and canoe building. The transfer of the technological expertise from generation to generation was accomplished in the interpersonal fashion typical of small-scale societies.

Because the material wants of the societies were extracted from materials readily available in the surroundings the people tended to gain a very thorough knowledge of the land and sea where they dwelt. Land to the Papua New Guinean is not just a commodity but a part of his life by which continuity is maintained with his ancestors and the spirit world in a personal relationship that ensures his security by providing tribal identity and the means of obtaining food and shelter. Thus the people and their technology are very closely related to their environment.

The impact of foreign technology has brought an end to much of this, causing dislocations in many traditional institutions within the various societies. For the average villager in Papua New Guinea there is perhaps something of a feeling of feebleness in the face of massive incomprehension about modern technology. This is one of the most important elements of this problem and it could be underlying the feeling of disappointment that seems to have stimulated many cargo cult type movements. The white men failed to deliver the goods or to give up the secret of their origin (by transferring the technological expertise for their production in Papua New Guinea). From the security and strength of an integrated village life the villager could dismiss the aberrations and shortcomings of the white man and return to his traditional pursuits a sadder but wiser man. This is not possible now as the impact of introduced technology is all pervasive and many people are actively involved in it. A very prosaic example of this is the situation I have observed in many places where villagers put their pigs in an agricultural station or school or any institution that has access to high protein stockfeed. They cannot see why the pigs do so well. Conversely the villagers put their pigs in a modern sty but brought the feed themselves—they could not see why the station pigs did so well and theirs did no better or even worse than when in the village. Those villagers who have learned the importance of high protein meal are frustrated about its high cost and infrequent supplies. The same applies to chicken projects, where the supply of chicks is plagued by transport difficulties.

Propects for Rural Development

Social institutions forged over the centuries for the maintenance of the integrity of the many hundreds of small-scale societies that constitute Papua New Guinea are the most significant constraint upon the adoption of new technologies. Thus to introduce new technologies, and all so-called development schemes seek to do just this, requires
social change. Unfortunately for planners the social implications of any particular technological innovation are very hard to predict or control.

An immense amount of social change has occurred in Papua New Guinea in the past hundred years. Some of this has been spontaneous but quite a bit has been in response to coercion by colonial officials, the most obvious example being the forced involvement of villagers in the cash economy by the imposition of taxation. Naturally coercion is not the ideal stimulus for evolutionary social change as, when the force is removed, reversion to former ways ensues. This has been documented many times in Papua New Guinea (Humphries 1944). The present ethos of decolonisation in Papua New Guinea is one of great discontinuity and contradiction. Coercion and lack of meaningful participation by local people are features of any colonial situation and the colonial bureaucracy becomes oblivious of the presence of such coercion. This was shown some years ago by the reaction of the outgoing colonial bureaucracy in Papua New Guinea to ground swells of indigenous activity aimed at the re-establishment of their autonomy. This was especially true of the response to the Mataungan Association. One would expect that many of the Papua New Guinean bureaucrats, trained in the colonial system, would tend to be much the same as their colonial predecessors, but I have seen many examples to the contrary.

Springing up all round the country at the moment are a multitude of grassroots movements aimed at social and economic development, self-help, getting rid of foreign economic control and so on. They are largely anti-bureaucratic and in some cases contemptuous of the ‘colonial’ bureaucracy, whilst at the same time struggling to cope with the diversity of their own small cultural groups upon whose unity they depend if there is not to be a complete reversion to the tiny units of former times. Naturally to unite even the smallest of non-traditional units, some form of bureaucracy has to be evolved since it was not catered for in the traditional social system. In traditional Papua New Guinea there were outstanding examples of inter-group activities such as the great trading and exchange ventures like the Hiri, the Kula, the Moka and the Te, to mention the most famous. However the political and economic bases of these exchanges have been almost completely destroyed by the ever increasing monetisation of the traditional economy and the replacement of so many traditional items by imported articles.

The new intergroup institutions such as local and central governments and the police, imposed by the colonial administration, are struggling for legitimacy even though they have been almost completely taken over by nationals. The strength of the indigenous institutions is evidenced by the fact that their partial submersion over the decades of colonialism did not lead to their extinction. The new, genuinely indigenous, grass roots, self-help movements have all come face to face with the same social institutions that were seen as constraints before. Naturally these groups cannot ride roughshod over their own social institutions as could the colonials. Now the real work of social change and development is beginning as these groups try to come to terms with those aspects of their traditional way of life that are inhibiting their desire for economic development.

It is one thing for expatriate economists to speak of social constraints on their carefully conceived economic development plans. It is quite another thing for Papua New Guineans to come face to face with these constraints in actually trying to direct economic development themselves. It is only now that the contending group and individual loyalties and jealousies, bases of traditional prestige and power and their corresponding control over the means of production, and the traditional patterns of consumption can enter into a real and hopefully fruitful strife, instigated, directed, and
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... hopefully resolved by Papua New Guineans themselves. It is only by such actions that new institutions can grow out of the old ones in such a way as to maintain features of the old system that are compatible with new demands. In this way the newly evolved institutions will be truly Papua New Guinean.

Melanesian societies have been described by many people, including anthropologists, as egalitarian and even communalistic. Possibly this stems from the observation that there was not a great deal of difference in the consumption patterns of big men and the ordinary men and, further, that the very exhibition of the wealth of the big man involved a largesse benefiting all. In my view it is wrong to argue from these typically Melanesian consumption patterns to egalitarianism and even communalism. The most significant aspect of society that results in stratification is the exercise of power. In Melanesian societies there are vast differences in power in the community and these are reflected in social and economic opportunities.

Papua New Guineans pride themselves on being landowners, yet to my mind too little is known about the economic inequality in many areas, especially where there is land pressure. This inequality is exacerbated both by the monetisation of the economy and by the increase in population occurring now in most places. Such problems are also related to the phenomenon of urban drift, as illustrated by one university student's analysis of his own area:

The land pay was in axes and knives and spades. The older people got the payment leaving the young men without. There and then was the division of the social order in my village, though the distribution of the land pay was according to ownership and age. With frustration the young men left the village to the patrol posts where they could work to earn a spade or an axe for a year's hard labour. [Plantation labourers and town labourers] ... tend to run after the money that buys them a bottle of cold beer and have forgotten about their parents. This is because of the misunderstanding of the young men. They do not know how to advance in the modern way of life without destroying the good old way of life. One must note that it is not an easy thing to accomplish. (Kukundi Alisi pers. comm., 1973)

The present conflicts in village societies now stem from the challenges to the traditional power structures by new forms of economic activity offered by the modern economy. Consumption patterns are undergoing change as hard earned money is not distributed in the same manner as was equivalent wealth before. Moreover the powerful men are in a position to exercise their control over economic resources by the planting of permanent cash crops on land which thereby becomes alienated from customary rotation patterns. This contributes to land pressure and obviously changes the attitude of villagers to land, which now becomes an economic asset in a non-traditional manner.

Thus at the moment there is a tremendous amount of ferment at the grass roots level which is helping village groups get themselves organised for economic activities. This ferment does not, of course, take place in a vacuum; the basic cause of it is the desire for economic development. The development projects that are the various foci for this social activity are tremendously important and every help is needed to make them technically feasible. The economic and social elements of the development are integrated to the technology.

**Appropriate Technology for Development**

Appropriate technology for development in Papua New Guinea will mean different things to different people depending upon their basic philosophy of development. Given the dual economy, the actual formulation of the right mix of technologies, ranging from high level to intermediate level, to low level or village technologies, is as elusive as the alchemists' elixir if the state of affairs in other developing countries is
any indication. And of course a formula is much easier to prescribe than to implement. I am not going to propose any facile solutions.

I do propose that finding the appropriate technological solutions to the production problems facing this country is a tremendously difficult task and that it is worthy of formal study by a research group, which should be a permanent part of the central planning authority because there are policy implications for every segment of the economy. At the moment there is no integrated policy for science and technology and conflicting decisions are being taken every day. I cannot hope here to prescribe a basic practical philosophy of appropriate technology. I intend to try to illustrate what I consider to be some fundamental points of such a philosophy and to outline in more practical detail the application of such a philosophy to present and future rural development in Papua New Guinea.

The transfer of technology is central to the whole question of technology for development. A thorough understanding of this is essential for any attempt to prescribe appropriate technology. Technology is basically a form of ‘knowhow’ associated with the making or the maintaining or the using of some particular thing. The thing itself, an item of technology in ordinary language, is in fact an artifact of the technology of some particular culture. When this artifact is taken into another culture there is no automatic guarantee that any of the three categories of knowhow mentioned above will be transferred with it.

For any artifact to be used in a new culture in any way remotely resembling the way it was used in the culture of origin, the recipient culture must possess the basic skills required to use it. This may already be present if the transferred artifact merely replaces an already present item. In this case there is no transfer of technology at all. The steel axe is a classic example in Papua New Guinea (Salisbury 1962). A hundred years ago Papua New Guineans traded and even killed for this metal, which was to them merely a new and better kind of stone. To this day the average villager knows nothing of the origin of metals or the elementary skills of blacksmithing (which would at least enable him to work the plentiful scrap steel lying round the country). Even today these skills are taught nowhere in Papua New Guinea to my knowledge, certainly not in the vocational schools and not to manual arts teachers.

The widespread adoption of transistor radios is another example. In the early days many people possessed one merely as a prestige item. Though of course there is no skill associated with switching it on, using it in the full sense implies some rudimentary concept of broadcasting. If we consider the example of the motor car we can see that to drive it correctly there is the need for quite a high degree of skill. Driving and maintaining it require quite a lot more. The difficulty in transferring an adequate amount of maintenance skill is notorious in this country, where many vehicles rapidly become places for chickens to roost.

The third level of expertise, the ability to manufacture any particular artifact, is more difficult again by several orders of magnitude and the transfer is therefore seldom attempted in developing countries until it is far too late. Traditional societies in Papua New Guinea naturally had the technology to use, maintain, and manufacture their own artifacts and thereby possessed the basic advantages of self-reliance and an innovative capacity. The fate of this enviable position must be closely examined during the colonial period.

Thus my first basic criterion for a philosophy of appropriate technology is that technological solutions to production problems must seek to introduce those technologies that give a reasonable chance for the transfer of the skill to use, maintain, and manufacture the technology in Papua New Guinea in the immediate or the
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The foreseeable future. Already much of the technology in use will not satisfy this condition and this situation will continue. The point of the condition is that it must be applied to alternative kinds of technological solution offered by the experts in order to choose the one that gives maximum transfer.

The second basic criterion is that the technology be assimilated at a rate that allows the people to adapt to the social dislocation consequent upon its adoption. This is entailed in the first consideration as the rate of successful transfer of technological skills will obviously relate to its complexity. One could also expect that the greater the amount of transfer associated with any particular artifact the greater will be the ability of the group to cope with the social dislocation.

A third basic criterion does not relate to the nature of technology itself but is concerned with the rationalisation of the dual economy: that kind of technology will be most appropriate which does most to establish a genuine Papua New Guinean economy, that is, one geared to the earning capacity of the local worker. In particular this could mean that we need a vast amount of small-scale industry spread round the country to produce consumer items in place of imports but at a selling price considerably cheaper than those prevailing at present. This point is of major importance since it seems to have escaped the notice of many planners and developers, who consider that the undoubted benefit of added employment and savings in foreign exchange is a good enough argument to justify even more expensive locally produced items. Far too many business efforts have been encouraged on the basis that the ridiculously high prices presently paid are to be maintained in planning the economy of the business. The crucial need for a genuinely Papua New Guinean economy is conveniently forgotten.

One important consideration must be spelled out to counter any claims that, because so-called appropriate technology is small-scale and not capital intensive, then it is second best and even a put-down by colonialists. One can only say that the foregoing criteria must be examined on their own merits. The technology must be fitted to the people and not vice versa. Of course, appropriate technology may not necessarily be low level. It depends upon what is available. In point of fact there is a significant amount of research and development being carried out in the affluent countries using the highest levels of trained manpower in science and technology precisely in order to produce low level technological solutions to problems facing the developing nations. For example, a research team in Canada is presently developing a village level cassava protein plant in which the per cent protein mash of fresh cassava roots is digested for one day by a heat tolerant fungus resulting in a per cent protein mash suitable for livestock.

This illustrates another criterion, that the level of technology sought as a solution to any particular production problem must be the highest level available consistent with the aforementioned criteria. Put in another way this means the highest level of technology that the villagers can master in a reasonable time. In this respect, it must be remembered that the skills associated with chemical and metal technology that are widespread in some Asian bazaar economies are absent from Papua New Guinea. This will necessarily affect the rate and the level of technology transfer. A second major difference between Papua New Guinea and many other developing countries with teeming populations is that there is no great excess of labour that must be taken up by the most labour intensive forms of technology available.

Suggested Appropriate Rural Technologies
The following is intended as a very brief sketch of some of the kinds of activities and
technologies that I think may be appropriate in rural development. Naturally not all are appropriate to any one area; they must be related to the material and manpower resources of the region and, more importantly, to the state of local social organisation, which alone can provide the demand and the incentive for the adoption of new ideas.

On the Farm

The productivity of the land must be increased by small-scale mechanisation for cultivating, weeding and harvesting of crops. Hand tractors and buffaloes seem appropriate. Carefully planned rotations, green manure crops, greater use of mulching and composting, and selective use of fertilisers would be needed to raise and maintain soil fertility. Diversification of farm stock to include hardy animals like ducks and goats would seem appropriate—both of these animals can be raised virtually for nothing as they exploit farm wastes. A greater use of scythes, cross-cut saws, pit saws, wheelbarrows, waggons, and even cargo bicycles, would greatly increase productivity.

In the Village

Without exception every village development organisation that I have contacted would like to be able to produce more meat, especially pigs and chickens for home consumption and for sale. This is impossible without the processing and storage of home grown animal feeds. An enormous amount of development could be planned round a village feed mill, which could process food for both animal and human consumption.

When village women discover what is possible in terms of labour saving devices from simple cheap technology there will be a revolution in the villages. From a public health point of view there is already a great need to introduce village water supplies and waste treatment facilities, particularly in the more densely populated areas.

Village improvements funded by the central Government for things like public health and education could be important vehicles for the transfer of appropriate technologies that would lay the foundations for the specialised skills enabling villagers to introduce improvements themselves as well as to serve rural towns. This could apply, for instance, to the exploitation of locally available building materials for the building of permanent buildings and plumbing and sewerage installations. For an extremely low capital investment, bricks, tiles, cement, lime, and plumbing fixtures can all be manufactured in the village and the materials are available in very many locations in Papua New Guinea.

Other village industry that could provide for the needs of the townspeople will depend upon local endowments. For example there seems to be a good argument for the small-scale processing of fresh coconuts on village plantations to provide cooking oil for the towns and oil cake for the village feed mills. To my mind the making of copra for export is nearly absurd. While it does something to earn export income, it effectively subsidises the economies of the developed countries, who will only use it when they can get it practically for nothing. On current prices the machinery for such a village factory costs between $6000 and $15,000 depending on capacity. In 1972/73 we imported roughly $1.5 million worth of cooking oils, fats, etc. (Bureau of Census and Statistics, pers. comm.). The same machinery can be used for oil extraction from peanuts, and soya beans, and others. Edible oils retail at $14 per tonne in Port Moresby while copra is exported at about $120 per tonne at the moment.

In particular places village feed mills could go a long way towards the supply of towns with processed feed and with animal products like meat and eggs, the present production of which is prohibited by the high cost of imported feedstuffs. In 1972/73
this was roughly $1 million but must be much more now (Bureau of Census and Statistics pers. comm.).

*In Rural Towns and Cities*
As village technologies begin to develop there would be a great need for small, and indeed large, industries to service the villages with items requiring a higher level of technology. 

**Fig. 50.2** Plan for an appropriate technology development organisation. This organisation would work in the closest possible fashion with the rural development agency, and the present government bureaucracy, including business development. It would serve regional governments also and eventually have branches in the regions. It would maintain close contact with the universities.
technology than is available there. As small machines came into use there would be a need, eventually, for their manufacture in Papua New Guinea and this would require small foundries and machine shops in the towns. Towns could perhaps be the loci of other manufacturing and processing plants, for example for soap making or leather tanning.

These, of course, are just a few of the opportunities that exist for rural development in Papua New Guinea but they amply illustrate my point that they would require an enormous emphasis on the introduction of appropriate technologies to make rural development a reality. If any such approach is taken up by the Government in earnest, and the eight point plan suggests that it should, then there is an obvious need for some kind of organisation that is formally devoted to technology transfer at the level mentioned. The scarcity of the skills that I have outlined at the village level in this country is obvious. In Figure 50.2, I have outlined the structure and mode of operation of such an appropriate technology development organisation in the context of the proposed Rural Development Agency.

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Self-reliance for Village Communities in Papua New Guinea

Russell Gluck

Basic resources and the willingness to develop them already exist in Papua New Guinea's villages. Some attempts to encourage village development have been unsuccessful because of neglect of several key considerations: villages must be planned with, not for; responsibility for development and implementation of development plans must finally rest with villagers; financial backing for the introduction of unnecessary or too highly sophisticated technology may result in breakdown of social cohesion rather than integrated development. Problems such as lack of technical expertise and conflict between short- and long-term objectives may be alleviated if technical expertise rather than funds is provided, village development is directed towards the evolution of self-reliant rather than market dependent village environments, and village commerce is developed on community lines. The framework proposed for village development centres around the introduction of trained village development officers, assigned to their own villages or districts for a length of time consistent with needs to reacclimatise and develop trust and commitment. Additionally, visiting aid teams with specific skills and techniques would come and live in villages for as long as necessary for a true transfer of skills and techniques. Village educational/vocational centres doubling as aid posts and community centres should be constructed to supplement training activities.

A village may be regarded as a collection of latent and actual resources available for the villagers to mobilise to develop the kind of environment that they wish to live in. Many village resources are latent because they are not utilised to produce goods and services that are regarded by the villagers as essential elements for the development of their environment and an increase in their welfare. Many village communities know the direction and pace at which they wish their villages to develop, but, owing to lack of exposure to the techniques available for the transformation of latent into actual resources, development does not occur; resources remain idle and villagers' desires for development are unfulfilled.

If self-reliant village development is to be achieved then it is essential that the village community be able to develop its environment at the pace and in the direction it wishes, maximising benefits to the community by utilising resources to meet its own needs. Thus the village environment may be regarded as an input/output model where the village inputs (latent and actual resources) are: water, sun, wind, land, soil, sand, clay, lime, labour (skilled and unskilled), wastes (human, animal, vegetable, fish), timber, livestock and fish. The desired outputs are: small-scale agriculture to satisfy nutritional and luxury food requirements; small-scale rural and cottage industries to satisfy villagers' requirements for processed foods, artifacts and consumer durables; educational and cultural activity; low cost housing; sanitation and water supply; security and community cohesiveness; low cost medicine; low cost transportation and communication.
The necessary import from outside the village is appropriate technology brought by work study teams that live in the villages and assist villagers to attain such skills as the production of sugar from coconut and the manufacture of gas for lighting, refrigeration and cooking from animal and human wastes. That is, imports should be in terms of teams that can teach the villagers elementary skills for turning latent resources into actual resources by working with the teams. Effectively, the importing of teams into the village environment would promote self-reliant village development, because the teams would work and live with the villagers, who could learn specific skills so that when the team leaves the village the practice of transforming latent into actual resources is firmly entrenched in the village system. Thus the need to import some of the resources that the villagers require for their development may be eliminated by the introduction of technology to transform latent village resources into what was formerly supplied by physical imports.

Exports from the village environment would be in the form of surpluses. The value of the exports (cash or barter) could be used to finance the import of technology or goods that cannot be produced from the villagers’ latent and actual resources. This situation would arise when the village does not have the basic ingredients to produce the required resource, or when the technology to produce it is either unknown or too complicated for the environment.

Certain materials for key infrastructure requirements may have to be financed from government funds because of limitations on utilisation imposed by the size of a required resource in relation to a village’s export earning capacity and the importance of the resource to the village’s development. Government finance should only be provided for the procurement of these resources when a village community has drawn up an adequate comprehensive village development plan. The plan should not only detail the technical reasons for its financial requirements but it should demonstrate the impact of the entire plan upon the village environment (human and physical). Village planning officers should be responsible for the concrete presentation of the villagers’ plan.

One of the key factors in the proposed framework requires that the village community realise the benefits that can be obtained from balancing long and short-term development objectives. The overriding consideration in this framework is that the village wishes to develop so that the community or clan is maintained as an organisational unit while the benefits of development are introduced. The market economy, which in the western capitalist sector dominates society to the point where individualism is promoted at the cost of traditions and communalism, is to be avoided. In this framework the community ethic rather than individualism is assumed to be dominant and large-scale and impersonal market systems are therefore regarded as having disadvantages that outweigh any benefits.

If the resource base framework for development is to assist in the evolution of self-reliant village environments, the villagers will have to accept a good deal of responsibility for the conceptualisation and implementation of their own holistic, environmentally sound village plan. This should not present a great problem as the desire to accept such responsibility has been displayed by a number of village development groups in the recent past. Leaders of these groups have co-ordinated a good deal of effort on behalf of both the younger and the older generations to derive a village development plan that is consistent with community consensus, involving the balancing of villagers’ long and short-term development aspirations.

The formation of some of the village development groups has been inspired by a graduate or partially qualified village member’s desire to return to his village from
university, the public service, teachers college or private industry to assist his fellow villagers to develop in the direction and at the pace they want. Frequently activists have left university or well salaried jobs in the public service to go back and assist in the development of their village environment because they have determined that the direction of development in the non-village situation does not satisfy their personal development and lifestyle requirements. They see the village as a viable alternative lifestyle and believe that, if the physical conditions of the village are improved whilst maintaining the community ethic, village lifestyle would be superior to non-village.

Some village groups have displayed a good deal of ability in drawing up their development plans and organising village resources and communications systems to implement the community’s aspirations. For example, some village groups have assigned their members to development portfolios (such as pig, vegetable and chicken production, housing and construction, cultural affairs). The portfolio holders have in some cases been sent to vocational centres to learn skills that have practical application in the development of a village and, upon their return, have been expected to disseminate this knowledge amongst clubs that have been formed within the village to implement the assigned portfolio. This activity has required a good deal of organisational ability, and in some cases personal hardship, but it does highlight what can be done.

Unfortunately, some of the village development groups, having achieved consensus and a workable plan, fail owing to lack of foresight and technical expertise to implement their plans. The lack of foresight results in conflicting long- and short-term objectives; conflict is encouraged by present aid funding arrangements for village development. It is suggested that the two problems may be overcome by a radical reorganisation of the public service and education system and a complete review of the present form of aid funding for village development groups so that

(a) technical expertise is provided rather than funds;
(b) village development is directed towards the evolution of self-reliant rather than market dependent village environments;
(c) village commerce develops on community lines.

Government funds for village development would be best applied to the importing of technical teams to impart complicated techniques for the conversion of latent village resources into goods and services that contribute to the village’s development. Funds should be made available to villagers only to import from outside the village environment resources that are necessary to the successful implementation of a comprehensive village development program. In addition, the resource being introduced must be able to be managed or maintained by the village operators (in the case of machinery) and it must be able to be incorporated into the village system. For example, some villagers under the present funding system have demanded and received government funds for sophisticated mechanical equipment that would not be required in the community’s development plan if full use of the latent village resources had been made.

Unfortunately, the introduction of certain forms of equipment is seen by some villagers as the easy and essential road to the development of their village environment. Frequently the equipment to be introduced is seen as a central element to the community’s program because (as in the case of trucks) the equipment confers social status in intervillage rivalry and enables the villagers to earn cash to purchase the finished products or additives that are regarded as essential to what is seen as the good life (in the short term anyway). In many circumstances so-called essential additives could have been produced in the village by applying simple technology to the village’s latent
resources. To add to the problem, once the village starts to earn money from the use of the equipment, the villagers in many cases expect to see immediate results via cash distribution and the introduction of market goods for consumption. In some cases simple business arithmetic is not understood and this has led to tremendous pressure on village leaders to distribute cash.

When cash is distributed the consequences are not beneficial to the village. Firstly, if the money is distributed to village members in cash rather than put towards a detailed, timed purchase plan for the community’s development, the villagers tend to purchase luxury consumer items and co-ordinated village development goes by the board. Secondly, the distribution of money can result in village rivalries as clans and clan members argue who should get what share of the revenue. This rivalry can lead to the creation of divisions within village communities to the point where the overall village development program becomes unworkable. Thirdly, people may tend to concentrate on the market activity and the introduction and collection of money generating status symbols that do not necessarily contribute to village development when they are accumulated in large numbers. For example, the introduction of one truck into a village to transport people to main centres, gardens or neighbouring villages may be a profitable venture. However, the introduction of another truck may, owing to lack of customers, result in both trucks running at a loss. This situation occurs in villages connected to main centres and is promoted by the provision of government financing and the lure of getting rich quickly; the owners can obtain market goods or items for development from the profits generated from running the truck. The fourth and quite frequent effect is that the villagers, upon receiving their government finance to purchase the complex mechanical equipment, are not capable of servicing and maintaining it and large amounts of money have to be spent in employing mechanics to repair it. This situation has grave implications for the village’s development plans because the villagers have to raise the money to repair the equipment as well as that to repay the loan. As a result the community tends to concentrate on the generation of money to pay for repairing the equipment and repaying the loan and the rest of the community’s development plan is delayed. Villagers become disgruntled and aspirations are dissipated. Thus village development fails because of the introduction of an inappropriate technology into the village environment. It should be stressed that this situation is promoted by the provision of government finance for the villagers to purchase inappropriate equipment.

To this point the government’s funding system has been laboured as a cause of the non-implementation of villagers’ aspirations. The sources of the problem lie also, however, in bureaucratic arrangements made available to assist villages to develop. Other than the Office of Village Development Task Force (which has not necessarily assisted villages to implement their integrated plans), there is no government agency in existence that assists villages to implement their comprehensive development initiatives. It can be argued that the Task Force was a radical attempt by the Government to reorientate its resources towards assisting villagers to develop self-reliance, but that the Task Force failed to meet the Government’s new direction because it raised villagers’ development aspirations and then frustrated them by emphasising commercial and compartmentalised development under the guise of holistic development. This return to the status quo has been brought about by inadequate leadership, which has been unwilling to listen to constructive criticism or be self-critical. It can and should be stated that many members of the public service have been willing to work with the Task Force but, owing to the manner in which it has been administered, have been turned off the venture.
In short, the present management and funding do not assist villages to develop because their approach is so compartmentalised and market orientated. Villages are planned 'for' rather than 'with'. Many government agencies will espouse the claim that they are planning with the people and that the villages are firmly entrenched in the planning and funding process through their elected representatives (area authorities, local government councils) and government field officers. Unfortunately the facts point in the opposite direction. The people are being planned for. It is possible to lay the blame for this situation on the bureaucracy and trace the origins of the present dilemma back to the colonial administration’s attitude to development. Blame laying is not, however, necessarily productive, and since the root of the problem has been identified, it is more constructive to offer a form of reorganisation that might provide a solution to the present dilemma.

**Suggested Reorganisation**

In reorienting the bureaucracy (including funding and education systems) towards assisting villages to develop in the direction and at the pace they desire and in a manner consistent with the preservation of their community traditions and environment, a key factor is the realisation that the villagers know what they want from development and how they want to develop. Villagers were planning for the maximisation of their welfare from their own limited resources long before the imposition of a bureaucracy that was not necessarily created for the benefit of the villagers. Villagers were self-reliant and their activities were consistent with the perpetuation of their lifestyle and environment. Essentially the bureaucracy’s influence (both pre- and post-independence) has disturbed the village ecology to the point where many villages in close contact with the country’s main centres are no longer self-reliant. In particular many villages are becoming or have become dependent upon the market systems concentrated in the main centres. The invasion of bureaucracy into the village environments brought an influx of resources that potentially increased the resource base available for the villagers to maximise their welfare. Unfortunately, in many cases, although the potential resource base has been physically increased, the villagers’ state of welfare has decreased because they have become dependent upon the market and government sector; their traditions, culture and basic cohesiveness have been disturbed.

Steps can be (and have been by the Papua New Guinean Government) taken to reorientate its activities towards assisting villages to develop in a manner consistent with village traditions and aspirations. The need for such reorientation has been highlighted by the pressure of village development activists. Development initiatives were instituted and have been used to pressure the Government in direct response to the inherited system’s inability to respond adequately to the needs of the village people. To put it quite bluntly, the inherited bureaucracy has been a hindrance to the development of Papua New Guinea’s rural sector. The new national Government is attempting to redirect the public service so that it is more responsive to the needs of the villagers (approximately 90 per cent of the population), but this redirection must be more than lip service.

The best form of assistance that could be provided would be in terms consistent with the input/output framework presented at the beginning of this chapter. Effectively the planning, development, funding and education systems should be orientated so that the needs and development aspirations of the villagers are serviced for the maximisation of their welfare and from their actual and latent resources. This could be achieved by aligning the public service along the lines suggested below.
Public Service Reorganisation

Public servants and technical village development officers should be assigned to villages or groups of villages to assist in carrying out development needs. The village officer would live with the villagers and assist in training through village development clubs and portfolio holders. The village officer would also assist visiting technical aid teams, or be part of these aid teams, living with the villagers to teach them techniques that would enable them to convert their latent village resources into development activities.

In the early stages of such a scheme, it would be desirable that the village officers remain in an area for a good deal of time. (This proposal would appear to be consistent with the Government’s village fellowship scheme whereby government officers who wish to return to their villages to assist development may do so for a period of six months.) Given the acclimatisation and acceptance problems that many activists have experienced upon return to the villages, it is suggested that a minimum period of one to two years’ stay would be required before any positive development could be expected. In addition, the officer should be given good promotional and training opportunities that enable him to continue working in his village or district; he should not be assigned to his village and promptly forgotten for one or two years. If promotional training facilities are not available and village officers are not able to return to their own district, the present system which often results in the appointment of ineffective district officers will be perpetuated; the only difference would be the creation of ineffective village officers. It is essential for officers to be assigned to their own districts because of the nature of the village communities; an officer from another district would be regarded by the villagers as a foreigner and little, if any, positive development activity could be expected to be initiated by him.

If rural development is to take place with the aid of village officers, a good many technical personnel that do not presently exist will have to be trained. The training of these people and a good deal of the development work itself could be achieved by introducing technical teams into the village. The teams would consist of technical people recruited by the Government from other developing countries, to work and live in the village, where they would hopefully become part of the community and act as a catalyst for development. It should then be possible to avoid the introduction of equipment too complex for villagers to maintain and it should be possible for villagers to become fully proficient in the necessary skills.

It would be necessary to establish village education and vocational centres to supplement these activities; these centres should be made an integral part of the community. This could be achieved by involving the village clubs in education and by locating the vocational centres in or close to a number of villages. For example, a number of traditionally tied and compatible villages that are close to each other could establish a common centre; its members could live in the villages, attend the vocational centre and conduct village improvement projects. The emphasis throughout should be upon the practical application of simple technology for the improvement of the village environment, not upon experimental work. Another way of incorporating the vocational centres into village communities would be to make them multipurpose activity centres, acting as an aid post, community centre and cultural forum as well as an educational facility. In addition to the village vocational centre there would be a need for a further, higher level training system to satisfy the country’s growing needs for trained technical staff. The students for these further training centres could be drawn from the graduates of the vocational centres and village officers and club portfolio holders.
In concluding it must be pointed out that this proposed organisational framework is not anti-commerce. If this were the case the frame of reference would be unworkable because commerce is and always has been a part of village life and to exclude it would be totally unrealistic. The essential point is, however, that commercial activity is only a part of life and its role should be kept in perspective. Commercial activities should be an integral part of the village's evolution, not its dominant aspect, so that villages maintain their traditional cultural community cohesiveness.
Traditional living in the Solomon Islands included subsistence agriculture, 'communal' society, and the 'big man', who acquired status and recognition by being a donor of wealth, usually by distributing any surplus of agricultural production. Colonisers and missionaries have disrupted this traditional society, confusing the people, and showing a complete failure to understand the customary land tenure that is basic to traditional ways of life. Immediately after the Solomons were declared a British Protectorate, a massive land alienation policy was carried out in the belief that the natives would slowly die out, leaving all the lands to the white settlers. Land legislation emphasising individualisation of ownership was meaningless and destructive to a population holding land rights in common. There had never been any abrogation of the right and the authority of the group and its leaders to assess the rights of individuals to a plot of land. The emphasis in Christianity on the rewards of the next world encouraged neglect of both land and possessions, and denominational affiliations often took over from the previous communal ties. The effects of 'education' and of 'development' have been similar, encouraging the individual instead of the group, holding out often unattainable riches and status as models and incentives to change, and most often leaving people with none of the benefits of their traditional ways and with all of the problems of the 'superior' white man's world.

In pre-contact days in Melanesia, the mode of production and the impact of man upon his environment were determined by the type of economic activity in which he was engaged. The activity then was subsistence and its essence was to provide for the daily needs and wants of the society. Any surplus accruing was not reinvested to increase the output, but distributed in a manner determined by the community concerned. The motive for the distribution of the surplus was essentially to secure more social prestige for the donor. The distributed surplus was often in the form of consumable not durable goods. Because pre-contact man's economic activity exerted little impact on his environment the process of natural restoration of resources was kept in balance with the rate at which the resources were exploited.

However, industrial revolution changed things. Man from the stone age to the present has forged machines and methods to alter his environment. Using his hands and brain he has sought means to improve the quality of his life. But this same paradoxical creature frequently works and lives in polluted environments and suffers from an epidemic of job dissatisfaction, stress and occupational accidents and diseases. For technology, instead of serving man, all too often damages and enslaves him. Man's unique ability to change his environment has become a mixed blessing.

An analysis of the technological advancement of industrial countries clearly indicates the type of relationship between the capital and labour inputs: as the labour input becomes more expensive, the profit motivated capitalist is impelled to seek alter-
native cheap forms of production. In a pre-contact Melanesian society, the 'big man' was motivated not by the process of accumulation of wealth but by the expansion of his sphere of influence as he became a donor of wealth. The pre-contact Melanesian man was not compelled to have a large labour force at his disposal; he did not have to worry about its cost and how he was going to meet the cost and simultaneously earn an extra income to make a living. In the Melanesian traditional societies, the unit of production was usually the extended family.

Before Melanesian culture came into contact with a 'superior' culture, that of the white man, Melanesian man was a self-sufficient organism, whose needs and wants were readily satisfied by the techniques then at his disposal. The intention of this chapter is to discuss the effects of colonialism, Christianity, education and development on customary land tenure in the Solomon Islands as an example of what happens when the traditional Melanesian mode of production comes into contact with a more progressive and aggressive one. I strongly believe that these four factors are responsible for the changes that are currently occurring in traditional Melanesian modes of production and for the way in which these changes affect the environment.

**The Effects of Colonialism**

In 1893, the Solomon Islands was declared a British Protectorate. The motives for the declaration were not entirely humanitarian; they were largely part of Great Britain's expansionary policy as she secured new lands for her growing and unwanted population and new markets for her manufactured goods. Immediately after the declaration, the first Resident Commissioner's first action was the authorisation of massive land alienation. The action was a direct result of the fallacious belief that the natives of the islands would slowly die out, leaving all the lands to the white settlers. The best and more accessible lands were alienated and the so-called waste lands declared Crown property. Thus, the native was confronted with a new force impinging on him and the ease with which he could exploit his land resources was restricted.

Up till the present, land ordinances in the Solomon Islands have explicitly reflected this expansionary policy of capitalistic ideology, which has been superimposed on a basically communal society. The colonial administration's land ordinance emphasises individualisation of ownership as a prerequisite to encouraging and promoting economic development among the indigenous population. Where individual titles are forcibly secured and registered under the land registration ordinance, the new titleholders are resented and disapproved of; in some cases this leads to destruction of property by the group whose land is now held by one or two of its members. In many cases economic projects based on individualisation of ownership proved unsuccessful because of various socio-political, economic and religious factors.

Slow but painful realisation of this over the years has led to a provision being added to the land registration ordinance for group registration under what is called the Land Settlement Scheme. The scheme is, however, self-defeating to the extent that, though group registration is permissible and legal, the methods used in assessing individual claims have merely perpetuated the conflicts and confusions among the members of the group. These arise when the different vested rights to different plots and properties in a territorial area are assessed for individual registration. This is because different individuals, though of the same group, have different vested rights in the same plot of land. Consequently any attempt to adopt the Land Settlement Scheme to minimise land disputes and secure stable ownership is bound to instigate further conflicts and discontent within the group.

However the scheme is somewhat nearer customary land tenure than previous prac-
tice. The methods employed in assessing ownership are its weakness and are responsible for its failure. It is my belief that the scheme would have been successful if had been based on the group’s own assessment of the rights of individuals to a plot of land; any concession to be made by members ought to be made independently of the Government’s interference. The land settlement officer should merely demarcate the group’s territorial boundaries off from those of others. The internal affairs related to the land and how and by whom its resources are exploited should be the responsibility of the leaders of the group. In carrying out these functions, the leaders should be supervised by the area authority to avoid arbitrary dealings and outrageous sales or leases of land.

The native court system is another example of the imposition of a British idea on Solomon Islanders, who have their own sense of justice. The court’s proceedings in land disputes are deeply rooted in the British concept of legitimising claims without due respect for customary norms in determining land title. The native court justices are fence sitters—a confused mob whose knowledge of rules for legitimising claims under the customary tenure are fragmented. Therefore, a move to standardise and register (in the land ordinance) customary means of assessing and proving land ownership would be essential.

We have mentioned the first Resident Commissioner’s land alienation and declaration of waste lands as Crown property. The result of such an inconsiderate decree was chronic resentment of the colonial administration by the indigenous population. The decree has deprived the Solomon Islanders of their best and most accessible lands. The native is confronted with an alien force, which has spread throughout the country like an epidemic. It is beyond his comprehension, and consequently he is left in a state of confusion and anxiety where the future is undetermined and the past is glorified.

Moreover, the traditional Melanesian and the infiltrating white man’s mode of production are continually meeting in confrontation. The traditional mode of production is no match for the white man’s; it is like a civilian armed with a spear trying to fight a soldier armed with an automatic gun. The inferior submits to the superior. It should not, therefore, be a surprise to social change analysts that the indigenous population deem the white man’s socio-political, economic and religious activities prerequisites to the kingdom of civilisation. Hence, the Solomon Islander, in trying to be like the white man, found himself imitating the white man’s institutions without really understanding that he would never be a white man.

In the course of such imitation he has deprived others of their needs and wants; he deprives them of their land ownership as he is now the sole owner; he deprives them of their socio-political, economic and religious institutions as they are now being absorbed into the institutions of the white man; finally he deprives them of their ethos as they are being forced away from their own community. The new technology determined how man could influence his environment in a more progressive and exploitative manner. Now he has at his disposal superior techniques for exploiting the resources of his land. In pursuance of improved quality of life, he can use those techniques to benefit him or, with unguarded hands and mind, he can use them to enslave him.

**The Effects of Christianity**

Christianisation of the indigenous population had its own impact on customary land tenure in the Solomon Islands. Among the land alienators were the missionaries, and neither the amount of land alienated nor the manner in which alienation occurred can be justified in terms of their soul saving activities. In many instances, Solomon
Islanders regarded the missions as business underground movements disguised by a mask of brotherly love in order to secure cheap land, cheap labour and an attitude of acceptance by the indigenous population.

Four techniques were employed to bring this about: suppression to bring so-called peace at heart to the natives; condemnation to undermine the native socio-political, economic and religious institutions, particularly the last; deprivation and acceptance to substitute for a valuable and unique indigenous culture a 'superior' western culture; and outright destruction of socio-political, economic and religious institutions.

By Christian suppression I mean the type of activity missionaries employ to bring 'peace' to the natives—exhibitions of brotherly love and the superiority of their god. The natives are suppressed because they are confronted with advanced techniques with which they cannot compete and they attribute this to the superior culture, which has its mysteries vested in Christian philosophy.

By condemnation I mean direct and indirect actions taken by missionaries to dissuade people from valuing traditional norms and institutions like sacrificing pigs to ancestors, which is an act that constantly reminds the members of a group of their relationship with the group.

By deprivation and acceptance I mean the way in which the Christian native population has been influenced to accept the white man's 'superiority' as characterised by his material goods and knowledge of the mysteries. This has led to an indiscriminate acceptance of the white man's ways and the rubbing off of native ways of doing things. Consequently the material and non-material things of the native are rendered to the missionary and are left at his disposal.

Finally, by socio-political, economic and religious destruction, I mean the total, deliberate undermining of the traditional system. Economic institutions like bride price and polygamy, for example, are essential in maintaining a workable traditional system, but they are criticised and labelled the work of Satan, and must be abandoned according to the Christian teachings. Similarly land ownership and the rights to exploit its resources are disrupted.

Subsequently, members of the same ethnic group become strangers as they are separated by distance and, more importantly, by the different Christian denominations. Hence, the rate of migration from one area to another becomes inflated and in many cases the migrants are given the right to make a living for themselves on the land belonging to other people. As years go by and the social status of big men changes, some of the migrants become big men themselves; lands that were never before theirs are then vested in them as the protectors of the groups, which have been redefined as Roman Catholics, Anglicans, South Sea Evangelical Church members, United Church members, etc.

The powers and influence of the leaders who were migrants increase as a direct result of the fact that they were the ones whom the colonial administration, missions and business people dealt through. This not only increased their respective spheres of influence but highlighted their social status. In many cases the new kind of leadership became the aspiration of young people, who discarded the old criteria for acquiring leadership. Ability to read and understand the Bible and to communicate with government officials, clergymen and traders is a prerequisite for the acquisition of this kind of leadership.

Under such circumstances, the impact such leaders have on the land and its transfer from one group to another bears no resemblance to the traditional one. In many cases, through such leadership, the various churches have acquired their present lands.
They have preached to the converts that the riches and joys of this earth have an end to them, but the riches and joys of heaven have none. This teaching indeed appeals to the indigene and consequently he divorces himself from economic activities that would have benefited him. Instead he renders his material well being to the ticket issuing agencies of god in the hope of securing the everlasting riches and joys of heaven; he is left with nothing but an illusion of his future reward.

Consequently the manner in which the traditional Melanesian man exploits his environment for resources is offset by the fact that the same environment now is being exploited by agencies of a different culture in a more destructive manner. And the indigenous population, eager for development, forget to ask themselves the question of development for whom. Nonetheless they honestly believe that the sacrifice of their material well being is for a hundredfold reward; they do not realise that what they forgo is to someone else's benefits.

THE EFFECTS OF EDUCATION

Before the colonial government saw the need to educate Solomon Islanders in the early 1950s, the Christian denominations were obliged to educate the natives. The focus of education then was essentially to Christianise the young generations and turn them from the so-called wicked ways of their parents and grandparents. The aim of education was to teach the natives the essence of the Bible and to produce native evangelists. The purpose of education then was very restricted and in no way prepared the people to acquire jobs in professions other than religion. Even with such a restricted education, Solomon Islanders, with their natural talent for learning through observation, began to be absorbed into posts with the colonial administration and in the private sector. The natives became more and more critical of the education system and its intention and, sixty years after the declaration, the colonial government was forced to establish its own primary education.

The various educational curricula at both government and mission schools emphasise the individual over the society. It is implied that when an individual is pursuing his own interests he is ultimately pursuing the interests of the community. This, however, is contradictory to Solomon Islands traditional philosophy that, when an individual is pursuing the interests of the community, the community in the end will make him prosper.

The capitalistic ideology and its accompanying material well being demonstrated clearly to aspiring leaders its superiority over the communal philosophy. The impact of this has been the urge within the new leaders and inconsiderate and unscrupulous people to lay individual claims on the lands that were once communal assets. The taste of the new leadership and its surrounding glories and material gains inspired the hopeful leaders to discard their old ways and adopt the introduced culture indiscriminately. The ease with which the subsistence farmer can move became restricted. Shifting cultivation became obsolete and subsistence farming became confined to specific plots of land.

Furthermore, the new techniques exhibited by the white man fascinate the young educated and old generations alike. The young people, then, attend schools in the hope of learning about and acquiring special skills. When this is not forthcoming they become disillusioned and frustrated. In many cases, the new introduced methods of doing things disrupt the social system, which is based on the traditional mode of production. Where resistance against such methods is successful, young aspiring capitalists find themselves not wanted in the community.

Where new tools and techniques of making a living proved successful, their utilisa-
tion became restricted because of fragmented ownership of land. Consequently the economies of such new techniques and tools have not been forthcoming; this also is frustrating and confusing.

**The Effects of Development**

Since the declaration of the Protectorate it has been the belief of the colonial administration and planners that a sound economy could be built out of a cheap labour market. Today’s urban basic wage is still a reflection of this fallacy. While the consumption of the urban workers justifies an urban basic wage of $53, the ongoing basic wage is $23. In a country like the Solomon Islands, where more than 90 per cent of the investment is in the hands of foreigners and the company tax is very low indeed, it can be argued that increasing the wage bill paid to the indigenous labour to a level where investment is not discouraged would be advantageous as it would mean an increase in the proportion of profits retained in the country.

Solomon Islanders are now beginning to ask themselves whom development is for. It is obvious to an average Solomon Islander that the development that is occurring is certainly not going to benefit him, but somebody in England, Australia, the United States, Hong Kong, etc., who has no knowledge of where the money is coming from. The aspiring Solomon Islands capitalists, with a new determination to be equal with their counterparts, engaged in huge economic undertakings that often proved unsuccessful. The reasons are first, that the white man is an old timer in business; second, that he has the capital required; third, that he knows how; fourth, that he has ready access to financial institutions; and finally, that the general policy of economic development in the Solomons is in his favour.

It is now an established cliche that the important facets of production are capital, labour and land. Here I want to look at land and the role it plays in development. We can argue in general that land is scarce: without going into the arguments that man can increase or decrease the fertility of the land, we can say that the land is still ultimately fixed in area.

We have seen how the Solomon Islander aspires to the white man’s material things, trying to claim individual ownership of a once communal asset. The only real development of the land has taken place where lands have been alienated. On customary land only small patches of development can be seen. The reason for the fragmented development in small uneconomic units is the battle between individualism and communality. This uncertainty as to which will win has paralysed economic development of customary land. The Government has not until now explicitly stated what course of development we should pursue in the Solomons. The emerging local entrepreneurs are entering tertiary industries where most Chinese and white men are already engaged, but they have found that the tide of such business activity is not in the local entrepreneur’s favour, and they are left in a state of uncertainty about which side the Government is on.

Furthermore, apart from land alienation and the declaration of all so-called waste lands Crown property, large-scale farming and a rapid rate of population growth have aggravated the problem of land shortage in the Solomons. In some areas of the Malaita and Western Districts land shortages have already been experienced. These new factors impinge on customary land tenure: the cultivation of one area of land becomes more intensive and permanent; the farmer can no longer rotate his plots and is confined to one plot; the area of land from which a household can make a living becomes smaller and smaller as the population increases.

The indigenous population is slowly realising the dangers of fragmenting plots of
land and in some areas they have now joined together scattered units into one large continuous area. The advantages of this collective activity are that economies of scale are now possible; that it is now possible for scarce resources such as capital and manpower to be pooled; and that it is now possible to introduce mechanisation. However the voluntary collective organisation is not really supported by the present Government, which prefers a milder form of amalgamation that will eventually result in public companies. In other words the war between individualism and socialism is still on.

**Conclusion**

The colonial government often argued that communal development of land defined by membership of the group owning the land had proved unsuccessful in underdeveloped countries. Nevertheless, because of the forces hindering development by individuals and the fact that this has led to the struggle for individual ownership and endless land disputes, the individuals concerned are seriously considering communalism. It is therefore strongly recommended that collective farming be encouraged as a revived and modified form of communalism consistent with the traditional mode of production.

The present Government ought, as a matter of urgency, to spell out clearly in broad terms the course of development the Solomons should pursue. As an immediate solution to the emerging problem of land shortage, consideration should be given to recovering the alienated lands and compensating the present holders, and to allocating lands firstly to the original owners and lastly to land hungry groups.

Whatever the new course of development the present Government pursues, it will never be the same as that characterised by the traditional Melanesian mode of production. The way in which development will affect the environment will always be more alarming to conservationists than the traditional impact of the former subsistence farmers.
Concluding Remarks

HAROLD BROOKFIELD and DOUGLAS E. YEN

We were jointly charged by John Winslow with the task of concluding the 1975 Waigani Seminar on which this book is based. In modifying these remarks for publication in the new context of a book arising from the seminar we have decided to preserve the original structure of the contributions delivered at Waigani. The book arose out of the Waigani Seminar, and the discussions from the floor in that seminar constituted an important part of our ‘data’ in what we say here. We therefore discuss both book and seminar in what follows; Yen, in particular, comments in some detail on the discussions that converted what would have been yet another academic meeting into a lively political debate. We are both keenly aware of this political aspect, and emphasise it strongly in what we write here. Nonetheless, we feel that these comments apply equally well in the present context, for this book will surely give rise to argument, and we hope that the disputation of May 1975 will go forward, and extend over a much wider public in Melanesia.

In a paper or papers which set out to sum up the issues faced in this book, we have sought to achieve three objectives. The first is to provide a setting for such a collection as this. Second is to review the seminar on which the book is based. In a third part, we try to draw some conclusions for the future.

I

Harold Brookfield

Perhaps it would be best to begin by defining our terms, of which there are three—environment, change, and development. Properly speaking, the environment of any system is all that complex around it which does not form part of its operation, but which may influence or constrain that operation. The human body, for example, cannot operate outside an environment composed of normal air, at a quite restricted range of temperatures, and with other resources available for its sustenance. Change in the ambient conditions creates stress, and calls into operation processes called homeostatic, which are designed to maintain the essential variables of the system in working order despite such environmental changes.

‘Change’, in the sense used here, seems to mean secular change, not variation. One wonders then why the word development is used as well. I once sought to define development very broadly as the set of processes creating interdependence in world

* At the time of final revision of this chapter, both authors were Visiting Fellows in the Research School of Pacific Studies at The Australian National University, respectively in the Development Studies Centre and in the Department of Prehistory.
social, political and economic systems (Brookfield, 1975). Others prefer a definition based on progress towards certain defined welfare goals, in particular the reduction of poverty and inequality. Still others might define it as progress towards balancing the budget. One wishes one could forget the term, but it is not possible. But the development philosophy, or the development argument, is part of the total environment of Melanesia. In this book, 'environment' has been defined by almost universal implication to mean only the natural environment. If we had allowed 'environment' to include the growth philosophy of development and the current argument over the goals of development, we might have attained greater clarity.

But let us follow the prevailing trend and treat 'environment' as being the natural environment. What can we say of that of Melanesia? I treat Melanesia as a whole, and shall do so throughout this discussion, notwithstanding a concentration on this one country in the book and in the seminar on which it is based so marked as to make me wonder if the Waigani Seminars can or should honestly continue under the present title. To me, coming to Waigani from Fiji, and after living four years in Canada, it was a little too reminiscent of the lip service paid to Canada in meetings in the USA of allegedly 'North American' organisations!

Climatically, all but a small part of Melanesia falls within the hot, wet tropics. The exceptions are areas of seasonal aridity, which are small but quite numerous, and the high altitude areas. This is one of the wettest portions of the hot wet tropics, and is the cloudiest portion, which is quite a serious constraint. The range of soil-forming processes, the product of a varied climate on a varied geology, is very great. The environment for agriculture contains pockets of high fertility, large areas of mediocre quality, and some areas so degraded by initial causes—or by the effects of use on a fragile environment—as to be almost worthless for arable purposes.

The environment of Melanesia also includes some quite substantial mineral resources, many large and strongly-flowing rivers, a marine environment of great diversity, and a landscape of quite remarkable beauty. It includes also all the problems of high seismicity and active vulcanism, some of it of a very dangerous type, exposure over large areas to risk of hurricane and tidal wave, risk of killing frosts such as those of 1972 at high altitudes, risk of unexpected deluge and drought over considerable areas. It has a high proportion of steep land, great physical constraints to communication by land, sea or air, and it is also a long way from anywhere else. All this is part of the Melanesian environment; we have not analysed it adequately, and therein perhaps lies the root of some of our confusions.

THE 'OLD' MELANESIA

We have made a somewhat rapid jump from the Old-Old Melanesia of ancient time to the New-New Melanesia of monstrous mines and hydro-electric schemes. It might help contextual thinking to try to ease this jump. The fragility of the capacity of Melanesian soils to support agriculture has been stressed by many writers. It underlies the generally successful adaptation that is shifting cultivation. But this environment also contains soils of greater durability, but which can be exploited only with the aid of a skilled and

1 Editor's note. The comment on 'lip service' may have some validity, but the editor recalls, wryly, his attempts well in advance of the seminar to broaden the range of areas treated and to elicit from faculty members throughout the Pacific topics on the environmental theme of specific interest to the region. For whatever reason—unwillingness to speak out? lack of interest?—no response at all was received from, for example, the University of the South Pacific. Three research workers in Fiji were, nonetheless, invited and attended as guests at the seminar.
laborious technology. We have heard of this mainly in relation to one particular environment—the swamps of the Wahgi valley in New Guinea—but the same was also true of the seasonally dry mountains of New Caledonia, exploited by means of terracing and soil management as elaborate as any in the world, and of comparable adaptations found quite widely in the New Hebrides and Fiji. The old swamp management which died in the Wahgi valley around the time of World War I remains fully alive and operative in the major valleys of the highlands of Irian Jaya. There are also some quite remarkable adaptations to extreme environmental constraints, on atolls of the Melanesian border, in the Rewa delta of Fiji in earlier times, and above all in the swamps of Kolipom Island, in Irian Jaya.

Several contributors have remarked that these elaborate practices of the people of Old Melanesia are quite remarkably conservationist, and our attention has more than once been drawn to the contrast between this maintenance of ecological balance in the past and the real or potential damage done by modern practices. This has truth, yet there is some danger that we might overdo this contrast. The impact of traditional resource use has been quite heavy in several parts of Melanesia, creating ecosystems of very low productivity for human use. Were it not for the stone and concrete wall of the lecture theatre in which most of the Waigani Seminar was held, we might even have observed this, for we were talking in the middle of quite a large area of thoroughly degraded environment, and moreover an environment degraded long before colonialism arrived on the scene! Removal of an original forest or bush cover by clearing and fire has greatly enlarged the extent of savanna and grassland in Melanesia. In some fragile ecosystems, consequent sheetwash and rill erosion have effectively removed most of the soil.

It was only quite recently the fashion to treat this whole continuum from forest to eroded wasteland as a single linear process in which the villain was traditional Melanesian man. But this is as untrue as the contrary view that all old Melanesian farming was ecologically sound. Both traditional and modern man have evolved techniques to make highly productive use of what scientific wisdom calls degraded environments. Each in their own time and place, the New Guinea highlanders, the New Caledonians, the Indian cane-growers of Fiji, and the entrepreneurs of Guadalcanal Plains Ltd, in the Solomon Islands, have demonstrated that a highly productive agricultural economy can be developed on the grasslands. And outside Melanesia, the ‘total logging’ complained of in New Guinea has preceded, in Malaysia, the conversion of large areas of primary rain forest on quite mediocre soils into the rubber and oil palm plantings of the new land development schemes. Elsewhere in Malaysia, many of the rubber plantations are on land earlier thought to be ‘ruined’ by conversion to grassland under nineteenth-century tapioca farming. The ecodoom of both traditional and modern practices is not necessarily inevitable, if we only look around us for models.

The ‘Old-New’ Melanesia
This collection tells us a lot about ‘Old Melanesia’—perhaps too much in proportion to the whole. There is also a great deal about the truly ‘New-New Melanesia’, and we shall say more on this anon. But we find very little about an ‘Old-New Melanesia’ of plantations,2 migrant workers and little else that achieved contemporary notice. Yet

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2 At the time of planning the seminar it was believed that the following (1976) seminar would deal exclusively with the topic of agriculture. It did, and the proceedings, when published, should be available through the University of Papua New Guinea Bookstore. See Preface—Ed.
this long period, occupying more than a century in the total history of the region, wrought very major transformation in the use of resources, natural and human. The basic framework of man/environment relations in Melanesia rests to this day on the doings of that period.

This was the major period of plant and fauna introductions in the region. Human populations underwent severe reduction followed by the genesis of the present population boom. Major displacements of people occurred, and large immigrant populations were introduced. And, as Ian Hughes pointed out, the autonomy of the Melanesian village producing and trading economy was destroyed—a hard fact that no amount of regret, or wishing, can overcome.

In terms of environment, the landscape of coastal and sub-coastal Melanesia was transformed by the spread of the coconut, the replacement of traditional food crops by new ones and by store-bought food, and the clearance of large areas for plantations, village groves, and livestock. Settlement patterns were substantially restructured. The new activities—tree crops and livestock—used much more land than the old, but they replaced diversity in ecosystem and production system alike with very narrow specialisation. Furthermore, much of it is of very low productivity per unit area. To lay down great areas of the better arable land in Melanesia to coconuts, then allow these to grow so old, and be so poorly tended, that they produce only between a quarter tonne and a tonne of saleable product per hectare is not a high intensity use of resources. Yet while we worry so much about present resource losses, this very large resource diversion of a recent past seems to be accepted as though it had always been.

The ‘New-New Melanesia’

I think it useful to remember this when we come to examine the problems of the New-New Melanesia that have dominated the book, and the fairly intense discussion of some actual and potential modern ‘developments’: Bougainville and Ok Tedi, Purari and Madang. We could have added others from elsewhere in Melanesia. These are big issues, and one fears that at least some aspects of their discussion at Waigani generated more heat than light. In so far as it is possible, I want to spend a little space in trying to separate out the issues basically involved in all such developments as these, and many smaller ones as well, and later relate these issues to my evolving argument.

First is the inescapable fact that all human activity of whatever kind modifies environment, generally creating a new form of ecosystem in place of the old. Some of these created ecosystems become very stable—as stable as primary rain forest, for example. Others contain dynamic elements, selecting for emphasis among the natural processes of environmental change. Abrupt new developments inevitably have a major and visible impact: the creation of anything demands the destruction of something—even the creation of the Universe destroyed emptiness, and who knows but that the Almighty may first have embarked on an environmental impact study of His own? If so, He might now have cause to complain of the work of His consultants.

Second to emerge is the fact that the larger developments raise problems of a kind already quite widely experienced in other parts of the world, even though the particular circumstances of any individual site are unique. A large and rapidly growing body of expertise is available in this area, and the means do now exist to make a well-reasoned assessment of the environmental and social impact of any proposed development. While this is not to say that unforeseen consequences may not arise, we are not dealing here with a new and untried field. Some of the means exist, even within Melanesia’s proven expertise, for the repair of environmental damage: for example, Papua New Guinea in particular was blessed with a rash of quite incredibly unsightly
urban development in the sixties, by planners well trained in the blighting of Australia. But tree planting is rapidly masking eyesores—an environmental innovation no doubt introduced from Canberra, where the creation and camouflage of ugliness is the business of an entire Government department.

But to be more serious, one fundamental lesson to be learned from the discussions on the Purari, Bougainville, Ok Tedi and Madang is this: given the will to do an honest and adequate job (and this is fundamental), the means exist to set out the environmental impact of any major proposal, and to lay out alternative strategies, for the decision of informed national and regional legislatures. The question then comes back to the quite fundamental one of public attitudes.

This would not satisfy Professor Daws and Mr Kelly, who will assume that any such control system can be subverted by pressure groups and private interests with large and open purses. I respectfully submit that this is not necessarily the case, and that the experience of the United States is not necessarily applicable in all lands, in this matter as in others. The highly individualistic ethos of personal gain prevailing in the United States is part of the environment of such practices; where the national ethos is different from this, different results follow. What we heard at Waigani from Melanesian speakers is most heartening in this matter, being suggestive of a strongly emergent social consciousness much more likely to add weight to collective than to private goals. This seems to me much more strongly developed in Papua New Guinea than in Fiji, and I write this with regret in view of my involvement with research and planning in that country. Perhaps William Clarke was being more far-sighted than even he realised, when in words originally written in 1970 (Clark, 1973) he expressed the hope that Papua New Guinea might pioneer the way to a wholly new and ecologically aware approach to questions of development.

But there is far to go, and the level of awareness that Purari and Bougainville arouse is not paralleled by anything comparable concerning more insidious and widespread but small-scale changes. What do we say of far-reaching changes in consumption patterns which, in the absence of nutritional knowledge or generations of experience with new dietary forms, are leading to a very widespread incidence of malnutrition symptoms, especially among young children? What do we say of changes in agricultural practices which reduce the capacity of the soil to recover fertility by natural means after cultivation? What do we say of the locking up of large areas of good arable land under low-yielding, ageing coconuts, when the price of copra has remained unrewarding for most of the last few years, and the price of imports for which it pays goes up ever more steeply? And while we complain of ‘total logging’, what do we say of the smaller and more selective logging which is mining out valuable timbers that nature will not replace for 200 years, if at all? What do we say of the consequences of grafting a partial commitment to cash cropping on to a subsistence base that it diminished by the competition—consequences that include loss of autonomy in the village economy for the gain only of a state of everlasting peasantry, or ‘persistent poverty’ (Beckford, 1972), and the replacement of a ‘primitive affluence’ for all by the modern affluence of a few, and the pauperisation of others? For this is the demonstrated effect of the free-market economy, applied in this way to village economy and society.

We say little in our discussions about all these things, for we accept change as inevitable, and its consequences as inevitable. Of academics, Karl Polanyi (1944) and Dalton (1968) remarked years ago on their total failure to come to grips with the harmful consequences of change. We have learned something since then, but we are deeply in the grip of an international philosophy which equates change with progress. The public need, we are told, demands that countries must pay their way, and so must
export. But everyone says this: it is not only the governments of developing countries. Britain, Australia, the United States equally strive to increase their exports, and every export is also someone else’s import. Public needs go on rising, and no one ever catches up. We are on a treadmill here in which we become more and more interdependent in our mutual dependence, and increasingly enticing opportunities are created for the acquisition of power and wealth through control over key elements in the system. Big men do this in the New Guinea village system too, controlling the system and its distribution through acquisition of power. But New Guinea big men last only a few years or at most a generation; ours are self-perpetuating, and go on growing bigger and bigger.

All this has been the context of this book—environment, and its processes of change, changes in human management of environment, and the ever-deeper impact of a world system of interdependence which reaches to the remotest Melanesian village, and is now presenting the Melanesian countries with their first environmental issues of crisis proportions. We now turn, through Dr Yen, to the seminar on which the book is based. Then finally, and briefly, we seek what message this seminar might yield for an enlightened public policy on the Melanesian environment.

II
Douglas Yen
Harold Brookfield has discussed the book in terms of its factual content and the analyses from which may be derived certain generalisations on the effects of development on the Melanesian environment. My role is to focus somewhat more closely on the Waigani Seminar itself, its nature, and its effects on the audience as the contributions of the formal speakers, the commentators and members unfolded during the week within the halls—and outside them. Then I will move into the topical area of great concern to John Winslow, the convenor and editor, with respect to the format of the seminar and the maximisation of its function to the Melanesian scene.

The first theme that emerged was development within the ecological framework of Papua New Guinea, and to a lesser extent, as Brookfield has emphasised, of the rest of Melanesia. The presentations that initiated the seminar set the environmental scene of the past. They were particularly apt, being descriptions of change in both natural and cultural terms. Although there were questions on their applicability, these contributions served to emphasise that early development in Melanesia was effected indigenously, that natural resources were exploited, that there were environmental consequences; but the deleterious effects on ecology were not on the scale that might be contemplated in the future development of Melanesia. The subsequent presentations on this latter theme covered very diverse fields—in fact, virtually every part of the ecosystem. There were few papers, if any, however, that either advocated total maximisation of resources or neglected the human aspects—the socio-economic effects and welfare of the people that such developments bring about.

Further concerns were the conservation of natural resources, the principles of sound planning and environmental control, and the ‘threat’ of increasing populations. This is an impressive catalogue and it fits, indeed, the temper of our more enlightened times. However, and also in tune with the tenor of our times, was an uneven and sometimes absent concern for the volition of people at local levels, and further, an uneven and sometimes absent concern for the alternative pathways that might be slower, that is less efficient in immediate business terms, but more in tune with the aspirations and environmental perception of the people concerned, rather than our own.

The grand designs of modern development often perceived by planners as being
The Melanesian environment

synonymous with social welfare have cast off the accusations of imperialism and colonialism by the incorporation of independent government and native participation. Genocide can no longer be practised in the name of progress, but the fear of ethnocide—the elimination of cultures and subcultures—looms large in the hearts and minds of those whose lives we seek to ‘improve’.

Many of the Melanesian contributions to the seminar were emotional in nature and questioning—not in terms of technology, but in terms of values that developers cannot possibly share, and with concern for the environmental background for cultures that are perhaps more subject to erosion than the landforms themselves. Sometimes discussions nearly reached the most basic level of pro or con development for Melanesia. Thus, the questioning reached into the system that is at the root of discomforts, and the political identification, capitalist structure, foreign participation on purely profit motivation, etc. hardly required the support of populist rhetoric.

This leads me from the development theme of the seminar to what became, in my view at least, the second theme—politics—the vehicle for planned development.

If my impressions are correct the questions revolved on:
1. the sincerity of politicians in their concern for local level constituents in their home setting;
2. their imposition of what others say is good for the nation;
3. their evaluation of environmental effects of their decisions as translations of what foreign consultants say;
4. the introduced parliamentary form as a social structure or super-structure whose relevance to native social structures has not had time to evolve to the degree that one can possibly represent the other;
5. the fear that the introduced form could eventually bring with it, in terms of its greater responsibility, corruption;
6. the alienation of politicians from constituents will be paralleled by the alienation of people from the land in the name of the national good.

The union of these two themes, development and politics, seemed to me to carry one message from the Papua New Guinean participants: slow down the plans for developments, at least until the people catch up with the politicians—or until the politicians catch up with the people. And then let the people be major contributors in impact statements, to their own fate, and, indeed, to the rate of development they choose. The forest, the water, the minerals will not deteriorate in the interim.

Turning to the structure of the Waigani Seminar of 1975, it seems that because of its subject—the Melanesian Environment: Change and Development—that the political cast of its ultimate effects as it unfolded was inevitable. Perhaps it is a pity that the politicians could not have made more than ephemeral appearances, like sweet potato flowers that bloom and fade too soon, and develop no seed through the interfertilisation of ideas; that they could not have been in the midst of and contributing to the verbal exchanges—rather than being the ‘result’ of them.

The continuing role of the Waigani Seminar has been criticised variously as a conclave of the expatriate, the academic, the technocrat and the local intellectual elite. The local elite in this seminar is, however, an elite with a difference. It has brought with it a message from the grassroots, from the village. It has expressed its dissatisfaction with the proceedings, with the contributors, it has expressed its own view—it may not have; it may take that view back to discuss with its own people—it will make up its own mind, may change its mind unencumbered with the expressions of theoreticians who may have some utility—but not the same responsibility to their living environment.
Whether the local intellectual elite likes it or not, it is a likely decision-maker of the future—the replacement for one of the targets of its present criticism. An an outsider I am grateful to have met some representatives of that future leadership.

III

Harold Brookfield

A book such as the present could and should be a milestone in the evolution of a public policy in environmental matters. We fear that it is unlikely to have so great an impact in the present economic environment, but this should not deter us from seeking a way forward, towards an approach to development planning that is in harmony with the need to preserve the natural environment for future generations—what Maurice Strong has termed 'eco-development'. This is the decade of the Man-and-the-Biosphere Programme of UNESCO, of which my project in Fiji has formed part. The Man-and-the-Biosphere Programme is much more than simply a scientific exercise: in the view of at least some of us involved in it, it is also concerned with the provision of guidelines for rational, ecologically aware, planning.

We are not going to stop development, for development will happen even if we do nothing. Only what will then happen is the dis-development that marginalises people and nations, intensifies inequality, and permits the forces which increase dependence and risk to advance unchecked. The proper goal of development emerges clearly enough from a conference such as this: it is to enhance welfare and opportunity, and distribute these more widely, through an optimal, balanced and sustained use of human and natural resources in which decision-making is informed and free, and not enforced or blind.

To do this, we must first of all clear our minds, and this is the essential role of this collection. I focus on two aspects, both of which have been treated extensively in discussion. First is the will to seek a wise and far-sighted path, even if it slows 'growth', and to rid the total environment of what George Beckford (1972) has called 'the colonized state of the mind of the people'. Second is the nature of the ecological goal. We read much of conservation, but conservation does not mean only preservation. A static ecosystem is an unproductive one, just as static political and social systems are unproductive. You cannot seek a static ecology in the context of dynamic social and political change, for all change is linked, and all change in society and economy has environmental impact. It is my personal view that the contemporary concern in the ecological movement with crisis situations on the one hand, and with the creation of national parks and reserves on the other is, while necessary and valuable, diverting attention from the real problem. This real problem is the much larger question of adaptation to change, and the rational management of this adaptation. It affects not only crisis localities, big projects, and places of great scenic or scientific value that should be preserved; it affects the entire fabric of environment and society, all places, all people, and at all times.

In this context, notions of preserving social systems, ecosystems, and environments 'as they were', or of striving to retain intact the 'essential variables' of a system are practicable only where the forces of change are slow and not strong. As a scientific aside, what I am saying is that adaptive systems theory in its application to ecological planning under change and development diverts attention from the real issues involved. In Melanesia, the forces of change are rapid and strong, both externally and internally. What is produced is a set of contradictions, old against new, this force against that force, these interests against those interests, new needs against old practices, new forms of environmental management against tradition—contradictions
endlessly repeated, and resolved with or without decision by the victory of one over the other, by breakdown and disaster, or by a rational synthesis.

Perhaps we can fuse together the two aspects of the collection, the ecological and the political, in these terms. We have been presented with two sets of contradictions, in which a third set is also contained. Ecologically we have the contradiction between conservation—in the meaning of preservation—and development—in the meaning of exploitation. Politically, we have the contradiction between auto-determination and domination by external forces. Both also contain a contrast of scale, the village economy and the industrial giant or, in Chinese terms, the village and the city.

The Chinese analogy may be instructive in several ways. One way in which we can benefit from it is to pay attention to the ‘walking on two legs’ policy, large and small, big industry and little, capital intensive and labour intensive, city and commune. The contradictions which were argued at Waigani, and are reflected in this book, seem to demand that we choose one leg or the other—do you want ‘development’ or do you want the village? The answer is that Melanesia needs both, in balance, and controlled by a Melanesian mind and body. This will not be easy, but Melanesia needs to attain this balance if it is to attain greater affluence, retain true independence, and so manage its environmental resources that their value will be enhanced by development, and not wantonly destroyed.

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