THE UNESCO/UNFPA POPULATION AND ENVIRONMENT PROJECT IN THE EASTERN ISLANDS OF FIJI

ISLAND REPORTS
NO. 5

LAKELA: ENVIRONMENTAL CHANGE,
POPULATION DYNAMICS AND RESOURCE USE

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Editors:
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MAN AND THE BIOSPHERE (MAB) PROGRAMME, PROJECT 7: ECOLGY AND RATIONAL USE OF ISLAND ECOSYSTEMS
GENERAL NOTE

The 'Island Reports' of the UNESCO/UNFPA Population and Environment Project in the Eastern Islands of Fiji are supplementary reports to the General Reports of the Project. Being on specific topics of more restricted scope than the General Reports, they are produced in only a limited edition. Subject to the general approval of the editor they are the responsibility of the authors concerned. The views presented in these Reports are not necessarily those of UNESCO and UNFPA.

The series replaces the 'Project Working Papers', which were preliminary statements published before the General Reports of the project were in draft. One of the Project Working Papers is reproduced in this series, being of a definitive nature; the others, of which only small stocks now remain, are not republished. However, a statement of the formerly-proposed numbers of Project Working Papers, as advertised in our General Report No. 1, is appended to each Report to facilitate cross-reference.

There are five issues of these 'Island Reports', as follows:

1. The hurricane hazard: natural disasters and small populations
2. Koru in the 1970s (reprinted from Project Working Paper No. 7)
3. Land, population and production in Taveuni District
4. The small islands and the reefs
5. Ledgea: environmental change, population dynamics and resource use

The series has been edited in Melbourne, by the former Chief Technical Adviser of the project, assisted by Tyna Charles. It is published for UNESCO at the Socopac Printery, Australian National University, Canberra. The series is not for sale, and is distributed by UNESCO and for UNESCO by the Australian National Commission for UNESCO to individuals and institutions in Fiji and elsewhere. A limited number of additional copies is available from UNESCO, Paris, and from the Department of Geography, University of Melbourne, on payment of a nominal charge to cover handling costs and postage. All enquiries should be addressed either to the Division of Ecological Sciences, UNESCO, or to the Secretary, Department of Geography, University of Melbourne, Parkville, 3052, Australia.
NOTE

In the first general report of the project (Population, resources and development in the eastern islands of Fiji: information for decision-making, Canberra (Australian National University, Development Studies Centre, for UNESCO, 1977), the papers in this 'Island Report' are announced as follows:

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Titles also differ from those announced in the General Report.
A NOTE ON PRONUNCIATION AND SPELLING

The standard Fijian spelling is used throughout this Island Report as in all reports of the project. It departs from normal English usage in the following:

b is pronounced mb as in lumber
c is pronounced th as in this
d is pronounced nd as in hand
g is pronounced ng as in ring
q is pronounced ngg as in singer (i.e., with greater stress)

There are differences in practice between hard and soft use of these consonants, and the pre-nasalization of 'b' and 'd' ranges from very slight to very strong, but these differences are not reflected in the spelling of the word.

Thus in this report:

LAKEBA is pronounced LAKEMBA
TUBOU is pronounced TUMBOW
YADRA NA is pronounced YANDRANA
NASANGALAU is pronounced NASANGALAU
KEDEKEDE is pronounced KENDE-KENDE
YAGONA is pronounced YANGONA

The stress in Fijian words of two syllables is either on the first syllable, or equal between both syllables. In longer words it is usually placed on the second syllable.

UNESCO/UNFPA FIJI ISLAND REPORTS No. 5 (Canberra, ANU for UNESCO, 1979).

5.0 EDITORIAL INTRODUCTION

H. C. Brookfield
(University of Melbourne)

This final report of the Fiji project appears a full year after its predecessor. The reason is clear below: a great body of data had to be analyzed and digested, laboratory analyses were required in quantity, and C14 dates had to be obtained. This work took a long time, especially as almost all of it had to be done against competition from other responsibilities. There was, moreover, a feeling among the authors that this report demanded special care. Not only was the project privileged in being allowed to work in such depth on the home island of the Prime Minister of Fiji, who as Tui Nayau is also the high chief of Lau; Lakeba was also the most complex of the islands studied by the project and the only one in which work in the fields of natural and human ecology was well balanced and in the main well integrated. This became possible because most of our work in Lakeba took place in the project's second year after we had learned some of the skills of team effort. Moreover, most members of the team who went to Lakeba had the advantage of a preliminary reconnaissance and our material and work plan were built up more gradually than elsewhere.

Although the editor was the first member of the team to visit Lakeba, participated in most of the initial reconnaissance work and made several later visits he was not among those who carried out prolonged research on the island. In the final months, much of his time had to be spent on project management in Suva, and in completion of work on Taveuni after other members of the team had left that island. The task of introducing the island itself, and of describing the work carried out on Lakeba and subsequently, is therefore left to Muriel Brookfield in the following paper. She undertook the necessary role of 'anchor-person' in a field programme carried out by others during shorter spells, and in addition to participating in the work on natural ecology, also carried out the main body of inquiry into the human ecology of the island. She was an unpaid member of the team because of UNESCO rules, but it is largely due to her efforts that the work on Lakeba is as well-integrated as it is. In the final paper in the present volume I have built on the results of the Lakeba work in attempting a wider integration over the project as a whole.

Most of those who participated in the Lakeba work are authors in this volume but there are significant exceptions. Tim Bayliss-Smith carried out invaluable preliminary research in the northern villages of Yadra and Nasaga, and this is reported elsewhere (Bayliss-Smith, 1977). Bernard Denis' reconnaissance of Lakeba soils is also reported in another place (Denis, 1976); subsequent division of work between himself and Latham led Denis to carry out his main work for the project on Taveuni. Patrick Haynes made a useful input on the agronomy of taro cultivation (Haynes, 1976). In addition Brian Hardaker made a reconnaissance visit to Lakeba but lack of time prevented him from working further on this island. John Campbell, as project assistant, gave very constructive aid at several points in the field programme.

1 It should be recorded that M. Brookfield's (1977) report on the effects of Hurricane Val is also published elsewhere.
It remains only to record the editor's appreciation of the hard work done by a splendid team, and the team's appreciation of extensive assistance received in Lakeba, and elsewhere; principal individuals are listed by Muriel Brookfield below. It is fitting, however, that I should offer the project's thanks to Ratu Sir K.K.T. Mara, Prime Minister of Fiji, for it was to me that permission was given to carry out the research reported here. We thank him for his welcome and his tolerance of our extended inquiries, and hope that he will find this report of value both to himself, and to his people.

REFERENCES


ACKNOWLEDGEMENTS

Like all of the Island Report series except No. 2, this issue has been typed by Tyna Charles, and all maps have been drawn by Robert Bartlett. Their enthusiasm and interest in this work have been an invaluable support to the editor. Tyna Charles, who has typed everything written by the project since late 1976, has typed the present number in Hobart, without opportunity for close consultation; her loyalty to the project has gone far beyond any 'call of duty'. In the present issue, Muriel Brookfield has assisted greatly with the editing of some papers other than her own. Thanks are also due to technician Ken Pohiner, who skilfully reduced the maps and diagrams, and not least to the staff of the SOCPAC Printery in Canberra for their excellent service to the project.

UNESCO/UNFPA FIJI ISLAND REPORTS No. 5 (Canberra, ANU for UNESCO), 1979.

5.1: INTRODUCTION TO LAKEBA

M. Brookfield
(University of Melbourne)

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I - INTRODUCTION TO LAKEBA

THE ISLAND

Lakeba is neither the largest nor the most populous island in Lau; Moala is slightly larger and Yanuva Balava has a few more people. It is however by far the most important, being home island of the fut Nayaum, High chief of Lau, and since Independence in 1970 Prime Minister of Fiji. Few visitors to Fiji ever see Lakeba or any part of Lau, for there is no tourism and the twice-weekly air service carries few passengers who are not either local people or government officials. The island covers only 65 km² and has 2070 people, living in eight nucleated villages around the coast.

Aspect

Seen from the sea, Lakeba has a low humped shape characteristically under a daily head of cumulus cloud. Behind the reefs and lagoon, the coastal plain seems almost wholly under coconuts with an occasional forest patch on a limestone bluff. The jungle of hills inland, by contrast, are lightly covered in ferns and casuarinas, with small patches of reed. From the centre of the island the aspect is very different. A radiating pattern of ridges is despite its small size and low height (215 m), eroded, and has produced 22 but some are permanent despite the dry climate; in the middle and lower courses of these latter are some extensive swamps.

In the centre of the island there is little to be seen either of cultivation or of people. And here, bare rocks crop out through the pine-planting scheme. Descending, we first see a few farmers working in their small gardens plots, and then the concentrated cultivation of the valley sides and floors. It is only on approaching the villages that people are encountered in number, for most of the life of Lakeba is lived close to the sea.

Lakeba in history

Man first came to Lakeba about 3000 years ago. Some light on his subsequent impact on the landscape is shrewd in this volume, and more will be revealed when the researches of archaeologists Roger Green and Simon Best of the University of Auckland in the middle of the Lau chain, 250 km east of Viti Levu and 400 km west of Tonga, has been of major importance in its modernity of the island. Over many centuries, perhaps millennia, the immigrants who came to Lakeba and other Laua islands have lived from the west and north, but there was no contact with Tonga to the east until this became more regular in the last centuries. Early in the 18th century Lakeba was a time dominated by the Levuka people --- ancestors of the people of the present Levuka village --- who came to Lau from the west and became the coast of Viti Levu. This yoke was overthrow and Lakeba then rose to dominance over the whole of Lau, including the Moala group. Increasing contact with Tongan seafarers, traders and warriors later opened the way to Tongan immigration and then suzerainty in the early years of the 19th century. The period of Tongan rule is of paramount importance in east-Fijian history. The region was unified, welded for a time into an independent state, and Christianity continued from Tonga, as did the commercialization of the coconut palm and a reform of land tenure which of minor traces survive. Lakeba was a principal base of Tongan power and Ma'am, ruler of the Lasa Confederacy or 'Tovata', is buried on this island.

Evidence concerning prehistorical settlement and population on Lakeba is slender. The sedimentological evidence analyzed in this volume by Hughes et al. provides clear indication of a period of heavy population pressure on resources some 2000-1700 years ago, when shifting cultivation led to mass erosion and destruction of fragile ecosystems. By the dawn of recorded oral history, perhaps 300-500 years ago, erosion rates had diminished so greatly that it seems clear that the system of land use had become well adjusted to the environment. At this time the majority of the population lived well inland, in a number of fortified villages of which the strongest and most important was on the hill called Kedekeke above the head of the Tubou valley (Fig. 1.1). The valley swamps were certainly cultivated quite intensively tor taro by this time, and it seems probable that most other cultivation was also in the valleys. The principal village, on Kedekeke, was named Tubou (Reid, 1977) when its people moved down to a moated site in the lower Tubou valley, late in the 19th century, the name went with them. In the 1820s a shipwrecked English sailor described this valley, a population of between four and five thousand people, in Reid, 1977), and when Wilkes visited Lakeba in 1840 he estimated the population of the whole island at 2000 (Wilkes, 1844). Already before this date, however, Lakeba had suffered the first of a series of devastating epidemics, derived from Oceania whether it was brought directly or Reppes (Reid, 1979). Moreover it would seem likely on prima facie grounds that the heavy warfare recorded in the 18th century had taken an earlier toll. The reforestation of certain catchments which took place during and since this period (Hughes et al., this volume) may thus be associated with some actual population decline, as well as the movement of settlement toward the coast.

All settlement moved down to the coast during the 19th century. Although the village itself was still inhabited, there were houses near the shore at Tubou when the first missionaries to reach Fiji landed here in 1838, and the site of Tubou was occupied during the 1860s when the valley site was abandoned. Although temporary shelters near the inland gardens continued to be occupied periodically until quite recent years, all permanent settlement has been in the eight coastal villages throughout the last hundred years.

A century of accelerating change

The introduction of new crops and technology and changes in economy and society have proceeded at an accelerating pace since the mid-19th century. Most agricultural gardens have remained inland, and have even contracted in land away from the coast as described by the present writer (this volume). At the same time the former coastal forest has been almost totally cleared for coconuts (Latham, this volume, a). Most recently, only within the last decade, a large part of the barren uplands has been planted with coconut palms. Each of these changes has involved an order-of-magnitude increase in the area of the island's surface brought into productive -- or intended
productive -- use. As the time scale of change has quickened, so has the amount of land used increased at each stage. Coconuts now cover four times as much land as its cultivated crops, and pineapples are also replacing coconut areas. The time and area scales are closely linked.

There have also been major infrastructural changes. Though a circum-
was still largely by sea until the late 1960s. The track was upgraded to
island track was made in the Tongan period, communication between villages
island's single road only in 1969. This development was quickly
become the island's single road only in 1969. This development was quickly
followed by construction of the airstrip for light aircraft only, completed
in 1972. Finally, between 1975 and 1977 a jetty was built out from the
in 1972. Finally, between 1975 and 1977 a jetty was built out from the
shore to deep water in Tubou harbour. Tubou has also been supplied with
shore to deep water in Tubou harbour. Tubou has also been supplied with
the piped chlorinated water and, most recently, electricity, but these innova-
the piped chlorinated water and, most recently, electricity, but these innova-
tions have still to reach the other villages of the island.

THE SOCIA ENVIRONMENT

Tradition and modernity

Although Tubou is the only quasitown in Lau, the seat of the
Although Tubou is the only quasitown in Lau, the seat of the
Provincial Administration, and the centre of the public health, agricultural
Provincial Administration, and the centre of the public health, agricultural
and police services, it remains very small, and has even lost the role in
and police services, it remains very small, and has even lost the role in
District Administration which it had before consolidation of this Adminis-
District Administration which it had before consolidation of this Adminis-
tration in the 1950s. Most government services are provided to Lauka, as
tration in the 1950s. Most government services are provided to Lauka, as
only to fourth grade; there is no cinema, library or dance hall;
only to fourth grade; there is no cinema, library or dance hall;
there are no public cars on the island, and there is no commercial accomodation for
there are no public cars on the island, and there is no commercial accomodation for
visitors; the road is unsuuated, and sometimes impassable; the only telephone,
visitors; the road is unsuuated, and sometimes impassable; the only telephone,
in 1976 a radio telephone, was at the Post Office and from other
in 1976 a radio telephone, was at the Post Office and from other
villages had to travel to the chiefly village to use it. Tubou is the
villages had to travel to the chiefly village to use it. Tubou is the
'standing of Lauka rests on its chiefly status and on the reflected glory
'standing of Lauka rests on its chiefly status and on the reflected glory
which it receives by virtue of being the home of the Prime Minister of
which it receives by virtue of being the home of the Prime Minister of
Fiji.

The traditions and customs of an older Fiji remain strong on Lakeba,
The traditions and customs of an older Fiji remain strong on Lakeba,
and there is a sense in which they are stronger on Lakeba than on some other
and there is a sense in which they are stronger on Lakeba than on some other
Lauan islands where a breakdown of the old system of inter-island travel has
Lauan islands where a breakdown of the old system of inter-island travel has
exposed less chiefly islands more directly to the influence of Suva. More-
exposed less chiefly islands more directly to the influence of Suva. More-
over, most other Lauan islands are more dependent on money brought back or
over, most other Lauan islands are more dependent on money brought back or
sent back by migrant workers than is Lakeba, and though their isolation is
sent back by migrant workers than is Lakeba, and though their isolation is
mataqali (clans). Individuals and whole villages is of major importance
mataqali (clans). Individuals and whole villages is of major importance
in Lakeba, and the sharp distinction between Tubou and the remaining villages
in Lakeba, and the sharp distinction between Tubou and the remaining villages
is first and foremost one of rank, and only secondarily of economy and possess-
is first and foremost one of rank, and only secondarily of economy and possess-
on of various terms. The formalities of custom and respect remain very powerful
on of various terms. The formalities of custom and respect remain very powerful
in this village. Each other village also has its chiefly, or Tu, and
each other village also has its chiefly, or Tu, and
every mataqali has its head. All this is also true in every other part of
every mataqali has its head. All this is also true in every other part of
Fiji, but in Lakeba it has unusual force.

The power of the church is also very strong on Lakeba, although the
The power of the church is also very strong on Lakeba, although the
island is less distinctive in this respect. In its early establishment in
island is less distinctive in this respect. In its early establishment in
Fiji, the church adopted some aspects of the role and behaviour of the
Fiji, the church adopted some aspects of the role and behaviour of the
chiefs, making material demands on its adherents while providing them with
chiefs, making material demands on its adherents while providing them with
a code of behaviour, freedom from the fear of violation which is a code of behaviour, freedom from the fear of violation which
and a few disregard its authority. Together, the chiefs and the church may
and a few disregard its authority. Together, the chiefs and the church may
command a significant proportion of the working time and leisure time of
command a significant proportion of the working time and leisure time of
Lakeban villagers, and the associated institutional structure of the
Lakeban villagers, and the associated institutional structure of the
Provincial Administration. Island Council and church meetings are effective
Provincial Administration. Island Council and church meetings are effective
in continuing to enforce obligations which no longer have the legal force
in continuing to enforce obligations which no longer have the legal force
that upheld them in former times.

This notwithstanding, there is greater opportunity for the exercise
This notwithstanding, there is greater opportunity for the exercise
of entrepreneurship on Lakeba than in most other islands of eastern Fiji.
of entrepreneurship on Lakeba than in most other islands of eastern Fiji.
In my paper below, I seek to demonstrate the exercise of scope of individual
In my paper below, I seek to demonstrate the exercise of scope of individual
enterprise and choice, and the manner in which this is increasing.
enterprise and choice, and the manner in which this is increasing.
It emerges most clearly in the growing disregard of the Co-operative Societies, which were set up on a mataqali or village
It emerges most clearly in the growing disregard of the Co-operative Societies, which were set up on a mataqali or village
basis; the scale of this disregard is unusual on an island without any
basis; the scale of this disregard is unusual on an island without any
significant private commercial sector, and is revealing of a rising trend
significant private commercial sector, and is revealing of a rising trend
ward individualization which is strong in Fijian society as a whole, But
ward individualization which is strong in Fijian society as a whole, But
weak on many of the smaller islands.

An overview of the Island

Lakeba is a beautiful island, remarkable both in its ecological
Lakeba is a beautiful island, remarkable both in its ecological
complexity and in the intricacies of its chiefly-dominated society but
complexity and in the intricacies of its chiefly-dominated society but
increasingly individualized economy. It is an island of small scale, and
increasingly individualized economy. It is an island of small scale, and
moreover is vulnerable both to natural hazards of hurricane and drought,
moreover is vulnerable both to natural hazards of hurricane and drought,
and to economic hazards of depression and inflation. The ownership of land,
and to economic hazards of depression and inflation. The ownership of land,
the only notable natural resource, is of prime importance, and this is still
dominated by the mataqali system. The scope for individual decision-making
dominated by the mataqali system. The scope for individual decision-making
is very limited. None the less, it is an island of major importance in
is very limited. None the less, it is an island of major importance in
eastern Fiji, and even in all Fiji.
eastern Fiji, and even in all Fiji.

There is no sense in which Lakeba 'typical' of any place other
There is no sense in which Lakeba 'typical' of any place other
than itself yet it contains many elements that are widely represented else-
than itself yet it contains many elements that are widely represented else-
where. Unusual in natural environment and in history, it is also unusual
where. Unusual in natural environment and in history, it is also unusual
in its seemingly paradoxical mixture of traditional social control and
in its seemingly paradoxical mixture of traditional social control and
economic innovativeness. The project went to Lakeba merely because of its
economic innovativeness. The project went to Lakeba merely because of its
distinctive ecology and the problems which this presented. We found much
distinctive ecology and the problems which this presented. We found much
greater complexity in the ecosystems of the island than we anticipated,
greater complexity in the ecosystems of the island than we anticipated,
and some highly intriguing problems in seeking to understand the human use
and some highly intriguing problems in seeking to understand the human use
systems by means of which these ecosystems are exploited and managed. We
systems by means of which these ecosystems are exploited and managed. We
found also an 'island at the cross-roads', no longer in terms of sea
found also an 'island at the cross-roads', no longer in terms of sea
communications, but in terms of the directions to be taken in its own
communications, but in terms of the directions to be taken in its own
future development. In the second part of this paper the manner in which
future development. In the second part of this paper the manner in which
the project worked toward the solution of some of these problems will be
described.

II - THE WORK OF THE PROJECT ON LAKEBA

WORK IN THE FIELD

Preliminary stages in 1975

In April 1975 H.C. Brookfield visited Lakeba in company with R.D.
In April 1975 H.C. Brookfield visited Lakeba in company with R.D.
Bedford and M. Latham for a preliminary reconnaissance visit which, in
Bedford and M. Latham for a preliminary reconnaissance visit which, in
effect, set up the whole of the subsequent programme. They were followed
effect, set up the whole of the subsequent programme. They were followed
by B. Salvat in June, and in July a major start was made when T. Baylis-
by B. Salvat in June, and in July a major start was made when T. Baylis-
Smith initiated field work in the northern villages of Yadreina and Nasagaualu,
Smith initiated field work in the northern villages of Yadreina and Nasagaualu,
remaining until September when he was joined briefly by Latham and B. Dents
remaining until September when he was joined briefly by Latham and B. Dents
who undertook preliminary work on soils and vegetation. H.C. Brookfield paid two further visits to the Island in 1975, being accompanied on the second occasion by P. Haynes.

Work in 1975 was constrained by budgetary limitations imposed by financial difficulties in the U.N. system; expenditure had to be limited to a figure well below the budgeted sum, and every effort under- taken on Taveuni in that year had to be curtailed. The preparatory work on Lakeba was, however, invaluable. Basic survey tools, such as a contoured topographic map, were nonexistent. It became clear that a first-class topographic map would be required, and the preparation of such a map on a scale of 1:12 500 was commissioned, using 500 m grid photography (all that was available) and a grossly limited ground control from R. W. Wassermann of the Canberra College of Advanced Education in Australia. A preliminary drawing of this map, contoured by 250 times intervals, became available late in 1975 and final drawings at 1:2500 were completed in April 1976. Our work could not have been done without this map, on which all the detailed maps in this Island Report are based. Also in 1975 a set of pit samples from the swamps was examined by J.M. Powell of Sydney, who reported them as unsuitable for the palynological analysis intended.

Work in 1976: the major stage

The project budget was fully restored in 1976, and after a short burst of activity on Taveuni our work was initiated on Lakeba. Haynes and J.R. Campbell sampled taro fields, and were briefly joined by J.B. Hardaker and M. Brookfield on reconnaissance visits. Latham then returned for the major field work on Lakeba, and was joined by the present writer and by R. McLean. In March B. Salvat and his colleagues of the marine group arrived and remained three weeks on the island in the course of their more extensive survey of the reef-lagoon resources. By complicated organisation of sea transport the whole Lakeba team paid a brief visit to Toba, on which Bedford and J. Macpherson had spent three weeks in 1975. This visit proved invaluable for comparison. In May the rapidly approaching end of the project’s programme dictated that the main field programme be terminated and that reporting commence; only the present writer remained behind, until late July.

Work in 1976: the second period

The core-group of the project assembled in Canberra to prepare its main initial report, and to commence work on the detailed reports. During this period the incomplete state of work on Lakeba was discussed, and the opportunity of working on Lakeba was not lost. Latham and the writer returned to Lakeba and with equipment borrowed from Taveuni and Malolo obtained cores from selected swamps. Other research was also completed, and I was the last to leave the island, at the end of November.

THE DATA ANALYSIS STAGE

Soils, geomorphology and palaeobotany

Many of our early soil-sample analyses were done in Suva, but the more refined work required by Latham and Denis was done largely in France, and took a considerable time. While this was going on, the geomorphological evidence from Lakeba was carefully evaluated against evidence from other areas, by Latham and McLean, each in their own fields. Several C14 dates were obtained, and by degree a chronology was established. The corers, however, proved stubborn in yielding their data. Examination by J.B. Hardaker of the sediments in Canberra confirmed Powell’s earlier view concerning the lack of pollen for palynological analysis. In 1977 the writer held discussions at the Australian National University with B.N. D’Arcy, J.M. Bowler, G. Singh, J. Olson and other specialists, and the suggestions arose from P.G. Hughes that sedimentological analysis might be of great value. To this was added the suggestion from G. Hope that the raw material might provide additional data suitable to test the hypothesis that the swamps were used, and that the uplands from which they were derived had been subjected to heavy human interference. Further C14 dating confirmed the potential interest of the cores, but at this stage the project budget was exhausted. Further support was obtained in 1976 from ORSTOM (the Office de la Recherche Scientifique et Technique Outre-mer) and from the University of Melbourne, permitting further analysis and additional C14 dates, the results of which are presented below. Though not conclusively, the problem was finally broken in a manner which lent substantial confirmation to Latham’s hypotheses based on soil and landform, and which adds greatly to understanding of man’s impact on landscape. Even now this work remains unfinished, only one inland swamp has been explored to the bottom, and the problems of the sub-coastal swamps — whose origin is discussed below by McLean on the basis of his transects — remain to be linked into the whole analysis.

Data on economy and society

Given the advantages of a smaller population and a more simply-structured economy, it was possible to obtain for Lakeba a more comprehensive and detailed set of data on economy and society than were obtained for any other island. In the Northern Division (Taveuni) where the project team worked closely with the District Administration and the Department of Agriculture, it was possible to undertake a comprehensive questionnaire survey, supplemented by other surveys and extraction of data, so that a large part of the interpretation remained on computer analysis. On Lakeba, in the absence of a District Office and other staff in the professional departments, we had to work with our own resources and such local assistants as we could employ. The resulting data base is smaller, but closer control over its collection also facilitated greater understanding of complexity. At the same time the fragmented nature of the data made analysis impossible except for some demographic data. It has been necessary not only to analyze data by desk calculator only, but also to piece together a mosaic of non-quantitative information.

Lessons of the Lakeba experience

Work of the nature which this project attempted in Lakeba requires time and patience at all stages. Our preliminary work in 1975 was of immense value both in revealing the complexities with which we had to deal, and also in establishing the project as a presence on the island. None the less, the sudden arrival of a substantial number of expatriate research workers in 1976 was not received with immediate enthusiasm. While this was a loss of a handicap in physical science research than in social research — and it was for this reason that the main initial emphasis was in the former
area, it was not until quite late in the field period, and during the
October-November return visit, that widespread co-operation began to be
experienced. Data collection was at first slow, but in the final weeks
the rate of information-inflow became almost overwhelming. One lesson to
be drawn is that this 'curve' of information flow must be allowed for in
planning, whether of United Nations projects or work of any other kind.
Time spent in gaining rapport is never wasted even though its immediate
results are meagre; it should be incorporated in all plans and budgets.

Second, perusal of the following papers will quickly demonstrate the
immense body of data analysis, discussion and re-thinking, that were
required before any worthwhile results could be presented. In the present
case this phase of work was prolonged by the fact that all members of the
team returned to different countries, to other duties, and to new tasks,
and that the demands of these tasks became increasingly pressing with time.
If superficiality is to be avoided, there should be a prolonged gap for data
analysis between the necessary writing of initial impressions and the more
valuable presentation of final results. It is not possible fully to evaluate
research on the basis only of its initial results, or to treat these initial
results as the final word. Second thoughts are usually best, and they
require time -- and support -- for their generation.

ACKNOWLEDGEMENTS

The team has an enormous burden of thanks to offer to those who
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5.2 THE NATURAL ENVIRONMENT OF LAKEBA

M. Latham
(ORSTOM, Noumea, New Caledonia)

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I - CLIMATE, GEOLOGY AND GEOMORPHOLOGY

INTRODUCTION

This paper reports the first comprehensive survey undertaken of the natural environment of Lakeba. As elsewhere in eastern Fiji, most early work in this area was done by geologists, in particular Gariney (1908), Ladd and Hoffmeister (1963) and most recently Coulson (1975). The soil and vegetation survey by Twyford and Wright (1965) offers only a reconnaissance sketch of Lakeba, and the botanical material consists only of a few floristic studies at various dates since the 1860s (Parham, 1972). All descriptions of the island in these accounts emphasize the Miocene-Pliocene volcanic core and its partial limestone integument, and the great depth of weathering in the volcanic areas, combined with barren soils and a heavily degraded vegetation. Lakeba provides one of the most striking instances of the degraded soil-vegetation complex widely known in Fiji by the name of tala-siga, and it was for this reason that the island was selected as an area of concentration by the project.

At the descriptive level, the first conclusion to be drawn from the ecological survey carried out in 1975 and 1976 is that these earlier descriptions conceal very considerable complexity. Indeed, of all the islands studied by the project, Lakeba is ecologically by far the most intrinsically varied. Moreover, the impress of human activity has had a major role in creating the present mosaic of land types and ecosystems, and in this respect also Lakeba is distinctive in the degree to which human modification of the original condition has moulded the present aspect of the island.

A VARIABLE TROPICAL CLIMATE

Lakeba has a tropical oceanic climate characteristic of the trade-wind belt (Table 2.1). Rainfall data indicate a moderate seasonality, but mean values mask very considerable year-to-year variation (Table 2.2). Over the ten years from 1966 to 1975 the annual total ranged from just over 1000 mm to more than 3000 mm. Particularly interesting are the changes in both intensity and time of dry periods in this short record. If we assume that the P/E in this area is likely to be over 100 mm/month, it is evident that the annual distribution of dry periods is in a high degree unpredictable. While deficit months occur most frequently in the May to September period, no less than ten 'dry' months occur outside these limits in this one decade alone.

Drought, deluge and hurricane

The data in Table 2.2 show monthly rainfall totals from half a millimetre to almost half a metre within a period as short as ten years. Over a 15 year period, the island has been afflicted by five droughts of more than four months' duration, sometimes in successive years. In 1966 only 158 mm

1 In Fijian, the term tala-siga means 'sun-burnt land' (Parham, 1972). The term designates both a pyrogytic vegetation complex dominated by ferns, often in association with Cassia marina aquagnetifolia, and also the very degraded and often eroded soils which support the complex. It is used here as a generic term for the complex as a whole.
were received during the five months from May to September, and in 1969 only 89.5 mm in the four months from May to August. Three dry periods longer than two months in duration intervened between these larger events. The effect of drought of this order would be to dry up most springs and small rivers, and starve much of the taro crop of water. Widespread fires are also most likely to occur during these long dry periods. Furthermore, much of the rainfall takes place in the form of heavy showers; Bayliss-Smith (1977, p. 67) notes that during a period of 195 months from 1959 to 1975, 61 per cent of the rain days experienced falls of 25 mm or more; the heaviest daily fall recorded in this period was 224 mm.

In the long term, therefore, the ecological effect of drought and deluge in this island is likely to be considerably greater than that of the rare but violent cyclonic storm, although the project placed emphasis on the latter in its inquiries because of the heavy impact of one major cyclone on Lakeba in early 1975 (Bayliss-Smith, 1977; M. Brookfield, 1977). While cyclonic depressions are frequent visitors to eastern Fiji, the intensity of wind and rainfall in them is very variable (McLean, 1977). A violent storm does, however, do great damage to vegetation, and the torrential rain causes rapid erosion of the soil and floods in the valleys.

The only meteorological information available for Lakeba is collected at Tubu, almost at sea level on the south coast (Fig. 2.1). The effect of relief and aspect can only be inferred, although the planned erection of a VHF transmitter and receiving station in the centre of the island will in time yield such information, since a rain gauge will be installed as on Taveuni in 1976. The effect of topography is certainly much less than that on Taveuni, for the island is far smaller, and its highest point reaches only 220 m. 'Fiji Ait' pilots, however, remark on fairly regular differences in temperature provided by the station at Tubu and the weather conditions encountered at the airstrip, in a valley on the leeward northwest side of the island. Examination of the vegetation suggests that the high ground in the centre of the island may receive more rainfall than the coast, and the build-up of cumulus cloud over the centre of the island is visible evidence of an orographic effect to be seen on most days of the year. However, the island is too small to experience large differences in climate between different parts of the whole.

GEOLGICAL SIMPLICITY OF LAKEBA

The geological substratum of Lakeba is very uniform. The island is made up of an andesitic volcanic mass belonging to the Lau volcanics, covered on the northwestern and southern fringes by the remains of a calcareous over-leaf of Putuana limestones (Ladd and Hoffmeister, 1945).

The lithological substratum

According to Coulsdon (1975), the volcanic rocks are formed of a mixture of lava, breccia and lapilli of andesitic-daicy composition (Fig. 2.2). Some basaltic elements were recognized in the region inland of Naitwai, but these are restricted to a very limited area. The andesitic-volcanic mass seem to be located in the headwaters of the Waibau valley, where isolated plugs with sub-vertical walls overlook the landscape. These are made up of massive andesitic breccia, little weathered. Dykes occur throughout the island, and often stand out in the present landscape due to their higher resistance to erosion. Ladd and Hoffmeister (1945) regarded this formation as Lower Miocene in age, but the more recent work of G ill
(1976) has shown the Lau volcanics to be Upper Miocene, between six and nine million years in age.

The overlying Futuna limestones vary in thickness from a few metres to as much as 70 m. They include two distinct facies: a lower, conglomeratic facies enclosing a mixture of limestone and volcanic elements, and an upper crystalline facies. The latter is more readily recognized in the landscape by virtue of its karstic morphology. The basal Futuna limestones, thought by Ladd and Hoffmeister (1945) to be Lower Miocene, have been shown by Gill (1976) to have been formed during a period extending from the Upper Miocene into the Lower Pliocene.

**Formation of the substratum**

Ladd and Hoffmeister (1945) recognized four phases in the geological history of Lakeba:

- a succession of andesitic eruptions during the Miocene, which elevated the western part of the island to about 120 m;
- subsequent marine and terrestrial erosion, and the deposition of about 100 m of limestone. Coral formation only a minor part of this accumulation;
- uplift of approximately 100 m, extending the size of the island and bringing the eastern part into the zone of coral growth;
- further uplift and continued erosion, which denuded the limestone from the eastern side.

Foye (1917) hypothesized a tilting of the island, downward toward the east, in order to explain the absence of limestone from this side of the island. This view was contested by Ladd and Hoffmeister, who explained this asymmetry by reference to greater marine erosion on the eastward side, thus assuming persistence of the present wind and wave climate throughout the island's history. Such asymmetric development is not uncommon in the Lau group; Yavua Balau and More, in particular, possess lagoons similar in form to that of Lakeba. However, this view is not easy to reconcile with the greater protection from wave action which the eastward development of coral reefs would have given to these windward coasts, and it also ignores completely the whole question of changing sea levels during the Pliocene and Pleistocene (McLean, 1979). Gill's work on the Lau ridge suggests that a tilt toward the east probably did occur, and is related to the formation of the Lau basin. The movement would have been during the Pliocene. Such an eastward tilt, if continued into the Pleistocene and Holocene, would also be sufficient to account for the formation of drowned and filled valleys on the eastern side of Lakeba.

**Complexity of Geomorphological Evolution**

Erosion, not construction, dominates the formation of the landscape of Lakeba. No trace remains of the original form of the volcano. The island has been gouged by deep sub-radial valleys separated from one another by rounded hills. Only small traces remain of former depositional landscapes. In discussing the evolution of the landforms on this island, it will be convenient to follow Tricart (1965), and distinguish between ablation landforms and those produced by accumulation, or other processes. The geomorphological map of Lakeba (Fig. 2.3) illustrates this section of the paper.

**Landforms due to ablation**

Landforms resulting from ablation dominate the island. They are represented mainly by hills with slopes mantled by soils exhibiting varying degrees of truncation. Two small areas exhibit greater denudation: these are the bare rock of the volcanic plugs in the Kaitabu headwaters, and the small patch of 'badland' that is prominent immediately inland of Tubou, and because of its prominence was used as a site for an unsuccessful tellurometer traverse of the Lau Islands undertaken a few years ago.

The eroded hills are the backbone of the present relief. They represent 55 per cent of the total surface of the island, and have slopes that may be divided into two main groups:

- gentle slopes, occurring on volcanic rocks, showing deep ferrallitic weathering;
- steep slopes, occurring on volcanic and calcareous rocks, with only moderate weathering.

The more gentle slopes are encountered in the upper parts of very narrow drainage basins. These undulating landforms are covered by ferrallitic soils, deeply weathered and truncated. Altered rock reaches the surface, and the formation of these landforms seems relatively ancient, since they are notched by steep valleys of more recent origin.

The steepest slopes in Lakeba are found in these incised valleys, where contemporary erosion is particularly active. The ferrallitic horizons have mostly been removed and hard rock outcrops in places. These valley bottoms, often giving rise to a series of waterfalls, and rapids. There is strong and consistent evidence of two major downcutting phases, the earlier giving rise to the gentler slopes that are still being carved into by more recent incision.

**Landforms due to accumulation**

Within and around the ablation landforms is a series of landforms due to accumulation, the most important being 'plateaux', colluvio-alluvial terraces and the alluvial and coastal plains. Plateaux, or remnants of former gently sloping landforms of small size, occur at several altitudes in Lakeba, ranging from 50 to 220 m. The highest part of the island is situated on one such tableland. Two main groups may be distinguished, one at around 50 m, and the other at altitudes between 100 and 200 m. All are covered by ferrallitic mantled morainic formations of similar form. Sometimes, the formations are underlain by andesitic fragments, moderately weathered. Millstone debris is sometimes encountered on the surface.

It is possible that these formations are the remnants of laterally expanding surfaces derived from greatly altered soils. There are few clues to indicate the date of their origin. Taking account of their topographic position, some at least would appear to be the oldest landforms on the island. In a study of similar formations on Viti Levu, Dickinson (1965) has suggested dates ranging from the Pliocene into the Pleistocene; the absence of anything resembling these plateaux on the islands of more recent geological formation in eastern Fiji lends support to this view of very ancient origin. In more recent times, since the present hydrographic system became established in Lakeba, material eroded from these surfaces has been deposited in the valleys and on the coastal plain.
One of the most striking characteristics of the surface geology of Lakeba is the great quantity of colluvio-alluvial deposits in the valleys, especially in the eastern half of the island. In places, the former landscape has been masked to considerable depth by this material. The deposits have a medium texture and are composed of a multitude of small fragments derived from heavily weathered rock. In many places the formation has been incised by subsequent erosion, and hanging valleys have been created, sometimes overlooking other hanging valleys below them characterized by the same colluvio-alluvial formation. They give the impression of having been formed over a long period of time, and with the strong suggestion of sub-humid climatic conditions during the period of origin. Today, they are still being overlain by new material derived from the burned hills above them.

Taking into account the topographic position of these extensive colluvioalluvial formations, it would seem certain that their deposition began much earlier than the origin of the present alluvial plains. The deposition of such a quantity of material may be related to truncation of the gently-sloping uplands, possibly during a relatively dry period of the middle Quaternary. It is not possible that they have been formed since the arrival of man in Lakeba, only some 3000 years ago, and their presence therefore suggests a massive erosion of the uplands during a period many millennia before arrival of man.

The present alluvial plains are often incised within these older colluvio-alluvial formations. In the eastern part of the island the alluvial plains along the rivers are often swampy, but sometimes the swamps are stopped along the valleys, separated by rapid sections. In the interior valleys they are filled with sediments of mineral origin, and in the sub-coastal valleys by sediments of organic-mineral origin. Organic-mineral sediments in the coastal zone overlie sands dating from the Holocene period (McLean, personal communication). At the present day, the coastal plain has a width ranging from several hundred metres to only a few metres; it is absent only from the promontory southeast of Tubou. The plain is mainly sandy on the western side of the island, and mainly clayey on the east, where it is continued into the lagoon by a large area of mangroves which attains its greatest width between Nukunu and Waitabu.

In summary, Lakeba would seem to have undergone three major phases of sedimentation, widely separated in time. The first formed the interior plateaux; the second formed the extensive mass of colluvio-alluvial material; the third formed the alluvial and coastal plains. A major problem of interpretation is posed by this brief description.

Landforms of other types

The only significant group of landforms not discussed above are the karstic formations encountered on the crystalline limestones. They take the form of limestone pavements, pitted with sinkholes and broken by small cliffs. Blind valleys and caves are both encountered, especially in the large block of limestone east of the airstrip. However, karstic relief covers only a few percent of the surface of the island; other karstic formations may now lie beneath the surrounding lagoon, drowned by the Flandrian transgression, for it must be recalled that during the maximum low sea level of the Pleistocene more than half the area of the then Lakeba would have been formed of limestone (McLean, 1979).
HISTORICAL INTERPRETATION OF THE FORMATION OF THE LAKEBA LANDSCAPE

This section of the paper is preliminary. During its writing, further analysis and radiocarbon dating of samples collected from the swamps of Lakeba in 1976 were still being undertaken. Part of the results of this work is reported elsewhere in this volume, and a synthesis will be presented in the final report of the ecological survey, to be published by ORSTOM. What follows is based on an interpretation of the evidence to hand at the time of writing, and should not be construed as final.

The geomorphological evidence suggests a number of hypotheses that might be put forward to explain the history of the island landforms, and possibly the palaeo-climatic history of the island. The age of all formations can be stated only in relative terms, for no dateable elements have been found except in the recent swamps, and none are likely to be found in the older formations. A tentative historical reconstruction is proposed, incorporating nine stages and probably originating in the Pliocene, when the limestones emerged from beneath the sea. The evidence is presented later in the paper.

A tentative historical sequence

The sequence may be presented as follows:

1. In the Pliocene the andesites were deeply weathered over a long period, during which humid conditions most probably prevailed. Bauxite would have been formed and silica leached from the soil. This silica would in part have been trapped in rock fissures, forming veins of millstone. It is possible that this first deep-weathering stage corresponds with humid periods noted elsewhere in the region, in Australia (Mulcahy and Churchward, 1973) and in New Caledonia (Latham, 1976). No remaining evidence of this stage is to be found in the landscape, except by inference, but its hypothesized occurrence is essential to the following stages of the sequence.

2. Probably about the end of the Pliocene, a major talus was formed from the previous bauxitic soils. Climatic change would seem to have been required. Fragments of hard rock would have been deposited close to streams, and the whole scree covered again by bauxitic soils. Erosion must have been deep enough to have reached the underlying millstone in places, and thus lead to an inversion of the parent materials. The talus deposit is today represented by the higher level of the remnant plateaux (Figs. 2.4 and 2.5).

3. Another talus layer would have been formed under similar conditions at the level of the lower plateaux (Fig. 2.5). It seems probable that there has been no subsequent humid period sufficiently prolonged to weather completely the layer of rock fragments underlying some of these plateaux.

4. The present-day configuration of landforms would then have originated during the early Quaternary, uplift of the island being accompanied by a fall in sea level. The stream network cut into the late-Pliocene talus, leaving only the remnant plateaux intact. Soil and landform conditions suggest that this might have been a period of relatively dry climate, punctuated by violent rainfall perhaps during hurricanes.

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<th>EPISODE</th>
<th>CLIMATE PHASE</th>
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<tr>
<td>1</td>
<td>Atlantic</td>
<td>Pliocene</td>
</tr>
<tr>
<td>2</td>
<td>Ferralitic</td>
<td>Pliocene</td>
</tr>
<tr>
<td>3</td>
<td>Ferralitic</td>
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<td>9</td>
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<td>Pliocene</td>
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Contrasted Holocene to present
5. The intense erosion of phase 4 would seem to have been followed by a period of ferrallitic weathering, probably under a forest vegetation and hence a humid climate. This period, which is represented in the record by deep weathering of soils on the gentler slopes, is probably best located in the middle Quaternary.

6. In the following period soils were truncated widely over the island, leading to the filling of valleys by colluvial and alluvial deposits, especially in the east of Lakeba. The amount of truncation and deposition that occurred during this phase seems to require major transformation of the vegetation cover, and hence in all probability a drier climate. The asymmetry in valley filling noted above is a clear feature of this phase, so that if tilting occurred it probably took place during this time. This phase of rapid erosion and sedimentation was probably influenced by rejuvenation of streams during a period of low sea level, and seems to have been terminated during a high sea-level phase, at some time in the middle Pleistocene.

7. There then ensued a new period of ferrallitic weathering, perhaps during a short humid phase. The evidence for this phase is weak, and it seems not to have been sufficiently long or strong to build up the soils of the slopes.

8. Renewed low sea level would probably have been the cause of the phase of rapid erosion suggested by the soil and topographic evidence. This is the phase during which the colluvio-alluvial plains were incised, and when the valley bottoms were stripped of any ferrallitic cover.

9. Finally, under a more humid if uncertain climate, ferrallitic weathering has been resumed in the valley heads. Rising sea level would have flooded the lower valleys, and the present lower alluvial plains, and the coastal plain, were formed in the manner described by Mclean (1979). It was during this final phase that man arrived in Lakeba.

Table 2.3 summarizes the stages of this tentative reconstruction.

**Contemporary Morphodynamics of the Landscape**

The reliance on alternating wet and dry phases in the paleo-climate of Lakeba seems rendered necessary by the evidence of the soils, and is rendered possible by the limited evidence of climatic variability in the contemporary period (Mclean, 1979). As Mclean emphasizes, there is no reason to suppose that the observed variability in external conditions represents the historical limits of variability even within the period of human occupation, or since the Flandrian transgression; the evidence of the soils and topography of Lakeba can hardly be interpreted in any convincing manner without supposing a much greater range of climatic variability in the longer past. Given this need to rely on long-period climatic change, it is not surprising that the present morphodynamics of the Lakeba landscape are of a low order compared with those whose record remains in the surface geology, landforms and soils of the island. At the present time few traces of erosion were visible on the soil surface. Gully erosion is present, but limited in extent, and is probably related to present-day utilization of the land. Yet erosion is certainly continuing. Study of recent sedimentation in the valley and sub-coastal swamps provides unquestionable proof of such erosion. Some discussion of this evidence is therefore appropriate, since
measurement of the volume of deposition accumulated in these swamps can yield some estimate of the minimum rates of erosion experienced in their catchments.

Sedimentation in the swamps

Three swamps in the southeast of the island have been closely investigated. Only preliminary results are reported here, and more later results are discussed in another context by Hughes et al., elsewhere in the present Island Report. The swamps discussed are in the upper valley of the Waitabu creek, at Nabuni west of Wacwaci, and in the Levuka sub-coastal swamp behind Tubou (Fig. 2.6). Cores were obtained in 1976, and C14 dating of samples has been carried out.

The inland swamps of Waitabu and Nabuni both have mainly a mineral composition. Both show the same succession of two principal strata, an upper clayey layer about one metre thick, and a lower layer of coarser texture which extends to a depth of six metres in the Waitabu swamp. The latter is made up of very weathered small rocky particles associated with charcoal grains and fragments of wood.

The bottom of the upper layer has been dated by the C14 method at 920±220 years B.P., in the Waitabu swamp. In the lower layer, in the same swamp, two dates were obtained. At 3.2 m age of 1910±210 B.P. was obtained, and at 6.2 m the same core the result was 10052±140 B.P. These rather contradictory results are possibly due to the weak carbon content of the middle sample, and the result is indicative rather than firm. However, the standard deviations of the two lower dates overlap. No dates have yet been obtained from the Nabuni swamp, but a cessation of charcoal content is visually evident at a depth of 2.5 m. This is in contrast with the persistence of charcoal in quantity of deposits exceeding six metres at Waitabu, suggesting incidence of fires of anthropogenic origin over a period of at least 2000 years; very probably a fuller analysis would show the use of fire back much earlier than this, for present evidence suggests that the island has been occupied for about 3000 years (S. Best, personal communication).

The Levuka swamp is much larger than the two inland swamps discussed above (Table 2.4). This is a sub-coastal swamp formed behind a beach bar of Holocene age, and only slightly above sea level. Its upper layer is again about one metre in depth, of organo-mineral content, containing by weight only 25 per cent organic matter and having a very slight bulk density — approximately 0.5 against 1.5 for the mineral swamps. The volume of mineral matter contained in a cubic metre of these peats is thus one third that contained in a cubic metre of mineral earth. A sample, taken at 1.2 m, was dated at 940±120 B.P.

Below this level is a mineral layer, ranging from 1.5 to 1.8 m in thickness, containing remnants of organic matter including badly decomposed Cypraeaceae fragments. At the bottom is a sandy layer rich in coral and shells, at a depth of 2.5 to 3.0 m. This sand has been dated at about 3500 B.P. (McLean, personal communication). The organic composition of the upper level, and the relatively organic nature of the intermediate layer, both suggest that terrestrial sedimentation in this area has been insufficient to fill the swamp since its initiation after the Holocene.

Sedimentation in these three swamps seem therefore to have taken place in two phases. In the first phase, until about 1000 years ago, sedimentation was rapid leaving coarse deposits. This phase probably commenced between 2000 and 3000 years ago, coincidentally with the settlement of man on Lakabu and his use of fire to clear land for cultivation. This was then followed by a slower sedimentation phase during the last 1000 years, the nature and origin of which is discussed later in this volume.

Evaluation of erosion rates

Estimation of the volume of material deposited during a determined time should enable us to evaluate the quantity of material taken from the upstream catchments during the same period. The calculation is, however, likely to be an under-estimate, since at times of peak flood a part of the material carried into the swamps was probably taken out and transported downstream into the sea. At the present stage of our research on these swamps, estimates can be applied only to the more recent sediments — since 1000 B.P. — since there remains too much doubt concerning the dating of the lower horizons. In our paper below, Hughes, Hope, Latham and M. Brookfield carry this analysis further, with interesting results.

Table 2.4 shows fairly high erosion rates, over 100 tonnes/km²/yr. This represents removal of from six to ten centimetres of earth per thousand years from the surface area of the upstream catchments.

**Table 2.4: Evaluation of the Erosion Index for the Waitabu, Nabuni and Levuka Catchments**

<table>
<thead>
<tr>
<th>CATCHMENTS</th>
<th>WAITABU</th>
<th>NABUNI</th>
<th>LEVUKA</th>
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</thead>
<tbody>
<tr>
<td>Vegetal cover of the catchment</td>
<td>Forest</td>
<td>Talasiga</td>
<td>Talasiga</td>
</tr>
<tr>
<td>Surface area of catchment in ha</td>
<td>45.6</td>
<td>27.5</td>
<td>51.8</td>
</tr>
<tr>
<td>Surface area of the swamp area in ha</td>
<td>3.4</td>
<td>1.9</td>
<td>13.1</td>
</tr>
<tr>
<td>Nature of the sediments</td>
<td>Mineral</td>
<td>Mineral</td>
<td>Organic-mineral</td>
</tr>
<tr>
<td>Evaluation in cm of the depth of deposits during the last thousand years</td>
<td>110.0</td>
<td>100.0</td>
<td>120/3 = 40</td>
</tr>
<tr>
<td>Evaluation in cm of the thickness of eroded soil on the catchment in one thousand years</td>
<td>8.3</td>
<td>6.8</td>
<td>10.0</td>
</tr>
<tr>
<td>Mean erosion index on the catchment in tonnes/km²/year</td>
<td>124.0</td>
<td>102.0</td>
<td>125.0</td>
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</tbody>
</table>

The mean erosion index has been calculated by the following formula:

\[ T = \frac{3}{2} (h \times d) \]

in which:

- \( T \) = mean erosion index in the last thousand years
- \( s \) = surface area of the catchment
- \( S \) = surface area of the swamp
- \( h \) = depth of accumulation during the last thousand years
- \( d \) = bulk density of the soil of the catchment, estimated for this calculation at 1.5
These results, which relate to the later and slower period of deposition, are high, but may be compared with those observed in other tropical regions, as follows:
- 2.7 cm/1000 yrs on the Dumbea river, New Caledonia (Trescases, 1973);
- 12.5 cm/1000 yrs as a mean figure for the New Caledonian ultramafic masses (Bauduin, personal communication);
- 2 cm/1000 yrs on the Kuk site in Papua New Guinea (Golson and Hughes, 1976);
- 7 to 12 cm/1000 yrs on the Ivory Coast under savanna (Lenoir, quoted by Trescases, 1973);
- 5 cm/1000 yrs in Madagascar (Hervieu, 1968).

The values obtained should also be related to indices of the rate of weathering in the tropics, presently estimated in the range 0.5 to 5.0 cm/1000 yrs (Leneuf, 1959; Hervieu, 1968). If these rates are applicable, then morphogenesis would proceed over pedogenesis in Lakeba, leading to the truncation of soil profiles. This truncation seems as marked in catchments partly or wholly under forest as in those with only talasiga vegetation, probably because of the effect of clearing and cultivating the forested slopes.

On the basis of these estimates erosion is an important factor in the contemporary soil and landform dynamics of Lakeba. However, the evidence obtained from deeper horizons in the swamps suggests that erosion rates may have been very much higher in an earlier period, two thousand and more years ago; we provide striking confirmation of this suggestion below.

II - THE EVIDENCE OF DIFFERENTIATED SOILS

THE SOIL UNITS

It is the varied geomorphological history of Lakeba, not the relative uniformity of its geology and present climate, that is responsible for a rather remarkable degree of soil differentiation for so small and island. The earlier work of Twyford and Wright (1965) recognized not only 'rugginous latosols' or 'talasiga soils', but also some 'litosollic soils', 'humic litosols', 'igneous soils', 'gley soils' and recent alluvial soils.

The study undertaken by the project distinguished the presence of eight Great Soil Groups according to the FAO (1974) legend, and seven by the French classification (CPCS, 1967, Annex 2). It is possible to regroup these soils into three main complexes: soils of ferrallitic evolution, soils of ferrallitic evolution, and an aggregate of immature and hydromorphic soils. Figure 2.7, the soil map of Lakeba illustrates this section of the paper.

Soils of ferrallitic evolution

Soils of this complex (Acrif, Humic and Rhodic Ferralsols, and Ferralic Cambisols) occupy almost 50 per cent of the surface of Lakeba. With the exception of the Humic Ferralsols, they represent what Twyford and Wright (1965) termed the 'talasiga soils'. All are characterized by deep weathering of the parent rock, clearly demonstrated by a silica/alumina ratio of less than 2.0 (Table 2.5) and by sorting out of clay minerals of the kaolinite family, and of iron and aluminum sesquioxides.
Acric Ferralsols: The most mature of these soils are undoubtedly the Acric Ferralsols encountered on the upper and lower plateaus levels described above. Deep brownish red in colour, they have a loamy clayey texture with high porosity in their upper-nongrassland horizons. They are rich in iron-manganese concretions which accumulate in the uppermost horizons; sometimes there is also a hard manganeseiferous layer lower down in the profile. The mineral composition of these soils consists basically of aluminium, iron and manganese sesquioxides: gibbsite, haematite, haematite and goethite (Table 2.6).

From their high alumina content these soils can be described as genuine bauxites. Some metaalloysite may also appear in deep horizons, but the A and B horizons are short of phyllites, and thus have a cation exchange capacity related to organic matter. There is, however, a very limited supply of organic matter, for these soils are covered only by a sparse vegetation and are subjected regularly to burning. They correspond well with the definition of Acric Ferralsols in the FAO legend, or with the Acrisols in the US taxonomy (United States, Soil Survey Staff, 1975). They are poor in organic matter, nitrogen, potassium and phosphorus; they are acidic, unsaturated in bases, and of low fertility.

Humic and Rhodic Ferralsols: These soils, developed in the centre of the island, have been subjected to a far less intense ferrallitic weathering than the Acric Ferralsols. They are either red or yellow in colour, clayey in texture, and fairly deep. The basic mineral components are 'fire clay' — an irregular variety of kaolinite, magnetite and goethite. Little gibbsite is encountered in the profiles. The exchange capacity of the mineral matter for these soils is high for the Acric Ferralsols; it is, however, below 15 me/100 g of clay, which allows their classification as Ferralsols. They are acidic and highly unsaturated in bases. Where under forest, the higher organic matter content permits classification as Humic Ferralsols, but under a more open vegetation the organic matter content is less abundant, so that the soils become Rhodic Ferralsols. In the Humic Ferralsols, a greater concentration of humus is linked with higher proportions of nitrogen, potassium and phosphorus than in the Rhodic Ferralsols, and hence the former group is chemically of higher fertility than the latter.

Ferralic Cambisols: In terms of areal extent, these are the dominant soils of Lakeba. They cover the duned hills of the talasiga formation and correspond well with the prototype 'talasiga soils' described by Tawford and Wright (1965). These are truncated soils with a superficial red sandy loam horizon 10 to 40 cm deep topping a weathered horizon in which the original rock structure is preserved. They are acidic, poor in organic matter, nitrogen, potassium and phosphorous. Cation exchange capacity is higher than in the soils discussed above, so that they cannot be classed as Ferralsols, and the cambic character of their weathering horizon places them among the Cambisols. This notwithstanding, their evolution is clearly of ferrallitic type. They have a mineral composition in which 'fire clay', haematite and goethite are dominant. Some traces of gibbsite may be still found in the upper horizons, and for these reasons they are classed as Ferralic Cambisols. These truncated soils, very poor in nutrients, probably constitute the least fertile edaphic entity to be found anywhere in the eastern island region of Fiji.

Soils of ferrallitic evolution:

Soils in this group have developed on parent material of much more recent origin. They have in common features such as moderate profile differentiation, the presence of smectites in their clayey complex and the separation

**Table 2.7: Physico-Chemical Characteristics of Soils of Ferrallitic Evolution**

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<thead>
<tr>
<th>Depth (cm)</th>
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**Table 2.8: Mineralogical Characteristics of Soils of Ferrallitic Evolution**

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**Data:** analysis of field samples.

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**Table 2.9: Physico-Chemical Characteristics of Soils of Ferrallitic Evolution**

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<td>Anomalous products</td>
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**Data:** analysis of field samples.
of iron oxides and hydroxides. The silica/alumina ratio exceeds 2.0 (Table 2.7 and 2.8).

Chromic Luvisols: These soils are formed from the extensive colluvio-alluvial formations in the valleys. They are brownish red in colour, clayey to clay-loamy in texture, and contain clusters of small andesitic fragments. The soils are deep and very weathered, giving them rather loose cohesion. The mineral composition is dominated by mica, biotite, and small amounts of nontronite and euptite. Among the sesquioxides, maghemite, magnetite and goethite predominate, and there are traces of gibbsite and goethite. There is evidence of clay movement in the profile yielding by clay skins on the andesitic fragments which lack light, grainy centres. The soils are moderately acidic and only slightly saturated in bases, permitting their classification into Luvisols and Chromic Luvisols in the FAO system, the distinction being on the basis of colour. Talus vegetation covers these soils, which are poor in organic matter, nitrogen, potassium and phosphorus, and of low fertility.

Humic and Eutric Cambisols: These soils occur on steep slopes under forest or reeds. They are shallow, brown to reddish-brown in colour, clayey in texture. They contain some large blocks and smaller fragments of andesite in process of weathering, giving the soils their cambic character. The main mineral component is mica, biotite, but nontronite, magnetite and haematite, together with small quantities of gibbsite and goethite are also found in the profile. The soils are slightly acidic and, rich in exchangeable bases. Where under forest, the upper horizons of these soils contain humus and can therefore be classified as Humic Cambisols; where the soils are under reeds they contain little humus, and are therefore classed as Eutric Cambisols. These soils, rich in exchangeable bases and quite high in phosphorus, may be considered as moderately fertile.

These soils are transitional between the weathered ferrallitic soils and newly ferrallitic soils. They are certainly relatively young soils, in which minerals such as smectite and gibbsite occur together. Though of medium to rather low fertility, they are quite heavily used for agriculture.

In mature and hydromorphic soils

Soils classed in this broad group lack the uniformity of the previous classes. They occur on the recent alluvial and coastal plains, on uplifted calcareous benches and on limestone. They have in common a recent history and weakly developed profiles (Table 2.9).

Fluvisols: Soils of this type are widely developed in the valley bottoms on the eastern and coastal plains. They are deep and clayey, and sometimes show hydromorphic staining at depth. A well-structured humiferous horizon overlies a subsoil in which horizons can barely be distinguished. These soils are fairly rich in organic matter, nitrogen, phosphorus and exchangeable bases. The lack of any diagnostic horizon, and their weakly saturated bases, put them among the Eutric Fluvisols. Because of their depth and fertility, these are the best agricultural soils on the island.

Gleysols and Histosols: These are the soils of the valley and sub-coastal swamps. Gleysols are found mainly in the inland swamps. They are deep, marked by permanent ground-water saturation reaching to the surface. They are humiferous and acidic, though quite rich in exchangeable bases, yet they often quite lean in potassium and phosphorus. There is generally a gley
horizon quite close to the surface, and this characteristic, together with their richness in organic matter, places them among the Humic Gleysols.

The Histosols characterize mainly the sub-coastal swamps, most of which have limited water catchments. They too are saturated to the surface with ground-water, and may have an accumulation of peat to a depth of two or three metres. Often these soils are very acid, and poor in plant nutrients. Though both groups of soils have traditionally been cultivated for irrigated taro and both seem to have a fairly high production potential, the potential of the Gleysols of the inland swamps is higher than that of the sub-coastal Histosols.

Rendzinas: Soils of this group occur on the sandy coastal plains of western and southern Lakeba. They are shallow and sandy, with calcareous sands, and often have a brackish water table quite close to the surface. Generally, these soils are organic matter, but have small reserves of potassium and phosphorus. These are, par excellence, the soils of the coconut plantation and groves.

Discussion

The lowland soils of Lakeba are very heterogeneous. Some have been formed from volcanic parent material, and some from calcareous material provided both by the limestone, and from the reef and lagoon. The depth of the water table varies greatly. Taken as a group, however, they are the most shallow soils on the island, and have been cultivated generally under coconuts except where the water table is close to the surface.

It is clear from this outline that the soils of this island are both varied and unusual. The variety emerges as much from their physico-chemical characteristics and mineral content, as from their index of fertility. In a small island with only 56 km² of land, plus a fringe of mangroves on the eastern side, eight great soil groups of the FAO legend can be recognized -- a circumstance remarkable enough in itself. The contrast with the geological homogeneity of younger volcanic islands such as Taveuni, or elevated atolls like Kabara, is of a major order.

Certain of the Lakeba soils, in particular the bauxitic Acric Ferralsols on the plateaux, and the Chromic Luvisols on the colluvio-alluvial deposits in the higher parts of the valleys, are soil types that have hardly been studied anywhere in the world before the present inquiry. This individuality of the soils of Lakeba is underlined by the difficulties experienced in applying the classification systems; the French and American systems, in particular, were found poorly adapted to the description of the soils of the island.

PEDOGENESIS AND THE DISTRIBUTION OF SOILS

Pedogenesis under contemporary conditions

The diversity and individuality of the soils of this island reflect great diversity in pedogenetic conditions. Climate, geology, geomorphology and the plant cover all need to be taken into account. The present tropical oceanic climate permits a moderate degree of ferrallitization, of a type well represented in the central uplands by the formation of Rhodic and Humic Ferralsols. Slow erosion of silica and a moderate concentration of gibbsite characterize the soil-forming processes of this area. These conditions are favoured both by the undulating topography of the central uplands, and by the forest or para-forest cover.

These conditions are greatly modified on steep slopes, and in areas covered by sparse talasiga vegetation. In these areas, runoff may prevail over infiltration, and weathering seems to be less active. This shows up in the soil through the slower elimination of silica, and a silica/alumina ratio which slightly exceeds 2.0 in the Ferralic Cambisols and is far above this value in the Eutric and Humic Cambisols. Some montmorillonite may be formed in the profiles of the latter soils, and this element becomes much more abundant in the Gleysols and Fluvialsols of the valley bottoms, under the influence of silica inputs linked to the flow of ground water.

In terms of present processes, Lakeba seems close to a climatic limit between the truly ferrallitic environment of wetter regions, as observed in the Medrasuatu Range of southeastern Viti Levu, and in the north of Taveuni, and a drier environment generating bisalitic soils, such as are found on the western coast of New Caledonia. It would be interesting to test this hypothesis by investigation of the soils of One-i-Lau, a heavily eroded andesitic island at the southern end of the Lau chain, where liability to drought is much greater than at Lakeba.

Paleoecologies and pedogenesis

Pedogenesis under present climatic conditions cannot, however, explain all the observed pedological forms observed on Lakeba. Compared with the present climatic conditions of some islands in the region, the Lakeba conditions would seem to require a drier climate. For such a phase, however, the most convincing evidence lies in the landscape and the surface geology of the island, with its huge areas of colluvium.

Vegetation and pedogenesis

The effect of vegetation has emerged at several points in the discussion above. Both the input of organic matter, and the balance between runoff and infiltration, are greatly affected by the nature of the plant cover. Most of Lakeba is today sparsely vegetated. Bayliss-Smith (1977) has shown that in the Vatukalto catchment, 71 per cent of which is covered by talasiga and related vegetation, the average evapo-transpiration reached 34 per cent of the rate of input by the sixth hour of an eight-hour storm. This is a high rate of runoff, especially when taken in comparison with the finding of Reese (1975) that on a 23 per cent slope under tropical rain forest the mean runoff rate was only 0.7 per cent. Talasiga cover facilitates both runoff and erosion, and in this respect stands in sharp contrast with forest cover. On several soils, furthermore, soil
fertility is virtually concentrated in the humiferous horizons; this is especially the case with the Acric and Humic Ferralsols. Removal of vegetation from such soils is inevitably followed by a significant decline in fertility.

The distribution of soils

The close correspondence of soil formations with landforms has been noted at several points. Soils of ferrallitic evolution are essentially confined to the hills, plateaux and moderate slopes (Figs. 2.3 and 2.7). They correspond with older landforms, and their present distribution is governed by their topographic position. Soils of ferralsitic evolution are encountered on slopes produced by subsequent incision, and in the colluvio-alluvial zones. They are not youthful, but on the contrary show advanced evolution in their profile development, and the beginning of rubefaction and clay movement. The only slightly differentiated soils on Lakeba are those formed in the recent alluvial plains. The pattern of variation is summarized in Table 2.10.

**Table 2.10: DISTRIBUTION OF THE SOILS OF LAKEBA**

<table>
<thead>
<tr>
<th>SOIL</th>
<th>AREA IN HA</th>
<th>PERCENTAGE OF TOTAL</th>
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<tbody>
<tr>
<td>Histosols</td>
<td>8.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Lithosols</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lithosols + Rhodic Ferralsols</td>
<td>260.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Thionic Fluvisols (Mangroves)</td>
<td>532.3</td>
<td>8.6</td>
</tr>
<tr>
<td>Eutric Fluvisols</td>
<td>647.1</td>
<td>10.5</td>
</tr>
<tr>
<td>Humic Gleysoils</td>
<td>186.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Rendzinas</td>
<td>374.1</td>
<td>6.0</td>
</tr>
<tr>
<td>Humic Ferralsols</td>
<td>70.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Acric Ferralsols</td>
<td>264.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Rhodic Ferralsols</td>
<td>204.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Chromic Luvisols</td>
<td>851.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Humic Cambisols</td>
<td>332.9</td>
<td>5.4</td>
</tr>
<tr>
<td>Ferralic Cambisols</td>
<td>2167.0</td>
<td>35.1</td>
</tr>
<tr>
<td>Eutric Cambisols</td>
<td>277.4</td>
<td>4.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6177.5*</td>
<td>100</td>
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* Includes mangroves

**III - VEGETATION: DOMINANCE OF PYROPHYTIC FORMATIONS**

The initial impression of the vegetation of this island is one of poverty and uniformity. The landscape is dominated by the very open talasiga. A more detailed inspection, however, reveals a wide variety of environments, and even the talasiga association itself is far from homogenous. There are significant areas of forest, thicket and herbaceous vegetation. These associations overlap in a complex mosaic and, despite the influence of fire, their pattern forms a good indication of edaphic conditions. Fig. 2.8, the vegetation map of Lakeba, illustrates this section of the paper.

**VEGETATION TYPES OTHER THAN TALASIGA**

The following discussion is based on the international classification of vegetation proposed by UNESCO (1971), but in view of the scale and complexity of Lakeba it is necessary to subdivide some of the main units. The invaluable compendium of Perham (1972) was the source reference for floristic determination. A list of plants collected, together with their distribution, appears as Appendix 3 below.

Closed forest and coconut groves

Together, these two units occupy some 40 per cent of the surface of the island. They are grouped together because, in many instances, the coconut groves have occupied areas formerly under beach forest and gallery forest, and both are tree communities. The UNESCO system does not take into account of cultivated species, but in dealing with an island where coconut groves are so important a formation, they cannot reasonably be excluded. Four main types of forest are distinguished, and are described below (Fig. 2.8).

**Forest with Casuarina equisetifolia**: This type of forest has developed mainly in the centre of the island, on steep slopes overlooking the valleys. It covers about six per cent of the island surface, but its distribution is a series of isolated pockets. The floristic composition is rather poor; in a short investigation only 29 species were counted. The forest is of medium height and all vegetal strata are represented. There are only a few big trees (in particular Casuarina equisetifolia, Acacia tortilis, Pisonia pistillata). The middle stratum on the other hand is quite abundant (Qusetha sp., Cerbera manghas, Pandanu aduncus). The herbaceous stratum is fairly rich in brackens (Euphorbiaceae sp., Odontites atrolineata, Haplocarpus aculeatum, Elaydium reticulatum). In addition, there are many creepers (Entada phaseoloides, Indica enstyla). These forests have been cleared several times to make way for subsistence crops (Diospyros dactylifera, coconut trees: Nono nana, papayas, banana, Colocasia esculenta, taro; Dillenia alata, yams; Piper methysticon, yagora or kava). These latter ground crops are carried for a period of two or three years, then the patches are abandoned and rapidly invaded by creepers, some of which are relative newcomers to Fiji (Mikania melanantha, Spigelia gracilis). These secondary forest remnants survive on clayey but often shallow soils, in wet situations.

**Forests with Strychnos inerme, Pisonia obliqua and Litsea pickeringii**: These closed forest develop on the limestones in the western and southern part of the island. Their spread, like that of the first group, is restricted, and occupies only four per cent of the vegetated area. Considering the limited time spent on survey in this formation, the floristic composition is probably richer than appears on our lists, but is still likely to prove to be comparatively small. The forest is dominated by big trees (Strychnos inerme, Pisonia obliqua, Litsea pickeringii), and occurs mainly on the lithosols and shallow soils on limestone. As soon as the thickness of soil begins to increase away from the outcrops of bare rock, this vegetation community tends to be replaced by an open vegetation of talasiga type.
Like the previous formation, this forest type has been cleared in many places in order to grow coconuts and subsistence crops wherever the soil permits. The growth of forest on these limestones remains relatively difficult to understand, though it is common on the limestones throughout Lau, because the plants have no easy access to water. We have to suppose, as we have elsewhere done for Kabara and as Tercrier (1971) has done for similar formations in the Loyalty Islands east of New Caledonia, that the necessary hydrologic nutrition is produced by capillary action through the limestone.

Swamp forests with *Vaccinium fusiforme* and *Pandanus odoratissimus*: These forests develop on some of the sub-coastal swamps, and cover very small areas, principally near the villages of Levuka and Nasaqalau. The following tree species are dominant: *Vaccinium fusiforme*, *Barringtonia racemosa*, *Flora tuberculosa*. A fairly well-developed middle stratum of *Pandanus odoratissimus* and *Carinbana mangus* is also visible. These forests have often been cleared for taro plantations, and the soil surface is covered with *Annona squamosa*, *Boerhavia microsperma*, and *Inga microcarpa*. The forests stand in areas saturated to the surface and sometimes above with fresh water, but are sometimes invaded by sea water during very high tides, and in storm surges and tsunamis.

Mangrove forests: Mangroves cover more than eight per cent of the total vegetated surface of Lakeba. Put another way they add a vegetated surface equal to some 34 per cent of the land area of the island. They grow almost entirely on the eastern side of the island, extending more than a kilometre from dry land. The mangroves consist mainly of *Rhizophora mangle*, *Bruguiera gymnorrhiza*, both species common throughout Fiji. However, the floristic variety is much less than around the main islands of Viti Levu and Vanua Levu. For in Lau mangroves are approaching the eastern limit of their extension into the Pacific.

The coconut groves and the forest they replaced

These groves are generally old -- often as old as 70 years -- and are rarely well tended. Their management is described in greater detail below by M. Brookfield, and is not further discussed here. They occupy two favoured locations, though they spread also onto less suitable land. These locations were formerly the domain of beach forest and clay-plain forest. It is impossible accurately to reconstruct the floristic composition of these old forests, so completely have they been replaced. However, a few pockets remain, and some individuals of the primitive communities are scattered through the coconut groves. Two communities seem to have occurred, differentiated according to the nature of the soil: forests on sand and coral debris, and forests on clayey plains.

On the sandy beaches, there is evidence of a low lignonous formation with *Quercus aestivalis* and *Mesembryanthemum argenteum* predominating, similar to the formation encountered on coral beaches throughout the Pacific (Fosberg, 1961). On clayey soils, some remnant patches indicate a formation particularly rich in *Barringtonia racemosa*, *Pisonia alba*, *Vaccinium fusiforme*, *Pisonia tetrasperma*, and *Terminalia catappa*. However, the floristic changes due to coconut planting are often almost complete. The original lignonous species have disappeared over wide areas. The amount of light penetrating the crowns of even densely-planted coconuts has permitted and invasion of undergrowth dominated by herbaceous and bushy species: *Malavacea*, *Osmundaceae*, *Leguminosae*, *Compositae*, *Labiatae*, and *Verbenaceae*. More than half of these species are either cultivated plants, or recently introduced weeds. Some have great dynamism, and tend to form a thicket under the palms which makes it difficult to collect the fallen nuts, or to permit cattle to graze. In some areas, grassy pastures enriched with *Korovia grisa* (*Broughmania humilis*) are deliberately being established.

**Herbaceous formations**

**Reed thicket:** This dense formation, often impenetrable without the heavy use of cane knives, appears on steep slopes in the main. There is also a block in the north on the plain between Nasaqalau and Vakano, that appears to have expanded considerably since the time of the last air photography taken in 1972. Most of the reed thicket is on shallow soils, rich in *montmorillonite* (Eutric Cambisols). It covers more than four per cent of the island surface. The formation is dominated by *Sasanthera floriduloides* forming a dense growth to a height of two or three metres, with occasional trees and bushes (*Pandanus odoratissimus*, *Carinbana mangus*, *Alpinia obtiorrumpens*), some brackens (*Nephrorpia sp.*, *Pteridium esculentum*) and some weeds (*Polidium guazava*, *Mimosa pudica*, *Hyptis pectinata*, *Cooman gratissima*, etc.).

These areas are frequently burned and cleared in order to cultivate *cassava* (*Manihot esculenta*) or sweet potato (*Ipomoea batatas*). These crops are grown in alternation with fallow, and give good yields. The soils on which they grow are relatively fertile, but often dry, so that moisture demanding crops such as taro and yam are rarely cultivated on this land. In many instances reed thicket is found around the borders of lagoon, and might therefore be a secondary or deflected succession following forest clearance.

**Hydromorphic rooted fresh-water vegetation:** These grasslands occur in the swamps of the valleys and the coastal plain, and cover only small areas. They are dominated by a dense, low herbaceous vegetation with *Oscularia* (*Ceara* sp.), *Solandra playcampi* and ferns (*Nephrorpia* sp.). Introduced plants (*Parradilla obovata*, *Mimosa pudica*, *Tetrapanax nammii*) and cultivated species (*Cyperus compressus* var. *minimus*, *Cyperus esculentus*) occur in considerable numbers. These areas have been cleared for irrigated rice cultivation for a very long time, probably for many centuries; the floristic composition is therefore rather heterogenous, and bears direct relation to the intensity of human use.

**THE TALASIGA**

The name talasiga groups together a range of communities with an herbaceous stratum dominated by forbs (non-graminaceous herbaceous species). Brackens are the principal component (*Diapensia tristis*, *Pteridium esculentum*). The lignonous synusia is more or less abundant, varying from locality to locality. By contrast with the talasiga areas of Viti Levu, in particular, mission grass (*Pennisetum polyzona*) is almost completely absent from the talasiga areas of Lakeba. The Lakeba talasiga has been divided into four associations according to their physiognomic aspect, floristic richness and the dominance of certain species. A description follows.

**Tall forb vegetation:** dense fern thicket with *Pteridium esculentum* and *Diapensi* *tristis* and an abundant lignonous synusia.

This vegetal community is especially associated with the deep ferrallitic
soils of the higher and lower plateau levels (Acris Ferralsols). It covers only a small surface area, some three percent per the island, and is regularly burned. This community sometimes has a para-forest aspect. The tree stratum can be relatively dense, and is dominated by Cassarina equisetifolia (nokonoko) and Pandanus odoratissima. Moreover, numerous bushy species occur and sometimes produce a canopy effect. These include Cerbera manghas, Dodonaea viscosa, Combretum bartanum, Metrosideros collina and Wikstroemia floridula. The herbaceous stratum is also dense, and is dominated by bracken (Pteridium esculentum and Diancompetria linearia). Traditionally, this formation is rarely exploited, and only for light timber or firewood. Now many of the areas on the western side of the island are being planted over with Pinus caribaea.

Tall forb vegetation: mixed fern thicket with Diancompetria linearia and Miconanthus floridulus and a restricted ligneous synusia

This formation is found in the large valleys, on deeply leached soils (Chromic Luvisols). It includes a fairly open tree layer dominated by individual Pandanus odoratissima and a few Cassarina equisetifolia. In the herbaceous layer, Miconanthus floridulus reeds predominate, but do not form real thickets. They are scattered among a fern carpet (Diancompetria linearia and to a lesser extent Pteridium esculentum) and some introduced plants.

Moister patches have for long been selected for clearance for cassava cultivation, and although these plots yielded a little less well than other and more fertile land, our informants agreed that the taste of the crop is better. This cropping causes local weed enrichment to flourish, but the extension of weeds remains limited due to the poverty of the soil. Some Pinus caribaeas have been planted, and their growth is more rapid than that of trees of similar age elsewhere on the talagai. In older plantations, some floristic enrichment of the understory is already visible.

Low forb vegetation: fern thicket with Diancompetria linearia and a restricted ligneous synusia

This community is developed mainly on hills with rejuvenated ferrallitic soils (Ferralsols Cambisols). Of all vegetal associations on Lakeba, this is the most widespread. It covers some 30 percent of the island surface, and is primarily responsible for the barren, open aspect of the uplands, so different from the characteristic Pacific island. Tree and bushy layers scarcely exist. As in the community discussed above, a few Cassarina equisetifolia, Pandanus odoratissima and Dodonaea viscosa occur, but with very few other species. At ground level, there is a fern thicket in which Diancompetria linearia is overwhelmingly dominant. This formation is regularly burned, but is little used by the population. With the sole exception of the mangroves, this community contains the smallest proportion of introduced plants. However, it is interesting to note that the opening-up of access roads to serve the pine plantations, and the movement of vehicles and some horses along these roads and the footpaths which join them, has led to growth of some introduced plants, particularly Osmarnthus along the worked sectors. Pinus caribaeas have been found to grow rather well on these soils.

Low forb vegetation: fern thicket with Diancompetria linearia, Pteridium esculentum, Miconanthus floridulus and many weeds, with a small ligneous synusia

This fourth association is found in the centre of the island, in the highest and most humid part, and occupies only a relatively small area. It is
possible to find all the same tree and bushy species as in the formations discussed above, but they are more abundant and the ratio between species is somewhat different. Certain species such as Astronium which are sparse elsewhere in the talasiga here become abundant. Species related to the forest associations such as Guatteria terminalis can also be found. Among the herbaceous plants, Malvophyta paniculata still predominates, but is associated with many other species, some of which have been introduced -- Cynara secalis, Agave americana, Ziziphus obtusifolia, Solanum spicatum, Virola odorata, and Brachiaria decumbens. These can form nearly 20% of the species have been introduced. Several factors probably favour their establishment: the clayey soils are not as well-drained as in the other talasiga rocks, and the climate is more humid. Man's use of this formation is, however, very slight.

The vegetation complex and the natural environment

The dominant influences on the nature of the plant cover are climate, parent rock and soil, together with human interference through fires, cultivation, wood-cutting and the introduction of new species. In the present conditions under which a strong human impact on the environment is evident, it is worthwhile to enquire whether something like an equilibrium between vegetation and environment has been achieved, or whether a process of degradation is still under way. The impression of a measure of equilibrium is strong, and it will be explored further.

Climate and soil climate

The influence of climate, and of the soil climate in particular on vegetation, is particularly clear in this island. We have taken note of some differences in the talasiga vegetation between the northern and higher parts of the island and the lower slopes and valleys. We must also call attention to the fact that forest formations are confined to the wetter sections of the upper valleys and valley sides, to limestone areas, alluvial and coastal plains, and the mangroves. In all these situations, hydrological nutrition appears to be the determining factor in the preservation or implanting of forest vegetation. Indeed, if we re-examine the variations in soil fertility between these areas, and adjacent areas covered by open vegetation, these variations seem linked more to the inputs of organic matter than to the nature of the soils themselves (Table 2.11). The most marked variations in the physio-chemical characteristics of soils under talasiga, red being thicker or forest concern the humus A horizons, not the B horizons. It can therefore be concluded that soil climate is the principal determining factor in present vegetal cover.

Parent rock

The parent rock is also an important factor. We have indicated the variations between vegetation on andesitic rocks and on limestone; to this should be added the former vegetation pattern of the beach and gallery forest. Differences in the floristic composition of forest are very noticeable across geological boundaries.

The influence of soil

The soil itself is also a major factor in vegetation differentiation. Close comparison of the soil and vegetation maps demonstrates this association very clearly, and it is also brought out in the transects shown in Figs. 2.9 and 2.10. Soil affects vegetation in two different ways: by its water re-

| TABLE 2.12: RELATIONSHIP BETWEEN WATER-RETENTION CAPACITY OF CERTAIN SOILS AND THE VEGETATION COVER |
|---------------------------------|---------------------------------|
| **SOIL TYPE** | **Q** | **VEGETATION** |
| Forestal Cambisol | 50 - 70 | Talasiga: low forms |
| Acric Cambisol | 80 - 90 | Talasiga: tall forms |
| Chronic Cambisol | 120 | Talasiga: tall forms |
| Lithic Cambisol | 150 | Reddish Oxidized |
| Lithic Fluvisol | 160 | Forest or coconut |

| TABLE 2.13: DISTRIBUTION OF IDENTIFIED SPECIES OF DIFFERENT ORIGIN WITHIN EACH MAPPED VEGETATION TYPE |
|---------------------------------|---------------------------------|
| **VEGETATION TYPE** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Indigenous species | 19 | 11 | 13 | 12 | 10 | 7 | 27 | 14 | 18 | 19 | 10 |
| Introduced species | 7 | 5 | 3 | 9 | 3 | 5 | 3 | 5 | 5 | 9 | 8 |
| Cultivated species | 6 | 5 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 4 |
| **Total** | **32** | **26** | **20** | **12** | **10** | **5** | **27** | **14** | **18** | **19** | **10** | 116 |
tention possibilities, and by its chemical composition.

The water retention possibilities of the soil are governed by the scope for root penetration, and also by the retention capacity of the soil itself. There is a close relationship between the water retention capacity of the principal soils and the height of the plant formations (Table 2.12). Chemical factors are of secondary importance. The abundance of cations in Ultic Cambisols and in Chronic Luvisols may be important for the growth of needthick. The sodium contained in some coastal soils may be of significance in facilitating the development of swamp forest. Soil thus reacts on the vegetation by either accentuating or reducing the effect of soil climate, and thus governing the nature of the flora.

The impact of human use

While at least a short-term equilbrium may therefore be recognized in the case of the vegetation in the forests, in the longer term there is evidence that man's impact by fire, cultivation and wood-cutting tends to homogenize, gradually reduce and transform the vegetation into more degraded forms. In opposition, however, the introduction of new species increases the range of plants capable of adapting to the environment.

The effect of fire

Especially on the talasiga, the effect of repeated burning is often to hide the complexity of the soil-vegetation relationship. This is particularly clear in the case of the tall forb vegetation with *Ptilidium caenulumendum* and *Distomoa sinuosa* which, under repeated fires, changes into low forb vegetation. Repeated fires keep the woodland of *Sinuosa*. Fire does not operate with the same intensity each year; in wet weather the impact is likely to be much less than in dry years, even given the accidental nature of many spreading fires. We therefore seem to have at best a fairly unstable edaphic equilibrium, especially around the outskirts of the forest patches where we often find many species of *Gelseola tenuifolia* among the forbs. The implication is of a fluctuating boundary between the formations. In the wetter zones the forest sustains a considerable dynamism. Clearings made by fire, and then cultivated, are fairly swiftly overgrown by forest type vegetation during the fallow period. In the long run, however, the impact of fire is particularly degrading in edaphically unstable areas. The forest tends to retreat under its impact.

The effect of cultivation

Cropping has important effects through clearing, the resulting exhaustion of soils, and the introduction of new species. Especially in edaphically unstable areas on the forest edge, cultivation tends to accelerate the retreat of the forest caused by fire. In many areas, red thicket has become established in the place of forest after repeated cassava plantings. Some swamp grasslands long cultivated for taro, and abandoned several years ago, did not return to swamp forest because the soil had become exhausted and more acidic. This is especially the case of the Levuka swamp in the south of the island, which has now lain uncultivated for almost 20 years. Where coconut have been planted, however, the regrowth of secondary forest and undergrowth is facilitated. This is a result of the use of good land and for coconuts during the past century, therefore, it is possible that the state of the land will ultimately be better, when it comes to be used again for other purposes, than it would have been if the former system had continued.

The introduction of new species has had major effects on the flora throughout Fiji, especially on the main islands (Parhan, 1958). Despite the isolation of Lakeba, a considerable number of new species have been introduced to this island, though the effect is less devastating than in other parts of Fiji. With the exception of the mangroves, there is not one of the vegetation communities described above that does not contain some introduced species. Some introductions have been deliberate and are of a whole range of new crops is in this category. Others, however, have been accidental, and are other neutral in their effect on man or even to his disadvantage. A case in point is the over-running of many coconut groves with weeds, greatly reducing the yield. In fact, the introduction of new species is seen as a necessity for the success of coconut plantations and under the palms for cattle or cultivation. Taro fields and cassava patches may also be invaded by weeds such as *Stachytarpheta jamaicensis*, *Mimosa pudica*, *M. intava* and *Malvastrum cosmodendron*, which impede growth and time are employed to eradicate or control them. As in many other parts of the world, floristic introductions such as these can become an increasing nuisance, and a disincentive to agricultural production.

Finally, mention should be made of the cutting of wood for houses, canoes and firewood; over time, this extraction has greatly reduced the number of large trees in the forests, and Lakeba has for many years, perhaps centuries, imported large-timber articles such as house-posts and canoes from other islands. The introduction of a portable sawmill as part of hurricane relief in 1975 encouraged new depredations on the remaining forest areas around the limestone massif in western Lakeba.

In sum, it would appear that the 'equilibrium' is somewhat illusory, and that the long term trend is toward reversion of the forest and impoverishment of the original cover of the island. Recent plantings of *Pison curvipes* has, however, led to control over the use of fire, and this replanting of an impoverished area encourages hope for a reversal of the trend toward degradation.

On the other hand, the recent expansion of yuca cultivation in the forests, discussed below by M. Brookfield, is a contemporary trend in the opposite direction.

CONCLUSION

This paper can only conclude on a number of questions. It has been established that the soil-vegetation complex of Lakeba has changed very greatly through several phases since the island was forested, and that even before the advent of man some of these changes have been of a very major order. Since the arrival of man, however, a new and disruptive force has entered the scene, and this force has wrought a great change in a fragile natural ecosystem. An anthropogenous origin is postulated for the talasiga, which now covers almost 60 per cent of the island. More than a third of the plant species identified have been introduced to Lakeba, whether intentionally or unintentionally. Burning has exposed slopes to erosion, and it is clear that erosion continues to predominate over weathering in this island, though probably with a lesser margin than in an earlier period when sedimentation in the swamps was much more rapid than today. Erosion regularly truncates the soil horizons, and degrades the soil by removal of the humiferous and most fertile horizons. The relation to these modern changes to earlier changes is, however, a continuing question of major importance. Later papers in this Island Studies Section will shed more light on this problem.

ACKNOWLEDGMENTS

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by M. Brookfield, and the whole was then partly re-cast in free translation by the editor. The author acknowledges this assistance, but while he is thereby freed from responsibility for errors in translation, he remains responsible for all material and views presented in this paper.

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## APPENDIX II: DESCRIPTION OF THE MAIN SOIL PROFILES

### Aeric Ferralsols LH 12

**Location:** Lakeba, central zone of the island; elevation 220 m.

**Climate:** Oceanic tropical with a marked dry season; precipitation: 2000 mm/year.

**Position:** Upper plateau level; flat.

**Parent Material:** Andesite.

**Vegetation:** Herbaceous vegetation; low forb communities (talasia); herbaceous strata: *Dianthus napina*, *Psilostachya angustifolia*, *Craspedia*, *Commotamus*; ligneous strata: *Dodonaea viscosa*, *Metrosideros collaris*, *Metrosideros floridana*, *Pandanus odoratissimus*, *Casuarina equisetifolia*.

**A1 - 0 - 8 cm:** Moist; dark reddish brown; 5 YR 3/2; with non-visible organic matter; sandy loam; many small ferromanganeseiferous concretions; weak fine to medium subangular blocky structure; great macroporosity; friable; abundant fine and medium roots; clear smooth boundary.

**A2 - 8 - 52 cm:** Moist; dusky red; 5 YR 3/4; silt loam; many small ferromanganeseiferous concretions; weak fine to medium subangular blocky structure; great macroporosity; many tubular pores; very friable; abundant fine and medium roots; gradual smooth boundary.

**B1 - 52 - 85 cm:** Moist; dusky red; 5 YR 3/4; clay; some ferromanganeseiferous concretions; weak medium blocky structure; some pores in the aggregates; firm; some fine to medium roots; gradual smooth boundary.

**B2 - 85 - 120 cm:** Moist; red; 2.5 YR 4/6; clay; some ferromanganeseiferous concretions; moderate medium blocky structure; slightly porous; shiny pebbles; weakly cemented; some fine roots; gradual smooth boundary.

**B3 - 120 - 150 cm:** Moist; red; 2.5 YR 4/6; clay; few ferromanganeseiferous concretions; moderate medium blocky structure; slightly porous; shiny pebbles; friable; no roots; gradual smooth boundary.

**B3C - 150 - 190 cm:** Moist; red; 2.5 YR 4/6; clay; weak medium blocky structure; some tubular pores; friable; no roots.

**Humic Ferralsols LS 10**

**Location:** Lakeba, central zone of the island, close to the Yadranu - Leveque track; elevation 130 m.

**Climate:** Oceanic tropical with a marked dry season; precipitation: 2000 mm/year.

**Position:** Undulated landscape; 30 per cent slope.
Parent material: andesite.
Vegetation: closed forest with *Gesaea* teretis, *Pisonia fulguriflora*, *Pandanus odoratissimus*, *Melosperma robustum*, *Quatea sp.*, *Nephrolepis sp.*, *Enbada phascoloides*, *Nikaua micrantha*.

**A₁ - 0 - 12 cm:** Wet; pinkish gray; 7.5 YR 6/2; with non-visible organic matter; clay loam; strong fine granular structure; great macroporosity; some pores in the aggregates; friable; abundant fine, medium and coarse roots; clear smooth boundary.

**A₂ - 12 - 30 cm:** Wet; light brown; 7.5 YR 6/4; clay; strong medium to fine blocky structure; great macroporosity; some pores in the aggregates; plastic; slightly sticky; abundant medium to fine roots; clear, waxy boundary.

**B₂ - 30 - 60/80 cm:** Wet; pink; 7.5 YR 7/4; some fine distinct red mottles; clay loam; strong medium to coarse blocky structure; slightly porous; shiny peds; plastic; slightly sticky; medium to fine roots; gradual irregular boundary.

**B₃c - 60/80 - 180 cm:** Wet; very pale brown; 10 YR 8/4; loam; many more or less weathered andesitic fragments; weak medium blocky structure; slightly porous; slightly plastic; non-sticky; little roots.

**Ferralic Cambisols LS 11**

**Location:** Lakeba; hill between Tubu and the airstrip; elevation 80 m.

**Climate:** Oceanic tropical with a marked dry season; precipitation: 2000 mm/year.

**Position:** Summit of an eroded hill; 3 per cent slope.

**Parent material:** andesite.
Vegetation: Herbaceous vegetation; low forb community (talasiga); herbaceous strata: *Dicanthera linnispila* predomiating; ligneous strata: *Dodonaea viscosa*, *Nikaua costata*, *Cuscuta aggregata*, *Pandanus odoratissimus*, *Nikaua micrantha*.

On the soil surface, some pinkish grits of weathered andesite.

**A₁ - 0 - 7 cm:** Wet; weak red; 2.5 YR 4/2; with non-visible organic matter; sandy loam; many little grits of weathered andesite; moderate fine subangular blocky structure; great macroporosity; non-porous aggregates; non-plastic; non-sticky; numerous fine roots; clear smooth boundary.

**A₂ - 7 - 20 cm:** Wet; weak red; 10 R 5/3; clay loam; weak medium to fine blocky structure; great macroporosity; slightly plastic; non-sticky; numerous fine roots some medium; clear waxy boundary.

**C₁ - 20 - 120 cm:** Moist; weak red; 10 R 5/3; some fine distinct green gray and white mottles; silt loam; rock preserved structure; friable; porous, with tubular pores; no roots; gradual irregular boundary.

**C₂ - 120 and more:** Hard rock sometimes little weathered with onion skin weathering features.

**Chromic Luvisols LL 5**

**Location:** Lakeba, Nukunu valley behind Waibau; elevation 20 m.

**Climate:** Oceanic tropical with a marked dry season; precipitation: 2000 mm/year.

**Position:** linear valley bottom.

**Parent material:** colluvio-alluvial formation derived from andesite.

**Vegetation:** Herbaceous vegetation, tall forb community (talasiga); herbaceous strata: *Dicanthera linnispila*, *Nephrolepis sp.*, ligneous strata: *Dodonaea viscosa*, *Nikaua costata*, *Houttuynia cordata*, *Dodonaea viscosa*, *Grevillea winteriana*, *Heliamphora denticulata*, *Nikaua micrantha*.

**A₁ - 0 - 12 cm:** Moist; dark reddish brown; 5 YR 4/2; with non-visible organic matter; loam; strong fine blocky structure; some fine weathered grits; great macroporosity; slightly porous aggregates; abundant fine to medium roots; clear smooth boundary.

**A₂ - 12 - 30 cm:** Moist; reddish brown; 5 YR 5/3; loam; abundant rounded weathered rock gravel; moderate medium blocky structure; great macroporosity; porous aggregates; friable; some fine to medium roots; gradual smooth boundary.

**B₁ - 30 - 50 cm:** Moist; reddish brown; 5 YR 5/3; clay loam; abundant small rounded weathered rock gravel; weak medium blocky structure; great macroporosity; friable; some fine roots; clear smooth boundary.

**B₂ - 50 - 160 cm:** Moist; reddish brown; 5 YR 5/3; clay loam; abundant rounded weathered rock gravel; weak medium subangular blocky structure; great macroporosity; clay skin on pores; friable; some medium to fine roots; gradual smooth boundary.

**B₃c - 160 - 230 cm:** Moist; light reddish brown; 5 YR 6/3; some gray and green faint mottles; loam; single grain structure; very porous; friable; no roots.

**Eutric Cambisols LC 9**

**Location:** Upper Tubu valley; elevation 30 m.

**Climate:** Oceanic tropical with a marked dry season; precipitation: 2000 mm/year.

**Position:** Lower part of a steep slope; 30 per cent slope.

**Vegetation:** Evergreen shrub (reeds); herbaceous strata: *Mimosa pudica*, *Nephelepis sp.*, *Eugenia ptiliflora*, *Nikaua micrantha*.

**A₁ - 0 - 12 cm:** Wet; dark brown; 7.5 YR 4/2; with non-visible organic matter; clay; compound very fine granular and fine blocky structure; great macroporosity; friable plastic; slightly sticky; very abundant medium to fine
roots; clear smooth boundary.

A₃ - 12 - 25 cm: Wet; brown; 7.5 YR 5/2; clay some slightly weathered andesitic stones; strong medium to fine blocky structure; great macroporosity; plastic; sticky; abundant medium to fine roots; clear smooth boundary.

(B) C 25 - 25 cm: Wet; light brown to pinkish brown; clay; many slightly weathered andesitic stones; very strong medium blocky structure; great macroporosity; plastic; sticky; clear smooth boundary.

C - 45 - 60 cm: Wet; pinkish gray; 7.5 YR 6/3; clay; abundant slightly weathered andesitic stones and blocks; strong medium blocky structure; plastic; sticky; some fine roots.

Eutric fluvisols LL 1

Location: Lakeba; coastal plain; south of Nukunuku; 150 m from the mangrove.

Climate: oceanic tropical; precipitation: 2000 mm/year.

Position: coastal plain; flat.

Vegetation: coconut plantation, Cocos nucifera, Inoa arum fugu ferve, Heliconia roxburha, Pandanus gracilis, Ratanu grueltelium, Spondias maeseta, articioida.

A₁ - 0 - 15 cm: Moist; reddish brown; 5 YR 4/3; with non-visible organic matter; clay; strong fine blocky structure; great macroporosity; some pores in the aggregates; friable; very abundant medium to fine roots; clear smooth boundary.

A₂ - 15 - 55 cm: Moist; reddish brown; 5 YR 4/3; clay; strong medium to coarse blocky structure; slight macroporosity; some pores in the aggregates; firm; abundant medium to fine roots; gradual smooth boundary.

C - 55 - 155 cm: Moist; reddish brown; 5 YR 5/3; clay; some sandy pockets; moderate fine blocky structure; slight macroporosity; some tubular pores; firm; some fine roots; clear smooth boundary.

C₉ - 155 - 175 cm: Wet; red; 5 YR 4/4; many yellow and black distinct fine mottles; sandy clay; single grain structure; many small weathered andesitic gravels.

Humic gleysols LAK 2

Location: Lakeba, upper Tubou valley swamp.

Climate: oceanic tropical; precipitation: 200 mm/year.

Position: swamp.

Parent Material: recent mineral sediments.

Vegetation: Hydromorphic fresh water vegetation; Nephrolepis sp., Selaria polycarpa, Mikania micrantha, Ludisia discolor, Nolina caudata, Nolina gracilis, Nolina longifolia, Nymphoides peltata.

A₁ - 0 - 10 cm: Wet; very dark gray; with visible organic matter; clay; moderate medium granular structure; great macroporosity; plastic; slightly sticky; very abundant medium and fine roots; clear and smooth boundary.
### GENUS, SPECIES

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<th>FAMILY</th>
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**Notes used in this Table correspond to:**
- * Species present
- ** Species abundant
- *** Species dominant
- N Native species
- I Introduced species
- C Cultivated species

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### APPENDIX III: LIST OF PLANTS IDENTIFIED AND LOCATION IN THE DIFFERENT VEGETATION UNITS (CONTINUED)

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<td><em>Elaeocarpus</em> verticillatus, A.C. Smith</td>
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### APPENDIX III: LIST OF PLANTS IDENTIFIED AND LOCATION IN THE DIFFERENT VEGETATION UNITS (CONTINUED)

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### UNESCO/UNFPA FIJI ISLAND REPORTS No. 5 (Canberra, ANU for UNESCO), 1979

#### 5.3 THE COAST OF LAKEBA:
A GEOMORPHOLOGICAL RECONNAISSANCE

Roger McLean
(University of Auckland)

#### REFERENCES

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I - INTRODUCTION

In contrast to the simple and uniform coastal structure and deposits of Kabara (Bedford, McLean and Macpherson, 1978), Lakeba's coast is much more complex and variable. This complexity and variability arise from the interplay of a number of factors associated with the terrestrial landmass itself (its lithology, topography, drainage) and the encircling reef-lagoon system; the first is discussed in detail by Latham (this volume) the second by Salvat et al. (this volume). Other factors influencing the nature and development of Lakeba's coastal environment include biological factors (particularly vegetation succession), meteorological events (e.g. hurricanes, storms) and oceanographic conditions (e.g. wave action, sea level change). Man too has modified the coast, most directly by the recent construction of seawalls and jetties at Tubou-Levuka and removal of sand and gravel for roadbuilding and building purposes elsewhere. More pervasive and indirect changes may have resulted from the island's three thousand years of human occupation, notably through the impact on vegetation, slope denudation and stream sediment yields.

Socio-economically the coastal periphery is of great importance. Because much of the island is rough and hilly, the coastal lowlands comprise the bulk of its easy country. Copra production is concentrated there. The island's eight villages are located on the coast and the circum-insular road which links these villages runs along the coast for much of its length. Lakeba's coastal zone can be regarded first and foremost as a land resource whose location provided optimum access to the whole range of terrestrial and marine environments and resources: hillslopes, valleys, forest and gardens; reef, lagoon, mangroves and inshore waters. However, this resource is geologically much the youngest of Lakeba's landforms. The present nature and configuration of the coast has developed only during the last millennia. It is not surprising then that the coast is still subject to considerable modification as a result of both natural and man-induced processes, some of which operate gradually, others almost instantaneously. In view of its importance as a resource it is somewhat paradoxical that the coastal lowlands are most vulnerable to the impact of catastrophic events, particularly hurricane waves and surges, and stream floods.

For these reasons a geomorphic reconnaissance of Lakeba's coastal zone was carried out during the Fiji project. Nineteen transects were surveyed at approximately one km intervals around the island from the beach-line to some 200-250 m inland. Shallow pits were dug into the coastal deposits in a number of places in order to obtain stratigraphic information and samples for analysis. Particular attention was paid to delimiting the extent of marine deposition in the past and storm wave inundation at present.

II - COASTAL ENVIRONMENTS

The salient features of Lakeba's coast and its major subdivisions (eastern mangrove, northern barrier, southern and western limestone, and southern barrier coasts) are shown on Fig. 3.1. Figure 3.2 depicts the generalized transect morphology and crude stratigraphy as envisaged for each coastal type. Both diagrams are schematic representations of what is in reality a rather more complex picture. The nature and development of the four main coastal subdivisions is outlined below.
to the east of the island. Only during severe storms and surges do waves penetrate through the mangrove baffle and reach the coast.

The landward edge of the mangrove belt is generally clear cut and is commonly marked by a low scarp, up to 50 cm high, cut into the seaward edge of the coastal plain (Fig. 3.2A). Contemporary landward erosion and extension of mangroves is suggested. Pits dug through the inner mangrove margin show a thin layer of mud and fibrous peat directly over fossil reefal materials, either coral sand and gravel or hard reef flat. At Waitabe (Fig. 3.2B) a loose coral sample from 25 cm beneath the surface was radiometrically dated at 4400 B.P. (G 4657). A similar though thicker sequence of 60 cm of dark brown clay above 20 cm of fibrous peat overlying coral fragments was noted beneath the Rapa Parepere forest, coconuts and mangroves at a roadside site 1.5 km north-east of Waitabe village. It appears that much of the present mangrove forest and mud only thinly veneers older reefal materials; these latter represent a stage when the east coast was more open and exposed. Extension of mangroves then took place and is clearly continuing at the present time. It is probable that the present pattern of mangrove cover has developed only during the last three to four thousand years.

Between the landward edge of the mangrove belt and the island's volcanic hillslopes and spurs is a narrow (300 m wide) discontinuous coastal plain whose elevation varies from 0.5 to 3.0 m above high water spring tide levels (HSL). In places steep volcanic rock meets the mangrove swamp directly with an abrupt change of slope at the boundary. This occurs at the village of Nukunuku and at promontories to the north-west and south-east of Yadrana.

In such places the coastal plain is absent and the circum-Insular road has to pass over the spurs or around the hillslope/mangrove boundary, where it is subject to periodic inundation. Elsewhere the coastal plain broadens to form a seaward dipping flat away from the backing hillslopes (Fig. 3.2A) or forms the outer portion of the series of stream valleys which drain the eastern half of Lakeba (Fig. 3.2B). In the first case the extent of the coastal plain is clear, while in the swampy valleys which in places reach right to the coast, it is rather obscure. There is some evidence to suggest that at least part of the coastal plain, as mapped in Fig. 3.1, is composed of old marine (mangrove) muds covered to a variable extent by recent alluvium and colluvium; as a result the former extent of marine deposition is unclear. Both surface micromorphology and tidal stream sections suggest that the flat on which Yadrana stands is 'raised' coastal mud; while toward the mouth of the large valley swamp south of Nukunuku, grey 'marine' muds with inclusions of drift pumice occur to the east of the road some 200 m inland from the mangrove edge. An auger hole immediately to the west of the road showed a quite different stratigraphy with non-marine deposition to a depth of at least 1.5 m. In this area it appears that the road marks the boundary between marine and terrestrial deposition. Shallow holes dug in the lower end of the Waitabe valley penetrated only alluvium and colluvium (unweathered volcanic pebbles). No obviously marine deposits were encountered though 20 m away at the inner margin of the mangrove swamp coral clasts were reached 25 cm beneath the surface (see above).

It is clear then that the coastal plain as mapped is a complex feature consisting of alluvium, colluvium and marine (mangrove) material. At least parts of the coastal plain and much of the mangrove swamp appear to overlie older reefal materials. It is suggested that the coastal plain and mangrove swamp essentially accumulated and developed during the last four thousand years.
(based on the single radiocarbon date). If this is sure, rapid changes in local environments and very high rates of terrigenous and marine deposition have occurred quite recently along the eastern coast.

NORTHERN BARRIER COAST

The northern coast from east of Vakanö to west of Nasaqalau (Fig. 3.1) is quite different from the mangrove coast. Four shore-parallel zones are present. In sequence from the reef edge landwards they are the reef flat, sand barrier, swamp and piedmont (Fig. 3.2C). West of Nasaqalau the intervening swamp is absent and the boundary between sand barrier and piedmont is poorly defined though usually marked by a shallow swale (Fig. 3.2D). The inner edge of the coastal zone is clearly marked by a series of truncated volcanic spurs plastered with Pliocene limestone. The straight-faceted outer edge of these spurs is indicative of a period of coastal erosion -- some four to five thousand years ago (see below) -- when waves lapped against the hills and presumably penetrated some way up the intervening valleys. The piedmont, swamp and sand barrier post-date this period of erosion and overlie reefal materials developed when the backing spurs were actively being trimmed.

Reefal flat

The reef flat along the northern coast is some 300-700 m wide and is completely exposed at low water. Its hard flat platform is veneered in places with fine sandy sediment either loose and free-moving or stabilized by algae and sea grasses. The sands are skeletal carbonates composed predominantly of foraminifera, calcareous algae and mollusc fragments. They are reef -- not island -- derived though small quantities of terrigenous muds are present. Close to the shore discontinuous clumps of mangrove occur; the presence of young mangroves and comparison of distributions on the 1972 air photographs with field observations in 1976 suggests active contemporary expansion of mangroves in this area.

Living corals occur only on the outer reef edge and slope and not on the reef flat. Two features are of specific interest. First, fields of dead coral micro-stalls in growth position cover the inner half of the reef flat patchily and in a couple of places pass beneath the present beach line. These well preserved colonies are clearly fossil and clearly emergent with respect to present coral growth levels (Fig. 3.2C, 3.2D). They occur on the Vakanö and Nasaqalau traveses though the largest and best preserved field occurs toward the limestone coast in the west (see below). Second, gravel pits excavated on the inner reef flat near the beach-line at Vakanö and west of Nasaqalau expose good sections to a depth of 0.5 to 1.0 m. These comprise accumulations of storm deposited rubble rather than reef framework and indicate that the build-up of the reef flat to its present level results not only from coral growth but also from storm transported materials.

Sand barrier

The inner edge of the present reef flat terminates at a sandy beach which marks the seaward face of a sand barrier covered with coconut palms. The sand barrier, 50-150 m wide, has a distinct convex ridge form which falls landward east of Nasaqalau into a swamp, and west of Nasaqalau abuts the piedmont (Fig. 3.2C, 3.2D). The width and height of the barrier increases from east to west. East of Vakanö the ridge is only a few centimeters above HWS; between Vakanö and Nasaqalau it reaches 1 to 2 m, and to the west of Nasaqalau is 3 to 4 m above HWS. It is not clear whether this variation is a
function of lateral differences in age, exposure, sediment supply or storm wave activity. Most probably it results from a combination of all four.

The sediment comprising the sand barrier is dominantly skeletal carbonate detritus with occasional larger coral fragments. These materials are similar to those on the adjacent reef and have accumulated under normal and storm wave action. Locally at Nasaqalau and Yakano the barrier sands are less pure and contain terrigenous clays and muds brought to the shore by fluvial processes. Much of the barrier sand is weathered to a light brown tan colour which contrasts with the creamy white colour of fresh sand. The barrier sand heterogeneity is relatively homogeneous across the barrier from inner edge to present beach. This, together with the fact that the beach is currently undergoing erosion, suggests that the sand barrier is in essence a 'fossil' feature. Progradation has ceased though vertical growth through beach-face erosion and sediment washover under storm conditions is continuing.

Coastal swamps

Behind the sand barrier is a series of coastal swamps which have developed synchronously with the growth of the barrier. Except for the larger streams at Nasaqalau and Yakano which reach the coast, other streams drain into the swamp, the presence of the barrier serving to impede direct through drainage or to direct it laterally east and west. Thus the swamp acts as a sink for land derived sediments. Three types of swamp exist:

- tidal mangrove in the east and west;
- L. lutheriana - epiphytes; and
- cultivated swamp taro.

It is believed that these represent both a vertical sedimentation sequence and salt- to fresh-water sequence. Boreholes in the freshwater swamp at sites LP4 and LP5 show lenses of coral gravels, sands and shells in reddish brown (mangrove?) muds at depths from 2-3 m beneath the surface; this suggests an essentially marine environment. Above this level reef-derived materials are rare though occasional fragments of coral and thin lenses of calcareous sand do occur up to 1 m beneath the surface; their presence presumably results from erosion and washover of barrier deposits into the swamps during storm events. Otherwise the bulk of the swamp material above 2 m depth consists of organic matter and stream-derived terrigenous muds. Though boreholes did not penetrate below 3 m the increase in reef-derived sediments with depth suggests that beneath this level reef flat sediments and corals would be encountered. No organic or carbonate samples have been dated from the boreholes; extrapolation of evidence from elsewhere in Lakeba however suggests an average coastal swamp sedimentation ratio in the order of 1m/1000 years from the last three to four thousand years, the rate not certainly not being constant through time. Sedimentation in the northern swamps and conversion of tidal mangrove to impeded freshwater swamps is continuing.

Piedmont

Landward of the swamps to the east of Nasaqalau, and of the sand barrier to the west, is the piedmont. Averaging 100-150 m in width, its surface slopes up to the backing marine faceted hillspurs; the break of slope at the junction reaches 4 m above HWS in places. The piedmont consists of alluvial and colluvial cones of island-derived volcanic clays and gravels which have incrementally built upwards and outwards away from the island's former shore. The ancient cliffline has become stranded and the former inner edge of the reef flat inundated with terrigenous sediments. These developments probably post-date the time when sea level first reached its present position in the Holocene or when it was marginally higher, that is, they post-date 4500 years B.P., and suggest that the last few millennia have been characterized by high stream sediment yields and very active mass-movement on slopes. The presence of the sand barrier and/or coastal swamps along the shore precluded the removal of piedmont sedimentary deposits by wave action. As the piedmont developed, its lower edge was transgressed in a seaward direction thus covering the inner edge of the swamps and/or sand barrier. Towards the Nasaqalau-Airport road the sand barrier, which here has the form of a series of subdued beach ridges and swales rather than a single ridge, is covered over its inner one-third by a landward thickening wedge of red brown volcanic clay and gravel (alluvium-colloval) overlying reef-derived calcareous sands. In this area the depth of weathering of the sands and degree of soil development decrease with distance away from the piedmont suggesting a seaward decrease in age of sediments.

Limestone Coasts

Limestone coasts occur in two separate areas on Lakeba (Fig. 3.1); one along the western side of the island, the other around the island's distinctive southern salient. The suite of coastal features associated with these two areas, where limestone rather than volcanic rocks form the immediate hinterland, is distinguished from the remainder of the coast on a number of counts. Mangroves and swamps are absent and surface streams and alluvial valleys are restricted to those gaps between limestone outcrops where the volcanic base- ment is exposed.

In gross terms the limestone coasts are characterized by a series of bold rocky promontories separated by low sand-filled 'embayments'. The promontories are steeply cliffed or scarped with an abrupt change of slope from vertical to horizontal where they meet the inner edge of the fringing reef flat (Fig. 3.2E). At high water waves lap against the cliff base making it impossible to walk along the coast at this stage of the tide. Frequently the cliff base is deeply notched; in places the notch is surmounted by an overhanging visor. These notches, which cut back 2-2.5 m and are still actively eroding, indicate the amount of limestone shore erosion in late Holocene times. Fossil notches, above the reach of present water levels, are found in a number of places; they indicate a sea level relatively higher than present.

In the 'embayments' in the limestone and between promontories sands have accumulated. The sandy flats are of variable width; they range from narrow bars only a few metres across to broader plains up to 300 m wide. Surface levels though commonly around 1-2 m above high water spring tide do reach up to 4 m in places. Irrespective of their width and height most of the sand flats are:

- backed by steep limestone cliffs;
- fringed by white sandy beaches with exposures of beachrock; and,
- covered with coconuts and a littoral fringe of creepers, grasses or shrubs.
The sands are also uniform being comprised almost entirely of small skeletal carbonate fragments derived from the adjacent reef and moved to their sites of deposition by wave action. Larger reefal materials, including coral fragments, are dispersed through the sand, sometimes in large numbers with drift pumice. These indicate that both normal and storm waves have played a role in the formation of the sandy flats. Generally, the soils thicken and darken with distance back from the shoreline, this being a function of the age of the deposits and length of occupation and cut-off time. Thus, presence of buried soils as well as coral gravel and drift pumice, all within 1 m depth of the surface near the inner edge of the sand deposit indicate episodic storms and storm-wave inundation.

On the western limestone sector (Fig. 3.1) a bulk sample of weathered calcareous sand from 50 cm beneath the surface, taken from a site roughly midway between the fossil cliffline and present beach (Fig. 3.2), was radiometrically dated at 20606 ± 150 years BP (26-4476).

This age, which dates the time when the organisms were living on the reef, is a maximum age for this level in the deposit. Thus in the last two thousand years 50 cm of sand has accumulated here; the presence of drift pumice and large shell fragments in the sand together with its height above present water level (at least 2-3 m above NAD) and distance in from the beachline (approximately 100 m) suggests a storm wave origin for the material.

Two features of the reef flat along Lakeba's western coast are of particular interest. The first is the occurrence of groups of low-standing reef blocks near the reef's outer edge. In the extreme north-west of the island, the large reef block stands 4-5 m high and is 3.5 m in diameter and 8 m off reef (Fig. 5.2). These massive reef blocks, torn from the reef edge and deposited during tropical hurricanes, are obvious reminders of the fact that the development of Lakeba's reef and coast is episodically punctuated by short-lived storm events of great magnitude. Second, in the same area but on the inner edge of the reef near the beachline is the largest and best preserved field of fossil, *On Actea*, emergent micro-atolls found on Lakeba. A sample from one large micro-stone (2 m diameter) from this site was radiometrically dated at 4560 ± 170 years BP (26-447). This is an important sample and date because it indicates that sea level was at or slightly above its present position at that time and that the coastal environment then was rather different from now. It is believed that most of Lakeba's coastal lowlands and swamps post-date this period.

The origin and development of the sandy lowlands along Lakeba's limestone coast is intimately connected with the adjacent reef and the recent history of sea level. Prior to the formation of the sand flats but immediately after the time when sea level first reached around its present position in the Holocene, the sea would have reached the foot of the seaward facing limestone bluffs (in much the same way as it does on the promontories today). With continued reef growth and productivity there was a ready supply of skeletal materials available for transport by wave action into the more sheltered embayments. Initially narrow beaches would form at the cliff bases. With a steady supply of reef detritus beaches became broader and the older surfaces became stabilized by vegetation. Seaward progradation of the beachface out over the reef flat could continue as long as reef productivity remained high. This way the embayments were filled with sand and the shoreline straightened. These events have taken place only within the last few thousand years. There is evidence to suggest that the main phase of progradation took place some two to four thousand years ago and that since then there has been a gradual diminution in reef sediment supply and beach deposition, such that at present the formerly prograding shorelines are now either relatively stable or have entered a phase of erosion. It is clear that at present the fringing reefs facing the limestone coast are far less productive than they were at or immediately prior to that time. Then the reef plates and fringing reefs in living coral and associated biota; the living coral is virtually absent on them. One possible reason for this change is likely to be a fall from a sea level slightly higher than that of today to its present level.

(Editorial footnote). Elsewhere in his reporting for this project, McLean (1979b) argues that the Lakeba evidence indicates attainment of a 'near stationary' sea level about 4000 years ago. Also (1979a) he admits the possibility of variation within a range of plus-minus two metres in the region as a whole. In a recent examination of the Australian evidence for Holocene sea levels higher than the present, C. Kidson (pers. comm.) finds ground to reject all such evidence, and moreover concludes that in Australia present sea level was reached about 6000 years ago. He points both to the last existing major storms in depositing material at higher levels, and to the possibility of tectonic movement, as capable of explaining all the evidence examined by him. Moreover, he also observes that only in *Actea* bio-genetic evidence can be accepted; it would seem from the above that we have such in *Actea* bio-genetic evidence of a slight fall in sea level here. However, the possibility of tectonic movement is not discarded and it should be remarked that the Lauan chain both lies close to a plate boundary, and also overlies a zone along which a great frequency of extremely deep earthquakes is being recorded (R. Rideout, pers. comm.). Within these earthquakes are of such depth that they are rarely felt at the surface, there are few if any areas in the Pacific which show comparable evidence of movement at great depth.

Elsewhere in Lau there is perhaps stronger evidence of change in relative levels of land and sea than at Lakeba. In their preliminary report for the project, Salvat and his colleagues argue for a recent small uplift of the island of Kaba as the cause of widespread death of coral on the reef flat of this island, though this could not also explain the poverty in living coral of large sections of the outer reef slope. It is unfortunate that the project was not able to work on other islands in the area, since the inner lagoons of Fulaga and Oqea, for example, mushroom limestone islets are thought to be levels unlikely to be reached by waves except in major storms. At One-i-Leu substantial uneroded portions of a former reef flat a metre or more in thickness remain in situ around the lagoon. The uneroded parts contain large shallow areas, many of them sanded and without living coral.

The purpose of this footnote is to underline the fact that McLean's study reported here is only of a reconnaissance nature. None the less, the human significance of land very close to NAD in these islands suggests that a deeper understanding of contemporary dynamics of the land-sea interface, which requires a knowledge also of the past, is of major practical as well as academic importance. A research area is outlined and important questions are indicated; they should be followed up by research more specific then could be accomplished within a multi-purpose, multi-disciplinary project such as ours.
In the gaps between limestone outcrops and at the lateral margins of the two main limestone belts volcanic rocks are exposed. Stream valleys cut into the more easily eroded rocks serve as conduits which direct island-derived sediments (clay and weathered pebbles) towards the coast. At the same time reef-derived sands have been directed landwards into the valley mouths so that many of the features of the immediate littoral area are similar to the rest of the limestone coast; they comprise white sandy beaches with beachrock backed by calcareous sandy flats and pregraded beaches. At the meeting between island-derived sediments and marine sediments, the two contrasting types of deposits interdigitate, giving a complex layered sequence of marine sands, alluvium and colluvium. Clearly the boundary between marine and island sediments has been a mobile one and has migrated throughout the development of the lowlands. In recent times the inner margin of marine deposition has become obscured by a seaward-thinning wedge of terrigenous alluvial clays, sands and pebbles which overtop the marine sands. Thus surface deposits of sand rarely indicate the true inland limit of Holocene marine deposition. At Nāmaka (Transsect XVII) the change from sand to brown clay on the surface takes place 130 m landward of the present shoreline. In the Taraku valley (Transsect II) it occurs at 140 m. In both places pits dug through the brown clay and soil showed weathered red clean marine sands at depths from 20-60 cm beneath the surface, the depth to the break increasing with distance away from the shoreline. At Taraku the landward limit of subsurface sand was reached some 230 m away from the shore though it may have been found still further inland if deeper pits had been dug. These data show that:

- the landward extent of marine deposition (and hence amount of Holocene prodgradation) occurs much further inland than the surface deposits indicate;
- large influxes of land derived stream transported sediment have occurred since the beach deposits accumulated;
- alluvial valleys have in recent times built up their floors and extended in a seaward direction.

These processes are continuing during episodic flood flows, and, in doing so, incrementally obscure the surface manifestations of marine deposition. In some places within the area mapped as limestone coasts alluvial deposits reach the shoreline, notably at Waiolii where the western side of the region abuts the mangrove coast. Here sandy marine deposits are both thin and terrigenous sedimentation has been the dominant process throughout the building of the low flats on which the village stands.

SOUTH-WESTERN COAST

The fourth coastal division of Lakeba is located on the south-western coast between the western and southern limestone belts. Its northern and southern boundaries merge with those of the limestone coasts and are not cut in. In these areas the sandy lowlands are broadest but they narrow towards the centre of the region where steep cliffs rise within 20 m of the shore. The south-western coasts are backed by volcanic hillslopes and alluvial valleys. However much of the present shore consists of a narrow sandy belt. The description of the island at this point shows that the thick stack of calcareous rock in the calcarcous matrix. There is evidence to suggest that the south-western coast is similar in character to the northern coast in that there is a narrow sand barrier immediately behind the beach. Where the sand barrier is not up against the adjacent hilltops it is backed by alluvial and colluvial deposits and locally, in the Levuka area, by a swamp (Fig. 3.2).

Much of the present shoreline is undergoing erosion and this erosional trend is not only a recent phenomenon associated with storms. That the barrier is moving more rapidly than was earlier indicated in the past is indicated by the old eroded beachrock outcrops on the reef flanks. Landward retreat of the barrier over the top of former back-barrier deposits is also evident in beach and creek sections in the central area. Here (Fig. 3.2c) show a complex stratigraphy with a basal layer of mangrove mud and stumps overlain by cemented calcareous sand topped by loose sandy washover deposits. Behind this is a thick unit of brown clay alluvium. Clearly the former mangrove swamp has now been washed both from the seaward side by the landward migration of the barrier and from the land by alluvial deposits. These data indicate great environmental changes at this site and suggest that the earlier beach progradational phase has now terminated.

Great changes in the nature of coastal environments are also evident in the Tubou-Levuka area. Within the large Tubou-Levuka embayment between the shoreline and inland perimeter marked by steep hilltops is the broad alluvial Tubou valley in the north and a sand barrier to mangrove swamp to Ladriga/Tapperwwwa swing sequence moving away from the shore in the south. Pits dug in the Tapperwwwa swamp some 500 m landward of the present shore passed through clays and peat before reaching a basal layer of calcareous sand, molluscs and a few coral cements two m beneath the surface (Fig. 3.2a). A sample of a large Forhead coral from one site was radiometrically dated at 3152 ± 140 years B.P. (GX-4674). It is envisaged that at that time much of the present Tubou-Levuka area was occupied by reef flat and that the beachline skirted the foot of the hills. Sea level at the time was similar to its present level or marginally higher. Subsequently a sand barrier of reef derived sediments developed across the mouth of the embayment partially sealing off the former reef flat from the sea. In the shelter of the barrier a large swamp developed and deposition of land derived alluvial sediments proceeded, particularly at the mouth of the Tubou valley. These processes of embayment infilling are continuing. In addition to the large influx of terrigenous material in the last thousand years reefal sediments have also accumulated at the shore and the sand barrier has prograded some 600-200 m in the south. Here a bulk sample of calcareous sand from 1 m beneath the surface and over a 1 m beneath the present shoreline was radiometrically dated at 1675 ± 125 years (GX-4477). Clearly substantial accumulation of the sand barrier continued after this date, the process an active one with the pumice layer one m beneath the surface indicates that storm waves have played a role in this development. The major phase of accumulation is now past as indicated by the fact that much of the shore is in an erosional condition. What is suggested is that the supply of reefal detritus has now ceased.

2 At Tubou there has been significant erosion in this century. In the early 1900s a European trade store is reported (Kycopedia Co. of Fiji, 1907) standing seaward of Naita's grave, and residents report that there was a tree-covered area on this island and other land that now forms part of the beach and lagoon. A portion of the road along this section of shoreline was washed away in 1971 due to heavy rain (1975). In 1976, during the El Niño event high tides (but calm weather), and again during stormy weather, seas surged right over the beach into the coconut trees east of Tubou, and at times right over the road in front of the Post Office, in spite of the remains of the old seawall (M. Brookfield, pers. observation).
sediments is now less than in the recent past and that terrigenous sedimentation is relatively more important than marine sedimentation in this coastal area.

III - COASTAL VARIETY AND CHANGE IN PERSPECTIVE

Synopsis

Apart from a few limestone bluffs and fewer volcanic spurs which form the actual shoreline, we have seen that Lakeba's coast is essentially a low depositional one built of materials originating either from the reef (carbonate sands and gravels) or from the island (volcanic muds and pebbles) or from in situ vegetal accumulation (organic muds and peat). Along the northern and south-western barrier coasts components of all three have been important in developing the coastal scenery though their relative significance varies across the shore giving a zonal pattern of sand barrier to swamp to plemont. Along the eastern coast, island-supplied alluvium dominates the subaerial coastal plain and mangrove deposits. Here the role of the very extensive reef-lagoon system to the east has been a passive one; reduced wave attack at the shore has permitted the accumulation of fines and colonization of the mangroves whose extension reinforced the subdued wave conditions. By contrast, the reef's role has been active along the limestone coast. Coraline sands and gravels originating from this source have been transported landward by wave action to build up the high cliff-front sandy benches. Here terrigenous sediments are unimportant, though they are found locally where the limestones are breached and volcanic rocks exposed. Lakeba's coastal scenery thus can be seen either as the landward extension of the peripheral reef ecosystem or as the seaward extension of the insular terrestrial ecosystem or a combination of both.

It is equally clear from our earlier discussion that the present coastal scenery has developed only in quite recent times. Large scale changes have taken place in the last few millennia since sea level first reached around its present position in the Holocene. Very substantial changes in the nature and distribution of coastal environments have occurred during the three thousand years that Lakeba has been inhabited. The net result of these changes was the creation of many hectares of new subaerial coastal land of quite diverse character. Men may well have had a role in this by inducing slope denudation and erosion (through changing the island's natural vegetation) thus increasing sediment input to the coast. The large contribution of reefal materials would however have occurred exclusive of men.

Coastal erosion

There is abundant evidence to suggest that the major phase of coastal land building around Lakeba is now over. There are few living corals on the reef flat at present and the associated rich biota, whose skeletons provided the bulk of sand sized material for shore accretion in the past, is now quite impoverished. Two reasons can be forwarded for this state of affairs. First, a slight fall in sea level relative to that at the time corals and micro-atolls grew on the reef flat has resulted in emergence of a hard cores in exposed portions with little detritus. Second, the fact that is reeval and land-derived sediment accumulated over the inner part of the reef the area for reef sediment production was incrementally reduced. This occurred in the north, west and south of the island while in the east the extension of mangroves produced a similar result.

Along the sandy shores a phase of sediment reworking and redistribution rather than recruitment of virgin sediment is currently under way. This is manifested in the extent of coastal erosion which is particularly acute along the narrow northern and south-western barrier coasts (Fig. 3.1). In these areas much of the erosion caused by recent storms -- including Hurricane Val (1975) -- has not healed naturally because the shore zone is in a long term undernourished condition. It is most likely that the sea front of the village of Liboe, Naka, Naka-levu and Naka-Vatokoro and Vaitupu are under threat from sea erosion. In the future Naka-levu and Vakano may become less vulnerable if the extension of mangroves along these shores continues apace. Such long-term natural protection is however unlikely at Tubou-Levuka and Macwaci.

Sediment eroded from both barrier coasts passes downwind towards the western and southern limestone coasts whose beaches are, as a result, in a much healthier state. At the time of the writer's survey (March 1976) most beaches in these areas were recovering from the effects of recent storms which had denuded foreshores and cut a vertical scarp back into the sand plains causing coconuts and shrubs to topple across the beach. There was also evidence that some eroded sediment was blown inland on to the vegetated surface depositing a landward-thinning veneer of fresh sand and rubble.

Post-storm recovery was indicated by a new bench of clean sand built against the hurricane scarp. Similar episodes of shore-face erosion and washover deposition during storms have occurred throughout the history of sand plain building, though the quantity of sediment available for the post-storm build-up is less now. The beaches along the limestone coast can be regarded as the most 'stable' on Lakeba though locally the presence of beachrock sediments on the beachfront suggests a longer term recessional trend.

Coastal inundation

During our coastal reconnaissance lines of levels were surveyed through each village in order to determine their potential vulnerability to storm wave, surge and stream flood inundation. Table 3.1 gives the results of this summary together with data on village sites and a comment on inundation potentials.

It is clear from this summary that apart from Nukunuku and to a lesser extent Watiwu, Lakeba's villages have very little 'free-board'. Because they are low standing and at the mouths of stream valleys most are vulnerable to a combination of see level rise and/or stream flooding not only during severe hurricanes but also in lesser storms. Some implication of this situation were outlined by Muriel Brookfield (1977) with particular reference to the ecological effects of Hurricane 'Val' and measures that were subsequently taken to 'repair' them. In the present context her comments and recommendations are particularly apposite.

Coastal resources

Coastal erosion and the inundation of coastal lands can be viewed as 'negative' coastal resources; they are problems that Lakeba has recognized in the recent past and doubtless will continue to face in the future. Outstanding these problems, Lakeba's coastal endowment is rich compared with most other islands in Lau. This arises not just from the island's size, but more particularly from the diversity of its coastal environments. Four
<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>SITE TYPE</th>
<th>HEIGHT ABOVE MSL LEVEL</th>
<th>INUNDATION POTENTIAL</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubou-Levuve</td>
<td>Alluvial muds and marine sands; flat</td>
<td>0.4 to 1.0 m above MSL; top Police HQ foundations 0.2 m; church foundations 0.6 m; MSL 180 m inland</td>
<td>Medium/High</td>
<td>Vulnerable to sea and stream flooding; beach erosion; sea wall ‘protection’</td>
</tr>
<tr>
<td>Government</td>
<td>Marine sand and alluvial mud; barrier ridge</td>
<td>0.4 to 1.0 m above MSL; base hospital generator 0.7 m; Post Office 0.9 m above MSL</td>
<td>High</td>
<td>Vulnerable to sea and stream flooding; in east sandbarrier only 100 m wide between sea wall and swamp; emergency services located here. Water level in ‘Val’ 1.0 m above MSL in Post Office.</td>
</tr>
<tr>
<td>Waichali</td>
<td>Marine sand and alluvial clay; flat</td>
<td>0 to 0.5 m above MSL</td>
<td>High</td>
<td>Vulnerable to sea and stream flooding; beach erosion. Water level in ‘Val’ reached 0.7 m above MSL 180 m inland.</td>
</tr>
<tr>
<td>Weitabu</td>
<td>Marine and alluvial mud, colluvium; slope rises landward</td>
<td>1.0 to 4.0 m above MSL between shore and road</td>
<td>Low</td>
<td>Main stream valley to south-west of village; coast protected by mangroves</td>
</tr>
<tr>
<td>Nukumuku</td>
<td>Colluvium and weathered bedrock; hillslope</td>
<td>14 buildings between 0.5 to 2.0 m; most village above 5.0 m</td>
<td>Low</td>
<td>Least vulnerable village; hillside site; absence of streams; coast protected by mangroves.</td>
</tr>
<tr>
<td>Yadraha</td>
<td>Marine and alluvial mud; flat</td>
<td>Average 1 m above MSL; rises to 2.7 m at road</td>
<td>High</td>
<td>Especially vulnerable to stream flooding; coast protected by mangroves; water level in ‘Val’ 2 m above MSL 260 m inland.</td>
</tr>
<tr>
<td>Yakano</td>
<td>Marine sands and alluvial mud; top</td>
<td>1.0 to 2.0 m above MSL; top of church steps 2.1 m above MSL</td>
<td>Medium</td>
<td>Susceptible to sea and land flooding in swale, beach erosion; main stream to east of village.</td>
</tr>
<tr>
<td>Nasaualeu</td>
<td>Marine sands and alluvial mud; low</td>
<td>0.5 to 1.0 m above MSL; lowest area inland</td>
<td>Medium/High</td>
<td>Vulnerable to stream flooding; beach erosion.</td>
</tr>
</tbody>
</table>
5.4 THE REEF-LAGOON COMPLEX: GEOMORPHOLOGY
BIOTIC ASSOCIATIONS AND SOCIO-ECOLOGY

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INTRODUCTION

There has not previously been any comprehensive geomorphological and ecological survey of the reef-lagoon system of Lakeba, or of any island in Lau. Such previous work as has been done in the area has been done by geologists (Sardiner, 1898; Agassiz, 1899; Andrews, 1916; Foye, 1917; Davis, 1928; Ladd and Hofmeister, 1945), by zoologists (Černohorsky, n.d.; Quelch, 1886; Fowler, 1959) or botanists (Chapman, 1971). During the past 20 years, however, there has been a major increase in research in French Polynesia, New Caledonia (Chavaler, 1973) and Micronesia (Ladd, 1973). Work of this nature in Fiji had become long overdue.

The approach taken in the survey reported here is distinctive in its attempt to combine three elements:

- the whole reef-lagoon system of the island was mapped and its differentiation examined from an environmental and evolutionary point of view;
- an attempt was made to analyze the incidence of the main biological groups (flora, corals, molluscs, echinoderms, fish and phytoplankton);
- there was an attempt to assess the socio-ecological aspects of marine resources - the use made of the productivity of the system by the islanders, and the importance of the marine system in their total ecosystem.

The island and its terrestrial resources are described elsewhere in this issue, and Latham and McLean discuss the geomorphology of Lakeba and its coasts in some detail. From our present point of view it is important to note the two basic geological elements - Miocene andesites and a partial overlay of Miocene limestone, and the complex geomorphological evolution of the island.

GEOMORPHOLOGY OF THE REEF-LAGOON SYSTEM

Research methods

We began with the study of available air photographs, supplemented by a low-altitude aerial reconnaissance made in May 1975. Ecological sub-systems identified by these means were then examined more closely by field mapping. For each sub-system, representative transects were then surveyed, running from the shore to the outer slope of the barrier reef. All members of the team participated in transect surveys, each paying principal attention to his own field of expertise: the substratum and topography; the qualitative and quantitative distribution of the different species of algae, corals, molluscs, echinoderms and fish. The hydrological conditions and primary productivity were also measured at stations both in the lagoon and the adjacent ocean.

Hydrology

Ocean waters enter the lagoons both through passes and across the barrier reef, and leave the lagoons in the same way. In addition to the oceanic influences, the lagoons also receive varying contributions of freshwater inflow carrying organic or mineral particles; these fertilizing influences are variable, being of principal importance in the rainy months of the year.
Sea surface temperature ranges between 27.9° and 29.3°; salinity ranges between 33° and 34°/oo. Oxygen concentrations below saturation at sunrise, but increase during the day especially at stations rich in living corals; nevertheless, the sink-holes and mangroves are characterized by persistently low levels of dissolved oxygen. In the mangroves, the level was only 73 per cent of saturation at 10 p.m. In these latter areas, salinity is lower than in the lagoon (30° to 33°/oo) and the range of surface temperature is higher (30° to 34°). Fresh water inflows and tides could partly explain the turbidity of the water at these sites, reaching levels of 370 to 520 mg/l of organic and mineral particles.

**Geomorphology, ecology and biology**

The north, south and west of the island is surrounded by a continuous reef barrier with only one large pass, demarcating a lagoon 500-700 m wide, generally less than three metres deep and bordered shoreward by a sandy beach (Fig. 4.1; see also McLean, this volume). The eastern shore is very different, largely fringed by mangroves, characterized by two sink-holes, and opening into the 'great lagoon'. The 55 km² island is surrounded by 82 km of reef and lagoon, including 5 km of mangrove, 36 km of reef and lagoon 0-10 m deep, and 45 km of large, deep lagoon. A semi-diurnal tide has an amplitude not more than one metre. The following sub-systems may be distinguished and described:

**Northern, western and southern margins:** Except opposite Tubou this lagoon is elsewhere shallow, and tides quickly renew the lagoon waters. Along the west coast (Lebta transect, Fig. 4.2) eroded coral flagstone, occasionally with sand patches, dominates the lagoon floor and living coral occupies less than half the area. The eroded reef flat is covered in dense algae (Caulerpa, Halimeda, Turbinaria). On the north coast (Nasaqalau and Yavako transects, Fig. 4.1) loose sediments predominate. Close to the shore the sediment is silty and without life, but seaward becomes colonized increasingly with 'seagrass' (Halodule, Syringodium) and algae (Sargassum, Ruvoidea). The frontal zone, in the lee of the island, is entirely covered by coral -- absent from many other areas -- but makes up only 10 per cent of the whole reef-lagoon complex. On the south coast the Tubou bay and harbour has some of the characteristics of the north and west. The bottom of the bay is a rocky sand beach, partly covered by 'seagrass' and algae as at Yavako. The reef itself has abundant living coral near the pass, but elsewhere is a flagstone partly covered in sand. There is no living coral near the frontal zone, but there is one algal bed (Caulerpa, Halimeda, Turbinaria). Around this whole zone of the island are great contrasts in morphology, substratum, lagoon depth and benthic population.

**Eastern margins:** the mangroves, sinkholes and great lagoons: Nine kilometres of the east coast are fringed by mangroves, attaining a maximum width of 1500 m between Nukumuku and Wastubu. This mangrove is young, with only a single species (Rhizophora) recently implanted on the coral flagstone still visible under a thin cover of slime. Associated biota are poor in species, but otherwise characteristic of mangroves, but rich in lagoon-type species. Beyond the mangrove the lagoon remains shallow and partly emergent at low tide for some distance. There are areas of flagstone, areas of sand or silty sand partly covered by seaweed, and coral formations which increase in significance with...
The great lagoon itself was studied only on its barrier reef (Maikeli transect, Fig. 4.4). Here the outer slope is rich in biota, especially coral. The reef flat is composed of eroded flagstone with algal beds in the surf zone, and coral elsewhere.

**THE CORAL REEF FAUNA AND PRIMARY PRODUCTION**

The corals

The main reef zones are very different in character. The outer slope is composed mainly of encrusting species of *Acropora*. The proportion of the substratum covered by living coral ranges from 20 per cent opposite Tubou to 70 per cent at other stations, and exceptionally even 100 per cent on some vertical walls (Leiba and Vakano transects). The frontal zone is generally poor in living corals -- 5-10 per cent at Tubou, Leiba (Fig. 4.2), Nati and Lute transects, but 50 per cent at Vakano. *Acropora* dominates everywhere, and on the outer reef flat, where coral is abundant, the same species is also by far the most important. The inner reef flat has large areas of dead coral flagstone, wide sandy beaches, mangroves and some seaweed beds; living coral, mainly *Porites*, covers only some one per cent of the substratum. In total, 65 species of coral were collected on Lakeba (28 genera and 12 families), together with three species of the genus *Mesophylla* (*Hydroida*).

**Molluscs**

The range of species collected on Lakeba was greater than in the other reef-lagoon systems studied by the team. A total of 218 species belonging to 52 families were dominated by *Gastropoda* (187 species) and smaller numbers of *Cephalopoda* and *Polyplacophora*. Because of the difficulty of examining deep-water sediments, few samples of bivalves were collected. The most representative species were the *Nidulina* (27), *Conidae* (27), *Cypraeidae* (16), *Teretidae* (16) and *Carinidae* (18).

In western Lakeba, *Cypraea annulata* settles on hard flagstone while *Carinidae* are numerous on the sediments. In the north, close to the mangroves and in the two sink-holes *Cypraea annulata* grows among the algae and is associated with *Colubrilellidae* and *Cuterithiidae*. At Tubou, *Nidulina*, *Teretidae* and *Conidae* are abundant in the loose seabed material while *Littorinidae* are abundant on shore. The sink-holes are very poor in molluscs; 95 per cent of those collected came from the margins. Inside the mangroves, plants are colonized by *Littorina scabra* and *Marina* sp., whereas the silt-covered flagstone carries *Cuterithiidae* and *Veneridae*. Loose sediments in the south and southeast are rich in *Teretidae*, *Nidulina*, *Olividae*, *Teretidae* and *Conidae*, the proportions varying according to the grain size of the sand. The barrier reef of the great lagoon has great species-diversity in molluscs (38 species in the southern part), but in the east particular families tend to dominate.

**Fish**

One hundred and forty-five species of fish belonging to 41 families were
collected around Lakeba. The small Pomacentridae occur all around the island, especially around coral patches, but are not exploited in any way. The mangroves, the sink-holes and the shallow upper northern areas are sparsely occupied by fish, but are sometimes used as spawning places. The outer slope of the barrier reef is particularly rich in both species and individuals, especially around the passes. Bregarious species are very abundant on the sandy bottoms south of the island, especially in Tubay south where they are intensively exploited. Surprisingly, herbivorous species seem not to frequent the seaweed beds, but carnivorous mollusc-eating species (Labridae) predominates. Recently, certain herbivorous species (Acanthurus, Humphead and Cteniophidae) probably use these important sources of food during one or several stages of their growth.

**Plankton and primary production**

The considerable variation in biotypes around Lakeba is paralleled by important variations in primary productivity. However, plankton population are generally poor in individuals (5000 to 10 000 cells/litre) both in lagoons and in the ocean. In the sink-holes and the mangroves, cells are mixed up with vegetal fragments. The main constituents of populations are small and medium sized pennate diatoms and dinoflagellates. The highest pigment concentrations were encountered in the mangroves (0.78 - 0.90 mg chlorophyll-a/m²) and in the sink-holes (0.21 - 0.61 mg/m²). Chlorophyll-a concentrations decrease in the lagoons (0.06 - 0.07 mg/m²) but are higher in the ocean close to the barrier reef (0.01 - 0.07 mg/m²). In the great lagoon pigment concentration is similar to that of oceanic stations, emphasizing the oceanic influences which dominate in the sub-system. Acid ratios are fairly similar in all oceanic stations but are lower inside the lagoon. They indicate that the phytoplankton populations are largely detritic or senescent.

Primary production (not measured in the mangroves) was highest in the sink-holes, where it ranged from 64 to 164 mg C/m²/day (684 mg C/m²/day), whereas in the great lagoon and at oceanic stations close to the reef the level was lower - about 8 to 29 mg C/m²/day (190 mg C/m²/day maximum value). Nevertheless, this level is greater than that reported for the open ocean, less than 100 mg C/m²/day, as reported by Kobelants-Mischke et al (1970). Nanoplankton is responsible for average for 85-87 per cent of photosynthetic production and microplankton for 13-15 per cent.

The higher productivity level of the lagoons is related to fresh-water inflows and organic matter carried by oceanic waters from the coral barrier reef. The high productivity of the sink-holes and -- presumably also -- the mangroves results from eutrophication. The explanation for the higher values encountered in the ocean outside the reef may lie in an ‘island-mass effect’ as suggested by Boty and Oguri (1956). It should be noted in conclusion that primary production in the lagoon at Lakeba is lower than that encountered in the lagoon of Tahiti (French Polynesia), perhaps because of differences in the hydro-dynamic features of the two islands and in the benthic populations, especially coral and molluscs such as *Zoophora*.

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1 For a statement of research methods, see Ricard (1977).

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**The socio-economy of Lakeba marine resources**

The marine survey team, with its background of experience in French Polynesia, was struck by the limited reliance placed on the marine ecosystem by the people of Lakeba. Far more food comes from the land than from the sea. Marine species living at depths below 10 m are hardly exploited at all, because they are not dive below this depth. Fishing is regulated by territorial rights, and is done mainly by women within the limits of the lagoon and reef. Only rarely are fish caught outside the reef -- and this only by men. None of the people of Lakeba do fish all around their island, and also in the lagoon of un-inhabited Atua to the southeast (see also M. Brookfield, this volume).

The means available for fishing are today very modest. It was reported that there were more than 25 boats with motors on the island in 1966; only about ten are left today. The completion of the circum-island road in 1969 eliminated the need for boats as means of transport between villages, and there are few people to whom fishing is a primary occupation. Small nets and nylon threads with hooks make up a diver’s gear, and though diving glasses are common we noted fewer than five dive-masks and even fewer spear guns. It could even be remarked that one of the most significant uses of the marine ecosystem is the cutting of mangrove wood for the drying of copra, but even this is of quite limited scale.

Among the 178 species of fish collected at Lakeba and Atua, 62 are edible. Much the most important for consumption is the ‘kanare’ (*Ocramgill sp.*, *Hapaludidae*) which lives in schools above sandy bottoms. The largest individuals reach a weight of three kilograms. *Spineidae*, *Acanthuridae*, *Dactyloidae* and *Scombridae* are far less important. There is no risk in eating the lagoon fish except, in a few rare cases, certain *Dactyloidae* which produce ichthyosarcoism. Six species of molluscs are gathered for food (*Chiton sp.*, *Prochius nilotica*, *Lambia lumbi*, *Oreophrym pencillum*, *Anaspis violacosa* and the giant clam, *Tridacna crocata*). The giant clam is the most sought-after species; an individual weighs about 3.5 kg, of which about 300-400 g can be eaten raw or cooked. Of lesser importance than fish and molluscs in food supply are mangrove crustaceans, echinoderms, holothurians, medusae (*‘halve’*) and the alga *Caulerpa* (*‘nana’*). Some of these products are sold from village to village, mainly to Tubay. Other than mangrove crabs, the only products exported from the island in recent years are the *Zoophora* nilotica and the mother-of-pearl shells. The total value of marine products sent to Suva was less than $2000 in 1972 and 1974. But while pressure on resources is comparatively light, it would seem that the standing stock of *Zoophora* is insufficient to withstand a greater level of exploitation, while the giant clams are already over-exploited, and are in danger of extinction.

**Acknowledgements**

The particular acknowledgements of the marine survey team are due to the Division of Fisheries, which made available a vessel, the *Atua*, outboard motors and gear, and provided the services of a professional officer (Mr S. Sewak) and an assistant. The paper presented above is edited and condensed slightly from a paper initially presented at the Third International Coral Reef Symposium at Miami in 1977. Responsibility for editing and condensation is with H.C. Brookfield.
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5.5 PREHISTORIC MAN-INDUCED DEGRADATION OF THE LAKEBA LANDSCAPE: EVIDENCE FROM TWO INLAND SWAMPS

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(Australian National University)

M. Latham
(ORSTON, Noumea)

and

M. Brookfield
(University of Melbourne)

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I - INTRODUCTION AND METHODS

INTRODUCTION

Much of the island of Lakeba supports a pyrophytic vegetation cover dominated by ferns growing on very impoverished and often eroded soils. This soil-vegetation complex, known as *talasiga*, is generally considered to be anthropogenic and to have resulted from the degradation of forested land through clearance and burning for shifting cultivation. For this to have been so, the extensive transformation of the forest to *talasiga* must have taken place in the last 3000 years or so, the time span that recent archaeological investigations have shown the island to have been occupied (B. Best, personal communication). However Latham (this volume) has argued that disturbed habitats probably existed before human arrival and that the *talasiga* might well be a natural formation which has since become more widespread (see also UNESCO/UNFPA Project 1977, p. 59-61).

In order to test hypotheses concerning the origin of the *talasiga* complex and implications for prehistoric man-induced degradation of the landscape M. Latham and M. Brookfield collected cores from a number of inland and near-coastal swamps in diverse ecological settings with the aim of constructing a vegetation history for the island through pollen analysis. The cores consist largely of inorganic sediment with a small percentage of microscopic organic debris, mainly cuticles, fungal spores and carbonized plant remains. On the basis of preliminary studies of two of them, J. Flenley and J. Guppy of the Australian National University concluded that since they contained very little well preserved pollen, detailed pollen analysis was not warranted.

A number of radiocarbon dates were obtained from one of the inland swamps (Waatabu) and their depth-age distribution showed that at least 1 m of sediment had accumulated in the last 1000 years and, less certainly, 6.5 m in the last 2000 years (Latham, this volume). As the contributing catchment for this swamp is small in area these rates of accumulation of sediment suggested the possibility that accelerated soil erosion had occurred on the surrounding slopes within the time span of man’s occupation of the island, presumably as a result of his interference with the vegetation cover. Recent work in the New Guinea Highlands has provided evidence in the form of accelerated deposition of inorganic sediments in swamps for accelerated rates of soil erosion in the contributing catchments over the last 9000 years, and these in turn have been attributed to forest clearance for shifting agriculture (Golson and Hughes, 1976; Harris and Hughes, 1968; Hope, in press).

In order to test the hypothesis that prehistoric man’s activities on Lakeba had resulted in accelerated erosion through disturbance of the vegetation cover, two sites were selected for study. A thorough investigation was made of their sediments and, through radiocarbon dating, of their histories of accumulation. The role of fire in transforming the vegetation cover was assessed through detailed studies of the carbonized particle contents of the...
seds. The accumulation of carbonized particles is taken to reflect the burning of vegetation on or near the site with the incompletely combusted material being washed in by local runoff.

The two inland swamps cored by the project team were selected for this study as in both cases the sediment and carbonized material in them must have been entirely derived from small local catchments (Latham, this volume, Fig. 6.2). The Waitabu swamp covers an area of 3.4 ha and its very steeply sloping contributing catchment, 46 ha in area, is largely vegetated with closed regrowth forest. The Nabuni swamp is even smaller, 1.9 ha, and its more gently sloping catchment, 27.5 ha in area, is covered with savanna. The outlets of both swamps are constricted either by bedrock or, more likely, by colluvial-alluvial deposits whose formation predates the arrival of man (Latham, this volume).

METHOD

Fieldwork

The cores were collected by M. Latham and M. Brookfield in November 1976. A D-section corer was used to recover the top 50 cm of the Waitabu core and the remainder of this core and the whole of the Nabuni core were collected in 50 cm sections with a Miller-Borer. The Waitabu core could not be extended down below 650 cm because of a lack of extension rods, and coring of the Nabuni swamp was not continued below 450 cm because of the extremely compact nature of the substratum.

Laboratory

The cores were opened and examined in the sedimentary laboratory in the Department of Biogeography and Geomorphology, KVPScA, at the Australian National University. Most of the sections were still moist and in good condition, however some of those from the Waitabu core that had previously been opened and sampled for pollen analysis and radiocarbon dating had completely dried out and had crumbled.

Detailed descriptions of the sediments, especially of their structure, moist Munsell colour and field texture, were then made after which the cores were cut up for further analyses as follows:

Radiocarbon dating: Three samples from each core were submitted to Geochron Laboratories, U.S.A., for radiocarbon dating.

Bulk chemistry: Six samples from the Waitabu core and five from the Nabuni core were chemically analyzed by ORSTOM in the laboratory in Noumea. The samples were prepared for analysis by digesting them at high temperature in concentrated nitric acid (HNO₃) and perchloric acid (HClO₄). This digestion dissolves all but the unweathered rock fragments and minerals.

Grain-size analyses: The grain-size distribution of three samples from each core were determined using the hydrometer method for the silt and clay fractions and dry sieving for the sand. The grain-size used was that of Wentworth (Folk 1968:25) in which clay is that fraction finer than 4 μ, silt 4-63 μ and sand 63 μ-200 μ. The field textures were then checked against these detailed analyses.

Mineralogy: Two samples from the Waitabu core were impregnated with resin, thin sectioned and their mineralogy was described in detail by A. Watchman, A.N.U. His descriptions were augmented by microscopic examination of the sand and silt fractions from a number of samples from both cores.

Organic carbon: The organic carbon contents of 30 samples from the Waitabu core, and 22 from the Nabuni core, were determined by combustion using a LECO automatic carbon analyzer.

Carbonized particles: The concentration of carbonized particles in 31 samples from the Waitabu core and eight from the Nabuni core were determined as follows. A 2 ml volume of sediment was extracted from each sample (2 ml) and treated with hydrofluoric acid (HFO) and zinc bromide (ZnBr₂) heavy liquid floatation to extract all the contained organic material. Most of the non-carbonized organic material was then removed by oxidation with concentrated nitric acid (HNO₃) over 24 hours. The remaining organic material, which consisted of fine carbonized particles and residual non-carbonized organic debris was suspended in silicone oil. A proportion of this suspension was then examined under a microscope. All black or blackened particles with a maximum dimension of 3-10 μ and all particles larger than 10 μ which were clearly derived from plant remains and which were carbonized to some extent were counted.

II - COMPOSITION AND STRATIGRAPHY OF THE SWAMP DEPOSITS

WAITABU SWAMP

The sediment is essentially composed of clay minerals and silt- and sand-sized angular to sub-rounded kaolinized feldspar grains, iron oxide-rich nodules and charcoal specks with minor amounts of fresh, angular plagioclase, fragments of fresh volcanic rock, opaque iron-oxides and charred plant stems and seeds. The sediment is generally mineralogically homogeneous throughout the core. The medium to very coarse sand-sized feldspar grains and iron oxide-rich nodules were usually so soft as to be readily crushed in the fingers or smeared with a trowel.

The bulk chemistry of the deposit proved to be homogeneous throughout and as there were no apparent trends with depth the analyses are presented in a summarized form in Table 5.1. The high silica/alumina ratio suggests the presence of well-ordered clays of the montmorillonite family in addition to clays of the kaolinite family.

The textures of the sediment do not show marked variations except that there is a small but steady increase in sand with depth at the expense of clay such that whereas in the top 550 cm the textures are generally sandy silt, silty clay below they are silty sandy clays. The bulk of the clay is extremely fine. The coarse sand grades, which give the deposit a 'gritty' feel, consist largely of kaolinized feldspar grains and iron oxide rich nodules in roughly equal proportions.

Fine plant material, humates and charcoal make up the organic component of the deposit which is low throughout, 0.5 to 2.5 per cent (Fig. 5.1). Macroscopic specks of charcoal were observed throughout the core and in general where charcoal was observed to be concentrated locally so also were the highest organic carbon contents.

The concentration of carbonized particles is extremely high throughout
TABLE 5.1: BULK CHEMISTRY OF SAMPLES FROM THE WAITABU AND NABUNI SWAMP CORES

<table>
<thead>
<tr>
<th></th>
<th>WAITABU (6 samples) % by wt.</th>
<th>NABUNI (5 samples) % by wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss on ignition at 1100°C</td>
<td>13.3 - 14.0</td>
<td>11.9 - 15.7</td>
</tr>
<tr>
<td>Residue following acid digestion</td>
<td>3.2 - 5.4</td>
<td>0.6 - 1.7</td>
</tr>
<tr>
<td>Silica SiO₂</td>
<td>39.3 - 41.4</td>
<td>41.1 - 44.5</td>
</tr>
<tr>
<td>Alumina Al₂O₃</td>
<td>27.2 - 30.4</td>
<td>26.4 - 31.7</td>
</tr>
<tr>
<td>Iron oxide Fe₂O₃</td>
<td>9.6 - 12.2</td>
<td>5.1 - 17.2</td>
</tr>
<tr>
<td>Titanium oxide TiO₂</td>
<td>1.2 - 1.4</td>
<td>1.0 - 1.5</td>
</tr>
<tr>
<td>Magnesium oxide MnO₂</td>
<td>0.4 - 0.6</td>
<td>0.5 - 2.0</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>0.15 - 0.26</td>
<td>0.02 - 0.04</td>
</tr>
</tbody>
</table>

Trace amounts of oxides of manganese, calcium, magnesium, potassium and sodium also present

SiO₂/Al₂O₃                  | 2.3 - 2.6                    | 2.3 - 2.9                    |

pH                        | 3.9 - 5.3                    | 4.5 - 5.5                    |

All but the top 20 cm of the core (Fig. 5.1). There is little correlation between the minor variations in the concentration of carbonized particles and those in the organic carbon curve.

Monolete fern spores are noticeable in many horizons through the deposits, together with occasional trilete spores and grass pollen. The frequencies are too low to say more than that ferns appear to have played a role in the local vegetation on the site throughout the history of the deposit. Fern spores are typically highly over-represented in most lowland tropical vegetation communities.

Colour does not appear to be related to organic content; for example, the very dark to dark greyish-brown colour of much of the sediment cannot be accounted for by the presence of humus, as the total organic carbon content of most of those parts of the core is less than one per cent.

The sediment appears to be essentially homogeneous in terms of mineralogy, chemistry, texture and organic content, and accordingly the following stratigraphic divisions are based almost wholly on differences in colour and structure.

1. 0-10 cm  Friable dark brown (10YR3/3) to brown (10YR4/6) slightly mottled soil. This grades sharply over 2 cm into

2. 10-82 cm dark greyish-brown (10YR4/2) to brown (10YR4/3) structureless sandy silty clay with brown (10YR4/6) to reddish-brown (5YR4/6) iron oxide-rich nodules and yellow kaolinite feldspar grains. This unit in turn gives way over 1-2 cm to
3. 82-92 cm dark brown (10YR3/3) sandy silty clay with a blocky structure and numerous reddish-brown iron oxide-rich nodules.

4. 92-97 cm This unit has the same characteristics as the overlying unit except that it is less distinctly very dark greyish-brown (10YR3/2) in colour. It gives way abruptly to

5. 97-310 cm brown (10YR4/2), dark yellowish brown (10YR4/4) and dark to very dark greyish-brown (10YR4/2 to 3/2) structureless sandy silty clays with brown to reddish brown iron oxide-rich nodules and yellow kaolinitized feldspar grains. The air-dry colour of this unit is generally greyish brown (10YR5/2).

6. 310-650 cm This unit has the same characteristics as the overlying unit except that its moist colour is dark greyish brown (10YR4/2) and its air-dry colour is light grey (10YR6/1). The sediment is increasingly sandy with depth and below about 550 cm its texture is silty sandy clay. Within this unit is a lens of distinctly brown coloured (10YR4/4) sediment at 490-93 cm.

NABUNI SWAMP

The mineralogy of the sediment in this swamp is essentially the same as that of the material from Waitabu with the notable exception that the coarse sand-sized feldspars of iron oxide-rich material characteristic of the Waitabu core are absent from this core. Again the bulk chemistry of the deposit proved to be homogeneous with depth and was generally similar to that of the Waitabu material. One noteworthy difference is the low phosphorus content compared with that of the Waitabu deposit (Table 5.1).

The texture of the sediment varied greatly with depth, there being a marked increase in sand, and decrease in clay, with depth. Again the bulk of the clay is extremely fine.

The organic carbon content of the deposit decreases markedly with depth from about 6.0 per cent near the surface to less than 0.1 per cent below 240 cm. The amount of visible charcoal also decreased with depth and none was observed in that part of the core from below 240 cm. The concentration of carbonized particles is extremely high in the upper part of the core but decreases markedly with depth to very low concentrations below 240 cm. There is a close relationship between the organic carbon content and the concentration of carbonized particles. Fern spores were present in the top 100 cm but were not seen below 125 cm.

Thus in contrast to the Waitabu deposit, the textural and organic composition of the Nabuni deposit shows considerable variations with depth and accordingly the following stratigraphic units were defined in terms of these characteristics as well as those of colour

1. 0-15 cm Slightly friable dark brown (7.5YR4/1) soil with diffuse dark brown (7.5YR4/2) mottles and an organic carbon content of about 6.0 per cent. This unit gives way sharply to

2. 15-125 cm Structureless sandy silty clay, dark brown (7.5YR4/1) down to 65 cm, changing gradually below this to dark greyish-brown (10YR4/2) and then below 80 cm to very dark grey (10YR3/1). This unit contains abundant small yellow sand-sized grains of yellow, kaolinitized feldspar and charcoal. The organic carbon content decreases down from about 4.0 per cent at the top to as little as 1.5 per cent towards its base. Below 120 cm the sediment becomes transitional in colour between that of the overlying clay and the underlying silt. This unit gives way over 1-2 cm to

    3. 125-240 cm silt with a sand content that steadily increases with depth such that the texture changes down from sandy clayey silt at the top to clayey sandy silt at its base. Down to 185 cm the colour is dark brown (10YR3/3) with up to 50 per cent diffuse mottles ranging in colour from dark yellowish-brown (10YR4/6) to dark reddish-brown (5YR3/4). Below this and down to 200 cm the sediment is dark reddish-brown (5YR3/3) with diffuse yellowish-red (5YR4/6) mottles. The basal 40 cm of the unit is dark reddish-brown (5YR3/4). Yellow kaolinitized feldspar grains are abundant throughout but the amount of organic carbon (including visible charcoal) decreases steadily with depth from about 0.9 per cent at the top to 0.1 per cent at this base. This unit merges over a few cm into

4. 240-450 cm charcoal-free clayey silty sand which becomes increasingly sandy with depth. The colour of this unit ranges from 2.5 to 5YR3/4 (dark reddish-brown) above 200 cm to 2.5YR3/4 (dark reddish-brown) below that depth. Again kaolinitized feldspar grains occur throughout but at a much lower concentration than above. The organic carbon content of this unit is extremely low (0.02-0.05 per cent).

III - AGE AND HISTORY OF THE SWAMP DEPOSITS

RADIOCARBON DATING

Six radiocarbon dates were obtained for the Waitabu deposits (Table 5.2) and these demonstrate an excellent depth/age relationship. A depth/age curve was fitted visually to the distribution and an envelope indicating the likely age limits of the deposit was drawn so that it encompassed the outer limits set by one standard deviation of each of the dates (Fig. 5.1). The core covers the time span from 1900 yr BP until the present and therefore provides a record of events that does not extend back before the arrival of man on the island.

Only two of the three samples submitted from the Nabuni core proved dateable (Table 5.2) and as these give an inverted depth/age relationship it was possible only to fit a broad envelope to indicate the likely age limits of the upper 125 cm of the core (2400-800 yr BP -- see Fig. 5.1) and, much less certainly, the upper 240 cm (1500-4800 yr BP).

The sediments in the swamps are derived from soil and regolith washed in from the surrounding slopes. At both sites the mineralogy and chemistry of the deposits is essentially the same as those of the soils mantling the surrounding slopes and there is no evidence that the sediments have undergone significant post-depositional alteration other than changes in the state of oxidation of the iron oxides. Difference in mineralogy and chemistry between the sites is taken to reflect local variations in geology, topography and weathering and erosional history. For example the larger proportion of un-
weathered rock and minerals in the Waiaturo deposit is likely to be because fresh rock crops out or lies closer to the surface of the Waiaturo catchment more frequently than in the Nabunui catchment.

The soils and regolith mantling the catchments have formed through deep weathering of the iron-rich volcanic parent rock and are characterized by their reddish-colour which is largely due to the presence of 'oxidized' from oxidation soils. The ferrallitic evolution - Latham, this volume). The marked colour differences between these soils and some of the sediments in the swamps are explained in terms of differences in the state of oxidation of these oxides resulting from differences in the depositional and post-depositional conditions under which the sediments have accumulated.

WAIATURU

The sediment consists largely of silts and clays that must have been deposited under still or sluggish water conditions. The presence throughout of fern spores which must have grown on the site suggests that the environment of deposition was swampy rather than open water lacustrine.

The accumulation of this deposit is interpreted as having taken place in three stages. The lowest 3.4 m (level C) was deposited at the extremely rapid average rate of 230 cm/100 years between about 1500 and 1750 years ago. The presence of some fern spores, possibly from wetland taxa, suggests, however, that the rate of deposition was never too high to preclude plants from growing on the site. The grey colour of this part of the core is due to the reduced state of the iron oxides and this suggests that it has never been subject to extensive drying out since it was deposited. However the abundant spores and hyphe, presumably from soil fungi, indicate that the swamp surface was aerated at least some of the time.

From about 1750 yr BP the average rate of accumulation decreased to about 27 cm/100 years and this was maintained until about 900 years ago. The bulk of the sediment laid down over this time span (level B) is brown to greyish-brown and this suggests that the iron oxides are less reduced than those below. This in turn may reflect deposition under drier conditions and/or a cooler post depositional environment. The dark brown and blocky structure of the top 10–15 cm of this unit suggests that from about 900 years ago there may have been a pause in deposition, allowing the formation of a poorly developed soil. Alternatively it is possible that the soil-like character of this material resulted from gardening of the swamp at that time.

Whatever the significance of the upper part of level B, over the next 900 years deposition continued at an even slower average rate of 9 cm/100 years. The lower part of this deposit (level A) is predominately grey in colour, again suggesting accumulation under wet conditions. The upper 10 cm of the deposit has been incorporated into a recent taro garden.

NABUNUI

The character of the basal material (level C) is essentially the same as that of the soils on the surrounding slopes and its sandy texture and reddish colour attest to its origin as a colluvial-alluvial deposit laid down in a dryland environment which has never been subject to long periods of waterlogging. The lower metre or so becomes increasingly compact with depth and the possibility is admitted that this material is the remnant of
TABLE 5.3: RATES OF EROSION FROM THE WAITABU AND MBU TANK CATCHMENTS

<table>
<thead>
<tr>
<th>THICKNESS OF SEDIMENT IN SWAMP (cm)</th>
<th>TIME SPAN (BP)</th>
<th>RATIO OF AREA OF SWAMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATES OF EROSION FROM CATCHMENT (cm/1000 yr)</td>
<td>LEVEL A</td>
<td>LEVEL B</td>
</tr>
<tr>
<td>MATTABU</td>
<td>0 - 900</td>
<td>0.075</td>
</tr>
<tr>
<td>900 - 1750</td>
<td>0.075</td>
<td>16</td>
</tr>
<tr>
<td>1750 - 3000</td>
<td>0.075</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>80</td>
</tr>
<tr>
<td>MBU</td>
<td>0 - 800</td>
<td>0.069</td>
</tr>
<tr>
<td>0 - 2400</td>
<td>0.069</td>
<td></td>
</tr>
<tr>
<td>2400 - 3000</td>
<td>0.089</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>36</td>
</tr>
</tbody>
</table>

The sediment in the central segment of the core, between 240 and 125 cm (level B), gradually changes in colour upwards from reddish-brown to brown, and this, along with the increase in silt and clay up the core, suggests deposition took place in an increasingly still or sluggish water environment. No fern spores or other plant microfossils were observed in levels C and B and their absence is attributed to biochemical oxidation rather than that they were never present. Biochemical oxidation proceeds most rapidly in well drained, aerated conditions. These conditions clearly would have prevailed in level C but for them to have existed during the accumulation of level B means that the swamp that is inferred to have begun to form during this period was subject to periodic extensive drying out.

The clayey texture, grey colour, presence of fern spores and relatively high organic content of the upper 125 cm of the deposit (level A) all indicate that accumulation took place in still or sluggish water in a swampy environment and that the sediment has never been subject to extensive post-depositional drying. This level accumulated in the last 800 to 2400 years at an average rate of between 16 and 5 cm/100 years. The upper 15 cm of the deposit has been incorporated into a recent taro garden.

IV - DISCUSSION

EROSION AND BURNING

The amounts and rates of soil erosion from the catchments were calculated as shown in Table 5.3. The assumption was made that the stratigraphies and depth/time relationships established for the cores reflect the histories of accumulation of the swamps as a whole. The calculations also depend on the assumption that the area of deposition remained the same throughout. However, it is likely that the surface areas of the swamps increased as they accumulated; if so the rates of erosion estimated for the lower levels are over estimated. On the other hand the calculated amounts and rates of erosion as they stand must be minimum as they do not take into account the losses downstream in suspension or solution that must have occurred.

The concentrations of carbonized particles in these swamps reflect the frequencies of burning, nature of fire and fire, efficiency of transport and dilution by other sediment (Singh et al., in press). Hence whilst fluctuations in these curves must be interpreted with caution, when they are used in conjunction with known rates of accumulation and erosion major changes in fire regime can be detected.

At Waitabu, in the 150 years between 1900 and 1750 yr BP a minimum thickness of 26 cm of soil was eroded from the catchment at an average rate of 173 cm/1000 years or 2600 t/km²/year. This is an extremely high rate of erosion (cf. Latham, this volume) and if the whole catchment had been so affected virtually all the topsoil could have been removed in this short period.

During this period of extremely rapid erosion and accumulation of sediment in the swamp the concentrations of carbonized particles remained steadily very high and this can only be interpreted as meaning that this massive erosion was accompanied by massive regular burning of the vegetation on and around the site. The presence of fern spores throughout the core at
level (A) was probably between 4 and 10 cm/1000 years or 60 and 150 t/km²/year, and the thickness of soil lost from the catchment by erosion was about 9 cm. Thus the erosion regime over the last 800 to 2400 years was similar to that which prevailed in the Kaltubu catchment over the last 900 years. The concentration of carbonized particles during this phase of erosion and deposition was extremely high and this suggests high levels of burning relative to erosion.

Whatever the explanation for the inversion of the dates from this swamp, their close depth proximity indicates that during at least the upper part of level B the rates of erosion and accumulation were not slower, than those of level A. Thus in marked contrast to Kaltubu there is no evidence for an early phase of extremely rapid erosion and deposition within the time span of human occupation of the island.

HUMAN IMPACT ON THE LANDSCAPE

The very high rates of accumulation of carbonized particles throughout the Kaltubu swamp, especially before 1750 yr BP, undoubtedly reflects heavy, regular anthropogenic burning of the vegetation in the swamp and its catchment. Over the last 2000 years at least 50 cm of soil has been lost from the catchment, more than half of it in a 150 year period between 1300 and 1750 yr BP. The pattern of erosion and burning during this early stage of accumulation suggests strongly that massive erosion and burning regimes must have been well established by 2000 yr BP.

Such accelerated erosion could only have come about through extensive clearance of the forest mantle on the steep slopes of the catchment, either by felling or fire or both. A likely explanation for this degree of disturbance in the forest is that it was cleared and burned for shifting cultivation. Clearance would have exposed the soil and greatly increased its susceptibility to rainsplash erosion, slope wash and gullying (Bolton and Hughes, 1975; see also Bayliss-Smith, 1977, p. 69). Accelerated erosion would have been facilitated by the extremely high runoff that occurs when severe hurricanes strike the island. Such events may well have occurred several times per century (Bayliss-Smith, 1977, p. 67-70). Erosion of this magnitude must have led to severe degradation of the soils and would account for the widespread truncation of soil profiles noted widely in catchments partially or wholly forested as well as those only under talasaagga (see Latham, this volume).

Clearance and burning of the forest and consequent erosion and impoverishment of the soils must have resulted in long term change in the composition of the vegetation in the catchment, although the presence today of regrowth forest shows that degradation of the landscape never led to the complete removal of the forest.

The decline in rates of erosion and incidence of burning after 1750 yr BP and especially after 900 yr BP, can be explained in terms of the response of the catchment to the following factors:

1. The intensity of human use of, and interference with, the vegetation and soils resulted in the land becoming less attractive for cultivation.
2. The progressive removal of soil and regolith at rates which far exceed the rate at which weathering of the substrata could produce
more regolith and soil would have rapidly diminished the reserves of easily-erodible material.

The sharp decrease in incidence of burning late in the history of accumulation of the swamp might reflect the cessation of human interference with the catchment in fairly recent times. This is an interesting correlation with evidence of late prehistoric and historic movement of population towards the coast (M. Brookfield, this volume) and a possible absolute decline in numbers since, say, 1800 AD. This decrease in burning would have favored the regeneration of forest and the establishment of the secondary forest which exists today probably dates from that recent time.

Like Waitabu, the Nabuni swamp shows evidence for anthropogenic burning and erosion rates. In its catchment extending well beyond 1000 years. About 2.4 m of sediment accumulated in the time span of human occupation and this represents a loss of soil of at least 17 cm. Differences in the erosion and burning histories of the two catchments can be explained in terms of differences in their original vegetation and soil covers (and consequent influences in land use) and topography.

The vegetation cover of the Nabuni catchment in pre-human times is taken to have been woodland with a substorey that included ferns. The basis of this contention is twofold. Firstly the phosphorus content of the Nabuni deposit is very low throughout (0.02 - 0.04%) compared with that of the Waitabu deposit (0.16 - 0.28%) and this suggests that the soils in the Nabuni catchment were already much poorer in phosphorus and therefore were unlikely to have supported a closed forest such as that now established in the Waitabu catchment. Secondly, the presence of carbonized particles in the lowermost pre-human colluvial-alluvial deposit probably reflects burning at the time of accumulation and this in turn supports the possibility that the vegetation was susceptible to fire. The accumulation of this colluvial-alluvial deposit must have led to a severe degradation of the soils at that time through truncation of the soil profiles by erosion.

The open vegetation and severely truncated soils might well have been similar to those of the present day taluqaga complex. Whatever the precise nature of the landscape at that time, it probably would not have been a productive environment for shifting agriculture and this may explain the small amount of man-induced soil erosion compared with the forested Waitabu catchment. The tendency for low rates of erosion due to low intensity of the use of the land would have been enhanced by the more gentle topography of the catchment and the lack of easily-erodible soil.

On the other hand this vegetation cover would have been highly susceptible to anthropogenic burning, and this would explain the high ratio of burning to erosion exhibited in the carbonized particle curve late in the history of accumulation.

CONCLUSION

1. In both catchments there is evidence for anthropogenic burning which in the case of the Waitabu catchment began before 2000 yr BP and in the Nabuni catchment well before 1000 yr BP.

2. There is evidence in both catchments for man-induced erosion at rates which are high by tropical standards and which in the case of Waitabu were extremely high early in the history of accumulation of the swamp.

3. Major differences between the burning and erosion regimes in the two catchments have been explained in terms of differences in their original vegetation and soils and the consequent influence of these on land use.

4. These findings have implications for the interpretation of taluqaga as an anthropogenic landscape. First, despite the almost total loss of vegetation and burning that occurred over the last 2000 years in the Waitabu catchment, the vegetation was not irreversibly or completely transformed to taluqaga; indeed in fairly recent times, with diminished erosion and a marked decline in burning, closed secondary forest may have been able to regenerate. Second, a case has been argued that when the island was first inhabited the Nabuni catchment had a vegetation/sol cover complex that may well have resembled that of today although human settlement of the island undoubtedly resulted in severe degradation of the landscape. It may not have irreversibly transformed the vegetation to the extent postulated by earlier workers (e.g. Ouyang and Wright, 1975).

This example illustrates that vegetation should never be allocated to strict 'natural' or 'anthropogenic' categories in the absence of firm vegetation histories. Many of the controversies over the status of grasslands or shrublands have subsequently been resolved by showing that man has been responsible for extinctions in range of these communities rather than their creation (e.g. Hope and Hughes, 1976; Hope, in press).

5. Finally, the evidence of the swamps themselves, especially Nabuni, suggests that their formation on a large scale may only have begun with the arrival of man and the consequent onset of vegetation disturbance, especially forest clearance and accelerated erosion. It is envisaged that following clearance, massive amounts of plant debris, especially branches and tree trunks together with leaf litter, were washed into the valley bottoms along with large quantities of soil. Transport of such debris would have been facilitated by severe hurricanes. Flood debris could then have choked the already constricted outlets of these swamps - and many of the other similar swamps on the island - leading to ponding of sediment-charged runoff for sufficient time for the sediment to settle out and accumulate. These swampy valley floors would have provided an ideal environment for wetland taro cultivation from early times and it is possible that prehistoric man, purposely or accidentally, encouraged their development through the instigation of water control ditching systems such as those described by M. Brookfield (this volume).

ACKNOWLEDGEMENTS

As described elsewhere in this volume, this task involved wider inter-disciplinary and inter-institutional co-operation than any other part of the Fijian project. Financial support for the analyses and for the radio-carbon dates was provided initially by the project budget, but was later supplemented by grants from ORSTOM and from the University of Melbourne. A. Watchman carried out the mineralogical analyses, and we are grateful to the Department of Biogeography and Geomorphology, Monash University, for storage of the cores and use of laboratory facilities.

The same department also provided instruction in the use of coring.
equipment and lent equipment to M. Brookfield; some equipment was also lent by P. Kershaw of Monash University. Particular thanks are due to Alan McDonnel of ANU for his assistance in getting the equipment to Fiji in time despite a cargo-handlers' strike, and in providing valuable logistic help at all stages.

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UNESCO/UNFPA Project (1977), Population, resources and development in the eastern islands of Fiji: information for decision-making, Canberra (ANU for Unesco).
I - INTRODUCTION AND METHOD

INTRODUCTION

In a paper for the second general report of the project (Latham and Denis, 1979), a method for the evaluation of land resources was presented, and illustrated by the particular case of Lakeba. The present paper makes reference to the methodology described in that paper, but does not repeat it in detail. The Lakeba material is, however, re-presented and expanded, since this is necessary for the purpose of the present Island Report.

Apart from some tiny potential reserves of manganese, the land resources of Lakeba are composed only of the soil and water of the island; crops, livestock and trees are the only potential products. Crops, food crops and yagana are the present products, together with some locally-used timber from the forest remnants; a much larger output of timber from the new *Pisonia aculeata* plantations will be added to this range in the future. Virtually all the cultivable land in the island is used, or has been used in the past, and while the recent trend has been one of contraction of food-crop production from certain areas it is possible that extensive cultivation of cassava and yagana may be increasing (M. Brookfield, this volume). Population is virtually static, and there is no immediate indication of heavy new demands on the island's resources. None the less, a potentially important role can be envisaged for the quasi-town of Tubou, and the pine scheme may ultimately generate some industrial employment if its problems can be solved (UNESCO/UNFPA Project, 1977, p. 375-380; M. Brookfield, this volume).

This exercise undertaken here does not assume these changes or rely on them. The purpose is to explore the production capacity of the island given available crops and technology. In a sense, therefore, this is a paper concerned with hypothetical possibilities rather than with likely developments. None the less, the exploration of these possibilities provides a benchmark against which the present and future utilization of the island's resources may be evaluated.

METHOD

In the method described in greater detail elsewhere (Latham and Denis, 1979), it is argued that three sets of possibilities and limitations must be evaluated in order to attain an estimate of land capability. These are edaphic, concerned with the soil and the availability of water and nutrients; morphodynamic, concerned with erosion and flooding; technical, concerned with land management. It is first necessary to define 'ecological units' within which these constraints and possibilities may be examined, then, having determined the basic agrological qualities of each such unit, to define land potential in terms of types of crops and land use technique available, and the chances of success of each type. In what follows, the landscape of Lakeba is evaluated along these lines. Ecological units are taken as the soil types described earlier in this Island Report (Latham, this volume), refined by topography and the availability of water.

Edaphic conditions

The extent of soil penetration by roots, the availability of water and the availability of nutrients are the critical variables. Lakeba soils are of varying depth, but shallow soils predominate. The natural forest is on shallow soils (Humic Cambisols), but the roots penetrate the weathered rock; the roots of *Pisonia aculeata* may also be able to penetrate the compact weathered horizon of the Ferralic Cambisols. However, field crops are less adaptable to shallow soils, and poor drainage is a barrier to all unadapted plants. Table 6.1 provides further data on soil depth, and on other conditions discussed in this section.

There is also great variability in soil-water retention. The range is from 50-70 mm in the Ferralic Cambisols to 140-160 mm in the Eutric Fluvisols. In a drought-prone climate, soils of low water-retention capacity dry out quickly, resulting in water-deficient conditions. The talasiga soils are the first to be affected by drought, but water availability is a limitation to cropping in most of the soils of the island. Particular importance therefore attaches to those sites where supplies are available from the water table, and especially to land below spring sites where shallow-rooted annual crops can normally obtain water even in long dry spells.

Nutrient availability is subject to a complexity of factors, including texture, structural instability, amounts of carbon and nitrogen, phosphorus reserves, exchangeable calcium and potassium, pH, cation exchange capacity and base saturation. The relevant data for the humiferous horizons of the Lakeba soils are presented in Table 6.1. There is a broad correlation between vegetation cover and the amounts of organic matter and major nutrients. Soils under talasiga are poor to very poor in organic matter, and deficient in nitrogen, phosphorus, calcium and potassium. This is determined by the 'index of biological activity', being the emission of carbon dioxide per square metre per hour (Bacheler, 1968), obtained by methods discussed elsewhere (Latham and Denis, 1979). On the talasiga-bearing soils (Acri-Cambisols, Ferralic Cambisols and Chromic Luvisols) emissions are generally below 50 mg/m²/hr, whereas on soils under forest (Humic Cambisols, Eutric Fluvisols, Humic Gleysols) emissions higher than 100 mg/m²/hr were measured.

Soil deficiencies are less readily evaluated. The only general deficiency of Lakeba soils is in nitrogen, but potassium is also low when it is considered that root crops are large consumers of this element. Phosphorus reserves are high, but assimilability of this element is uncertain. A more detailed study might reveal deficiencies in micro-nutrients which could be of considerable importance; the Institute de Recherche des Huiles et Oleagineux in the New Hebrides found the addition of such micro-nutrients to have a major effect on coconut production, and it is possible that this is the case for the wide range of similar soils, as similar results have also been reported from Papua New Guinea and the Solomon Islands.

In general, it can be concluded that edaphic constraints are least on the alluvial and coastal plains, in the swamps and on steep slopes under forest; though generally deficient in nitrogen and potassium, these are the soils least liable to drought. The talasiga areas, which cover some 40 per cent of the island, have, on the other hand, an extremely low fertility.

Morphodynamic conditions

It has already been shown that erosion rates on forested catchments may be as high as on talasiga catchments, and that both are of a high order (Latham, this volume). The fact that forest soils on slopes of 30-60 per cent are very liable to erosion after clearance is amply confirmed by the work of Servant (1974) on comparable slopes in Tahiti; during the wet season, he found erosion
rates of 1500 tonnes/km²/month, more than ten times the index calculated by the 
present author in the forested Kaitabu basin of Lakeba. The most 
vulnerable soils would seem to be the Hemic and Eutric Cambisols, which may 
explain the long fallow periods traditionally used in such situations in 
Fiji.

Soil structure is almost as important as steepness in determining 
vulnerability to erosion. The Ferralic Cambisols and Chromic Luvisols are 
particularly weakly structured, and rapid gullyng has been observed on 
Chromic Luvisols even on gentle slopes. A striking instance is the deep 
gullying of the drainage ditches alongside the airstrip, which in places 
reached a depth of nearly five metres in less than four years; rapid runoff 
and structural instability are the main predisposing causes of this alarming 
erosion.

Allied to erosion is deposition. The deposition of silt on flat 
stretches of new forestry roads in the interior of the island is destroying 
the utility of these roads almost as rapidly as gullyng and sweet erosion 
on the steep pitches. Measurements of the importance and speed of silting 
in the swamps of the island are reported elsewhere (Latham and Denis, 1979).
In view of the small size of the island much silt is carried rapidly into 
the sea, and the impact of flooding is more apparent in the destruction of 
rao plants in irrigated plots than in any visible change in the morphology 
of the plains. It is none the less very probable that aggradation of the 
plains is a continuing process, and also that there continues to be deposition 
of colluvium on terraces in valleys draining the talasiga country. There is 
an important difference in effect according to the source area: material 
derived from the forest areas may increase fertility in the swamps and on 
lower slopes, but material derived from the talasiga is likely to reduce 
rather than enhance the qualities of the soil. Considering the high 
proportion of talasiga land in most of the catchments, the effect of de-
position is probably more often negative than positive in terms of soil 
fertility in the valleys.

Technical considerations

Even though little use may be made of them at present, there are 
technical possibilities for the amelioration of constraints, and by no means 
all of these demand the use of high technology; many are already known in 
Fiji and other parts of the Pacific. Erosion can be controlled and reduced; 
the depth and texture of the soil can be improved for better root-penetration; 
the mineral content of the soil can be improved by fertilization; hydro morphic 
zones can be drained.

In protection against erosion the vegetation cover is of prime impor-
tance. Fire prevention is the first step, and where this is accompanied by 
aforestation, as on Lakeba with pines, the results are likely to be of a 
dramatic order. In cultivated areas, it is possible to encourage a suitable 
fallow cover by planting fast-growing ground plants, or trees as in the New 
Guinea highlands. Use of perennial rather than annual crops on steep slopes 
is also advantageous. The length of uncovered slopes can be shortened by 
terracing, the construction of contour ridges, or planting of contour-line 
hedges of densely-growing plants such as Cymbopogon to check runoff. Mulching 
and manuring improve soil structure and hence resistance to gullyng. All 
these practices are incorporated in the traditional agriculture systems of 
different Pacific societies.
### Table 6.2: Evaluation of the Agricultural Quality of Lakeba Soils

<table>
<thead>
<tr>
<th>soils units</th>
<th>edaphic limitations</th>
<th>agronomic limitations</th>
<th>investment required</th>
<th>land class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eutric Fluvisols</td>
<td>Possible hydrology</td>
<td>Mechanization and fertilization</td>
<td>Contour cultivation, protection against fire</td>
<td>A</td>
</tr>
<tr>
<td>Haplic Fluvisols</td>
<td>Hydrography, low fertility, high acidity</td>
<td>Contour cultivation, protection against fire</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Haplic Cambisols</td>
<td>Calcareous sandy texture</td>
<td>Contour cultivation, protection against fire</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Haplic Cambisols</td>
<td>Low fertility</td>
<td>Contour cultivation, protection against fire</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Haplic Cambisols</td>
<td>Weak slope</td>
<td>Contour cultivation, protection against fire</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Haplic Cambisols</td>
<td>Very shallow</td>
<td>Protection against fire</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

One technical skill is still employed on Lakeba -- drainage of the swamps for taro cultivation. However, so many areas of formerly-drained land have now been lost that it would probably require major works to re-establish cultivation in some of the larger swamps.

### Possibilities for technical introduction

There is as yet very little use of imported energy in the agriculture of Lakeba, but given the relatively low population density it would seem that no large extension of cultivation is likely without it. The coastal plains and occasional alluvial terraces could grow maize, sorghum or other crops given use of mechanization; the sawing of improved pastures is necessary for expansion in stock-rearing. For such enterprises to be initiated on any scale, the use of tractor-drawn ploughs and harrows would seem essential, and is entirely feasible on the plains with their light soils.

At present very limited use is made of mineral fertilizer, in some food gardens and in the pine nursery. The widespread deficiencies in nitrogen and potassium would suggest that the wider use of imported fertilizer might be attended by considerable improvements in yield. However, both the use of green manure and more careful fallow management are viable alternative or supplementary paths whose specific object is to increase the level of organic matter in the soil. Recently *Combretum pterocarpaceae*, locally called 'centre', has been introduced for this purpose; as a legume it also has the advantage of fixing nitrogen in the soil.

### II - Evaluation of Land Resources

#### The Classification of Land

On the basis of agrological quality, five land classes are recognized on Lakeba. Details are set out in Table 6.2. The classes are as follows:

- **A. Good land without major limitations** and with soil of sufficiently high fertility for a range of crops. Mechanized cultivation would be feasible on this land. The soil types involved are the Eutric Fluvisols and Humic Gleysols of the alluvial and coastal plains, now mainly under coconuts.

- **B. Land of moderate potential**, with some limitations but capable of improvement. These soils either have lower fertility than those in the first group (Histosols; Rendzinas), or have marked liability to erosion (Humic Ferralsols).

- **C. Land of low potential for cultivation**, with major limitations. Most soils are susceptible to erosion, and some (e.g., the Chronic Luvisols) are of low fertility. None the less, these soils could be improved by measures to reduce erosion, such as the cultivation of perennials, or by the addition of fertilizers and planting of legumes to improve fertility. Though difficult to work, these soils have agricultural potential.

- **D. Land of very low potential for cultivation**, with low natural fertility and serious liability to erosion. These are the true talasiga soils (Ferralic Cambisols; Rhodic Ferralsols) which are of such low cropping potential that their only worthwhile use is under trees. This is the land on which reafforestation work should mainly be concentrated.
E. Land of no productive value. Soils in these areas exhibit from one to several major constraints to cultivation, and the land should best be conserved in its natural state and protected from fire.

The wide range of land quality in Lakeba has in the past enabled farmers to employ the potential of different ecological units so as to spread the risk of natural events such as drought and cyclone. In the future it would be possible to make use of this variety to obtain a better balance between cash and subsistence crops within a more varied and more productive agricultural system. It must be stressed that the agricultural and forestry potential of the island as a whole must be classed as quite good. Notwithstanding the large area under talasiga, the agricultural potential of Lakeba gives the island a favoured position among the Lau islands, and this fact has historical importance in that it was the basis for the political dominance achieved by Lakeba in the pre-colonial period.

PRESENT AND POTENTIAL CROPS

The range of crops presently grown in Lakeba is limited, notwithstanding some efforts at new introduction by the agricultural extension services. Coconuts and food crops have been augmented by pines, and are now being further augmented by the creation of pasture. However, greater diversification is possible, together with some re-allocation of land between uses, and a discussion of some land-use possibilities that might be available in a more intensively-developed Lakeba now follows.

Annual crops

A range of crops quite outside the present inventory is entirely suitable for Lakeba, though large-scale production would require some degree of mechanization. The list includes maize, sorghum, dry rice, and especially groundnuts and soya beans. These crops, almost unknown on Lakeba at present, require fairly fertile and deep sandy-clay to clay soils. They could readily be established on the clay soils of the alluvial and coastal plains, and on the Chromic Luvisols of the colluvial areas with heavier addition of fertilizer, in rotation with a legume to provide green manure and increase the organic matter content of the soil. Such crops could be used to feed stock, either locally or elsewhere in Fiji. Cassava could also be cultivated on a larger scale, to supply food for pigs.

Irrigated crops

Irrigated taro is already the most distinctive of Lakeba's food crops, even though they may have taken second place to yams in a bygone time. The system of taro cultivation is intensive, and varied, and is described elsewhere by H. Brookfield (this volume). Wet rice has been introduced on a trial basis in the past, but abandoned, and the hrenched padi plots now returned to taro. It could, however, be tried again, and it might be noted that islanders on Kadava have turned their taro beds into rice padi plots with success. In view of the large local consumption of rice, and the possibility that problems experienced by taro cultivators through disease elsewhere in the region may strike Lakeba, it seems wise to sustain experimentation with rice.

Dry-land subsistence crops

The wide range of present dry-land subsistence crops is well suited to the natural resources of the island. Some concern should be expressed at the recent extension of yasawa cultivation on Humic Oxisols in the forest patches, but as this is a long-term crop the principal consideration is the management of the fallow period. The 'less-demanding' subsistence crops -- cassava and sweet potatoes -- are the dominant crops on the poorer soils of the Chromic Luvisols and of the Eutric Cambisols under reed thickets; with care, the use of these soils could be extended.

Improved pasture

The recent increase in cattle numbers has raised the possibility of creating improved pasture under coconuts. Animals are generally pastured in fenced areas of natural grassland on the plains, and are cultivated within. The native grassland flora is poor in fodder, and successful trials have been made with Koroniya grass (Isokoria humida) and the leguminous 'centro' (Centrosema pubescens) discussed above in another context, and with 'stilo' (Stylosanthes graminea), but the systematic creation of pasture has not yet been essayed in Lakeba. Experience elsewhere has shown that it is entirely possible to create good pasture under coconuts, given mechanical cultivation and the addition of fertilizer.

Attention may also be called to experiments on the Nausori Highands in Viti Levu, where some areas in forestry plantations have been fenced off for stock breeding. Without the introduction of fodder species results might be disappointing, and would certainly be so in Lakeba, where the talasiga vegetation includes no grass flora comparable with that in the Nausori Highands. Trial introductions of Koroniya grass, 'stilo' and Nadi Bluegrass (Plicachlamys ornati) have been made under trees in a lowland talasiga site near Tubu. These trials need to be extended, and consideration given to possible conflict between the forestry requirement of a closely-spaced stand of trees and the pastoral requirement of wide spacing to permit light to reach the soil.

Tree and shrub plantations

Coconuts presently cover about 20 per cent of the land area of Lakeba, occupying especially the Eutric Luvisols and Rendzinas. Though the trees are old, yields still averaged 0.54 t/ha in the early 1970s (UNESCO/UNPFA Project, 1977). When the question of replanting arises it will be necessary -- or desirable -- to make a rational decision between continuing the monoculture of copra, mixing coconuts with cattle or field crops, or replacing some areas of coconuts with new field crops discussed above. The spacing of trees, and the varieties that might be planted, depend on the choices made.

Mention may be made of the possibility of establishing coffee on Lakeba. Though this crop is virtually abandoned in Fiji after the introduction of leaf-rust (Hemileia vastatrix) (Wyford and Wright, 1965), Robusta coffee is hardly affected by this fungus, and its establishment would help diversify the cash base. The relatively dry climate of Lakeba would be of advantage. Forestry plantations

Pipturus crassicaulis was first planted in Lakeba more than a decade ago, and the planting programme envisages the almost complete coverage of the present talasiga country with pines. The edaphic requirements of Pipturus crassicaulis are modest, and the trees grow satisfactorily on these soils. The best growth is achieved on the Aeric Ferralsols and Chromic Luvisols, but results are
encouraging even on the Ferralic Cambisols (Table 6.3). Unfortunately, the
effect of cyclones on the pine plantations is disastrous. About a quarter
of the area was destroyed by Hurricane Val in 1975, and many others were
bent. For this, and other reasons, there would be a case for diversifying
the planting programme to include other tolerant species.

TABLE 6.3: GROWTH OF PINUS CANTHARCA ACCORDING TO SOIL

<table>
<thead>
<tr>
<th>SOIL</th>
<th>MEAN HEIGHT</th>
<th>MEAN DIAMETER</th>
<th>PERCENTAGE OF TREES LIVING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m</td>
<td>cm</td>
<td></td>
</tr>
<tr>
<td>Acric Ferralisols</td>
<td>4.2</td>
<td>26.9</td>
<td>75</td>
</tr>
<tr>
<td>Chronic Luvisols</td>
<td>4.7</td>
<td>27.4</td>
<td>76</td>
</tr>
<tr>
<td>Ferralic Cambisols</td>
<td>3.5</td>
<td>19.0</td>
<td>76</td>
</tr>
</tbody>
</table>

Note: Measurements were taken on trees four years old, with a sample of 60 individuals for each soil category. Dead trees were not measured.

SUMMARY OF LAND SUITABILITY FOR AGRICULTURE AND FORESTRY

Assessment of the suitability of land for crops and forestry has been made in accordance with the propositions of FAO (1976) which emphasized the
importance of evaluating the likelihood of success of a project in relation
to the investment necessary to achieve success. The summary presented in
Figure 6.1 presents the possibilities for development as a function of the
quality of the soil, offering a range of choices rather than a single
recommendation.

Four levels of land suitability for productive use are recognized on
the map:

1. Land with very high development potential, on which development would
have a high chance of success without a large investment. For example,
the establishment of pasture or field crops on the alluvial and coastal
plains involves no initial investment beyond clearing and planting.

2. Land with high development potential. Here a moderate investment would
lead to a good chance of success. Two examples may be cited: the
establishment of crops on the Humic Ferralisols with measures to prevent
erosion; more intensive cultivation on the Chronic Luvisols, which would
require a large addition of mineral and organic fertilizer before
precropping could begin.

3. Land with low development potential. On such land a considerable
investment would be required for the possibility of only a marginal
return. This is the case with cultivation on the Acric Ferralisols, or
field treeing on the Eutric Cambisols.

4. Land unsuitable for development. On this land there is either no chance
of success, or else the investment needed would be so great that no
profitable return could be obtained. Land in this category should be

conserved in its natural state and protected from fire and clearing
by man. A possible exception may be made of the mangroves, since
while the thin soil covering of Typhonic Fluvisols over coral flagstone
would result in failure, the establishment of aquaculture in some sites (UNESCO/UINFE Project, 1977, p. 92-93). However, the timber resources of the
mangroves should be protected, in view of their importance to the marine
ecosystem.

Unfortunately, this classification has had to depend heavily on
empirical observation, because very few experiments have been made in this
part of Fiji. We have taken all observable variables into account, including
the characteristics of the soil, the state of the natural vegetation, the
environment in general, and the known edaphic requirements of the various
crops discussed. A wide range of development possibilities is indicated;
only the mangroves and some very steep and rough ground are quite unsuitable
for cultivation or planting with existing technical means.

III - TOWARD RURAL DEVELOPMENT ON LAKBEA

Successful rural development needs to take account of the two priorities:
both an increase in production, and also the protection of the soil -- which
is the basis of production -- against degradation and erosion. Three issues
are selected for discussion in the light of these twin priorities: the
intensification of cultivation on the fertile land of the valleys and the
coastal plain; the protection of hill-sides under forest and reed thickets;
the reforestation of the talasaiga-covered hills.

INTENSIFICATION OF CULTIVATION IN THE VALLEYS AND ON THE COASTAL PLAIN

More intensive development of this good land should be the first stage in
planned rural development of Lakeba. Development depends on replanting
the ageing coconut stands, on the extension and cultivation of improved
pasture on the plain and on the cliff-land slopes, and on the introduction of
mechanized cultivation with use of mineral and organic fertilizers.

Possibilities for crop diversification are seriously limited by the
present extension of coconuts over almost the whole of the fertile flat land
and the alluvial and coastal plains. Coconuts can be combined with other
types of agricultural production, whether the palms remain as continuous
groves or are merely used as boundary markers between fields, as in parts
of southeast Asia. The random planting of most of the present stands
mitigates against combination with other activities, including the establish-
ment of improved pasture which would demand mechanical cultivation of the
soil. With random planting it is also impossible to reach a balance between
the sunshine requirements of other crops and the shading of the coconuts.
The present association is unsatisfactory, and prevents maximization of the
agronomic potential of a valuable land resource.

The colluvio-alluvial terraces also have a significant agricultural
potential. At present these areas are only lightly included in cassava plots because of their low fertility. There is some planting of
Pinus Cantharca, in the airstrip valley for example, and as this has been
successful further extension is envisaged. However, with the addition of
fertilizer and the possible use of mechanized cultivation these soils would
be suitable for the establishment of crops such as maize, sorghum or ground-
nuts, with a good chance of success. Before the whole area is planted with pines it would be as well to investigate these more rewarding possibilities more thoroughly. Lakeba may not yet be ready for more intensive agriculture, but the time may come, and it is not wise to neutralize the potential agricultural resources without taking account of possible future needs.

THE PROTECTION OF HILLSIDES AGAINST EROSION

The hillslopes under forest and reed thickets are of some present importance for the cultivation of subsistence crops and yaqona. Shifting cultivation methods are used, and as has been demonstrated many times in mainland Fiji, they lead ultimately toward a general impoverishment of the environment. Several modifications of the present utilization of these hillslopes can be suggested.

First is the introduction of perennial crops, which can initially be grown with annuals but in a few years replace them. Coconut stands are sometimes established in this way on Lakeba hillslopes, but there are other possibilities with shrub crops, such as coffee. The growing concept of mixed use of forest is also applicable, following practices long developed in Indonesia and the Philippines. Forest species with useful timber and fruit are planted together with crops, regenerating the forest while augmenting the number of useful trees.

The planting of leguminous cover crops would also assist regeneration, and facilitate the recovery of natural or planted forest. Crops such as Centrosema pubescens and Pueraria phaseoloides could be planted after the cultivation of annuals is finished. Not only would they improve soil fertility, but they are less invasive than the 'mile-a-minute' [Macaranga micrantha] which, together with species of Jeponta, now occupy the clearings very rapidly and impede natural reafforestation by suffocating young tree growth.

Lastly, the building of terraces and earth ridges along the contour after clearance of the forest and before planting of yams and taro would restrict soil erosion; even cultivation in narrow belts along the contour without earthworks of any kind would have some beneficial effect.

REAFFORESTATION OF THE TALASIGA

The effect of Pison cariboea planting on the talasiga soils has been discussed at some length in an earlier report (UNESCO/UNFPA Project, 1977, p. 51-64). These plantations not only allow the restoration of degraded soils, changing the structure of the A horizon and significantly affecting its chemical characteristics and biological activity; they also encourage the absorption of water into the soil, and hence reduce runoff and regulate stream flow. If this second effect is not yet very conspicuous, this is due to the youth and limited size of the plantations, and it will become more evident as the pines increase in age and area. Not only is the hydrological regime likely to be modified significantly, but the reduction of erosion from the hills will also reduce the accumulation of infertile material in colluvial zones in the valleys. While we may express some doubts concerning the wisdom of Pison cariboea planting on the valley colluvium, there seems no question of its utility on the hills, and the programme should extend across the whole of the Lakeba uplands as rapidly as possible. Except in so far as some of the talasiga 'para-forest' on the bauxitic plateau areas might be spared to add variety to the landscape and conserve a very distinctive vegetation complex, nothing but good can come of the replacement of talasiga by pines, and perhaps other trees also, throughout the Lakeba hills.

A programme on these lines would both permit a major increase in rural production, bringing the larger part of the island into productive use; it would also assist in maintaining the rather delicate ecological balance of the island, and halt the degredation that seems clearly to be continuing at the present time.

CONCLUSION

The land resource potential of Lakeba is large and diverse. Nearly 30 per cent of the island is capable of agricultural or pastoral development, and the diversity of the environment would permit the cultivation of a large variety of crops. However, any programme of intensification would need to take account of the serious morphodynamic constraints which are an integral part of the environment. Erosion of the slopes, and the deposition of infertile material down-slope, are the principal ways in which the environment is currently being degraded. It can be argued that some measure of diversification and intensification is necessary for the preservation of the present agricultural environment, as well as for future expansion of agricultural and pastoral production. Such a programme would also improve the resistance of both economy and environment to natural hazard arising from drought and hurricane. Dependence on, and vulnerability to external forces of both human and natural origin, which is so much a characteristic of the present environment and its utilization (McLean, 1979), would certainly be reduced.

ACKNOWLEDGEMENTS

Work in the field on Lakeba was greatly aided by the generous co-operation of Villami Osborne (Osipam) and Faitake (Fred) Mua of the extension staff of the Agriculture Department. Members of the Division of Mineral Resources in Suva were generous with their own material on the Lakeba environment, and the Ministry of Agriculture were of major help in the analysis of soil samples, and in assisting me to identify plant specimens. The paper was first written in French, and a close translation into English was made in Noumea by Dr Helen Brinon. The editor then prepared a free translation, which appears above, using both these manuscripts.

1 However, see also M. Brookfield (5.7 below) on the question of fire risk. The recommendation here assumes the provision not only of wide fire-breaks, but also of adequate means for fighting fires.
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5.7 RESOURCE USE, ECONOMY AND SOCIETY:

ISLAND AT THE CROSS-ROADS

Muriel Brookfield
(University of Melbourne)

I LAND USE AND RESOURCE DEVELOPMENT

Change through time
Land use and agricultural practices
Wet crop gardens
Dry crop gardens
Coconut and copra
Livestock and fish
The pine scheme: reclamation of the talasiga?

II LAND DISTRIBUTION

The mapping of land holdings
Measurement and perception

III THE ANALYSIS OF INCOME AND EXPENDITURE

The analysis of income
The analysis of expenditure
The balance of income and expenditure

IV THE CHANGING SOCIAL ECONOMY OF LAKEBA

The social organization of production
Classification of resource users
Two Lakebas, and the future

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INTRODUCTION

In the preceding papers the environment of Lakeba has been analyzed in considerable detail. The present paper turns to the use made of its resources and opportunities by Lakebans, and examines their income and expenditure patterns, and the social economy of an unusual island. The work reported here is based on the principal village and quasi-urban area, Tubou-Levuka, and to a lesser degree on nearby Macwaci; surveys were carried out in these communities, and the countryside around them was explored in detail. Less intensive work was carried out in all other villages. On the northern side of the island the project has already available the account of Yadana and Nasauilau by Bayliss-Smith (1971), some findings from which have been incorporated here. My attempt was to provide a comprehensive account of the use of resources and of the island economy. Inevitably there are gaps, for though I lived several months on the island, Lakeba and its society are not easy to understand. A substantial part of my work was also taken up with the effects of a hurricane which struck the island 12 months before my arrival, a study which is reported elsewhere (M. Brookfield, 1977). Much more could have been done with longer residence, even though I was the last member of the project to leave Fiji in November 1976. I left the island reluctantly, for I had become fascinated by its bare hills, surprising valleys, ever-changing lagoons and diverse attractive people. Even though the message of this paper is uneasy in terms of the prospect facing Lakeba in the future, I hope I have reported faithfully on the present condition of the island, and that my findings will be of some help to those whose decisions may assist the islanders to achieve more satisfaction from their efforts, and make more effective use of this infinitely varied island and its resources.

The first part of this paper deals with land use. I then go on to an analysis of land distribution and the social economy of the island, seeking to identify the human use systems which manage the island resources. A third, more quantitative section examines the income and expenditure of Lakeba and of the Lakebans, perhaps more comprehensively than in any other of the project's island surveys. The analysis of the massive body of data on which this section is based has taken a long time, and I apologize to my colleagues and readers that it is three years after field work that this report is produced.

I - LAND USE AND RESOURCE DEVELOPMENT

CHANGE THROUGH TIME

Viewed on a small scale, the present distribution of settlement and land use on Lakeba is characteristic of any developed and well-populated Pacific island. Eight villages lie either on or close to the shore, linked together by a circum-insular road. The island is almost completely gridled by coconut groves and most food crops are grown a little way inland. There is no settlement in the interior, but when the island is examined more closely an a-typical proportion of the cultivation lies deep inland. This situation is largely a creation of the last century and a half. Before the early 19th century most villages were located inland, and old fortified sites on the high ground were still occupied periodically in time of warfare. Much of the coastal plain was still under forest, and cultivation of a subsistence nature was both more concentrated than today and also more intensive in its application of labour and skills. An exchange economy which flourished in
the 18th century, in which Lakeba at first dominated Lau and then was in turn dominated by Tongan invaders, brought people and settlement to the coast, fertilized the fringe of coconuts, and accelerated the rate of innovation by which the economy and land use of the island have been transformed.

By the early years of the present century the present pattern was becoming established, with growing dependence on a commercial tree crop; the physical form of the land use pattern concealed a dualism that has only by degrees diminished. Most food was still grown on the island or obtained from its surrounding lagoon, but other requirements were being bought with copra incomes which also financed the building of churches, the purchase of boats and paid the taxes levied by both colonial government and the church. Two large blocks of land had been alienated on lease, and were developed as copra estates with resident managers and workers: this land only more recently has reverted to Lakeban ownership. Since mid-century there has been a shift to increasing dependence on imported foodstuffs, paralleled by growing interest in the cultivation of cash crops with which to pay for needs that now include education, store-bought foods, cigarettes, communication with relatives elsewhere, stronger housing and furniture, oil for cooking and lighting, radios and -- in Tubou since late 1976 -- also electrical appliances. The last decade has seen both a substantial increase in copra production and a search for additional or alternative cash sources. This search has been pursued with renewed vigour since copra failed temporarily as an income source in the dual aftermath of market collapse and a violent hurricane in 1975 (M. Brookfield, 1977; Bayliss-Smith, 1977).

LAND USE AND AGRICULTURAL PRACTICES

The writer's initial task in Lakeba was to construct a map of land use. Intendedly, this task was closely linked to the project's work on soils, vegetation and geomorphology which required to be complemented by examination of the use of natural resources. With the advantages of much longer residence on the island than other project members, however, it became possible to extend this study into the social and economic context of Lakeban land use, and hence into a study of Island society and economy as a whole. The twofold basis of all this work were, however, the land-use map and a household study of the population in the southern villages. The whole discussion that follows therefore grows out of the land-use inquiry, and presentation properly begins here. Because the relationship of land use and environment is taken up in two other papers in this Island Report this aspect is touched on only briefly; greater emphasis is given to agricultural practices and their social and economic context.

Land-use map

The method of survey was initially standard. A preliminary map was prepared on the 1: 12 500 scale which became available to us in 1975, simply by plotting from low-altitude air photography (1500 m) taken in 1970. This map was then checked, amended and updated during field traverses over all parts of the island. Many additional garden sites were discovered under

1 Sample household inquiries were carried out in the northern villages of Yadranra and Nasaqaleu by Bayliss-Smith in 1975 (Bayliss-Smith, 1977), and with the aid of J.R. Campbell data were also obtained from Nukunuku households in 1976.

trees and coconuts, invisible from the air. After some experiment with finer classification, ten classes of land use were ultimately recognized. A revised version of the map appears as Fig. 7.1. Table 7.1 below summarizes the distribution of land use classes.

<table>
<thead>
<tr>
<th>AREA</th>
<th>PERCENTAGE OF LAND AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ha</td>
<td>%</td>
</tr>
<tr>
<td>CROP LAND</td>
<td></td>
</tr>
<tr>
<td>Coconuts</td>
<td>1101.2</td>
</tr>
<tr>
<td>Gardens with coconuts</td>
<td>67.1</td>
</tr>
<tr>
<td>Wet crop gardens and fallow</td>
<td>83.9</td>
</tr>
<tr>
<td>Dry crop gardens</td>
<td>89.4</td>
</tr>
<tr>
<td>NON-CROP LAND</td>
<td></td>
</tr>
<tr>
<td>Pine plantations</td>
<td>872.0</td>
</tr>
<tr>
<td>Forest; swamp and beach forest</td>
<td>598.1</td>
</tr>
<tr>
<td>Swamp</td>
<td>50.3</td>
</tr>
<tr>
<td>Village land; schools; airstrip</td>
<td>1006.6</td>
</tr>
<tr>
<td>Unused, mainly talasiga</td>
<td>2627.3</td>
</tr>
<tr>
<td><strong>5589.9</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Note: Data obtained by weighing cut pieces of a copy of the land-use map on stable material by torsion balance. Areas adjusted on percentage basis to the total land area of the island determined by Tektronix digitizer. Mangrove areas excluded. These measures replace earlier estimates published by the project.

The location and distribution of crop land

The most striking feature of both map and table is the small area actually used for farming. Excluding the pine plantations, it covers 24 per cent of the island, but food crops are planted on only 4.3 per cent of the land area, 240.4 ha or 0.12 ha per head of the 1976 census population. Nor is this small crop-land area clustered around the villages; a high proportion is inland, and in fact radiates from the central high part of the island in scattered patches and narrow strips down the valleys towards the coast, terminating within the frill of coconuts that surround the island. Visually, the pattern is of a water-seeking agriculture, and the whole aspect of the land use map, in so far as it concerns agricultural land, recalls to mind the semi-arid regions of south-west Asia as glimpsed from the windows of high-flying aircraft. A primary reason emerges in Latham's (this volume) discussion of the significance of drought in Lakeba, and his emphasis (this volume, b) on the varying soil-water retention capacity of Lakeba soils. More striking confirmation of the significance of drought and soil-water conditions as primary determinants of the distribution of Lakeba crop-farming could hardly be sought than in a study of the land use map. There is very little cultivation on the talasiga, except on the Chronic Luvitizal of the colluvial areas, but each of the valleys -- and especially those best provided with permanent water -- descending toward Tubou and Yadranra, and inland of Wabatu, carry almost continuous chains of
wet crop gardens on the valley floor and dry crop gardens on the lower slopes. This pattern would have been even more striking before 1970 when the Pine Scheme was initiated and when there was no airstrip. The greater part of the island would then have appeared blank as uncultivated land, broken only by the tightly constricted chains of cultivation in the valleys.

Two other features of the map demand attention from the ecological point of view. One is the association of dry crop gardens with the inland forest patches, where the Humic Cambisols are being utilized. With the recent expansion of yacca cultivation discussed below, there is a somewhat disturbing recent increase in the use of this land. Second is the very small amount of crop land in the coastal plain, except for patches strung mainly along the circum-insular road together with convenient dry crop gardens in the immediate vicinity of villages, and a few areas of wet crop cultivation remaining in sub-coastal swamps mainly in the north. It is not only the 'coconut overlay' described elsewhere by the project (UNESCO/UNPFA Project, 1977; Latham, this volume, b) that restricts the use of this land for food crops. Also important has been the large and probably growing numbers of village livestock, pigs and more recently cattle, which had often wandered unchained, and have damaged crops or trampled irrigation systems. According to the Lakeba people there is also much theft from gardens in accessible spots. For both these reasons most of the crop land in the coastal plain is fenced, whereas inland gardens are not protected in this way.

WET-CROP GARDENS

While ethnologists who visited Lakeba before World War II (Hecart, 1929; Thompson, 1946) are firm that yams, the most important crop for ceremonial purposes, were the staple crop on Lakeba, this is certainly not true today. Nor do the older inhabitants interviewed remember yams being grown as much as taro in their youth. Though taro may be exceeded by cassava in volume of production, it is the crop which demands the greatest effort, and the food which is mostly highly prized. While a small proportion of Colocasia esculenta, and all the more recently introduced Xanthosoma, are grown in dry fields, the main output of taro in Lakeba still comes from irrigated/drained fields in the valley and sub-coastal swamps. These systems are certainly ancient, and the recent decline in their area has already been reported above (Latham, this volume, b). On Fig. 7.1, the swamp land category is described as 'swamp, partly used for taro in the past' because almost all the swamp land still carries physical evidence of former ditching, visible either on the ground or in air photographs.

Despite their small area, the swamps and other wet areas are capable of yielding far more taro than is required by the resident population. This enables the Tui Nayau, other chiefs and islanders to extend hospitality to visitors, and to send food to other islands in time of need. Lakeba was traditionally regarded as the 'food larder' of central and southern Lau, and this is one reason for its pivotal place in the Lauan political system, and in linkages with Tonga and the Fiji island groups to north and west. The Lakeba wet lands are a resource envied by the people of other less-favoured islands.

Types of wet crop gardens

Three main types of wet crop gardens are encountered:
Swamp taro gardens, made by digging ditches to carry off excess water and control the flow of water to the plots, as the plant requires different amounts of water at different stages of its growth. In the upper Tubou valley under Kadavu is the outstanding example, and is illustrated in Fig. 7.2a.

Valley gardens, fed by diverting stream water to valley-side plots, as in the Yadra valley (Fig. 7.2b).

Stream-bed gardens. These are usually very small, and occur either in the valley’s heads or at places lower down where the stream has become incised, or meanders, so that taro may be grown on low terraces alongside the incised stream or in the meander loop. Good examples occur at Yessby, near Magatalacca, and behind Nausuva. All possible sites are utilized. Even where streams are ephemeral small taro patches are encountered wherever the underground flow rises close to the surface, and hillslope sites immediately below springs often carry taro.

In the swamps, taro gardens usually take the form of a series of roughly rectangular plots separated by channels and cross drains, with an occasional raised path to facilitate movement. Plots are purposely not regular, as irregularity slow the flow of water. In some cases (Fig. 7.2a) gardens are crescentic to conform with the configuration of stream and valley. There is no uniform plot size, or uniform distance between rows of plants; each farmer has his own preferred methods and varieties of taro, and each will normally leave at least half his plots in fallow. A view of the swamp gardens is one of plots of ordered green plants, alternating with plots of weeds by a thick herbaceous tangle of weeds and yellow flowers, often stepped in height according to the length of fallow.

Planting methods

Preparation of the ground is by hand. There is only one tractor on the island, and it can be used in the swamps only under dry conditions. There is no set planting season and taro may be put into the ground at any time; however, planting varies in difficulty according to the level of soil moisture. The number of plants per hole may also vary. There are two main methods of planting, known as biji and lauvo.

Biji (or biti): This is the Lauan term for the more elaborate of the two methods, which requires the larger labour input at time of ground preparation. It is known in some parts of Fiji as 'tuki tuki' -- a term which in Lakeba refers to the raised pathway between the biji plots. On the first day the plot is cleared by cutting the weeds; these are put aside and may be burned when dry. On succeeding days the ground is completely tilled with a spade, the soil being turned over down to below the water table. The aim is to make a raised bed above the surrounding water channels. Time required depends on the wetness of the soil; a sample quadrat of five m², under good conditions, took one hour to clear but nine hours to dig, spread over as much as three days. The plot is then left untouched for about a week to dry out; during this time the channels and ditches are cleared and cleared where necessary. The channels are then blocked before planting, when the ground is about dry. Taro suckers -- that is, the top of the corn stalk, are taken from mature plants harvested earlier. Holes are made with a digging stick, or seupa, down to the water table; the stick is pulled backward and forward to make a good vertical hole in which the sucker is placed. When the plants have grown to a height of about 25 cm and two or three leaves are showing the ditches are unblocked and water flows between the plots. From this time on the plants need more and more water, and about three and a half weeks before harvest weeding is needed with the biji method than with lauvo, but both plot and drains must be kept clear. The first weeding takes place after the first month, occupying about one hour per 5m², and a second weeding may not follow for several months, though farmers differ in practice and preference. Most plants mature in nine months, but others such as the Samoa variety can take 12 months and are usually considered better eating; a few varieties may be left in the ground up to two years without rotting. Insect and rodent damage may occur during dry periods, affecting both leaves and the taste of the corn, and when this happens it is best to leave the taro in the ground until wet weather has resumed.

Lauvo: This method is quicker, the digging stage being omitted; the ground is both cleared and planted at the same time. It is favoured when farmers have planting material which they wish to get quickly into the ground. Holes are made with the digging stick, as in biji; the planted suckers are then left standing with no soil packed around them. Corms grown by this method are smaller and less tasty than those grown by biji; the plants grow to a lesser height, and weeding is required more frequently -- about three weeks after planting, then almost monthly.

A third method described, but nowhere seen in the field, is the vuci or vakanawa method, which is most similar to the padi method of rice cultivation. Water is diverted across the surface of the prepared ground and the crop stands in flowing water. This method, also described elsewhere in Fiji, approximates the conditions of terraced cultivation still utilized in several parts of the Pacific including Viti Levu, and to be seen in its most highly-developed form in New Caledonia. There is no physical evidence of former terraced plots in Lakeba. Some changes in practice are reported. The former sequence of work was first to attend to the drains, then to make the paths, and only then to clear and plant the land. Today the land is cleared and planted first, and the drains are attended to later. The biji and lauvo methods for irrigation are not restricted to specific areas; in fact they can be found in adjacent blocks, sometimes belonging to the same farmer.

Taro is the only crop grown in the swamp area, sometimes for two seasons consecutively. It is not uncommon for two or more suckers to be planted in one hole; as many as four were seen occasionally. The resulting corms are smaller and shorter, and the distance between holes has to be increased to allow for the heavier planting. Row may vary from 0.5 to one metre apart, and distance between plants may increase from 50 to 80 cm.

Information from farmers suggests that the decision on planting density is taken in relation to moisture conditions; single planting is a wet-season practice, while in dry periods multiple cropping is preferred.

Varieties of taro

Though all taro in the swamp is Colocasia amanita, most farmers grow several varieties. This is partly by choice and partly by necessity; in 1976 there was still a shortage of planting material after the damage done by...
Hurricane Val in January 1975, and any material that came to hand was still being used — from relatives, other islands, the Agriculture Department or the Hurricane Relief Committee. Sometimes four or five varieties, planted at different times, could be seen in one small plot. The better varieties are generally planted at the top of the block, where water is best, and sometimes there was an edging of smaller and younger plants close to the water channel and in the lower section of the block. The 1975 hurricane did very serious damage by flooding, washing out many plants and causing others to rot in waterlogged conditions. Many people went hungry, and an official re-planting target of 100 plants per months was set for each household by the Island Council. Because of supply difficulties, and differing size of households, this target was only very variably achieved.

Yields of taro: For this reason some doubt must be attached to the yield values obtained by Haynes (1976). Part of his table is reproduced in Table 7.2, and shows very considerable variation. With hindsight, it should be added that Haynes' work was done at the beginning of concentrated project work on Lakeba, just before his own departure from Fiji; the selection of sample farmers and plots could have been improved a few months later. While the mean yields are good, they probably under-represent the potential production of the Lakeba swamps.

**Table 7.2: Yields of Taro in Lakeba in Tonnes/ha**

<table>
<thead>
<tr>
<th>Weight</th>
<th>Mean</th>
<th>Range</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn fresh weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasagau</td>
<td>17.21</td>
<td>10.30 - 29.42</td>
<td>7.26</td>
</tr>
<tr>
<td>Waitabu</td>
<td>17.45</td>
<td>10.44 - 24.67</td>
<td>7.01</td>
</tr>
<tr>
<td>Tubou</td>
<td>13.75</td>
<td>10.94 - 19.57</td>
<td>3.43</td>
</tr>
<tr>
<td>Corn dry weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasagau</td>
<td>4.44</td>
<td>1.70 - 7.33</td>
<td>1.99</td>
</tr>
<tr>
<td>Waitabu</td>
<td>5.69</td>
<td>3.19 - 8.20</td>
<td>2.50</td>
</tr>
<tr>
<td>Tubou</td>
<td>4.10</td>
<td>3.00 - 5.78</td>
<td>1.08</td>
</tr>
<tr>
<td>Whole plant yield</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasagau</td>
<td>42.11</td>
<td>33.02 - 61.85</td>
<td>12.59</td>
</tr>
<tr>
<td>Waitabu</td>
<td>34.97</td>
<td>20.03 - 49.91</td>
<td>14.94</td>
</tr>
<tr>
<td>Tubou</td>
<td>29.75</td>
<td>19.97 - 38.33</td>
<td>6.52</td>
</tr>
</tbody>
</table>

Data: Haynes, 1976, p. 14

Social and economic aspects of taro production and use

Since each household prefers to eat taro frequently, if not daily, the crop has to be pulled at least once or twice a week. Bunches of four or five corms are tied and carried on a stick, or by horse. Saturday is the main collection day, in preparation for Sunday on which no work is done. Each part of the harvested crop can be used for some purpose. The corn is for preference baked in a ground oven or 'lovo' and has a favoured place in any feast. It may also be steamed or boiled, and already-cooked slices can be fried. The leaves are a good green vegetable, usually cooked with coconut milk (lolo). This dish (rourou) is frequently served with fish. The stem and top of the corn are used as planting material, and a paste can be made from the core which is used in the making of bark cloth (masi) to attach the beaten pieces to each other. Nutritionally, taro has many advantages over sweet potato and the now-popular cassava, having almost twice as much protein and less carbohydrate content. To the islanders, taro is 'real food' (kai dina); the hurricane relief rice was unpopular by comparison.

Regular planting is therefore necessary, and a year after Hurricane Val many farmers interviewed had more than 100 plants in the ground at different stages of growth. Table 7.1 sets out the result of a question on this topic asked in household surveys. While most figures reported were in multiples of 500, corresponding with reports made to satisfy the agricultural extension officer, a good impression of the quantity and variation is provided. The amount of taro planted is related to size of family, the amount of wet taro land available, and the number of workers; some men with jobs could afford to employ others to cultivate their fields. Numbers calculated on a per capita basis would show gross inequalities.

As might be expected from the size of its taro lands, Tubou village showed the highest average number of plants per household, a number boosted also by the presence of chiefs who grow additional taro to meet their entertainment requirements, and can muster assistance in the work of cultivation. Wage-earning farmers, who could afford to employ labour, showed a higher average than the subsistence farmers (1973 plants/ha vs. 880 plants/ha). The averages for other villages were lower, reflecting a different way of life and less suitable land.

An important factor in present taro production patterns is the distance which farmers have to travel from village to the taro plot. When settlements were in the valleys — korovoua before the move to Tubou; Lagona and Karonna Tua before the move to Waialawi — the taro plots were within minutes walking time from the farmers' homes. In modern times, abandonment of most of the sub-coastal swamp areas has required coastal-dwelling farmers to use taro land in the upper valleys; the centre of the upper Tubou valley is two km from the village, and many plots lie beyond this, in upper valleys difficult of access. This may account for the growing popularity of the lavooro method of cultivation with its lesser work input at the initial stages, and for the poorly weeded condition of many plots; it is perhaps significant that the most active bilo plots seen were in the sub-coastal swamp (solole) only a few minutes walk from Nasagau village, which is still much cultivated despite some problems with disease, and with invasion of the lower parts of the swamp by saline water. It was the problem of distance also that compounded the damage done by Hurricane Val; gardens were often too remote to be reached over mired tracks for waterlogged crops to be saved.

The future of taro in Lakeba

An important element in the present situation is that the largest area

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2 Data in the Food Composition Tables for use in the South Pacific (South Pacific Health Service, Suva, n.d.), show the following values per 100 g edible portion:

<table>
<thead>
<tr>
<th>Food</th>
<th>Calories</th>
<th>Protein</th>
<th>Fat</th>
<th>Cho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava</td>
<td>153</td>
<td>0.7</td>
<td>0.2</td>
<td>37.0</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>114</td>
<td>1.5</td>
<td>0.3</td>
<td>26.0</td>
</tr>
<tr>
<td>Taro</td>
<td>113</td>
<td>2.0</td>
<td>0.0</td>
<td>26.0</td>
</tr>
</tbody>
</table>
TABLE 7.3: NUMBER OF Taro PLANTS PER HOUSEHOLD IN PART OF Lakeva

<table>
<thead>
<tr>
<th>VILLAGE/GROUP</th>
<th>NUMBER OF PLANTS</th>
<th>MEAN NUMBER</th>
<th>STANDARD DEVIATION</th>
<th>COEFFICIENT OF VARIANCE</th>
<th>RANGES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAMPLE SIZE</td>
<td></td>
<td></td>
<td></td>
<td>LIMITS</td>
</tr>
<tr>
<td>TUBOU AND LEVUKA</td>
<td>24</td>
<td>1183</td>
<td>1040</td>
<td>0.88</td>
<td>0 - 3000</td>
</tr>
<tr>
<td>- TUBOU only</td>
<td>6</td>
<td>900</td>
<td>663</td>
<td>0.74</td>
<td>0 - 2000</td>
</tr>
<tr>
<td>- LEVUKA only</td>
<td>18</td>
<td>1373</td>
<td>1227</td>
<td>0.89</td>
<td>0 - 3000</td>
</tr>
<tr>
<td>- Wage-earners only</td>
<td>15</td>
<td>880</td>
<td>572</td>
<td>0.65</td>
<td>0 - 2000</td>
</tr>
<tr>
<td>- Farmers only</td>
<td>15</td>
<td>1127</td>
<td>973</td>
<td>0.86</td>
<td>0 - 3000</td>
</tr>
<tr>
<td>Total population</td>
<td>30</td>
<td>478</td>
<td>644</td>
<td>1.35</td>
<td>100 - 3000</td>
</tr>
</tbody>
</table>

MAGICWACI
- Wage-earners only | 4 | 975 | 330 | 0.34 | 500 - 1200 |
- Farmers only      | 7 | 686 | 393 | 0.57 | 100 - 1200 |
Total population    | 11 | 709 | 428 | 0.60 | 100 - 1200 |

NURUNURO
Total population    | 20 | 478 | 644 | 1.35 | 100 - 3000 |

Excluding chiefly households

Data: Household questionnaire administered to a sample population by the project.

of taro land belongs to members of the most urbanized village, where incomes are high and store-purchased foods are most readily available. This is not applicable to all the people of Tubou, and certainly not to those of Levuka who are virtually landless, and who borrow their taro land from Magicwaci villagers in the Nabunui swamp. Nasagala and Yadraa both have either adequate taro land, or adequate water supply of which they make good use, but the resources of the other farming villages are lean in taro land. Hence the surplus is produced in the northeastern areas and is supplied to the market that used to function in Tubou before Hurricane Val, and to the hospital.

There is a very real fear among older farmers that the centuries-old skills of irrigation and water management are in danger of being lost in Lakeva, as they have been lost in many other parts of the Pacific. Young men are much less interested in garden work of any kind than their families were, and in particular are less interested in the labour demanding work of wet taro cultivation. In 1976 many stagnant drains were visible, creating excellent mosquito-breeding sites; comparison of field observations with the 1970 air photographs on which Fig. 7.2a and 7.2b are based showed an overall decrease in wet garden areas of approximately 50 per cent, particularly in the Tubou valley system. One or two side valleys had virtually been abandoned. Older farmers recall a time when taro was planted almost continuously from the Levuka solove (swamp), immediately behind Tubou, through the old village site at Korovusa right up to the head of the Tubou valleys. Today the Levuka swamp lies unused due to damage by marauding pigs, the Korovusa site is returning to secondary forest, and most of the remaining taro areas are in the head of valleys, away from untethered livestock.

Prospects for future commercialization are difficult to evaluate. If the pae scheme advances to an industrial stage, or if government services in Tubou are enlarged as recommended by this project, there will certainly be a larger market in Tubou itself. At present, however, there is no market for the island except for individually-carried parcels of small quantities taken to other islands; the formerly active inter-island pretation system has virtually ceased. The mainland market is inaccessible because of poor shipping, and the National Marketing Authority does not extend its operations to this far. This situation may improve, but at the time of fieldwork Lakeva had lost its former role as regional supplier, and in face of competition from imported foods the island's taro production was clearly in decline. If this trend continues it will be a great waste, not only of a valuable natural resource in the swamp, but also of the accumulated skills of very many generations. It may be emphasized that few Lakeva households had more than 0.4 ha under taro, yet even a plot of this size could produce 1000 plants or more. With only a fraction of the available land under use it is clear that, given marketing opportunities, there is considerable scope for renewed expansion.

DRY-CROP GARDENS

This second category of crop land, which occupies a slightly larger area than the wet crop land, is very different from the first. A wide range of crops is grown and a wide range of sites occupied. Tuberosous crops are the main users of land, but sugar cane, maize, fruit and a range of green vegetables are included in the gardens. Dry crop gardens are found in contrasted situations: close to villages, far up the valleys often on steep slopes, in the talasiga, in areas of red thicket, under coconuts, and in the forest, as well as the coastal plain and on the limestones (Fig. 7.3). In detail, however, there is a marked association with moister locations, so that dry crop gardens tend to occur as penumbra around the wet crop areas; however, in some parts of the island large blocks of dry crop gardens stand alone (Fig. 7.1).

Many of the dry crop gardens carry several different crops, although blocks of a single tuberous crop are common (Fig. 7.3a,b,c). The mix of crops depends on soil, soil moisture and slope. By far the largest area is now taken up by cassava (Manihot esculenta), and some farmers practice mono-cultivation of this undemanding crop in the talasiga. Sweet potato (Ipomoea batatas) and 'delo-ni-tana' (Xanthosoma sagittifolium) are also found in single blocks, although there may be a border of pineapples, and bananas, or a single row of onions or some other crop. As noted above, some Colocasia esculenta are also found in the dry crop gardens, generally in moister spots. The one dry crop which almost always stands alone is the yam (Dioscorea alata; D. esculenta) although a few onion plants may be inter-planted (Fig. 7.3a). Because of the ceremonial importance of the yam, and the great care that has been taken with soil preparation and growth, tilling a demanding interspersed crop could be harmful. Due to its historical importance rather than its present significance, discussion will begin with this crop.

Yam (vu, Dioscorea alata; kawai, D. esculenta)

Yams hold a special place in Lauan agriculture, as they are the crop grown for special occasions and prestations. They have probably never exceeded taro in volume in the regular diet of Lakevans, at least within living memory, and in any case certainly much more importantly. Each year, the Tui Nayau is still presented with the best of the yam crop from each yam-growing Island in Lau, and there is keen competition to grow the longest yam: the Tui Nayau himself enters this competition, which he has
encouraged in order to foster maintenance of the traditional skills.

Yams are an ancient crop in Lau and there is a great number of varieties within the two main species. Long yams are the most highly prized, and demand the most careful cultivation. There is an important group of wild relatives, in particular 'tivoli' (D. nudicaulis) which is common in the forest, and important as famine food as well as being regularly eaten. Cultivated yams are found in a wide range of situations, even in the talasiga. In the forest they are often grown in association with yamams (Piper methysticum).

For ordinary use, D. alata are planted in tilled mounds, one to each mound, the shoots being trained along horizontal canes between crossed supports to keep them out of contact with the heated earth which might scorch their growth. The network of canes can be extended, and may become very complex in a yam garden of any size. Because of the importance of the crop to the owner, permission must always be sought to visit a yam garden, and great care taken not to step on any part of the network. Frequent weeding is necessary, and weeding every third day is not uncommon. Harvested yams were formerly stored in small houses in the gardens, where they would remain unspoiled for a year or more; this food reserve was invaluable in hurricanes.

The cultivation of long yams demands holes at least a metre in depth, the topsoil is placed at the bottom of the hole, and the subsoil is packed loosely so as not to impede the growth of the tuber. These are practices widely encountered in Pacific yam cultivation, with different degrees of elaboration.

Yams are best planted between July and October, and take about nine months to mature. When Hurricane Val struck Lakeba in January 1977 it wrought great havoc among the maturing yam crop, and left many farmers without planting material for the next season. Many farmers were still without yams in 1976, though over 24,000 had been planted. Events such as this accentuate the tendency to abandon seasonal crops in favour of the year-round crops -- cassava and taro.

Kawai (D. esculenta) has, however, also regained some popularity since the hurricane. It demands less soil preparation than D. alata, and the vines can more readily be managed by means of a simple pyramid of sticks. Greater care has also been taken of the stocks of wild yam, in view of their proven value in 1975.

Cassava (tavioka, Manihot esculenta)

Cassava is a modern introduction of uncertain date, which has come into prominence in Lakeba agriculture only since 1945, probably mainly at the expense of yams. It is now the second crop of the Island in volume, if not importance. Like taro it can be planted at any time of the year, but unlike taro requires neither particularly fertile soil nor abundant moisture. It is more adaptable to the talasiga than any other crop. Recently cleared hill slopes and valley sides are therefore fairly heavily planted in cassava, and most farmers will admit to having more cassava than taro plants. The nutritional value is far less than that of taro or yams, but Islanders remained unaware of this fact until recently alerted of the risks of a cassava-based diet by the medical authorities as part of a public health campaign to reduce the incidence of malnutrition in Fiji. Many families continue to include a disproportionate amount of cassava in their daily diet because of its ease of cultivation and harvest.
Ground preparation is simple. Slopes are generally cleared by burning and cutting off unwanted growth; because of the importance of fire, cassava is often camera-1. hut in some lore, the mand is often avoided. About a week after burning small mounds are dug and made ready. In better-soil yams are planted first, but in poorer soils cassava is generally the initial crop. The mound takes only five minutes to dig, and the stems of a plant are inserted into the mounds from three to five shoots at a time and pointing uphill; this part of the job may be accomplished in as little as 30 seconds. The plot then requires weeding about one month for other crops, and may not again until six months; the stem grows to a height of 2-3 m easily overtopping weed growth. The crop is harvested from nine to 18 months. The tubers can be eaten boiled or baked, a flour can be made from it, and it can also be used for feeding pigs. The crop has only a short life in storage, and suffers further disadvantages -- the tall stem is easily swayed in high winds, and broken; even if not broken the swaying stem may crack the tuber, which then rots in the ground. For this reason a large part of the cassava crop, especially that part grown in plots remote from the villages and unprotected among low talasiga, was lost in Hurricane Val.

No yield measurements of cassava were undertaken by the project, but there are probably considerable differences between sites, as cassava grown on better soils is generally more leafy. Work done in South America suggests that the carbohydrate content of cassava is naturally a weed. We have four months is ready in all other parts of the world, so that the tubers produced by leafy plants are much larger. The northern and eastern regions of the crop (Vakana, Nukunuku, Wacis) are limited to taro land and large areas of talasiga on colluvium are thus not only more dependent on cassava than on taro, but also probably obtain lower yields than the villages with larger areas of moisture-retentive soil. The trend toward increased dependence on cassava is probably continuing in Lakeba, as elsewhere in Fiji, but there is no prospect of marketing. In 1972 some farmers were misled by rumour into planting large areas of cassava in expectation of purchase by the National Marketing Authority for sale in Suva (Fig. 7.3b); in 1976 they were either giving the excess crop away, or allowing it to spoil in the ground.

Other tuberous crops

No other tuberous crop is of major importance in Lakeba, but several are grown. Sweet potato (Ipomoea batatas) is long established in Lau, but is of lesser significance on Lakeba than on some of the drier and less fertile islands. The crop has the advantage of greater hurricane resistance than others, but its planting and harvest are seasonally bound.

American taro (Colocasia esculenta), planted one to a mound, is a relative newcomer; the value of which is not yet fully exploited in Lakeba. This quite nutritious and high-yielding crop requires less moisture than either Colocasia taro or Dioscorea alata, and is much less vulnerable to hurricane damage than cassava; the tubers will keep for several weeks. After Hurricane Val the Islanders were encouraged to increase their planting of kava, and in the succeeding months much of this crop was planted as sweet potato, though there were great differences between villages. There were some quite large patches on the side slopes of the upper Tubu and Yadrana valleys in 1976. A few plants of the tall-growing variety (Colocasia sp.), a similar hurricane resistant crop, were often included, on advice, but were not popular.

Swamp taro (Cyrtosperma ohnellianum), a major food crop in the atoll regions to the north of Fiji, is long established in Lakeba but of little importance. Elsewhere in Fiji it is often allowed to deteriorate and, planted in small patches by individuals collecting specimens for replanting, while the Island Council has recommended its expansion of this large-leaved, slow-growing and rather less tasty tuber, there has been little response.

Yaqona (Piper methysticum): a new cash crop?

Local accounts have it that this crop, called kava elsewhere in the Pacific, was introduced into Lau either from Tonga or from Taveuni, but its social importance would suggest that it has long been present in Lakeba. The powdered root and basal stem, mixed with water, has been a ceremonial drink with mild narcotic properties for centuries, and its formal consumption -- limited to the chiefs until the modern era -- is surrounded by elaborate and courteous ceremony. It is a vital element in all prestations, and the only element in the simplest prestations; moreover the sessions around the yaqona bowl are the focus of much important business throughout Fiji -- sometimes they were the only places where this researcher was able to find and interview certain of his informants! Another generation recalls the planting of a great deal of yaqona on Lakeba, and visitors from other islands specifically the limestone islands which cannot grow the crop -- calling to exchange goods for 'grog'. In those days the matagali elders would discuss the programme of work around the yaqona bowl, and the young were excluded; nowadays the young drink yaqona -- and beer -- a great deal, and not much in the way of work-planning is discussed.

Yaqona is usually planted in shaded sites, often in recently-cleared forest land. It needs moist soil, with sufficient depth for the root system to develop; one farmer defined a good site as one in which the mile-a-minute creeper (Mikania mironensis) grows in abundance. Some yaqona is also planted under coconuts in the coastal Rendzinas. Farmers tend to be secretive about
their yaqona, and since a high proportion of the crop is in the remnant forest patches in the valley heads in the interior, the gardens have low yields. To the casual observer, about 20 per cent of the Tubou/Lekua farmers admit to growing yaqona, some with as many as 400 shrubs. While the production is minute by comparison with that of Taveuni, and Lakeba is currently a net importer of yaqona from Viti Levu and Maola, the crop in the interior has considerable potential value at present prices, and several farmers hope to export it to the mainland, as well as to use it themselves or sell it on the local market.

Before planting, the ground is carefully tilled and weeded. Then three pieces of stem about 15 cm long are placed diagonally on echelon on the ground about 10 cm apart; they are then covered with about 3-4 cm of soil. When they first appear the shoots are very carefully cultivated, and the surrounding ground is carefully weeded. When the plant has reached about 30 cm in height, humus collected from nearby is placed around the plant to conserve moisture. In order to preserve shade, the crop is often interplanted with Paulownia, the large leaves of which protect the plant from the sun. Some farmers prefer yams or kowai, as they compete less for soil moisture and the plants can therefore be spaced more closely. All this care is in sharp contrast with the much more casual methods employed on the richer, deeper and moister soils of Taveuni and Koro.

Yaqona is left in the ground for from three to seven or more years, as flavour improves with age. By harvest time it has formed a root mass one or two metres across and it takes several men to lift a fully mature plant out of the ground. A five-to-seven year old plant may produce as much as 18 kg of saleable yaqona, which at 1976 prices would yield as much as $180. Local trade was through the main Cooperative Store in Tubou, with sales up to 40 kg in a busy week, buying at $2.65 - $4.00/kg and selling at $5.00 - $6.00/kg. There was also much informal trading. In times of severe shortage good quality root might fetch as much as $6.00/kg.

With prices at these levels, some farmers decided that yaqona would be preferable to copra as a cash crop, and those with access to suitable land were planting as many as 500 to 1500 plants. Some of the last remaining forest areas were being invaded, and yaqona was also being planted experimentally on the coastal plains. Since other farmers throughout Fiji have taken a parallel decision -- the yaqona crop in the ground in Taveuni was estimated by the project team there to have a current-market value of more than a million dollars -- it remains to be seen whether prices on the national market will remain at these high levels.

Yaqona will store for a considerable time, and may be left longer in the ground. Gone the less, it seems unfortunate that current misallocation of land in Lakeba, as elsewhere, is putting the remaining small areas of forest at risk for a crop of rather uncertain future value.

Experiments with new crops

Farmers in Fiji have always been willing to try new crops, though they have remained remarkably faithful to the coconut as basic cash crop until at least the 1930s. Latham (this volume, b) has made mention of the possibility of rice. A concerted effort was in fact made in the late 1960s to grow rice on taro land, and the paddi plots can be seen clearly on the 1970 aerial photographs. However, farmers had no experience with the crop, and the extension officer was unable to advise them adequately; in terms of water management the demand of rice are quite different from those of taro, and this was not understood. Some farmers tried to grow it in drains. Much of the crop became infected, and by the time the appropriate insecticide had arrived from Suva it was too late. Those few farmers who persevered found that rice had to be processed in Suva, then returned to the island for use; the cost perched them of any profit, and it would have been cheaper for them to have bought imported rice in the store. This experiment failed, and notwithstanding its potential virtues is unlikely quickly to be resumed. Taro is preferred, and only if it falls victim to some major blight such as Phytophthora colocasiae is there likely to be a renewed interest in local rice-growing. This is, meanwhile, a good example of an ill-considered introduction -- one of far too many in rural Fiji.

Rather better hope attends the latest introduction of peanuts. In 1976 only three farmers on the island were growing this crop, but by 1978 there was a considerable expansion, mainly if not entirely on the coastal plain (S. Best, personal communication). Islanders like the roasted product, and despite its high price would buy imported nuts at the local store. Once again, however, much depends on planning and infrastructure. Lakeba should be sufficiently dry and sunny for peanuts, and has large areas of suitable soil, but much more than this is needed to make an introduction a success. Meanwhile, it seems this has happened since the writer left the field, and details are wanting.

The introduction of non-local vegetables has been attended with greater success. The traditional agricultural system provided only taro leaves and 'bele' (Abelmoschus manihot) as green vegetables, together with the leaves of certain trees. Two or three individuals, in particular the Tul Nayau, have embarked on the production of a range of market garden produce, including China cabbage (Brassica oleracea), onions, chilis, eggplant, ginger, lettuce, carrots, pumpkin, watermelon, beans and tomatoes. All do well. Produce is sold at the government station and the hospital, and several of these plants have been taken up by individual farmers elsewhere in the island for their own use.

Tree crops other than coconuts

Though there is nothing in Lakeba, or Fiji, resembling the dawun, or orchard garden, of south-east Asia, a considerable range of fruit-bearing trees, both indigenous and introduced, is grown in the gardens and in the villages. Breadfruit (Artocarpus altilis) has for long been an important supplementary food, especially in the wet season, and numerous specimens of this large and elegant tree grace the villages and their environs. In 1975 this crop was entirely lost because of the Hurricane, and many trees were cut down before they could be blown down and destroy houses. The breadfruit was of greater relative importance in the past than it is today. Pawewa (Aleurites moluccana) is a modern introduction now widely adopted, and found mainly in and around villages. Its fruiting is seasonal, and is important -- but unfortunately not of year-round value -- in correcting Vitamin-C deficiency. Bananas (Musa nana) and plantain (Musa balbisiana) are commonly found in dry crop gardens and around villages. The black leaf-streak disease of Viti Levu has spread to Lakeba, causing a shortage of bananas in the 1970s. In most villages at least one farmer specializes in growing bananas, selling to the

4 Information in 1979 suggests that prices have stabilized, at least in Suva.
co-operatives for local distribution. Citrus fruits are scarce. Formerly they grew wild, but have been cleared from most village sites. The whereabouts of individual trees in the bush is prized knowledge, as fresh lemon drinks are much valued. Pineapples, though a ground crop, should also be mentioned; they are often grown as edge plants in dry crop gardens, and are a favourite fruit; most households have from ten to 300.

Industrial tree crops

Two further tree crops, in part wild and in part cultivated, may most conveniently be discussed at this point. These are the volofoi (Ficus benghalensis) and the paper mulberry (masi, F. benghalensis papyrius). Volofoi grows both in the swamps and in the talasiaga, and is both preserved in clearing and sold in the market. Its leaves are used to provide material for a very durable matting. Mats are extensively used in Fijian houses to soften floors, for bedding, and also for outdoor use on any occasion which assembles people in a society largely without chairs. High-quality mats are important as gifts; poorer-quality mats are used to wrap goods for transport. Some are patterned, others plain. Within Lakeba most mats are made in the outlying villages, not in Tubou. Most farmers in Wacwaci had between 100 and 200 volofoi trees; one claimed 600. In Nukunuva the range was from 20 to 200. Volofoi is often given to people without it, in need.

The paper mulberry is far less important in Lakeba than in some other of the Lau Islands where the art of making 'tapa' -- bark cloth carrying elaborate designs in natural dyes -- is much more highly developed. The method is to hammer out a white cloth from the bark, and to join the pieces with a paste made from yoba (Zooa sarcoptosloideae), taro or cassava. The cloth is then decorated with geometrical designs, showing great variation in style between islands and in quality between individual women tapa-makers. Tongan influence is strong in some Island designs.

Traditionally all Lauan women make tapa, but today this is no longer so. Hocart (1850) describes women's groups in Tubou as making masi sheets, and the Wacwaci women as expert in stencilling designs. By 1976, however, the art of making tapa was virtually lost on Lakeba, though some splendid old specimens still decorated some houses. Only older women still recall the skill, and while girls are now taught it in school, they make little use of their learning. Most tape on Lakeba comes from Mocu, Nakas and Oneta, where sale through channels in Suva is an important income source. In former times, masi, decorated or not, was important for clothing on all islands, and this role has now been displaced entirely by imported cloth; masi is kept for ceremonies.

COCONUTS AND COPRA

Much has been written about the coconut economy of eastern Fiji in almost all reports of the project, in greatest detail in the first general report (UNESCO/UNIPA Project, 1977) where some account was given of the Lakeba situation. Although there is a general "coconut overlay" over the coastal areas of the whole region, and over some whole islands, the nature of the economy differs quite significantly from place to place, even within Lau. Some Lauan Islands, such as Kanawa and Mago, are entirely estates. On other islands, such as Tabara, all production is by smallholder farmers, and only a few estates. Individuals produce quantities significantly greater than the mean. Lakeba is different again. The island, in normal times, a significant producer, exporting as much copra as the much larger and more populous Island of Kadavu, and coconuts cover 20% of its land surface. There were formerly two estates on the island, and although all producers are now Fijians resident on the island, there are very considerable differences in the scale of production. In spite of all that has been written about the coconut economy elsewhere in the project's reports, therefore, a detailed discussion of the situation on Lakeba is both necessary, and illuminating.

History of the coconut on Lakeba

Burned coconut shell found in a rock shelter near Ulunikoro, the limestone massif in north-west Lakeba, has been dated around 3000 B.P. (S. Best, personal communication.) It would seem that the coconut has been in Lakeba about as long as man, used then as now for food and a cooking ingredient, with the husk and shell serving as fuel and containers. Much later the oil expressed from the meat of the coconut acquired value as a perfume base, and for lighting and cooking purposes. It became an article of trade at some time before or during the 18th century, and in the 19th century entered into trade with Europe first for the manufacture of candles, and then of soap. Improvement in refining methods led to a shift in demand from the coconut oil to the copra from which the oil is extracted, and by the 1870s this dried meat of the coconut became the principal trading commodity of Lau.

In 1970, while Ma'afu was still ruler of Lau and before union with Fiji, an expatriate obtained a 50 year lease on 94 ha of land in the west of Lakeba, at Mainiyaba, at a rent of $13.00 per annum. In Ma'afu's home domain, unlike other parts of the Tovata (Lau, Caukudrove, Ba), land could be alienated only on lease. In 1920 this same land, then held by Burns Philp Ltd., was purchased by the Tovata Land and Title Co., and in 1950 the company was purchased by the Government of Fiji. This company, now known as the Fiji Islands Agricultural Corporation, has considerable interests on Lakeba. In 1970, Lakeba was described as a successful enterprise. Managers gave credit to Lakeba because (against headquarters' instructions), and because it was a "good place to work". Local labourers were required to work: all of the local labourers were from the town of the Tui Naya (Reid, 1977). Mainiyaba is now operated by a holding company, Mainiyaba Holdings, in which half a dozen leading islanders have an interest, and for which the Tui Naya takes responsibility. The Tui Naya personally holds the estate between Tubou and Wacwaci. Driers are maintained by paid labourers who are the only permanent occupants of these entirely Fijian estates, and the produce is now exported through Tubou.

The former Waqatalala anchorage at Mainiyaba is used only by vessels which do not arrive too late at night to enter the harbor. Since completion of the circum-insular road in 1969 Tubou has become the only importing and exporting point on the island. A jetty was constructed between 1975 and 1978.
All coconut land in Lakeba now belongs to Fijians. However, not all is collective mataqali land. Apart from the former estates, there are other plots belonging to individuals through their parents or through the institution of kou kou, land separated from the mataqali domain to women and their male descendants on marriage. No land in Lakeba has been surveyed or registered with the Native Land Commission, but the boundaries are as well known, and as well observed, as if they were formally registered. Chiefs, and some leading commoners, have been the recipients of sizeable blocks of land. Much of this is coconut land.

These 'individualized' areas are quite large, though in the absence of a land register they cannot be measured. They are not concentrated in one mataqali territory but are spread around the island; some are indicated below in Fig. 7.6. The quasi-estates are worked by hired labour, often from other islands, but there is usually at least one resident family in charge of the copra driller, and responsible for collection and delivery of the crop.

Coconut land is put to three uses. Much is combined with dry crop gardens, or with livestock. Some land is used mainly for subsistence purposes, and little copra is made and sold. On other land, especially the larger holdings, most of the coconuts are made into copra for sale. It is this last aspect that is examined most closely in the present section.

**Structure of the copra industry on Lakeba**

The copra industry of Lakeba has evolved through a series of stages, which remain to be explored more fully by archival research of the type conducted by Knapp (1976) on Vanua Balavu. Initially there were company estates and trade areas which bought green or sun-dried copra from the Fijians. Lauan farmers were encouraged to produce copra in several ways: copra or coconut oil was acceptable in payment of taxes, and the vakamistonei -- the payments to the church; they were also acceptable in payment for goods, on credit; offenders against the law were ordered to plant such-and-such a number of coconut palms; chiefs were encouraged to impose planting quotas on their people. As a large body of Fijian producers of copra came into being they at first sold mainly to the trade stores, often at extraordinarily low prices; larger growers then began to construct their own driers and consign their own copra, plus that bought green from others and dried, directly to Suva. In the 1960s Co-operative Societies were set up, based on each leading mataqali; the societies now bought the green copra, and new legislation enacted in the light of the Silsoe Report (1963) led to the licensing of buyers; as was intended, this move hastened the decline and disappearance of the private trade stores, and their replacement by co-operatives. Later, the Lakeba Co-operative Association was formed, with all co-operatives on the island as members, and all copra was supposed to be consigned to Suva through this one body. However, most of the larger growers remained outside the organization, and continued to dry and consign their copra individually. In 1974, the last 'normal' year before Hurricane Val, the proportion of copra sales through the different outlets was as follows:

<table>
<thead>
<tr>
<th>Co-operatives</th>
<th>55.2 per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quasi-estates, etc.</td>
<td>11.1 per cent</td>
</tr>
<tr>
<td>Individuals</td>
<td>33.7 per cent</td>
</tr>
</tbody>
</table>

43.8 per cent of all copra was, in fact, being exported privately. The grading received, following the system also recommended by Silsoe (1963), suggests why this should be so. Table 7.4 sets out the number of bags despatched, and the grading that they received. The Co-operatives obtained the smallest proportion of Fijl 1 grading, with its price premium, and only 80 per cent of Fijl 2 grading. This is scarcely surprising in view of the large number of individual suppliers of green copra of very varying quality; moreover, some of the copra was sun-dried, and it was not uncommon in 1976 to see hams pecking at the copra on the 'vatas'. Individual sellers had the highest proportion of Grade 1 copra, and the 'holdings' or quasi-estates did little better than the Co-operatives; they would have done no better but for a single member of this group.

**Table 7.4: Copra production and grading by class of producer, 1974**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>BAGS OF DRY COPRA</th>
<th>PERCENT OF GROUP GRADED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO.</td>
<td>PER CENT</td>
</tr>
<tr>
<td>Co-operative Societies</td>
<td>1151</td>
<td>18.7</td>
</tr>
<tr>
<td>Quasi-estates, 'holdings', etc.</td>
<td>2317</td>
<td>20.7</td>
</tr>
<tr>
<td>Other Individual sellers</td>
<td>7015</td>
<td>41.3</td>
</tr>
<tr>
<td>Total</td>
<td>20843</td>
<td>26.5</td>
</tr>
</tbody>
</table>

**Data:** Records, Suva copra grading station

In the years immediately before Hurricane Val the production of copra had been increasing more or less steadily, a trend very unlike that of the industry as a whole. The rise of production continued through a period of slump and subsequent boom (Fig. 7.4), the actual peak in production being reached before the peak in prices in 1974, at least from Co-operative Society records. It seems that there was a long-term trend in which the movement of prices had had only small effect before the slump at the end of 1974 (Fig. 7.5). Together with the hurricane in early 1975, however, this slump did have a disastrous and possibly long-term effect on expectations (Bayliss-Smith, 1977). The effect of the hurricane, and perhaps lower prices also, continued through 1976; by September of that year only 6000 bags had reached Suva from Lakeba.

The rising production of Lakeba is rather surprising considering the age and condition of the palms, emphasized by Latham (this volume, p. Few Lakeban groves are laid out in neat lines; many trees are a hundred years old, and some are past bearing. The hurricane did some unexpected clearing of aged trees, but many were spared and have since been neglected, with some growth rising high around them. There are quite large areas from which all production has ceased, and this is on some of the best land in the island.

During the 1960s, however, again following the Silsoe (1963) recommendations, the then-Department of Agriculture paid a subsidy on new planting, offering £5 per acre ($14.83/ha) in the first year and £10 ($39.79/ha) in subsequent years to those who cleared, and replanted their land, 1 or 2 acres of new land. The scheme was revived in 1972, despite realization that much of the subsidy in 1960s had been wasted in new planting on marginal land, including talasiga, which would come to nothing. Some of this took
place in Lakeba, especially on the talasaq behind Waciwaci, but in general
the scheme seems to have been more successful on this island than in Fiji
as a whole; some farmers had hired a tractor to assist in the work of
clearing and replanting. By 1974, there was a fair proportion of
new trees coming into full bearing. Perhaps more than this, however, is
the rising need for cash income in Lakeba. Copra is cut as the need for
money arises; it seems that it was arising with increasing frequency.

TABLE 7.5: GROWTH OF COPRA PRODUCTION IN LAKEBA, 1970-1975

<table>
<thead>
<tr>
<th></th>
<th>NUMBER OF BAGS</th>
<th>TONNES AT 0.053 t/bag</th>
<th>TONNES AT 0.045 t/bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>13 828</td>
<td>733</td>
<td>627</td>
</tr>
<tr>
<td>1971</td>
<td>13 920</td>
<td>738</td>
<td>631</td>
</tr>
<tr>
<td>1972</td>
<td>16 068</td>
<td>852</td>
<td>729</td>
</tr>
<tr>
<td>1973</td>
<td>18 988</td>
<td>1005</td>
<td>861</td>
</tr>
<tr>
<td>1974</td>
<td>20 843</td>
<td>1088</td>
<td>945</td>
</tr>
<tr>
<td>1975</td>
<td>10 058</td>
<td>533</td>
<td>456</td>
</tr>
</tbody>
</table>

Note: The Agriculture Department, Northern Division, has calculated a mean
bag weight of 0.053 tonnes for copra produced in the Northern Division (Yavua
Levu, Taueuni, etc.), but consider that the mean bag weight for the Eastern
Division is lower. The mean for Lakeba Co-operative Association deliveries
in 1975 was 0.0449 tonnes/bag; for Tarakus Co-operative Society over several
years it was 0.054 tonnes/bag but declined year by year from 0.059 tonnes/
bag in 1965 to 0.042 tonnes/bag in 1976. The mean weight of bags graded in
the Tubou grading station in late 1976 was 0.0449 tonnes/bag. Since the
only fully-comparable data are given in bag numbers, it is necessary to
assign an arbitrary weight; unfortunately the nationally-comparable data
are not given in weight terms; it would be entirely possible from sales
records. It is indicative of the present state of records that the sum
of bags consigned to Suva in 1974 exceeds the figure given in the Coconut
Board annual summary by 315 bags (14.2 tonnes). Similar discrepancies were
encountered in Taueuni (Brookfield and Hardaker, 1976, p. 365, footnote).

The size of holdings and ownership of coconut land

Data examined more closely below show the production was very unevenly
distributed between the villages and mataqali. Such unevenness is character-
istic of the whole structure of the industry, for the amount of coconut land
per household varies much more than the amount of garden land -- wet or dry.
Many families have more than one coconut plot; they would forget extra plots
during interview, though these might later be discovered in the field. The
table below presents data for Tubou, Levuka and Waciwaci summarizing a house-
hold range of from less than one hectare to more than 20 ha, excluding all
the really large holdings. Though coconut land is mataqali land, the trees
are individually held and measured by their owners in terms of land area.
Some mataqali members claimed that they had sufficient coconut land; others
maintained that they had insufficient for their needs. Almost without ex-
ception respondents perceived the island as having insufficient coconut land
for its population, though many recognized that much could be done to improve
production by judicious thinning and planting. Excluding the estates and
private landowners, the sample for the three villages gives the following
mean values:
the writer hopes will be helpful to those involved with decision-making on the future of this island. First, however, there remain some further aspects of the land use system to be discussed, which belong most appropriately to this point in the discussion.

LIVESTOCK AND FISH

Livestock

Livestock do not yet play an integral part in the economy of Lakeba; fish rather than meat supplies most of the animal protein in the island diet, as perhaps it has done since man first reached Lakeba. By custom, livestock have been allowed to roam unattended, and as their numbers have increased this has resulted in the partial or total destruction of some cropping and irrigation systems; the contemporary role of livestock in the land-use system may be said to be more negative than positive.

Pigs: Less care is taken over pigs than in many other parts of the Pacific, where a major part of their diet is cultivated; there they are hand-fed and penned at night, so that their wanderings are confined. In Lakeba, though the meat is prized for feasts, most pigs are allowed to forage at will, and while none are truly wild as on some larger and more forested islands, they have in modern times made serious depredations on gardens and taro patches close to the villages. This problem seems to have grown more severe in recent years, leading farmers to shift gardens to remoter sites, while major sub-coastal swamps such as the solokes of Levuka and Karowusa (Tubou valley) are no longer cultivated. Fencing is ineffective, and hand-feeding is very restricted, even the prized vegetables in village compounds and on the Government Station have been attacked by marauders. The pigs are worm-infested, and the Agriculture Department advises that any attempt to rebuild an efficient pig-husbandry should begin with new breeding stock. One group at Nabaqalau agreed to set aside a piece of land for this purpose and to import a boar, but the cost of materials was high, and in the aftermath of the 1975 hurricane the scheme went into abeyance.

Cattle: Company traders seem to have brought the first cattle to Lakeba, but numbers have declined and in 1975 there were only about 140 on the island, of very mixed breeds. Most were on the 'estates'. Cattle have also been responsible for damage to crops and water-control systems, but today they are mainly fenced. Unimproved land will carry only about one beast per four hectares, but experiments with introduced grass on the Tui Nayar's land show that a much higher carrying capacity can be attained. An experiment is also underway to plant pasture between pines. Clearly, the island could carry a larger stock, but in the absence of proper facilities for butchering and freezing, or for milk storage and carriage, no major expansion is likely. Meanwhile milk is imported in powdered form, together with some tinned coconut milk and canned fruit (tuna, prawns, etc). The major use of the local cattle is on feast days.

Goats: Goats, as 'mini-cattle', are in some ways better adapted to the economic and social conditions of island farmers than are cattle. Until recent years, however, most goats in Lau have been kept on uninhabited islands. The Lakeban herd has been on Amoa, which belongs to the chiefly mataqali, and in the absence of control they have stripped much of the vegetation to grazing height; numbers are reported to have diminished. Greater interest is now being taken in goat farming on Lakeba, since there is a strong demand among the Indo-Fijian population of the country, and visiting Indo-Fijians...
on ships have paid $20-30 for animals. A goat project has been started under connotans, but fencing has been a problem mentioned above. Rabbits are no longer sold but are being fished for part of their land for goats, as less land and water would be required than for cattle. Unfortunately, perhaps, such thinking is not widespread.

Horses: Except in Tubu-Levuka there is a considerable number of horses on the island; Suituku has 24 horses between 20 households, used for the transport of both people and goods. They are ridden bare-back, and young men may sometimes be seen galloping through the hills; however, the main use of these animals is as beasts of burden. The Tu'f Nayaru has introduced a Tonga-type cart, put to use in collecting coconuts and copra, and one Tubu man has contemplated the use of horses for ploughing. With only one tractor on the island, which costs $9/hour to hire, there would seem to be many potential uses for horses. Talk of mechanized farming is as yet meaningless for most Lakeans, and road transport is limited and very costly, but the more extensive use of horses remains an idea only in the minds of a few.

Chicken: Most households have chicken, and let them run loose around the compound. Eggs are frequently not found, are eaten by rats, or fertilized; despite the large number of birds, cooked chicken and eggs are comparative rarities in the diet. Heavy casualties in the chicken population occurred during the 1976 hurricane; they were not housed, and quickly dwindled. Since that time, more farmers have considered building hen-houses, but the outlay was often prohibitive (M. Brookfield, 1977). Only one successful construction was observed.

Conclusion: In all this, there is an obvious need for guidance. Better livestock management would save garden crops from damage, would provide animal protein cheaply and perhaps reduce the import bill, and yield a low-cost transport system while also providing the basis for more extensive arable farming with new crops, at a cost within reach of many farmers. Lakeka is not short on ideas and experiments, but success and significant change demand both official guidance and technical advice, and also financial aid. There was little indication in 1976 that such would soon be forthcoming.

Fish and their place in the economy

More important than the question of livestock, however, is the future of the large and varied marine resources of Lakeka; as Salvat observes elsewhere in this volume these are very under-utilized by the standards of other parts of the Pacific. Yet in former times the sea was as important as the land to Lakeans, being the road over which they maintained an extensive trade with their neighbours; both large and small sailing canoes in consider-

able number were based in Lakeka during its period of power in the 18th and 19th centuries. Today, only two or three small sailing canoes remain, and the outboard-motor 'punts' which have taken their place throughout Fiji and the Solomons. Several are still in commission in Lakeka, and the circular-island road was completed, and more were badly damaged in the 1975 hurricane. In 1976 there were hardly a serviceable privately-owned boat on Lakeka. Government and the Co-operative Association had work-boats which could be used for fishing, as well as in the canoes which could be used for fishing, as well as in the lagoon (including the Aiaua where large fish are plentiful). Most fishing that is now done locally is confined to the lagoon and is done by women. Fish is still the principal source of protein, eaten almost daily by most people, but a large proportion of this comes in cans, bought from the Co-operative Society store.

Most fresh fish, molluscs and crustaceans eaten in Lakeka come from the lagoon, fished by line and net, or collected from the mangroves. Line fishing is individual, and 40 per cent of the Tubu-Levuka women who went fishing in 1976 used this method. For net fishing most women work in groups, and are away from home for several hours at a time. A circle is formed in waist-deep water and fish are beaten into the centre of the nets. The catch -- usually kanace (Ctenogorgus sp.) -- is flung over the shoulder into a bag made of plaited coconut fronds. In the Tubu lagoon such drives were often unsuccessful, and women complained that the fish caught were smaller in earlier days. Often the fishing groups would not even bother to try Tubu lagoon, but would walk two km east to the southern end of the Wakavil lagoon. On very hot days they would blacken their faces with charcoal to protect them from glare and burning. Fishing is not done on Sunday, and when the weather is bad the lagoon becomes turbid and unfishable by nets and sometimes even by lines. Fresh fish has never been available every day, and surplus catch is generally smoked to preserve it against lean times. However, in modern times those who could afford it would often prefer to buy a can of 'mackerel' from the store.

On the north side of the island there is less interruption. This is the lee side of the island, and the lagoon is shallower although apparently -- with fewer fish (Salvat et al, this volume). Moreover, when fishing is impossible there is the alternative of searching for mangrove crabs which would be caught by anyone travelling through the mangrove-coast villages. When northern village women had a surplus catch in 1976 they would walk or ride into Tubu to sell at the Government Station or in the village. Depending on size, one fish or three live crabs would fetch $1.50 - $2.00, and there was always a ready market among the non-Lakeka women of the Government Station, who would not form part of the local fishing groups and could only themselves fish by 'permission' of the right-holders.

There are many changes in practice. Nets used to be made from local material, then later from cotton. Now they are store-bought and lines are made of nylon. Inner-reef fishing used to be undertaken by young girls -- one woman recalled wrapping her hair in cloth and pulling fish out of holes -- but this shallow diving is now done mainly by young men. Powerful pressure lamps are sometimes used in night fishing by line, usually with the men assisting. When boats are available, people will sometimes fish all night in this way.

Spear-fishing is undertaken mainly by men, less often by women. Goggles, and more rarely masks, are used. There is only a single full-time fisherman on Lakeka, equipped with scuba gear and a spear gun. He makes his living from the reef, working most days except when the weather is bad, or when he

7 Apart from the rising cost in fuel is the problem of maintenance. In 1976 there was no qualified mechanic on the island, and even official vehicles requiring more than minor service were shipped to Suva for repair, or left un-serviceable for long periods. None the less, project members once accompanied by the Divisional Commissioner and Engineer on a tour of Lau islands investigating requests for the construction of vehicular roads to landing points; no-one seemed interested in expanding the use of horses, and it was likely that at least some of the roads would be constructed.
needs a spare part for his gun, obtainable only from Suva. He catches both larger fish and turtles; he also dives for molluscs. In a good year he might receive $15 to $20. Others rent men and women sometimes seek a commercial surplus for supplementary income, making from $12 to as much as $100 a year.

The varied marine environment of Lakeba (Salvat et al., this volume; McLean, this volume) leads to considerable differences in the pattern and content of fishing around the island. In the southern villages about 75 per cent of the women fish, and most of those who do not are old, pregnant or in employment. In Tubu, 30 per cent fished from four to six days a week; and 70 per cent fished once or twice for periods of two to four hours. The catch, however, consists mainly of a single species, and is somewhat un-constant. In the northern village of Makawai, land crabs are added to the harvest, and northwest from Nakawai mangrove crabs assume greater significance. The Waitau people had a formal arrangement to catch fish for the Provincial Office staff, and were provided with nets and paid a fee.

At Yadran, Bayliss-Smith (1977) found in the course of a week-long activity survey that 90 per cent of the productive work-time of women was spent fishing and collecting sea-food. At Nasaqalau the proportion was 93 per cent. At Yadran each adult woman performed on average 10 hours fishing per week -- some much more -- and at Nasaqalau 8.9 hours. The mean time per fishing session at Yadran was 4.7 hours, which is longer than in other villages (Tubu, Lepuka, Nakawai, Nasaqalau) where the present writer interviewed women or left household books; in these villages the mean time was about three hours. It would seem that results are more rewarding on the northern and eastern coasts where variety is greater, and lack of fish may be compensated by collection of molluscs, crabs and sea urchins. This is also supplemented at several points around the coast by edible seaweed and algae, and in October-November by the balolo worm, which swarms in the lagoon and can be caught in buckets. Turtles, traditionally the property of the chieftain, are sometimes caught in the northern and eastern villages, and giant clams (Tridacna gigas) also came from these villages.

The project surveys were carried out in 1975 (Bayliss-Smith) and 1976 (this writer), which is in some ways an unusual period, with both food and money scarce. There was greater-than-normal dependence on marine resources. Under 'normal' conditions, except when large collections of food are being made for a feast, fishing is as much a recreational and social activity as it is a productive activity for the men, and even some of the women. Fishing is, however, still an almost daily necessity for the women of most families, and there was a strong desire for assistance or loans for provision of new boats and better rods and lines, together with a large freezer in which a surplus could be preserved against lean times. Few islanders thought that their marine resources could sustain exploitation on the scale required for a modern cash economy. They were horrified at the prospect of the much larger possibilities outside the reef, which were beyond their reach because of lack of boats and gear, as well as lack of arrangements to store and market the harvest. In 1976 the only marine export was a small number of live mangrove crabs, sent by air to Suva; however, the plane was often full and could not take the crabs, which might not survive until the next flight two or three days later.

Data from this element of the research, along with other elements, will be analyzed more fully in a separate publication.

The place of marine resources in the life of the island is perhaps more significant that is suggested by Salvat, who compares it with more highly-commercialized French Polynesia. Apart from the produce of the sea, the diet of Lakeba would be mainly vegetarian. However, these are the least vulnerable of the island's resources; after the 1975 hurricane, catches were back to normal after only a month (M. Brookfield, 1977). If for this reason alone it is important that their use be sustained, and supported, in a hazardous environment.

THE PINE SCHEME: RECLAMATION OF THE TALASIGA?

The significance of the pine scheme in modern Lakeba

The picture of natural resources use in Lakeba presented above contains little of cheer. While there has been a number of promising experiments -- mainly on the chiefly estates -- and there is plenty of constructive thinking, it seems that little goes forward while much goes back. Traditional Yam cultivation barely survives, and the whole wet-land cultivation system is in contraction at an alarming rate. The monocultural cash-crop economy has faced severe blows in the 1970s from depression and hurricane, and its vulnerability has again been underlined since 1976 by the near passage of further hurricanes, outstandingly the small but very violent 'Meli' which devastated nearby Nayau in early 1979. Attempts at diversification all come up against the problems of marketing and transport, coupled with an understaffed and under-informed agricultural extension service. The livestock story is not only negative, and even the use of local grasses were contracted mainly to the inner side of the reef-lagoon complex leaving the larger resources of the outer side untouched. Against all this, however, stands the pine scheme: an enterprise that has been pushed with vigour: the reclamation of the long-barren talasiga which covers so much of Lakeba by the planting of Pinus caribaea.

The story of the pine scheme is recounted in some detail in Appendix 6 of the project's first report (UNESCO/UNFPA Project, 1977, p. 375-80). Only a summary of this account is offered here, and the main purpose of this section is to place the pine scheme in context.

The replanting of talasiga with pines began in Viti Levu and was subsequently extended to Vanua Levu, where it is intended to form the basis of a saw-timber or woodchip industry on a sustained basis. There was interest in this development on Lakeba, and in the Tul Rayau, other chieftains and the Island Council were persuaded -- and persuaded the islanders -- that pine planting was the means to utilize their 'agricultural desert' and to create many jobs on the island in the future. It was understood by all that there would be no return for input during the first 15-25 years. After initial plantings by individual islanders in the late 1960s, the Forest Service provided a ranger and established a nursery in 1971. With a small labour force, but principally with voluntary labour, a large planting programme was then initiated. By 1976 the area planted was approaching nine km², though a part of this required replanting and up to 25 per cent of the young pines were destroyed or damaged by Hurricane Val. The target area was 15 km². Meanwhile several hectares had been replanted for smaller plantings on other islands in Lau. The purpose of the scheme on Lakeba, and still more its purpose on islands as small and remote as Ono-i-Lau, has never been determined, and some serious questions arise -- economic, social and environmental. What are likely to be the consequences of this 'reclamation of the talasiga', and will it be effective?
Economic considerations

Even though pines have been successfully established on some of the worst soils in Viti Levu for more than 15 years, it is still not clear whether an ultimate cost/benefit analysis of this major enterprise will prove to have been positive. Much depends on movements in the price of timber products in the coming 20 years. The increasing importance of industrial need over the past few years, at least in the East, is likely to mean that the market is becoming more remote and small scale, and it is obvious to any observer that no woodchip operation can be contemplated. No alternative has yet been defined, but part of the cost of the project is the cost of 20 years of labour and tax, together with the unexplored possibility of adding value by on-site manufacture based on the pines.

There are problems confronting any solution. The pines are planted at a relatively low density. Many of the roads have grades too steep for trucks, and become impassable after rain. Without major investment in road maintenance, it is unlikely that only short and interrupted periods of working will be possible. Growth rates vary between soil types (Latham, this volume, b), and maturation schedules will not correspond closely to planting schedules. Thoughtful islanders pin their hopes on allowing the trees to grow a full 25 years, then using the timber available to one firm willing to bring its own machinery and boats to the island. More positive thinking than this is required, and it needs to come from informed sources outside Lakeba. An alternative view recognizes the improvements in soil and proposes cattle grazing under pines as a main enterprise. However, for this purpose the pines are too closely planted, and the effect of trampling by hooved beasts on the talasiga soils remains to be evaluated.

Social considerations

Communal, voluntary labour in planting was initially popular, but once it was seen that all the initial plantings were on Tabuai land enthusiasm waned in the other villages. The programme required that all men devoted one day a week to pine-planting, and in the dry season, to clearing and maintenance of the plantations. Later, the Island Council ruled that each mataqai should plant on equal number of seedling-boxes during the planting season—so a solution of which the inequity can be perceived by a glance at Table 7.5 below. By 1966 the ‘voluntary’ aspect of the scheme was fading rather rapidly; the resultant surplus of seedlings produced at the forestry station provided the basis for spreading the scheme to other islands.

So far, however, there has been no charge for lease of land, and no wages bill for the Islanders’ ‘labour and time, and only minimal indirect costs of government personnel and equipment. In financial terms, therefore, this must be regarded as an unusually low-cost afforestation scheme.

Environmental considerations

Latham has elsewhere demonstrated (this volume, b) that pine planting over large areas of the talasiga has almost immediate effects on the ecology of the planted area. Ground flora is rapidly diversified, soil structure is changed, and infiltration capacity is enhanced. The wider effects remain to be examined. There is already evidence discussed above by Hughes, Hope, Latham and M. Brookfield (this volume), that sedimentation rates in the valley swamps have diminished greatly in recent centuries; it could be that an equilibrium phase was being approached, at an accelerating pace due to reduced human demands on the interior of the island, even before pine planting. The effects of the latter on the hydrological cycle need to be evaluated against the evidence outlined by Bayliss-Smith (1977) for extremely rapid run-off on unplanted talasiga. If runoff is increased capacity increased there will be less erosion and transport of suspended and dissolved material into the valleys, and greater ground-water flow which will have significant effects on water tables throughout the island. An alternative forecast is that the wet-land agriculture will have to cope with a change in its environment at a time when interest and labour-input are already low.

The long-term effect on the talasiga soils is perhaps more important; a slight decline in pH is recorded, and it may be that podzolization—which is a consequence of pine planting elsewhere—will be the ultimate result. All these questions can be answered only by careful monitoring.

There are also more alarming considerations. Harvesting of the pines, if it is done with modern machinery, will create major disturbance on very fragile soils and will undoubtedly lead to erosion on such a scale as to modify fluvial processes in the valleys. It could, moreover, be that the ‘harvest’ will be achieved by a quasi-natural process bringing no benefit to the Lakebans. Pinus araucana is highly combustible. Growing in an environment already dominated by pyrophytic plants, its widespread planting must be regarded as providing an out-of-control increase in the supply of fuel. Lakeba has a drought-prone climate, with strong and steady winds accompanied sometimes by atmospheric instability which builds great clouds of cumulus over the island without producing rain. A fire initiated in these conditions could quickly achieve such proportions as to spread beyond the limits of the pines. As of 1976, and I believe today, there was not a single piece of fire-fighting equipment on the island; there was no cross-island telephone, the forestry land rover was a write-off and even the forensic truck was out of action more often than not. A small accident could readily convert the experiment, and all its hopes, into a catastrophe which would dwarf recent hurricanes in its physical and psychological effect. Moreover, a major hurricane of great violence could itself destroy most of the pines as useful timber, and simultaneously provide a tremendous increase in the stock of readily combustible fuel.

Discussion and suggestions

Reclamation of the talasiga is certainly desirable, though more efficient use of the coastal plain and the wet-lands might claim a higher priority in terms of rational ecosystem management. Pinus araucana is perhaps the tree that will grow on all parts of the talasiga, but other trees will grow on some parts of the talasiga, and in some difficult locations the talasiga has its own arboreal vegetation which deserves preservation. Lakebans have made a major investment in the pine project, even if it is to be judged only in unpaid labour, and this investment deserves a national counterpart. What this argues for is not yet another ‘overlay’, but a more sensitive management of the resources of the whole island. Lakeba has large areas of oceanic coconut palms as well as pines; indigenous species such as Gulaetaa termita have demonstrated ability to colonize parts of the talasiga. If Lakeba is to have a timber-based industry of small size it can have a wider foundation than just the pines, and the more value that can be added to the production of wood products for specific purposes—such as flooring—the greater will be the chances of success. Some of the talasiga is also suitable for extensive forms of agriculture.

The most important question is diversification. Despite its small size Lakeba is not minute, and its varied resources offer the Island some compar-
active advantages over its more homogenous neighbours. Development is not, however, only a matter of the economic utilization of natural resources; it is an important social factor as well. The island will not be easily explained, in depth, if we are to reach any useful conclusions concerning the future management of a small island for the real benefit of its people.  

II - LAND DISTRIBUTION

THE MAPPING OF LAND HOLDING

A cautionary preamble

Lakeba is a chiefly island, and the pattern described below is in no sense unique to this island, but is characteristic of chiefly regions throughout Fiji. The project has worked on two such islands, and the sort of dominance in land held by the principal mataqali of Lakeba parallels the dominant position of the Valelevu mataqali and especially its chiefs in northern and western Taveuni, and of the Vusaratu mataqali at Vanua Levu in southern Taveuni, before land redistribution under the wise precepts of the late Tuiloma in the 1960s (H. C. Brookfield, 1978). In Taveuni the position is obscured by the massive alienation of Fijian land. In Lakeba all alienations have reverted to Fijian hands, and the position resembles that described by H. C. Brookfield for central-west Taveuni in the late 19th century more than it resembles the present day condition of that island. It is normal in Fiji for chiefs, and especially high chiefs, to hold large areas of land. This is not the same as alienation between ethnic groups, but it is also normal for much of this land to be made available to lesser chiefs. Large chiefly holdings correspond with large chiefly obligations, and although the changes in the Fijian regulations that followed the Spate (1959) report have weakened both these obligations and also the duties owed by commoners to the chiefs, the degree to which this change has resulted in emergence of a land class separate from the commonality varies very greatly between different chiefdoms. In Lau, the erosion of the old pattern in all its aspects has been much less than in other parts of Fiji, and the discussion which follows must be viewed in the context of a society in which much more of the old pattern of mutual obligations between chiefs and people survives than is now normal in the country. Value judgments, except those expressed by the people themselves, are therefore avoided, for it is not proper for an outsider observer who was a guest on the island, and cannot fully comprehend the nuances of its society, to make such judgments.

9 It is acknowledged that the view of the Lakeba land scheme presented here in Figure 7.5 was presented two years ago (UNESCO/UPPA Project, 1977, p. 375-80). The intervening years have, however, yielded growing evidence of the low reward obtained by developing countries from export of whole logs or woodchips, and of the possibilities that exist for development on different principles, even in quite small units. Questions that need to be explored in such a case as Lakeba include the use of multi-purpose species in reclamation of the talasiga, the interrelation of forestry with agricultural improvement in the more fertile areas, and the sort of mini-industry that the natural resources of Lakeba might sustain on a continuing basis. In short, the land scheme needs to be re-thought in the context of other aspects of Lakeba development. See Asian Development Bank (1978) for a useful statement of principles.

The history of the chiefly Vunikoro mataqali, built upon a mixture of known fact and legend, has recently been recounted by Reid (1977), and other writing on the history of Lakeba is in progress. Little therefore is said here. According to legend, the island was first settled in the north-west and Ulunikoro on the limestone massif below the airstrip was the first village site. Since Ulunikoro is a very defensible fortified site, this is perhaps unlikely, but some of the earliest evidence of settlement on the island, around 3000 B.C. (comes from this area (S. B. H. genitalia). The Vunikoro were late arrivals, like the Vegalevu in Taveuni, coming to Lakeba long after the island was already settled. At this time fortified sites were certainly occupied, and the site of the present-day central hill -- Kekede -- was in the hands of the Narewadu and Celinea people; the Toaalevu and Katubalau (or bete) people occupied the country to east and west. After the coming of the Vunikoro the land was redistributed, in a manner common in Fijian history. The Toaalevu gave the Vunikoro coastal plain and limestone country because a Toaalevu girl married the Vunikore chief. The Katubalau made over land west of present-day Tubou, so that the Vunikore now hold most of the southern and south-western coastland -- the best coconut land in Lakeba. Gifts of land in other villages were also made to the Vunikore 'because they were the chiefs'; areas in Nukunu territory such as Tulaki and Potu, both close to the old village site of Naracake, and the Mata Lalai block in Nasqalau territory are examples.

The Narewadu did not part with the area then of principal value -- the bulk of the valuable swampland in the Tubou valley. They have, however, given or lent many small blocks in this area to members of other mataqali without wet taro land (Fig. 7.6). It was the early realization of this complexity, and also the later realization of great inequalities in the present participation distribution of coconut land, that led the writer to seek more information on the land holding pattern of Lakeba.

The land-holding map

Data for the construction of such a map were poor. The mataqali land of Lakeba had never been surveyed by the Native Lands Commission; no part of Lau was reached by the Commission during its lengthy deliberations in the first generation after Fiji became a Colony in 1874. On the initiative of Ratu Sir Lala Sukuna, village territories were demarcated on the ground by survey markers in the 1950s; these were intended to be visible on air photographs. In some cases, they are, but the necessary ground survey did not follow. There is therefore no cadaster of land at even the most basic level. Territories now less the exist, with exactly the same force as elsewhere in Fiji.

The job could not have been commenced without the help of Kaminelli Tabuenave of Namwai, a former land surveyor who had assisted in the village-territory demarcation, and who had an intimate knowledge of the distribution of mataqali land on the island. An initial map was prepared with his cooperation, and was later modified by information received from other informants -- their fields during walks across the island -- and in some cases by information contained in mataqali books. Often, however, it was difficult for mataqali members themselves to agree on which physical feature specified in the books as boundary marker was the actual feature on the ground. The map was therefore re-prepared and presented, in this paper as Fig. 7.6, with great caution and reservation. As is clearly indicated on the face of the map itself, it must be regarded as tentative in the highest degree. Table 7.6, which is based on this map, must also be regarded as having no more
Figure 15

LAKEBA
FIJI

VILLAGE AND MATAQALI LAND

LEGEND

- Boundary of village land
- Boundary of Mataqali land
- Boundary of former village land
- Land allocated to another village
- An example for one Mataqali of plots of land inter given to members of another Mataqali.
- Gardens of one land held in land of other village.
- House or building.
- There are disputes over boundaries in this area. Conflicting evidence was found in the field.
- There are three Mataqali in Lakeba (Naukusa, Nakakiri, Naiwai) with known land rights in Lakeba. Their lands were sold land from other Mataqali either through court cases or through marriage.

A
B
C
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V
W
X
Y
Z

Contours at 40 metre intervals.

N.B. This map has been constructed from information received in the field and the representation of a boundary is no evidence of its exact position.
than indicative value.

The pattern of territories

The village territories are the most reliable element of the map, and also the simplest in conception. The intention going back to Mataqali time was that each village should hold a wedge-shaped portion of the island, extending from the coast to the highest part of the interior rather like the slices of a cake. The preliminary work undertaken in Ratu Sukuna’s time employed ridge-crests as boundaries. This intention remains evident on the map today, but the objective of a land distribution in which each community should have shares in land of all types has been realized only in part. In four of the village territories mataqali also have wedge-shaped territories within the village land, but there has been a great deal of change within the holdings of three of the largest villages — Tubou, Yadra and Nukunu. Moreover, the shares are far from equal in terms of land quality. While some mataqali have large areas of land, much of this is talasiga of very limited or no agricultural value. Other mataqali have little coastal land in the coconut girdle, so that their members’ chances of a profitable copra income are diminished in comparison with others. A mataqali holding a wedge containing one of the permanent streams is clearly much less at the mercy of the drought hazard than another with only ephemeral streams in its block; irrigated or swamp taro can be planted with assurance only where the water supply is secure.

Agreement between individuals, with or without a kinship basis, is of fundamental importance in equalizing these distributions. Many men farm plots of land in the territories of other villages than their own, e.g. several disadvantaged men from the small village of Wattabu journey to Nukunu territory to plant their crops. One example shown on the map is of a farmer from landless Levuka, who has tilled crop land in no fewer than three village territories, and some coconut land in Tubou territory. These plots are widely scattered, and represent a great deal of ‘travel to work’ time, and the expenditure of much energy in carrying tools and harvested crops long distances over slippery tracks and steep hills. Even within a favoured mataqali, fragmentation of individual holdings is more the rule than the exception. Few farmers have all their coconut and food-crop land close together; plots may be at opposite ends of a village territory. The best land is highly valued, and access to it is jealously guarded; half-hectare of good land is worth more than ten hectares of indifferent and eroded terrain.

MEASUREMENT AND PERCEPTION

The quantitative distribution of land

Because of these inter-personal arrangements the quasi-legal allocation of land should not be interpreted as rigid. None the less, it is possibly growing more rather than less significant — at least in regard to the more valued land — in consequence of the spreading individualization of Fijian society which Lakeba has escaped, and which we discuss more fully below. Quantitative measurement of the population-land ratio within village and mataqali territories has much less than full meaning, but is not without meaning in modern Lakeba. Such measurement is set out in Table 7.6, which is based on Fig. 7.5, areas being measured with a Tektronix computer-linked

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>AREA (km²)</th>
<th>POPULATION</th>
<th>AREA PER CAPITA (ha)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUBOU</td>
<td>19.4</td>
<td>460</td>
<td>5.0</td>
<td>Includes former leasehold estates now held by Yuvurewa members</td>
</tr>
<tr>
<td>Yuvurewa</td>
<td>6.3</td>
<td>431</td>
<td>1.5</td>
<td></td>
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<td>Namalotu</td>
<td>1.7</td>
<td>34</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Kataleum</td>
<td>5.0</td>
<td>68</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Cikuma</td>
<td>2.7</td>
<td>21</td>
<td>12.9</td>
<td></td>
</tr>
<tr>
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<td>66</td>
<td>3.2</td>
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<tr>
<td>LEVUKA</td>
<td>0.1</td>
<td>129</td>
<td>0.0</td>
<td>Land at Nabuni from Wacwaci (Matawugalei mataqali)</td>
</tr>
<tr>
<td>WACIWACI</td>
<td>4.6</td>
<td>270</td>
<td>8.7</td>
<td></td>
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<td>Tavakua</td>
<td>1.1</td>
<td>47</td>
<td>2.4</td>
<td></td>
</tr>
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<td>Matawu</td>
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<td>15</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Naduruvei</td>
<td>1.7</td>
<td>80</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Viti</td>
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<td>28</td>
<td>0.7</td>
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</tr>
<tr>
<td>WATABU</td>
<td>3.5</td>
<td>150</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
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<td>53</td>
<td>2.4</td>
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<td>22</td>
<td>4.4</td>
<td></td>
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<tr>
<td>Qalitoka</td>
<td>0.7</td>
<td>35</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Nukunuku</td>
<td>8.0</td>
<td>242</td>
<td>3.7</td>
<td>Excludes blocks given to Vatuineua individuals</td>
</tr>
<tr>
<td>Narokea</td>
<td>2.6</td>
<td>57</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>Maliala</td>
<td>1.3</td>
<td>35</td>
<td>3.8</td>
<td>Combines land of subdivided mataqali</td>
</tr>
<tr>
<td>Bete</td>
<td>1.3</td>
<td>24</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>Luaniko</td>
<td>2.8</td>
<td>25</td>
<td>11.3</td>
<td></td>
</tr>
<tr>
<td>YADRAINA</td>
<td>2.0</td>
<td>354</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Babuaia</td>
<td>2.2</td>
<td>188</td>
<td>1.2</td>
<td>Combines land of subdivided mataqali</td>
</tr>
<tr>
<td>Yawalevu</td>
<td>1.0</td>
<td>60</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Cawu</td>
<td>2.9</td>
<td>95</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Sau</td>
<td>0.9</td>
<td>51</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>VAKANO</td>
<td>4.4</td>
<td>108</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Maliau</td>
<td>2.6</td>
<td>40</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>Suweme</td>
<td>1.7</td>
<td>68</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>NASAQALI</td>
<td>8.0</td>
<td>142</td>
<td>4.4</td>
<td>Excludes blocks given to Yuvurewa individuals</td>
</tr>
<tr>
<td>Nukusu</td>
<td>3.4</td>
<td>56</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Nukatua</td>
<td>1.0</td>
<td>92</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Loma</td>
<td>0.5</td>
<td>26</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Orakiti</td>
<td>3.2</td>
<td>68</td>
<td>4.7</td>
<td></td>
</tr>
</tbody>
</table>

VILLAGE AND OTHER LAND: 0.2

Notes: Areas are rounded to nearest 10 ha (0.1 km²) to allow for possible inaccuracies. Most small blocks of individually-held land are included within mataqali areas, and a few larger blocks are also included. Mataqali population, and hence the village populations used in this table, are from local records and census figures taken from official sources and used in other tables. The total is 1977 persons against the 1968 in the 1976 census data.

Persons living in the Government Station, and on individually-held land are excluded from both sets of figures. See also paper 5.2 above.
digitizer.

Even disregarding the estates operated by some of its leading members, or land given to individual Vuanirewa chiefs elsewhere in the island, Tubou has more than twice the land area of any other village, including a large coastal segment and the major permanent stream. At the other extreme is Levuka, with no direct mataqali land rights; when the immigrants who founded Levuka came to Lakeba they asked for no rights other than land on which to dry their nets. They were seamen and fishermen from Bau, and only after two years settlement on the island and the end of the dry season of the 19th century did they acquire a need for subsistence and cash-crop land. Today they get most of their taro land at Nabuni from the people of Wacwaci, and individual allotments are widely scattered.

Nasaqalu and Nukunuku(1034,340),(992,346) are next largest to Tubou in land area, but on a per capita basis Nukunuku is far better provided. Yadra would seem to be poor in land, but its territory includes two permanent streams of useful size and in terms of water this village is better provided than any village other than Tubou.

There are great differences between mataqali within villages. In Tubou the chiefly Vuanirewa have the most land but also the largest population; the non-small Celeka mataqali have a far larger holding on a per capita basis. Similar contrasts emerge in all villages where there may be few able-bodied men left in the smaller mataqali; but it must be emphasized that these figures refer only to the resident population of Lakeba. At least as many Lakeban now live on Viti Levu, or elsewhere, as reside in Lakeba itself. Were they all to return -- which is unlikely in the extreme -- pressure on land resources would be very real under present land-use technology.

Perception of land adequacy

In the perception of present-day Lakeba residents the distribution of land differs significantly from the quantitative picture presented above. Most Islanders will say that Tubou is the best provided -- though admitting that the Vuanirewa have little -- and regard Nasaqalu as the most favoured. A sample of people in four villages was asked if they had enough land for their own needs. The results of this question were as follows:

<table>
<thead>
<tr>
<th></th>
<th>ENOUGH LAND PERSONALLY</th>
<th>INSUFFICIENT LAND</th>
<th>RESPONDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
<td>Number</td>
</tr>
<tr>
<td>Tubou</td>
<td>64</td>
<td>36</td>
<td>22</td>
</tr>
<tr>
<td>Nukunuku</td>
<td>40</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>Wacwaci</td>
<td>36</td>
<td>64</td>
<td>11</td>
</tr>
<tr>
<td>Levuka</td>
<td>22</td>
<td>78</td>
<td>9</td>
</tr>
</tbody>
</table>

Only Tubou residents, several of them wage earners, provided a majority satisfied with their present land. Pressed more closely, these and other respondents held that Lakeba has inadequate coconut land. They held this view almost to a man, disregarding the large area lying under old trees or overgrown with weeds. What they seemed to mean was that under the present cash-crop monoculture, Lakebans lack the land to provide the incomes they desire.

III - THE ANALYSIS OF INCOME AND EXPENDITURE

THE ANALYSIS OF INCOME

A statement of hypothesis

In the discussion up to this point we have encountered a fairly wide range of differences in the farming practices of Lakebans, both in the subsistence and in the cash-crop areas; in the immediately preceding section we analyzed in some depth that aspect of variation in personal opportunity which is represented by differential access to land. In the present section we turn to the pattern of cash incomes, aggregated to village and island levels, and to an analysis of the pattern of expenditure which they support. The evidence to be reviewed suggests that aggregated expenditures are rather inelastic in their response to short-term variations in the levels of income. In turn, this suggests that desired expenditure is the prime determinant of the level of income-earning activity.

While this may be true of aggregated populations, however, there is also wide variation between communities, and between individuals. Data indicating the range of individual variation are presented below in this section, and in the following section are complemented by a qualitative discussion of behavioural variation among farmers and wage-earners. From this evidence, it will be argued that there are two populations in Lakeba, distinguished more on the basis of motivation than of opportunity. Because opportunity can pursue a range of activities within Lakeba is largely confined to Tubou, the contrast appears initially as a geographical contrast between Tubou and nearby Wacwaci on the one hand, and the remaining villages of the island on the other. However, the whole 'Lakeban' population also includes emigrants living elsewhere, who have sought opportunity further afield. In presenting the thesis of 'two Lakebas', therefore, it is at the same time hypothesized that 'motivated' Islanders are both the effective driving force in development at home, and also the migrants in search of greater opportunity elsewhere. In the attempt to mobilize human resources for island development need to be focussed around these people, rather than among the majority who merely accept what is made available. The discussion that follows needs to be read in the light of this hypothesis, full development of which is deferred to the final section of the paper.

A fortuitous problem with data and time

Survey data employed in the following analysis were collected in 1976. They relate, therefore, to the year 1975-76 which was in no possible sense 'normal'. Not only was it a year of rapid inflation and depressed raw-material prices, but it was also greatly influenced by the hurricanes which smote Lakeba on the last day of January-1975; this event reduced the 1975 and 1976 production of copra, the one major cash-crop, to a fraction of the levels attained in 1973 and 1974. It would have taken until 1978 or even 1978 for something like a 'normal' pattern of copra production to be restored. Moreover, the effect of Hurricane Vai was by no means uniformly distributed across the island. Some areas were able to resume limited copra production

10 The same operation led to a final measurement of the total land area of the island at 55.90 square kilometres, replacing previous measurements made with a hand-operated planimeter.
### TABLE 7.7

#### (A) CASH INCOME BY VILLAGES: 1976 DATA WITH 1974 COPRA INCOMES

<table>
<thead>
<tr>
<th>Village</th>
<th>Income from Produce Sales (&quot;Environmental&quot;)</th>
<th>Other Income (&quot;Non-Environmental&quot;)</th>
<th>All Cash Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COPRA</td>
<td>Other</td>
<td>Total</td>
</tr>
<tr>
<td>Tubou</td>
<td>$97349</td>
<td>$1500</td>
<td>$98949</td>
</tr>
<tr>
<td></td>
<td>Levuka</td>
<td>$14615</td>
<td>$1000</td>
</tr>
<tr>
<td></td>
<td>Nacwaci</td>
<td>$31778</td>
<td>$5400</td>
</tr>
<tr>
<td></td>
<td>Maitabu</td>
<td>$15363</td>
<td>$2000</td>
</tr>
<tr>
<td></td>
<td>Nukunuku</td>
<td>$34736</td>
<td>$1958</td>
</tr>
<tr>
<td></td>
<td>Yadra</td>
<td>$97846</td>
<td>$6000</td>
</tr>
<tr>
<td></td>
<td>Vakano</td>
<td>$19876</td>
<td>$1000</td>
</tr>
<tr>
<td></td>
<td>Nasoalau</td>
<td>$63162</td>
<td>$4000</td>
</tr>
<tr>
<td></td>
<td>Unallocated</td>
<td>$55852</td>
<td>55852</td>
</tr>
<tr>
<td></td>
<td>LRKEBA</td>
<td>$368937</td>
<td>23058</td>
</tr>
</tbody>
</table>

Notes: 1. Copra bonuses paid by Co-operative Societies included for 1974, but no allowance made for this source in Table 7.7 (B).
2. Estates, 'cubs' and individual copra sellers not identified by village.

### (B) CASH INCOME BY VILLAGES: 1976 DATA WITH 1974 COPRA PRODUCTION AT 1975-76 PRICE

<table>
<thead>
<tr>
<th>Village</th>
<th>Income from Produce Sales (&quot;Environmental&quot;)</th>
<th>Other Income (&quot;Non-Environmental&quot;)</th>
<th>All Cash Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COPRA</td>
<td>Other</td>
<td>Total</td>
</tr>
<tr>
<td>Tubou</td>
<td>$33644</td>
<td>$1500</td>
<td>$35144</td>
</tr>
<tr>
<td></td>
<td>Levuka</td>
<td>$4354</td>
<td>$1000</td>
</tr>
<tr>
<td></td>
<td>Nacwaci</td>
<td>$11142</td>
<td>$5500</td>
</tr>
<tr>
<td></td>
<td>Maitabu</td>
<td>$5363</td>
<td>$2000</td>
</tr>
<tr>
<td></td>
<td>Nukunuku</td>
<td>$12300</td>
<td>$1908</td>
</tr>
<tr>
<td></td>
<td>Yadra</td>
<td>$20358</td>
<td>$6000</td>
</tr>
<tr>
<td></td>
<td>Vakano</td>
<td>$6594</td>
<td>$1000</td>
</tr>
<tr>
<td></td>
<td>Nasoalau</td>
<td>$18547</td>
<td>$4000</td>
</tr>
<tr>
<td></td>
<td>Unallocated</td>
<td>$19490</td>
<td>19490</td>
</tr>
<tr>
<td></td>
<td>LRKEBA</td>
<td>$130696</td>
<td>$23058</td>
</tr>
</tbody>
</table>

Notes: 1. Copra bonuses paid by Co-operative Societies included for 1974, but no allowance made for this source in Table 7.7 (B).
2. Estates, 'cubs' and individual copra sellers not identified by village.
much greater significance; in 1974 the largest Society in Tubou paid out $14,000 in bonuses, approximately $3000 for store bonuses and $11,000 for copra.

In interpreting Table 7.7 it must finally be recalled that while all income from copra and remittances comes from outside the island, a small but significant proportion of wages is paid from incomes generated within Lakeba, and that most 'other environmental income' (mainly from sales of fish, vegetables and livestock) represents money circulated within the island economy. The net income of the island and its component villages is thus rather less than the figures shown in the right-hand column. It is none the less clear that the cash element is of major importance in the Lakeban economy. The principal sources of that income will now be examined more closely.

Income from copra

In reviewing the structure of the copra industry at pp. 150-53 above, we noted that in the last year of full production before Hurricane Val, 43.8 per cent of all copra sent to Suva was exported privately. Greater detail on the distribution of copra receipts between the Co-operative Societies and individual exporters is provided in Table 7.8 below. Leaving aside the estates and the 'unlocated individuals', the Societies emerge as the major exporter in all villages, but by widely varying margins. Vakamo has no individual sellers; in the south, contrast, much of the estate and 'club' income comes into the chiefly village, so that Tubou people in fact sell at least as much dry copra privately as through the Societies. Including the estates and half the unlocated sellers within Tubou, Levuka and Wacwaci, 48 per cent of the copra comes from the south, 52 per cent from the villages of the east and north.

Tables 7.9 and 7.10 provide greater detail on the income patterns of

### TABLE 7.9: DRY COPRA RECEIPTS BY INDIVIDUALS - WHO CONSIDERED DIRECTLY TO SUVA, 1974

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>NUMBER OF SELLERS</th>
<th>TOTAL RECEIPTS</th>
<th>MEAN RECEIPTS</th>
<th>STANDARD DEVIATION</th>
<th>COEFFICIENT OF VARIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubou</td>
<td>47</td>
<td>44618</td>
<td>949.33</td>
<td>937.13</td>
<td>0.99</td>
</tr>
<tr>
<td>Levuka</td>
<td>3</td>
<td>1466</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wacwaci</td>
<td>11</td>
<td>14715</td>
<td>1337.79</td>
<td>1350.32</td>
<td>1.01</td>
</tr>
<tr>
<td>Maitabu</td>
<td>4</td>
<td>7514</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nakukuru</td>
<td>7</td>
<td>13994</td>
<td>1927.59</td>
<td>1650.58</td>
<td>0.88</td>
</tr>
<tr>
<td>Yadra</td>
<td>16</td>
<td>18912</td>
<td>1182.00</td>
<td>1360.52</td>
<td>1.15</td>
</tr>
<tr>
<td>Nasaqalau</td>
<td>9</td>
<td>6525</td>
<td>725.05</td>
<td>867.74</td>
<td>1.20</td>
</tr>
<tr>
<td>All villages</td>
<td>97</td>
<td>107245</td>
<td>1104.59</td>
<td>3167.02</td>
<td>1.06</td>
</tr>
<tr>
<td>Not located</td>
<td>42</td>
<td>27365</td>
<td>636.18</td>
<td>554.45</td>
<td>0.87</td>
</tr>
<tr>
<td>Estates</td>
<td>3</td>
<td>27234</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'Clubs'</td>
<td>3</td>
<td>1262</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAKEBA</td>
<td>145</td>
<td>163096</td>
<td>1142.82</td>
<td>1994.77</td>
<td>1.77</td>
</tr>
</tbody>
</table>

Data: Suva grading station records. Bags converted to tonnes and priced according to grading and ruling price on day of grading. Cess and freight deducted.

### TABLE 7.10: GREEN COPRA RECEIPTS BY MEMBERS OF CERTAIN CO-OPERATIVE SOCIETIES

<table>
<thead>
<tr>
<th>SOCIETY (VILLAGE)</th>
<th>NUMBER OF SELLERS</th>
<th>TOTAL RECEIPTS</th>
<th>MEAN RECEIPTS</th>
<th>STANDARD DEVIATION</th>
<th>COEFFICIENT OF VARIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagalevu (Tubou)</td>
<td>24</td>
<td>2863</td>
<td>119.29</td>
<td>97.27</td>
<td>0.82</td>
</tr>
<tr>
<td>1972-73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973-74</td>
<td>26</td>
<td>5000</td>
<td>192.15</td>
<td>169.31</td>
<td>0.88</td>
</tr>
<tr>
<td>1974-75</td>
<td>25</td>
<td>6794</td>
<td>271.76</td>
<td>473.33</td>
<td>1.74</td>
</tr>
<tr>
<td>Uuanawa (Tubou)</td>
<td>65</td>
<td>12695</td>
<td>195.31</td>
<td>199.53</td>
<td>1.02</td>
</tr>
<tr>
<td>1973-74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974-75</td>
<td>68</td>
<td>13087</td>
<td>192.46</td>
<td>201.28</td>
<td>1.06</td>
</tr>
<tr>
<td>1975-76</td>
<td>48</td>
<td>1151</td>
<td>23.99</td>
<td>27.84</td>
<td>1.16</td>
</tr>
<tr>
<td>Nadawa (Tubou)</td>
<td>28</td>
<td>4538</td>
<td>162.07</td>
<td>170.60</td>
<td>1.05</td>
</tr>
<tr>
<td>1974-75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levuka</td>
<td>24</td>
<td>4971</td>
<td>207.13</td>
<td>122.00</td>
<td>0.59</td>
</tr>
<tr>
<td>1973-74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarakua (Wacwaci)</td>
<td>17</td>
<td>9097</td>
<td>535.12</td>
<td>306.67</td>
<td>0.57</td>
</tr>
<tr>
<td>1973-74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vakamo</td>
<td>21</td>
<td>9288</td>
<td>442.29</td>
<td>366.65</td>
<td>0.83</td>
</tr>
<tr>
<td>1973-74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasaqalau</td>
<td>50</td>
<td>20103</td>
<td>402.06</td>
<td>262.00</td>
<td>0.65</td>
</tr>
</tbody>
</table>

N.B. The financial year runs from a date in May, variable between Societies, but usually close to the beginning of the month.

Data: Co-operative Society records.
Figure 7.6

The graph shows the monthly purchases at Nasaqaipau (actual) and the weekly purchases at Taraku Co-op, Waidiaqoq (7 week moving average). The price of Nasqaipau and Hurricane Val are also displayed.

The data indicates a significant increase in purchases and price from 1972 to 1976, with a peak in 1973 and a slight decline in 1974. The price also shows fluctuations, with a peak in 1974 and a slight decrease in 1976.

The graph is useful for understanding the trends in copra purchases and price over the specified period.
is evidence of seasonal pattern unrelated to price, but related to the need for cash. A glance at the production and receipts of five selected suppliers of green copra, averaged on a mean monthly basis through three time periods, reveals something of the range of individual diversity in economic behaviour:

<table>
<thead>
<tr>
<th>GROWER</th>
<th>PRODUCTION in kg/month:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RECEIPTS in $/month:</td>
<td>kg/</td>
<td>kg/</td>
<td>kg/</td>
<td>kg/</td>
<td>kg/</td>
</tr>
<tr>
<td>1974 (12 months)</td>
<td>590/75</td>
<td>82/11</td>
<td>281/35</td>
<td>373/46</td>
<td>69/6</td>
<td></td>
</tr>
<tr>
<td>1975 (May-December)</td>
<td>230/13</td>
<td>172/11</td>
<td>60/3</td>
<td>167/7</td>
<td>67/4</td>
<td></td>
</tr>
<tr>
<td>1976 (January-June)</td>
<td>239/11</td>
<td>452/25</td>
<td>121/6</td>
<td>117/7</td>
<td>84/4</td>
<td></td>
</tr>
</tbody>
</table>

It is only new data are aggregated that clear trends emerge. If we refer back to Fig. 7.4 something like a 'lag-effect' is evident in the relationship between price and the business handled by the Societies. Thus a drop in sales during the mini-bum of 1971 is followed by an increase during the 1972-73 depression, followed in turn by a drop in 1974 ahead of the natural disaster of 1975. What is unclear, without a full examination of the year-by-year data on deliveries to Suva, is the extent to which each decline in Society business represents merely a cluster of individual decisions to dry copra and ship it privately. There is at least a suggestion here that some individuals respond positively to price improvement by undertaking the additional work involved in private sale as well as, or instead of, increasing production; others, it would seem, produce copra in connection to cash needs, sell more when the price is low and less when it is high, and even produce more in the aftermath of a hurricane than they did in a good year when the price was the highest ever known.

In November 1976 a grading station was opened in Tubou, so that all copra can now be graded in Lakeba rather than in Suva. It was immediately a major innovation. The writer left the field only two weeks after commencement of operations, so is unable to state what further changes have taken place. It would seem likely, however, that a considerable increase in dry-copra production by individuals might result.

Income from wages

On the low-copra-price basis in Table 7.7B wages are by almost 40 per cent a more important source of income than copra income in Lakeba. Even on the high-copra-price basis (Table 7.7A) they are more important in the Tubu area in the south of the island. There are only 173 wage earners in Lakeba, among whom few of the 26 on the Government Station are Lakebans. However, at an average household size of 6.47 persons, wages supported at least in part more than a half of the whole population. The distribution of wage incomes is set out in Table 7.11, where it is shown that 67 per cent of the wage earners and 82 per cent of the income are concentrated in the quasi-urban complex formed by Tubou, Levuka and the Government Station. Most of the remaining wage income is received in the two villages with primary schools, Wacwaci and Vakano (13 per cent of the wage earners and 12 per cent of wages). The remaining four villages have one fifth of the wage earners but less than six per cent of the income.

### Table 7.11: Wage Incomes, 1976

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>TOTAL WAGES</th>
<th>MEAN WAGE</th>
<th>STANDARD DEVIATION</th>
<th>COEFFICIENT OF VARIATION</th>
<th>WAGE-EARNING POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubou</td>
<td>103771</td>
<td>1440</td>
<td>1392</td>
<td>0.97</td>
<td>72</td>
</tr>
<tr>
<td>Government Station</td>
<td>581'81</td>
<td>223'27</td>
<td>1322</td>
<td>0.59</td>
<td>26</td>
</tr>
<tr>
<td>Levuka</td>
<td>252'57</td>
<td>1329</td>
<td>426</td>
<td>0.32</td>
<td>19</td>
</tr>
<tr>
<td>Wacwaci</td>
<td>170'30</td>
<td>1064</td>
<td>1029</td>
<td>0.37</td>
<td>16</td>
</tr>
<tr>
<td>Waitobu</td>
<td>3180</td>
<td>530</td>
<td>520</td>
<td>0.50</td>
<td>6</td>
</tr>
<tr>
<td>Nukumitu</td>
<td>1188</td>
<td>119</td>
<td>103</td>
<td>0.86</td>
<td>10</td>
</tr>
<tr>
<td>Yadraen</td>
<td>4648</td>
<td>664</td>
<td>549</td>
<td>0.83</td>
<td>7</td>
</tr>
<tr>
<td>Vakano</td>
<td>10646</td>
<td>1521</td>
<td>1724</td>
<td>1.13</td>
<td>7</td>
</tr>
<tr>
<td>Nasuala</td>
<td>3438</td>
<td>346</td>
<td>278</td>
<td>0.81</td>
<td>10</td>
</tr>
<tr>
<td>ALL WAGE EARNERS</td>
<td>227279</td>
<td>1314</td>
<td>1267</td>
<td>0.95</td>
<td>173</td>
</tr>
</tbody>
</table>

Data: Field survey.

In Tubou and Levuka about 55 per cent of householders are wage earners and ten per cent of households contain more than one wage earner. In the Government Station all households depend on wages. Table 7.12 summarizes the occupations of all males over 15 in this area.

### Table 7.12: Occupations of Adult Males in Tubou, Levuka and the Government Station in May 1976

<table>
<thead>
<tr>
<th>OCCUPATION</th>
<th>TUBOU/LEVUKA</th>
<th>GOVERNMENT STATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Farmer only</td>
<td>61.1</td>
<td>-</td>
</tr>
<tr>
<td>Public Works Department</td>
<td>11.4</td>
<td>-</td>
</tr>
<tr>
<td>Government services</td>
<td>6.9</td>
<td>68.0</td>
</tr>
<tr>
<td>Commercial enterprise</td>
<td>4.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Pine scheme</td>
<td>2.2</td>
<td>8.0</td>
</tr>
<tr>
<td>Scholar/student</td>
<td>6.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Other (including retired)</td>
<td>7.9</td>
<td>12.0</td>
</tr>
<tr>
<td>TOTAL (Number)</td>
<td>229</td>
<td>5</td>
</tr>
</tbody>
</table>

Data: Field survey.

The distribution of rewards is determined by the nature of employment. The more highly-skilled professional posts on the Government Station and in the education system are worth from $1500 to $7500 per annum, but most of the more highly-paid posts are held by officers from elsewhere in Fiji. In the Provincial Administration, the Lakeba Co-operative Association, and in the teaching and nursing professions, posts worth from $360 to $550 per annum are available to Lakebans, but few receive the higher rates. Typists
and clerks on Lakeba earn less than the rates for comparable work in Suva.

For unskilled, or semi-skilled men able to drive a car, work in wood
or in metal, employment by the Public Works Department (PWD) is much
the best job opportunity available. After a rapid rise of almost 25 per
cent in two years, labourers could get 83 cents/hour, semi-skilled
men 90-99 cents and the rare skilled man as much as $1.20/hour. Such employment depends
however, on the vagaries of the PWD budget. Thirty or more men might be
engaged when a particular project is in hand, but all but a core of skilled
and semi-skilled men will be stood down when work is no longer available.

Some other unskilled work is available at the Pine Station; farmers who are
regular wage earners may need labourers, and casual work is often available
for the larger landowners. Many workers are casually employed, paid good
wages for a time, then left to their own resources for periods of varying
length. They thus alternate between income levels in employment at rates
of $500 to $1800 a year, and as farmers on the low-copra-price basis of $50
to $100 a year (Table 7.6).

The effect of this uncertainty on farming is clearly visible around
Tubou, and contributes to the low and variable mean incomes from green copra
which characterize this part of the island. It is mainly the small farmers
who deliver copra green to the Societies, and the same small farmers compete
for temporary wage employment when it becomes available. Elsewhere in the
island men have few opportunities for wage employment and are more single
minded in their farming activities. Almost the only employment available
in the farming villages consists of part-time jobs in the village Co-opera-
tive Society stores, paid at from $80 to $580 a year; however, this work is
available only on a one-year-to-year basis.

Most employment is male, and some jobs are split between two or more
people. There is little scope for female employment except in nursing and
teaching, some typing, and domestic work. Nurses may earn up to $2000 a
year, but the junior nurses receive only $800 and uncertificated school-
teachers earned only $75 in 1976. There is a considerable untapped labour
force among the educated unmarried girls who, in the project census, gave
their occupation as 'staying home' or 'helping in the house'. Many of these
girls, and many young men also, would grasp eagerly at the chance to work
for wages.

Of the 173 employed for wages, 139 were males, and 34 females. Twenty-
three, i.e. 68 per cent of employed women lived in the Tubou/Levuka/Govern-
ment Station complex. Eight Nacwal women worked either as teachers or
nurses and three women worked in Vakan. No women were employed
in the remaining villages. The income for Tubou employed was as follows:

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>MEAN</th>
<th>S.D.</th>
<th>C.V.</th>
<th>TOTAL WAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMPLOYED</td>
<td>WAGE</td>
<td>$F</td>
<td>$F</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>56</td>
<td>1064</td>
<td>1463</td>
<td>0.91</td>
</tr>
<tr>
<td>Females</td>
<td>16</td>
<td>657</td>
<td>929</td>
<td>7.07</td>
</tr>
</tbody>
</table>

Conclusion: a comment on inequalities

During field survey in 1976 a sample of households in Tubou and Nac-
wac w was investigated more closely than the population as a whole. After
the initial census, samples were drawn on the basis of number of wage-earning
and farming-only households in each village. The range of household incomes
in the preceding 12 months was from $95 to $806, with a mean of $295 for
36 Tubou households and of $1354 for 12 Nacwaci households. The sub-sample
of farming-only households, however, had a mean income from all sources of
only $301, and the median was only $176. In this copra-year Leon, Nacwaci
farmers were doing better off than their counterparts in Tubou because they had
more yacca ready for sale. A later survey of 20 households in Nukunu, carried
out by J.R. Campbell, showed a village very hard-hit by the 1975
hurricane. There was almost no wage employment, and the median income was
$450, with a range from $126 to $1032. The income of the poorest household
was made up of $70 for copra, $18 for fish, $8 for mixed vegetables and $30
for casual wages in a whole year.

Notwithstanding the general base of subsistence farming and fishing,
while these income contrasts have very real meaning in terms of living standards,
there are also great differences within all communities, and especially in
Tubou/Levuka itself. Tubou is part-village, pert-town, and wholly neither.
Wage incomes are substantial but for a significant proportion of the
population are very insecure. Landless Leviuka has a heavier reliance on
wage employment at a generally low level; In Table 7.11 the standard deviation around a mean wage income lower than that of Tubou demonstrates the
absence of any significant wealthier minority. In this community, and in
the poorer parts of Tubou also, the loss of a job can mean real distress.

THE ANALYSIS OF EXPENDITURE

An overview

As with data on incomes, information on expenditures had to be built
up from a range of sources. The most important single source was the Lakeba
Co-operative Association, the principal and in many cases sole agent for all
Co-operative Society stores on the island. Data were also obtained from
local Society books, and useful additional information came from household
interviews. Store purchases, however, made up only 65 per cent of a total
recorded through painstaking search, and when the data were fully assembled
they still took no account of direct purchases of radios, hardware and other
equipment from Suva. The result, recorded in Table 7.13, is however probably
a fairly complete inventory of 'normal-purpose' expenditure over a year.

More than half the total expenditure is in Tubou and the Government
Station alone, and almost 40 per cent consists of store and liquor purchases
in Tubou. While people from other villages buy in the better-stocked shops
in Tubou, the disproportionate per capita spending in Tubou is real, and
reflects the much larger wage-earning capacity of this community. In order
to understand the situation, it is useful to divide the expenditure pattern
into two groups: socially-determined spending, including education, church
and tax; individually-determined spending, including store purchases, water,
electricity and travel. On a per capita basis their distribution between
the villages is very different.
<table>
<thead>
<tr>
<th>Village</th>
<th>'Socially-determined' $</th>
<th>'Individually-determined' $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubou/Government Station</td>
<td>46</td>
<td>266</td>
</tr>
<tr>
<td>Levuka</td>
<td>40</td>
<td>149</td>
</tr>
<tr>
<td>Waiwai</td>
<td>57</td>
<td>116</td>
</tr>
<tr>
<td>Waitabu</td>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>Nukuru</td>
<td>45</td>
<td>78</td>
</tr>
<tr>
<td>Yadra</td>
<td>38</td>
<td>73</td>
</tr>
<tr>
<td>Yakumo</td>
<td>40</td>
<td>139</td>
</tr>
<tr>
<td>Nasagala</td>
<td>37</td>
<td>114</td>
</tr>
<tr>
<td>Lakeba</td>
<td>42</td>
<td>153</td>
</tr>
</tbody>
</table>

It will be apparent that there is very much greater variation in the second group than in the first.

'Socially-determined' expenditure

Church and Provincial taxes or an equivalent were established in Lau, as elsewhere in Fiji, during the 19th century. Knapman (1976) has traced their importance in generating cash-crop production. Provincial tax is paid by all males over 21, and church contributions are based on village populations, sometimes falling more heavily on the smaller villages. Levies are made on special occasions, but they are not included here. Added to this historical baseline of cash needs is the cost of educating children, on which all Fijians even minimally able to afford the cost place great value. Though the lower primary schools are now free, a fee of $4/tax was still charged for grades 5 and 6 in 1976; even though uniforms were generally cheap, the others they cost about $10/year, and a minimum of $5 was required for books and stationery. The cost per child at the senior primary level was thus at least $27, and the cost of secondary education was much higher.\(^{13}\)

It was not uncommon for households in Tubou to be paying $160-180 per annum for local schooling. The Ratu Finau Secondary School provides education only to standard four, and further education can only be obtained on the mainland. While expenses in Suva might be reduced when children stayed with relatives in the city, some households were paying $800-900 per annum for the education of their children in Viti Levu. In these circumstances it is not surprising that some farmers were forced to bring their children back to Lakeba in the year after the hurricane. Some even kept children away from local schools because of the expense.

Education, the demand for which reflects dissatisfaction with the rural way of life and the hope of providing the rising generation with a wider range of opportunities, is not only a major expense but also a principal incentive to cash-crop production and the search for wage employment. It should also be noted in relation to what follows that above-average income

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\(^{13}\) The one Junior Secondary School was partly subsidized by Government, remaining funds being found by the School Committee. Fees of $5/term were charged in Forms 1 and 2, and of $10/term in Forms 3 and 4. The cost of textbooks and uniforms was about $15/year. For boarders, fees include students from other villages in Lakeba as well as other islands in Lau, there was an additional minimum charge of $72/year.
earners are not necessarily above-average 'voluntary' spenders; if they have several children at school, a high proportion of their income may be absorbed in education.

'Individually-determined expenditure'

This more variable category of spending is not completely separate from the 'socially-determined expenditure' discussed above, since it includes fares of children, or parents, to and from Suva, while the Tubou water rate is charged on! households in the village. Moreover, travel across the island is necessary for almost all people in the outlying villages. Nowadays, also, everyone has to buy clothes or cloth, tools and utensils, and at least a minimum of store-bought supplies. With these principal exceptions, however, the level of spending in the shops, on travel, clothing, beer and cigarettes, and on luxuries are to a great degree variable. External travel, in particular, is in large measure a privilege of the relatively well-to-do in money terms. Table 7.13 shows that most of this class of expenditure is incurred in the Tubou area; in per capita terms the level of travel spending in the four rural villages without primary schoolteachers is less than one-third of the level in Tubou-Levuca. Such considerations should be borne in mind when the viability of new airstrip proposals in the eastern islands is being assessed. On the basis of Lakeba traffic measured simply against the whole island population, as in a recent study by Aplin and Wall (1976).

By far the largest category of all expenditure on Lakeba is, however, in the island stores. Among the eastern islands, only Taveuni and Ovalau are better provided with shops than Lakeba, and we now turn to a closer examination of store expenditure and its place in the Lakeba economy.

Store expenditure

There have been trade stores on Lakeba since the middle of the 19th century, established initially by Europeans. Early in the present century there were two in Tubou -- one on land since eroded away by the sea -- and one in Nasaqalau (Cyclopaedia of Fiji, 1907). Between the two world wars, most European traders in Lau were replaced by Chinese and a small number of Indo-Fijian storekeepers; in the mid-1960s there were still two Chinese stores and one Indo-Fijian store on Lakeba (Couper, 1967). After the Co-operative Society movement began to gather strength in the 1960s such monolithic traders found that their position depended increasingly on the granting of credit, especially to chiefly sponsors (Sahinis, 1962) and by the early 1970s they had all but disappeared from Lau. Moreover, the licensing of copra buying after the Stiloe (1963) reforms deprived many traders of an important part of their livelihood, while favouring the emergent Co-operative Societies. Only one Chinese trader now remains on Lakeba, on mataqali land just east of the Government Station. He has been encouraged to remain because he is the island's only baker; moreover, he finds that he can obtain credit at his store more readily than elsewhere.

The dominance of the Co-operative Societies is not, therefore, quite complete. Apart from the Chinese, there are some half-dozen 'canteens' -- mini-stores -- run by individual Fijians, mainly in the northern villages. These entreprenuers buy supplies directly from Suva and avoid the Co-operative Societies altogether. As a section of goods. Since 1973, however, all mataqali and village Societies have, with one exception, bought their supplies mainly through the single channel of the Lakeba Co-operative Association (LCA) which was set up in 1972 to co-ordinate all external transactions of the Co-operative movement on the island. By 1974 at least 80 per cent of all imports were handled through the LCA and in certain commodities the proportion was close to 100 per cent. In 1974 and 1975 the LCA imported goods valued respectively at $117,607 and $150,064 (Table 7.14). The LCA itself retails only liquor and petroleum products, and charges a mark-up of 12.5 per cent of the cif value of its imports. The retailing village and mataqali Societies charge a further mark-up, which is usually 10.0 to 12.5 per cent according to distance -- an aggregated 22 to 26 per cent on the beach-price of the goods.

| TABLE 7.14: IMPORTS BY THE LAKEBA CO-OPERATIVE ASSOCIATION, 1973/76 |
|------------------------|--------|--------|--------|------------------------|
| $                     | $      | $      | $      | $                      |
| Food and edible oils  | 30659.14 | 73010.15 | 53189.49 | 179506.25             |
| (48.7%)               | (40.2%) | (36.6%) | (43.6%) |                        |
| Cigarettes and tobacco| 19160.90 | 35570.00 | 33711.50 | 99974.55              |
| (30.2%)               | (59.6%) | (52.5%) | (53.6%) |                        |
| Beverages, beer and liquor | 1622.10 | 17300.82 | 30714.19 | 53800.35             |
| (2.6%)                | (11.0%) | (8.0%)  | (11.6%) |                        |
| Petroleum products    | 5676.35 | 13966.00 | 17401.12 | 44001.13              |
| (9.0%)                | (8.9%)  | (12.7%) | (11.6%) |                        |
| Other household goods | 5386.82 | 11069.99 | 11575.17 | 30432.17             |
| (8.5%)                | (7.0%)  | (7.7%)  | (6.6%)  |                        |
| Construction materials, etc. | 609.00 | 6740.47 | 3292.25 | 10750.22             |
| (0.2%)                | (4.3%)  | (2.3%)  | (2.6%)  |                        |
| TOTAL                 | 63313.31 | 157667.43 | 150043.72 | 418552.67             |
| (100.0%)              | (100.0%)| (100.0%)| (100.0%)|                        |

Data: Records of the Lakeba Co-operative Association, Tubou.

In 1974 and 1975 respectively, the import values shown in Table 7.14 therefore represent an approximate per capita value at shelf price of $91 and $97. In per-household terms, the respective values are $494 and $565. If we tentatively assume that as much as a further 20 per cent of imports entered Lakeba through other channels, then the per-household level of imports would be in round figures respectively $700 and $675 mark-up14.

Data on imports through the LCA are summarized in Table 7.14. It was only during 1973 that the village Societies began regularly to purchase through the LCA, so the large jump between 1973 and 1974 exaggerates a real increase in purchases that may have occurred in response to rising incomes.

14 Data on mean household size in the several villages of the island, derived from project data and public Health Department figures, are as follows: Tubou/Levuca 6.61; Nacwaci 6.70; Waitabu 5.77; Nukumuku 6.32; Yadrami 4.46; Vakano 5.48; Nasaqalau 7.30. The island mean is 6.49.
Moreover, beer was first imported commercially only in 1974. True comparison must therefore be restricted to 1974 and 1975, both unusual years.

Given the sharp decline of incomes in 1975, it is first remarkable that there was so small a drop in the value of imports. Purchases in the first three months of 1975, if continued at the same rate for a full year, would however have represented a 15 per cent drop on 1974 and a 19 per cent drop on 1974 at current prices. Even this is not large in relation to a drop of not less than 40 per cent in island income between 1974 and 1976. Between 1974 and 1975 the major reductions were in food and edible oils (55 per cent) and construction materials (minus 51 per cent). On the other hand the value of liquor and beverages imported rose by 78 per cent and of petroleum products by 25 per cent. The import of cigarettes and tobacco declined by only five per cent.

The hurricane relief programme is important in helping to explain these anomalies. From February 1975 until early 1976 irregular quantities of certain basic foodstuffs were supplied free of charge, as also to other islands struck by Hurricane Val. The distribution of this aid and its problems have been described elsewhere by the writer (M. Brookfield, 1977). The main products supplied were flour and rice, together with quantities of biscuits, milk powder, canned fish, tea and sugar. Data on these supplies in files made available to the project are incomplete; for example, no flour is shown, even though large quantities were received. According to the records, the per capita value of food supplied to the whole of Lau was $5.50, which seems improbably low.

Examined in greater detail, the LCA imports for 1975 show sharp reductions in starch foods, canned meat and fish, but increases in some other foodstuffs, including some items listed among the relief supplies. This may be related to the irregularity and uncertainty of the relief programme. It must, however, be concluded that even though there were genuine shortages of subsistence foods for several months, they were not so serious as to prevent islanders from sustaining their consumption of cigarettes and increasing their consumption of beer; the income-elasticity of demand for these products is clearly less than for starch food and animal protein. It is also remarkable that there was such a drop in the value of construction materials imported, even though several months elapsed before the first hurricane-relief houses reached the island. Some waited, while others with sufficient money bought material directly from Suva at lower cost than through local channels.

Inequality in expenditure patterns

On the unlikely assumption that everyone shopped in the villages where they resided, the people of Tubou and the Government Station bought $224.50 of store goods per capita in 1974-75, against only $75.75 elsewhere in the island (Table 7.13). Table 7.15, derived from the same data base as Table 7.10 above, provides an indication of inequality within, rather than between communities, at least among members of Co-operative Societies. Taking the comparable year 1974-75, there is less difference than might be expected between the mean expenditure levels of members of Tubou Societies and those of other Societies, and although variation around the mean is less in the other villages, the pattern is not altogether consistent. What is more significant is comparing this table with Table 7.10 to see the very wide margin between mean expenditure and the value of copra sales in Tubou and Levuka Societies, by comparison with the much narrower margin in Wachwai, Yakano and Nasaqalau.
they do on the small islands. Both income and expenditure channels are more widely dispersed.

THE BALANCE OF INCOME AND EXPENDITURE

A summary of the data

Table 7.16 recapitulates our data on income and expenditure by village, and for the whole island. Both sets of income estimates are presented, employing the recorded high copra incomes of 1974 and the estimated lowered incomes for an equal production in a supposed '1977', in association with survey data which relate mainly to the year 1975-76. For the island as a whole, the 1975-76 expenditure is about in balance with the '1977/1978' income, but far below the 1974/1976 income. Since the actual income of the islanders in 1975-76 was well below the lower of the two estimates, because of the low level of copra production, it follows that expenditures substantially exceeded incomes in that year.

TABLE 7.16: INCOME 1974/76 AND 1977/78 AGAINST EXPENDITURE IN 1975/76

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubau and Govern-</td>
<td>299662</td>
<td>216924</td>
<td>220264</td>
</tr>
<tr>
<td>ment Station</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levuka</td>
<td>43504</td>
<td>33243</td>
<td>23702</td>
</tr>
<tr>
<td>Waclaw</td>
<td>56018</td>
<td>36442</td>
<td>28290</td>
</tr>
<tr>
<td>Waitabu</td>
<td>21624</td>
<td>11624</td>
<td>12320</td>
</tr>
<tr>
<td>Nukunuku</td>
<td>20152</td>
<td>12716</td>
<td>14924</td>
</tr>
<tr>
<td>Yadra</td>
<td>71255</td>
<td>32797</td>
<td>40620</td>
</tr>
<tr>
<td>Vakanu</td>
<td>32148</td>
<td>17864</td>
<td>18390</td>
</tr>
<tr>
<td>Nasaklau</td>
<td>68903</td>
<td>27288</td>
<td>35890</td>
</tr>
<tr>
<td>Unlocated copra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sellers</td>
<td>27335</td>
<td>9546</td>
<td>-</td>
</tr>
<tr>
<td>LAKEBA</td>
<td>65867</td>
<td>40042</td>
<td>401500</td>
</tr>
</tbody>
</table>

Data: Project surveys, as above. It should be noted that the unlocated copra sellers are not differentiated by village, but that village incomes are compared with village expenditure; the unlocated sellers enter the latter but not the former side of the village balance.

At the village level it seems clear that every community in the island must have enjoyed a substantial surplus of income over needs in 1974, and this surplus was important in enabling the island to weather the severe financial loss brought about by the coincidence of Hurricane Val and economic depression in 1975. On the 'low-copra-price' basis ('1977/1978'), however, only Levuka and Waclaw remain in surplus, though there is close to a balance in Tubau, Waitabu and Vakanu. While the island as a whole could sustain its 1975-76 level of expenditure on the basis of its current income from wages and minor sources, together with full copra production at the stabilized price, certain villages could not do this, and in every village there were men who would need to trim their expenditure very closely in order to make ends meet. Certainly the reckless spending of 1974-75, and the liberal distribution of bonuses by Societies in 1975, were both being called into question in 1976. There was not, however, much indication that the large expenditure on beer and cigarettes was seen as an economic problem; the main complaint was of shortage of income with which to satisfy felt needs.

Conclusion

If we review the evidence and argument backward from the conclusions reached above, it seems to support our hypothesis that, under normal conditions, desired expenditure is the main determinant of the level of income-earning activity on Lakeba. It is not possible to say what part savings play in this process; savings in cash were certainly used in 1975 but the fact that there was no large net withdrawal from the Savings Bank tells us little; with few exceptions, most accounts are very small and often in the names of children. The larger bank accounts of Lakeba people are maintained in Suva. The evidence of the expenditure data does, however, suggest that at least parts of the Lakeba economy have reserves sufficient to withstand adversity of some magnitude; the contrast with the situation found on Kabara (Bedford, McLean and Macpherson, 1978) is striking.

None the less, many Lakeban families suffered very real hardship in 1975 and 1976, and even breakdown of analysis to the village level merely shows that those who were able to sustain their wants by wage employment, use of savings, or the good fortune of having some of the coconut groves which were spared by the hurricane, were unevenly distributed around the island. Others suffered the depression mainly by virtue of a limited commitment to the cash economy, and these too were to be found in all villages. The second hypothesis with which we began this section, that there are two populations in Lakeba differing in their economic motivation, is only weakly illuminated by analysis of aggregated data. It remains to be examined in the final section which follows.

IV - THE CHANGING SOCIAL ECONOMY OF LAKEBA

THE SOCIAL ORGANIZATION OF PRODUCTION

The subsistence element in Lakeba

Little was said in the preceding section concerning the subsistence production of Lakeba farmers, but the income and expenditure patterns make clear that this element remains of prime importance for all but a small minority of households dependent wholly or mainly on wages. Even for the wage-earners, moreover, there is no trade store or market place in which all food requirements, including root crops, vegetables, fresh fruit and fish can be bought, or which stocks any sort of an adequate range of packaged and frozen substitutes. In this respect the Lakeban wage-earning household is much more poorly served than its counterpart in, for example, Taveuni. For the population as a whole the buying of basic foodstuffs is still an innovation, and flour, rice, biscuits and canned fish or meat are not yet more than supplements to the home-produced diet of most people.

Beneath the cash economy discussed above, then, the subsistence economy continues almost right across the island, and still absorbs the greater part of total work inputs in most of the island's villages. Some rather variable data on uses of major crops in the ground, by household, were discussed above in the first section of this paper. Data were also collected on the composition of meals, and on work inputs. Bayliss-Smith (1977, p. 91) found
that 67 per cent of the working time of men in Yadra and Nasaqalau was occupied in food production during sample weeks in 1975. This was, however, an unusual situation in which food gardens were being re-established after the hurricane and when coconut yield was greatly reduced. The writer’s data, obtained a year later than Bayliss-Smith’s, show a wide degree of variation between places and between individuals.

These data will be presented in another place, but it is clear from the data already analyzed that an energy input-output analysis will have only rather limited meaning as an Island-scale. This may be said of an attempt to value subsistence production in cash terms, using either of the two approaches employed in other studies by the project: valuing goods at local market prices converting both cash and subsistence production into energy values, in turn converted into cash at local food prices. The absence of a local market for produce makes the former procedure unrealistic, while the patterns of expenditure revealed above show that the proportion of all outgoings actually spent on food may have been as little as 30 percent, averaged over the whole population. In what follows we therefore depart from an effort in quantification which builds approximation onto approximation, with growing risk of major error, and turn instead to a qualitative analysis of the different groups of resource-users in Lakeba.

Community or individual

In Sahlins’ (1962) classic review of economy and society on the west-Lauan island of Moala, discussion was organized in successive levels from the household through the social groupings — tokatoka, mataqali and yeva — to the ethnocultural area or island. Major changes in social organization place in Fiji since 1962, and even in the eastern islands the significance of the social groupings has declined greatly. It would have declined still further if it were not for the fact that: in Lau the mataqali is still the land unit through which land rights are held in law; the Co-operative Society movement has been set up in part on mataqali lines, though mataqali Societies have often become combined into village Societies. Actual use of land, and actual buying and selling of goods, both show considerable departure from mataqali affiliation, and the individualization of land-holding that was initiated in the land-settlement movement of the early 1960s has continued since the demise of that movement to levels at which half or more of the land of many mataqali is individualized; in some parts of Fiji the mataqali land has been almost wholly individualized. This is not yet true of Lau, and certainly not of Lakeba, but there is a clear trend away from group intra-dependence and toward a consequent emergence of differentiation between farmers; in Lakeba this is most clearly exhibited in the widespread desertion of the Co-operative Societies as channels for copra sale by most of the larger growers on the island in the early 1970s.

The role of the mataqali remains strong in land, and in the perception of the authorities, who still employ the mataqali in fixing targets for pine planting, and in contributions to major feasts, and the like. In actual day-to-day behaviour, however, the mataqali has become only a weak intermediate level of organization between the village on the one hand, and the household on the other. All our analysis in this paper has led toward such a conclusion. Whereas in the preceding section we concentrated on the village, in this section emphasis is placed on the household. While the mataqali membership, and rank, of a household head sets his family in a particular niche in the social system, whatever his income, education or commitment to the commercial economy, it is also true that some high-ranking families are included among the poorest households with the least cash income, while commoner households are included among those supported quite comfortably by wage income and diversified production.

It is common to consider the subsistence and ‘plantation’ modes of production as the only choices available to Pacific island farmers (c.f. Warner et al. 1970). In the ‘tradition’ of the colonial period they are combined on the one farm which produces both food for the people it supports and a ‘surplus’ cash production. This pattern of ‘development’ has widely been adopted, but with serious limitations. Howlett (1973) has described it as ‘terminal development’, leading to an ‘infinite pause’, beyond which there is no further progress. This model over-simplifies the Lakeba situation, or any other in which local wage employment is also available. A wider range of combinations becomes possible, and five can be recognized on Lakeba. The method of ‘ideal types’ is employed to describe them.

A CLASSIFICATION OF RESOURCE USERS

The traditional subsistence-oriented farmer

Farmers of this type, quite numerous in Lakeba, rely on traditional systems of co-operation and have made few concessions to ‘modernity’. Most such household heads are middle-aged. The modal individual employs inherited knowledge of crop rotation and soil conservation, and his activities do less to affect the inherited managed ecosystems than do those of other farmers. He usually has a substantial taro planting, in the swamps or in irrigated land. His dry crops will be grown on valley-side plots, or in valleys in the ‘高潮’. He also has a garden plot or two under coconuts in the coastal plain. Coconuts are used more for domestic purposes than for making, except when he needs money. Animal protein for the household is provided mainly by fish caught by his wife, though he himself may occasionally fish in the lagoon or dive on the reef at night.

His work-force will consist of himself and his sons if they are big enough and unmarried. This farmer has little livestock other than chicken which run loose in the compound. He may possess a horse, and if lucky, a cow. Such a man tends to have pigs rather than cattle; few are penned, and their main use is on feast days. Life for a man of this type has become more difficult than it was for the mataqali group which used to work as a party on each other’s land in his youth is now rarely gathered together. The burden of cultivating additional food for feasts, of meeting educational, church and other expenses and their associated responsibilities, now falls on himself alone. He requires money for a range of purposes including many household goods now regarded as indispensable, and even if the household buys no store food of any kind — which is rare — there are few which buy no cigarettes. The replacement or repair of a house now requires money and is

15 Clothing must be bought, and even if the farmer and his family never travel off the island he needs an occasional bus or truck fare -- 40 cents to and from villages on the far side of the island. Farmers must also purchase their tools of trade, and these can be quite costly, e.g.: Flat spade (for 'biti' and yam holes) $12.00 Narrow spade (for taro holes, house posts) $12.00 Fork (for breaking up cassava middens) $12.00 Cane knife (for clearing weeds, cutting copra) $4.50 Digging stick $3.00 Rake (for yam garden) $14.50
costly even at the simplest level of construction; those households which suffered complete loss of housing in the 1975 hurricane and who received a 'hurricane-relief house' had to make, save or borrow $690 with which to repay its cost over the following five years.

This is the type of farmer for whom the principal incentive to cash-crop production is the immediate need for money. His coconut palms are a sort of bank, and he makes copra from his coconuts when he needs to pay taxes or school fees, or to keep himself and his family supplied in basic needs. Other possibilities, such as growing a surplus of food crops or catching additional fish, are of only limited value. Farmers in this class whose coconut palms were badly damaged in 1975 had to face a year or two of financial stress with very few reserves. As we have noted above, some of them even had to withdraw their children from the local primary schools. Though they might have received some aid in food from fellow mataqali members they would have received little or no aid in money.

Notwithstanding government efforts to persuade its rural population to remain on the land and grow traditional food crops, farmers of this first type are a disappearing breed. They argue the virtues of the 'old days' when needs were less and there was greater co-operation, but at the same time admit that in hard times they could almost never cease to worry about money. The youth of such families are quite widely abandoning this pattern of living, and are taking little interest in the traditional farming skills.

Part-time farmer; part-time wage earner

Many farmers now see wage employment as a more secure and less anxiety-producing way of living for their family. For the poor this is not entirely a new phenomenon. Since many of the limited number of jobs are available and most of these are offered in Tubou, most of the farmers who opt for wage employment live in Tubou, Levuka or Waukevuci.16 Farmers who obtain casual jobs tend to neglect their gardens while they are in wage employment, and will probably make no copra at such times. Some will seek help from relatives to maintain, or later to re-establish their gardens, but this can never be done. Even though they enjoy periods when money is not a problem, their existence is as precarious as that of members of the first group; only men with some acquired skills can hope to remain most of their time in employment.

For those who are dissatisfied with this way of life, and who lack either the resources or the confidence to shift more fully into a commercial pattern of production, the only real alternative lies in emigration to the mainland. There are, however, reasons why many who might wish to leave the island feel constrained to remain at home. Members of mataqali with little or no land may lose their rights if they leave; if their families remain behind on the island and they work borrowed land, others will be quick to take up plots which the reduced family is unable to use. Many of those who stay are making every effort to ensure that at least some of their children are well-educated; they perceive education for employment elsewhere in Fiji as the only answer to the land/cash problem for the coming generation.

All these problems are sharper in Tubou-Levuka than elsewhere. While employment is more readily available, land is more unequally distributed. Whereas 24 per cent of households in Tubou-Levuka have part-time or temporary wage earners, and there are also a few households in this category in Nasaqalau, the alternative paths for the eastern and northern villagers consist in the main of rural production, or emigration.

The dual-economy farmer

This third 'ideal type' is also numerous, and is encountered in all parts of Lakeba. Few have much education, but horizons have been broadened by listening to the radio, by hearsay, and by the advice of Government and the island authorities. Many have travelled off the island, to Suva or elsewhere in Viti Levu. Some have been further afield, in the army or on temporary work-permits to New Zealand. This group therefore includes a number who opted for emigration, but decided to return and seek a more secure and rewarding way of life at home.

Farmers of this type are keen to improve their incomes from copra and to try any new crop which promises some chance of reward. Many have their own copra-driers, and most of the 145 individual consignors of copra to Suva in 1974 belonged to this group. Some men without driers of their own hired time on the private driers of their neighbours, and this practice increased after the hurricane in which many private driers were badly damaged or destroyed. As elsewhere in Fiji, some men bought green copra from their neighbours, dried it and sold it as their own — an illegal but sometimes quite profitable enterprise. A number of these farmers grow extra supplies of taro, fruit and vegetables for sale, and before the hurricane used to offer these crops for sale in the market building in Tubou, where a market was held each day. Farmers on the hill are thus able to diversify with destroyed the institution of the market, but this remained true at least up to the end of 1976. In 1976, a few farmers would still bring supplies into Tubou and hawk them around the village; others had made regular arrangements to supply households on the Government Station and elsewhere. During this time in the field the goods most frequently hawked around the village were fish and crabs, brought in by women from outlying villages after a successful catch.

These were also the farmers who tried growing rice in the 1960s and who responded in 1975 to a rumour that the National Marketing Authority would buy cassava in Lakeba. The farm represented in Fig. 7.3 (b) was one of many left with surplus cassava when this rumour proved false. Since 1976 many are likely to have planted groundnuts, already a hope in 1976 and reported by a much more important crop in 1977 and 1978 (S. Best, personal communication). Most of them have yagona gardens in the forest areas in the hills. Yaqona is widely judged to have a better future than copra, so that the geographical balance of interest of these men is shifting inland despite the increased 'journey to work' time involved.

Interest in livestock production is strong among these men, though the cost of fencing and material for animal pens is such that few are able to 'go it alone'. A number of groups has therefore come into existence, for example in Masaqalau and Tubou. There were about 15 groups of varying size in Tubou-Levuka in 1976, some based on mataqali, others on clubs such as the Boxing Club. Their co-operative work was mainly in arable farming, though some included poultry as did one at Waiteka. In the fishing villages such as Waukevuci and Masaqalau there were also groups of women who expressed a desire to enter the cash economy by fishing, if a freezer in which to
to store the catch could be provided. This interesting reversal of the
	trend toward individualization depends on success for its continued growth.

The activities of farmers of this type extend across all types of
ecosystem because of the fragmented nature of the land holdings which they
work[1]. While the pattern of their holdings is similar to that of farmers
in the first group, the pattern of their activities is radically different.
These are some ecological consequences of possible significance, including
the new emphasis on yacca production in the forest areas, and the possible
effect of mechanized ploughing without associated soil-conservation measures.
In terms of their organization, the co-operative aspect of some activities by
farmers in this group recalls the traditional system of intra-matagal
co-operation, but the purpose is quite different. The motivation is to
maximize personal incomes within what might be described as 'comfortable,
input limits'. Other activities of these men are highly individual.

These farmers seek enough money to save and invest for the future,
while meeting perceived needs. They contribute a high proportion of
the income from copra, and most of the income from the sale of other local
produce ('other environmental income') discussed above. They are, however,
aced with all the uncertainties of farming conditions encountered by
islanders in the 1970s. They see themselves as placed at a serious dis
advantage by distance from the mainland, the irregularity of the sea
service, and their own lack of tools and mechanization. Especially in Tubou-
levuka many also compete for wage employment, along with the truly small
farmers, and their enterprise in rural production suffers. Their most
strongly-expressed wish is for a regular sea service sponsored by the
National Marketing Authority to give them access to the mainland market.
Though still eager to try new paths of enterprise they were, in 1976, a
discouraged group of men.

The Lakeban with a full-time job

This fourth group is very much in the minority, and almost confined to
Tubou-levuka; even here permanently-employed males account for only one-
third of the total number of householders. The Lakeban who works from eight
nine in the morning until five or six in the evening retains his land
rights, and will generally pay someone -- a relative, or a man from another
village -- to work his land, collect his crops and even catch his fish. Some
employed days are recognized by the gardens being kept in order... work on Sundays, but some rely on employees even to bring home a regular supply
of food. Thirteen householders in Tubou employed wage-labourers to do such
work in 1976. In this way, wage income circulates a little further in the
island; some of the fully-employed Lakebans can even afford to have their
distant holdings well-worked, which self-employed farmers find hard to
achieve.

Wage incomes are also spread in other ways. Many in better-paid jobs,
especially those of chiefly rank, feel obliged to offer support to others.
But the time these obligations are fulfilled not much short of their wage
incomes. It follows that wages paid to their employees are often rather poor,
and are sometimes given in kind rather than cash. None the less, the
Haitubu man who looked after the garden depicted in Fig. 7.3 (a) received $20
per fortnight. His income is thus comparable with that of the village

17 For example, the farmer whose active gardens are plotted in Fig. 7.5.

Co-operative Society employee who gets only $6-12 per week, and both are
well off by comparison with the self-employed farmer who must work much
longer in order to achieve the same monetary reward in 'normal' times.

The outsider

In 1976, outsiders on Lakeba included only Government servants and
some islanders working on the estates of the Tui Naya. Such people had no
rights in land, or even fishing rights, but some were lent small plots on
which to grow subsistence crops. Otherwise they depended entirely on their
wages, but had no local obligations. In the whole history of Lakeba this
is a relatively unusual state of affairs. When the economy of Lakeba was
linked more closely with that of other parts of Lau, on the basis of mutual
specialization, large immigrant groups as well as other outsiders were given
land on Lakeba; before Tongas became, by intermarriage, a part of the
Lakeban population, they too were given land (Hocart, 1929). In 1979 the
people of Naya were brought to Lakeba after destruction of their own
villages and gardens by Hurricane Meli, and settled temporarily on the
estates of the Tui Naya.

Movement of people from place to place and their accommodation by gift
or lease of land, is part of the history of eastern Fiji, including Lakeba
itself. The population of Taveuni and Qamea includes dispensed groups
from Kanacea, Rabi, Naitaua and elsewhere, and a large number of Lauans and
people from Nativi (Vanua Levu) who work on estates, and as settlers on
some Lakeba's smaller villages were called on from 1971. All these immigrants
are also islanders in Lau, sharing perhaps with Moala the advantages of greatest resource-
endowment and best location in the group. Lakeba is very likely to have
accept new groups of outsiders in the future. Whether these people are
accepted as landless workers, or as settlers, depends on decisions which
Lakebans will be required to take concerning the allocation of their resources.

The two lakebas, and the future

Some characteristics of a chiefly island

In the scheme outlined above, work arrangements and the intermeshing of
subsistence and cash-earning activities become more complex as we proceed
upward through the 'hierarchy'. But while individualization and differentia-
lion have wrought great differences in island society, and continue to do
so, all people on Lakeba are differentiated from the people of other islands
around them, by the fact that Lakeba is the most chiefly island in Lau con-
taining the most chiefly village and the most chiefly natagai. While the
very considerable advantages of a strong wage-employment sector flow directly
or indirectly from this historically-inherited regional role, individual
Lakeban households experience rather less freedom of choice in the allocation
of their resources and especially of their time than do households in islands
of lower rank, such as Kabara.

In an unusual, but not wholly unrepresentative week, the people of one
of Lakeba's smallest villages were called on to provide goods and services on
each of five consecutive days. These included foodstuffs for their own
household and for men working on a ceremonial bure in Tubou, the actual
formal presentation of these supplies, work on the bure itself, the preparation
of food for those working in the chiefly family, and work on the pima plantations
on the far side of the island. Such duties are rotated around the villages
of the island, and time also has to be found for communal work on the school,
for the church, and for meetings — both within the village and those called by the Island Council. The demands placed on islanders’ time are mounting. Although the church is relatively quiet and can sometimes be seen as onerous, similar demands were sometimes placed on villagers in the other chiefly island studied by the project, Taveuni, but in the more highly individualistic environment of society on this larger island, absenteeism was common; in Lakeba this is much less easy.

Two Lakebas, or many?

Lakeba has been dichotomized in different ways in the course of this discussion. A crop-dependent and a wage-dependent Lakeba emerge strongly from the third section, while in the second and fourth sections the sharpest distinction seems simply to be that between Tubou and the rest of the island. This is of major importance in social terms, for all outer-villages interact more with Tubou than with each other, and are conscious of their subordination to Tubou and of the privileged status of the chiefly village.

There are, none the less, sharp distinctions within Tubou, and in all parts of the island there are people who move between the crop-dependent and wage-dependent sectors; the greater part of the latter sector is made up of people who are also farmers. Within the crop-dependent sector we have drawn a distinction between innovators and those who simply accept the constraints of a dependent economy. Though there is a shade-zone between them, and though individuals may move from one to the other, there seems in this island to be a fundamental distinction between those who seek opportunities for betterment and those who simply accept conditions as they are. The emphasis placed by all forward-looking Lakebas on education, the former group must be expected to grow at the expense of the latter.

In this connexion it is necessary also to take account of the large number of people of Lakeban origin now living elsewhere in Fiji, principally in Suva and in settlement areas along the Seawani-Sereia road in south-eastern Viti Levu. This emigrant population is believed to number at least as many 'Lakebas', including emigrants of the second and third generations, as now live on the island itself. Many of these people have been successful in their new homes and though visiting has been quite frequent not many have returned to live. Those who have emigrated, those who have found secure employment at home, and those who have demonstrated quite striking enterprise in rural production all have much in common; they are seeking — in the context of modern, individualized Fiji — a 'better' way of life. The remainder of the population is far more passive, perhaps not content with the lot of a rural peasantry, but without the same degree of demonstrated motivation. The stresses placed on the people of Lakeba by the unusual conditions of the mid- to late-1970s have brought out these behavioural differences in a rather striking manner.

The future of Lakeba

In a period of rapidly changing social and economic aspirations in Fiji as a whole, Lakeba seems unusual among the eastern islands in the substantial number among its people who have, up to now, found opportunity at home. In large measure this fact arises from the quite large input into the wage sector economy and it has had an important effect that, unlike almost all other islands in Lau, Lakeba has not suffered a net loss of population through emigration in the decade 1966-76 (Bedford and M. Brookfield, this volume). Whether or not this situation will continue is, however, very unsure in the light of the widespread discouragement encountered in inquiries by this writer and by Bayliss-Smith (1977). There is no prospect of enterprise in Lakeba, but the level of success has been disappointing, and the shocks of 1975-76 were a severe jolt to many hopes.

Lakeba as a whole is no longer able to determine its own fate; the real decisions which will affect its future are taken in Suva. Decisions already taken to provide the island with a circum-insular road, an airstrip and a jetty, and to provide a government ship to improve the shipping service, have been of great importance. The introduction of the Pine Scheme is of less certain value until firm decisions are taken concerning the processing and marketing of the wood, and the scheme is modified to integrate it better with the rest of the island economy. Different paths are possible from the political establishment of a new-established infrastructure to restore to Lakeba its former role as a central space in Lau, by re-establishment of District Administration, the development of locally-based shipping to serve other islands, and enlargement of the commercial function of Tubou. Marketing of agricultural produce in Suva can be encouraged and aided by the National Marketing Authority. Plans for the establishment of a small wood-based industry can be prepared, using the pine, old coconut palms and — in time — other timber. Such steps would require the encouragement of entrepreneurship and the entry of people from other islands. In particular it would seem to require either a reconstruction of the Co-operative movement, or else recognition of the fact that the present system fails to satisfy the needs of a large number of Lakeba's people, who need a competitive outlet for their produce and a competitive supplier of their needs.

If these things are done, Lakeba may again become the regional centre of activity that it was in pre-colonial times, and play an important role in the more effective integration of Lau with the national economy. If at least some of these things are not done, however, the future is not bright. In Viti Levu, rapid urbanization, the development of hydro-electric power and the likely opening of a major copper mine will create increasing opportunity. Land settlement, road and port development on Vunca Levu may succeed in creating a second focus of national activity on that island. What has been done in Lakeba during the 1970s has led neither to economic diversification nor to the generation of a focus of entrepreneurship on the island. Physical infrastructure must be made to work more efficiently and provide another focus of innovation in order to succeed. Without the latter it must be anticipated that discouragement will grow, that net emigration will set in, and that it will be selective of those very people who could best seize hold of opportunities for the more effective development of the island's resources, given only the encouragement which they seek.

This is a conclusion that could be applied to any part of Lau, or any part of the eastern island region. It has, however, particular force in Lakeba for two reasons. In the first place Lakeba has already been selected for early infrastructural investment, ahead of the other islands, and it is only on Lakeba that anything so imaginative as the Pine Scheme has been undertaken by a combination of local effort and government backing. In the second place the unusual presence on Lakeba of a significant number of innovative farmers operating outside the umbrella of the Co-operative Society system, who have demonstrated their willingness to embark on new enterprises. There is already in place, therefore, a combination of the physical and social requisites of further development effort that is not common in the outer islands, and which both springs from and supports the
pride of Lakebans in the chiefly status and historically-important role of
their island. The 'success of their islands' are good in Lakeba, given
continued leadership and given real support by national decision-makers for local
enterprise. There is a striking 'independence' in this portion of Fiji's
dependent periphery, and it is deserving of sustained backing by the nation
to which Lakeba has contributed much over more than 150 years of modern
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5.8 POPULATION CHANGE IN LAKEBA 1946-1976:
PERSPECTIVES ON FERTILITY AND MIGRATION

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I - INTRODUCTION

Muriel Brookfield spent almost six months on Lakeba in two spells during 1976. Towards the end of the first and longer period of field research a comprehensive household survey of the villages of Tubou and Levuka was undertaken. In addition to the basic demographic data usually collected in census-type surveys, information was also obtained on population movement and reproduction. The relevant data were coded and analyzed by Bedford (who spent only three days on Lakeba in 1975 examining family planning records). The following short paper is essentially a statistical analysis of the data collected by Brookfield using the results of her field investigations to interpret certain trends revealed in the analysis. The paper should be viewed therefore as a micro-study of population change, in parallel with studies made by the project on Taveuni and Kabara (Bedford 1978; Bedford, McLean and Macpherson, 1976), and should be read in association with the analysis of Lakeba society and use of resources presented by Muriel Brookfield in the preceding paper.

II - A PATTERN OF VILLAGES

The present-day population of Lakeba is concentrated in eight villages on or very near the coast; four along the south coast, and four 'on the other side', i.e. to the north and north-east (Fig. 8.1). The people of Lau traditionally have lived in villages. In Lakeba they formerly lived inland on defensible hill sites; when defence was no longer necessary, and trade in copra grown along the coastal belt became important, settlements moved closer to the sea. Although some shifting cultivation is still practised on the island, there are few dispersed dwellings, unlike the situation found on some of the larger islands such as Taveuni. To review population change in Lakeba is to examine demographic developments in a village society.

ASPECTS OF POPULATION DISTRIBUTION AND COMPOSITION

The uniqueness of Tubou

The most striking feature of population distribution in Lakeba is the dominance of the chiefly village of Tubou with its enclave, Levuka (Fig. 8.1). These two contiguous settlements have more than twice as many people in residence as the next most populous village (Yadra). The population of Tubou/Levuka fluctuates, sometimes quite markedly, from month to month and on occasion from day to day. Great gatherings are held of representatives from other islands, sometimes for the Provincial Council, sometimes for the all-Fiji Council of Chiefs, sometimes for church conferences. Men and women come in from other villages on Lakeba to feed, look after and 'meka' (dance) for the visitors. A sporting occasion, such as a cricket 'test match' will bring in boatloads of players and spectators from Suva. Numbers in residence may also be swelled when the Tui Nayau exercises his rights as paramount chief to ask men from Nayau to come and work for several weeks on his coconut plantations, or to request that men from Kabara, renowned as carpenters, come to Lakeba to aid in the construction of some chiefly or ceremonial building. At the time of Hurricane Val in January 1975 there were 90 men from Kabara in Tubou helping to build the Tui Nayau's bure (N. Brookfield, 1977). These visitors usually have relatives with whom they stay in Tubou or Levuka and their presence at the time of a
almost ten per cent between 1966 and 1976, numbers in Lakeba rose by one per cent from 2056 to 2076 (Table 8.1).

<table>
<thead>
<tr>
<th>CENSUS PERIOD</th>
<th>LAKEBA TOTAL</th>
<th>LAU PROVINCE TOTAL</th>
<th>FIJI TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946-56</td>
<td>6.9</td>
<td>8.4</td>
<td>23.1</td>
</tr>
<tr>
<td>1956-66</td>
<td>4.9</td>
<td>5.8</td>
<td>18.4</td>
</tr>
<tr>
<td>1966-76</td>
<td>0.9</td>
<td>1.0</td>
<td>-9.6</td>
</tr>
<tr>
<td>1976-86</td>
<td>13.3</td>
<td>15.9</td>
<td>31.7</td>
</tr>
</tbody>
</table>

Data: Censuses 1946, 1956, 1966 and 1976

THE ROLE OF POPULATION MOVEMENT

The main explanation for recent differences in the demographic development of Lakeba and the province of which it is a part lies in the effects of population movement on population growth. For various reasons Lakeba became the source of a disproportionately large share of Lauan emigrants seeking a livelihood elsewhere. One of these relates to the early establishment (1909) of a provincial school on the island -- a school which has become the main educational establishment in the Lau group. As home for a significant proportion of eastern Fiji's customary chiefs, many of whom were quick to perceive some benefits of a school education for their children, Lakeba became an important source of civil servants during the colonial period.

In the post-war years there has been substantial movement of educated high-ranking Lakebans and their families to Suva -- a movement which has contributed to the low intercensal rates of population growth since 1946.

A second reason relates to land development schemes on Viti Levu. During the 1950s and early 1960s there was an exodus of Lauans to two agricultural settlements inland of Suva -- Waiwai and Lomaiviti. Although Lakeba's contribution to this exodus is not precisely known, it is generally recognized that a large share of the Lauan emigrants were from this chiefly island. In spite of its fair size (for Lau) and low population density (33 persons/km²) compared with some of the smaller islands to the south, land distribution between mataqali is highly uneven (see M. Brookfield, 5.7 in this volume). Real and perceived land shortage became more serious for certain groups as interest in cash cropping intensified in the 1940s and 1950s. The chance to gain access to property in a more productive rural environment was attractive to Lakebans in the era of land subdivision schemes. As was noted in the project's first general report; (UNESCO/UNFPA Project 1977, p. 162):

the large Waiwai and Lomaiviti subdivisions on Viti Levu are populated almost wholly by Lauans, mainly from the southern islands [including Lakeba]; at least 2000 Lauans -- as many as the population of Lakeba -- are now living on land in these two areas of south-east Viti Levu. These rural opportunities were an important element in Lauan emigration in the 1960s.
Effect of emigration on fertility

In addition to a direct effect on population numbers, high levels of emigration since the mid-1940s have also served to contain the rate of natural increase in Lakeba's villages at lower levels than were experienced in other parts of the province. Whereas village populations in many parts of Lau rose by more than 30 per cent between 1956 and 1966, over half the villages on Lakeba experienced a decline in numbers of residents (Fig. 8.2). Although data on crude birth rates for the island during the 1950s and 1960s are not available, a comparison of some simple structural measures of the populations enumerated in three villages (Tubou, Levuka and Yadran) in 1956 and 1966 with those for Lau Province suggest possible differences in levels of fertility (Table 8.2). In both census years the proportions of infants and children in the Lakeba villages were below those for the province.

TABLE 8.2: ASPECTS OF POPULATION STRUCTURE: THREE LAKEBA VILLAGES AND LAU PROVINCE, 1956 AND 1966

<table>
<thead>
<tr>
<th>STRUCTURAL ASPECT</th>
<th>CENSUS YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1956 LAKEBA</td>
</tr>
<tr>
<td>Proportion of population (%)</td>
<td></td>
</tr>
<tr>
<td>Under five years</td>
<td>18.9</td>
</tr>
<tr>
<td>Under 15 years</td>
<td>45.0</td>
</tr>
<tr>
<td>Ratio (per 1000 pop.)</td>
<td></td>
</tr>
<tr>
<td>Child-woman b</td>
<td>749</td>
</tr>
<tr>
<td>Sex c</td>
<td>823</td>
</tr>
</tbody>
</table>

a Tubou, Levuka and Yadran only
b Children 0-4 years per 1000 women aged 15-49 years
c Males per 1000 females

data: Censuses 1956 and 1966.

Even though birth rates were rising, the proportion of the village population under five years of age actually fell between 1956 and 1966 on Lakeba. The child-woman ratio rose slightly over this period (by three per cent), but the increase in the three villages was well below that for the Lau as a whole (16 per cent). In both areas the sex ratio (number of men per 1000 women) went up, but in the case of Lakeba the increase (26 per cent) was more than eight times that recorded for the province (Table 8.2).

These structural changes reflect the impact which movement by increasing numbers of younger women in the most reproductive age groups was having on the overall contribution of fertility to population change. The average age of childbirth among women left behind was increasing, and since most women tend to have children early in their reproductive cycle, this 'ageing' trend artificially depresses the overall birth rate. We see no reason to suspect that actual levels of fertility (such as age-specific birth rates) in the Lakeba villages were any different to those in Lau Province as a whole over this period. It was emigration, rather than variations in fertility levels, that generated the structural differences suggested in Table 8.2.

Introduction of air service

A recent development, with implications for patterns of population movement, was the establishment of an air service between Nausori (Suva) and Lakeba. Analysis of passenger traffic on this service, which commenced in 1972, suggests that improved linkage with the country's main urban centres did not immediately result in an upsurge in the rate of net emigration (UNESCO/UNITAF, 1977, p. 288). In the early part of the air service, passenger traffic to the island was more intensive than movements to Viti Levu; the traditional use of sea transport remained the normal method of migration. Between 1974 and 1976, however, the annual volume of outward passengers exceeded arrivals in Lakeba -- initially because of relative prosperity during a year of high copra prices in 1974; later as a result of devastation of the island's agricultural economy following hurricane Val in 1975. While net population loss through movement to Viti Levu continues, improved linkage between the rural-resident and urban-based components of Lakeba's population is undoubtedly one factor accounting for the marginally greater number of residents on the island in 1976 than there had been in 1966.

An inquiry among a group of Lauans residing in Qaua, a peri-urban community, close to Suva, established that 1974 -- the year of prosperity in the villages -- had been a favourable year for return visits to Lakeba. Of the 82 members of the 12 households headed by men born in Lakeba, 15 (18 per cent) gave 1974 as the year of their last visit to the island. Although this is a relatively low proportion, and the sample is very small, Lakeban households surveyed in Qaua had maintained closer physical contact with their rural kin than the Lauan sample in general. Forty per cent of the 82 people had been back to the island since 1970, and this was among a sample in which the great majority (82 per cent) had either arrived before 1969 or had been born in Suva.

IV - TUBOU-LEVUKA: DISTINCTIVE COMMUNITIES IN A DISTINCTIVE ISLAND

Tubou and its neighbour Levuka are distinctive and separate social entities comprising people of quite different origin. For much of our discussion, however, their populations can be combined; the settlements are contiguous and residents in both have access to the range of services afforded by Tubou's role as administrative headquarters for the province. At the time of the last national census (September 1976) the population of Tubou-Levuka was 767 (excluding government station personnel, see below) -- 37 per cent of the island's total residents. Tubou accounted for 84 per cent (641) of those enumerated in the two communities, and the trends and characteristics outlined below obviously relate essentially to the chief's village. Levuka's population (126 in 1976) comprises only a small share of the combined total, and has changed little since 1946 (Fig. 8.2).

Just as Lakeba's recent population history has differed somewhat from that of Lau Province, so too has the post-war pattern of demographic development in Tubou been different from that found in most other rural communities on the island (Fig. 8.2). In 1946 the population of this village was at its highest enumerated level since census recording began in Fiji in 1911. Numbers increased substantially between 1936 and 1946, but then declined sharply over the next two decades. Although the patterns of growth/decline
In other villages are quite variable, none have the very accentuated peak-trough characteristic of Tubou's post-war census record (Fig. 8.2). There is some semblance of order in the overall pattern, however; the southern villages (Tubou, Levuka, Wacwaci and Waitabu) tend to have their ups and downs in numbers at much the same time. The north-eastern villages, especially Yadroa, Vakani and Nukunu also follow roughly similar paths of growth and decline. Over the last intercensal period the southern villages have all experienced population growth while those in the north and north-east have either remained stable (e.g. Nasaqalau) or declined. While the major decrease in Yadroa's population is probably due to the devastating effects of Hurricane Vai, a more general explanation for the divergent trends between villages in the north and south is that the latter have been much more affected by recent developments in Lakeba's cash economy than the former.

![Population chart](image)

Figure 8.2

VILLAGE POPULATIONS, 1911-1976.

When endeavouring to account for intra-island differences in growth patterns it is important to bear in mind that personnel residing in the government station located in the Tubou area seem to have been excluded from official census populations for the village, and presumably do not contribute to the differences noted in Figure 8.2. A variable number of people (between 22 and 264) have been recorded as living outside villages on the island at all censuses since 1921. In the absence of substantial commercial plantations and numerous dispersed small hamlets, this non-village population is believed to comprise mainly civil servants associated with the government services located in Tubou, as well as a few families employed in tourism. After small estates and copra drying, the last are by far the most important economic activities on the island, and families come mainly from other Lau Islands and generally are related to Lakeba.

Without detailed knowledge of socio-economic developments in the Tubou-Levuka area since 1946 it is difficult to account for the distinctive pattern of post-war population change in Tubou. One factor which could account for the unusually large number enumerated in Tubou in 1946 is the loss of what were then the census, of Fijians who had been employed in the Army and Civilian Labour Force during the Second World War. This was found on Taveuni, for example, that Somosomo's population in 1946 was much larger than it had been in 1936 for this reason. If a similar situation applied in Tubou, the short-term influx of reentrated labourers, many of whom would have left soon after to seek wage employment elsewhere, would also account for the significant decline in Tubou's population between 1946 and 1956.

The census population for Tubou-Levuka in September 1976 (767) was quite a bit lower than the resident total (834) enumerated during the household survey conducted by Hurtle Brookfield in May 1976. In that month 702 people were enumerated in Tubou and 132 in Levuka; included in the combined total were 65 members of 16 households located in or near the main cluster of government offices. This group almost equals the difference between the enumerated totals in September and May, and it must be assumed that the difference between the two populations lies in the inclusion or otherwise of 'government station' personnel. For the purpose of comparison with the 1956 and 1966 census data on age-sex structure, the government station households have been excluded from the village population. When examining other aspects of residents in 1976, however, the total population enumerated in the project survey is covered.

**POPULATION STRUCTURE, 1956-1976**

**Characteristics of age-sex pyramids**

Over the past twenty years there have been some significant changes in the age-sex composition of Tubou-Levuka's population (Fig. 8.3; Table 8.3). Except for the 1976 structure, which is reasonably similar to that for the province as a whole, the pyramids for the two villages differ markedly from those for Lau in certain respects. In 1956 Tubou-Levuka had an unusually high proportion of males aged between 45 and 49 years in residence; a group which does not reappear in the 55 to 59 age group in 1966 pyramid. The reasons for this bulge in 1956 are not known, but it could well be related to a particular communal work programme or chiefly meeting of the kind mentioned earlier as being a feature of village life in Tubou.

In 1966 the main structural difference between the village and the province lay in the pronounced 'nip' in the base of the Tubou-Levuka pyramid (Fig. 8.3). There were fewer children aged under five years than there had been at the time of the previous census even though fertility had been seen between 1956 and 1966. Emigration of young women is the main factor accounting for the 'nip'; between 1956 and 1966 the proportion of women in the most fertile age range (15 to 29 years) actually declined on Lakeba (Table 8.3). The higher fertility of the residents (which is
reflected in the rising child-woman ratio) was not sufficient to replace the births lost to the villages when young Lakebs emigrated, or the infants who accompanied parents leaving the island between 1952 and 1956.

Between 1956 and 1976 the decline in proportion of infants in the Tubou-Levuka population accelerated, even though the number of women in the reproductive age span rose from 128 to 147. The proportion of young women (15 to 29 years) was marginally below that for 1966, but declining fertility rather than continuing emigration was now the main explanation for structural changes in the base of the pyramid. The crude measure of fertility that one can obtain from age-sex data -- the child-woman ratio -- was much lower in 1976 than it had been at any time in the previous twenty years in the two communities or, indeed, in Lau Province. The government-sponsored family planning programme had an important role to play in this fertility decline among the Fijian population -- an issue which is considered at greater length in the next section.

The other structural characteristics which merit some comment in the Tubou-Levuka case are the rising proportions of males aged 15 to 29 years in the population since 1956 and the consistent downward trend in the overall dependency ratio (Table 8.3). Given the emphasis which has been placed on emigration as a regulator of demographic change, it was rather surprising to find the proportion of young adult men to be rising while that for the corresponding female group was declining. Rising fertility levels followed by a drop in birth rates will lead to such increases, as

<table>
<thead>
<tr>
<th>POPULATION CHARACTERISTIC</th>
<th>1956</th>
<th>1966</th>
<th>1976</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers of residents and households(a)</td>
<td>332</td>
<td>326</td>
<td>402</td>
</tr>
<tr>
<td>Males</td>
<td>366</td>
<td>312</td>
<td>365</td>
</tr>
<tr>
<td>Females</td>
<td>700</td>
<td>638</td>
<td>767</td>
</tr>
<tr>
<td>TOTAL</td>
<td>83</td>
<td>93</td>
<td>116</td>
</tr>
<tr>
<td>Average size households</td>
<td>8.43</td>
<td>6.86</td>
<td>6.61</td>
</tr>
<tr>
<td>Proportion of population(b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 15 years</td>
<td>45.6</td>
<td>48.9</td>
<td>43.8</td>
</tr>
<tr>
<td>15-49</td>
<td>43.9</td>
<td>40.8</td>
<td>41.4</td>
</tr>
<tr>
<td>50+</td>
<td>10.5</td>
<td>10.3</td>
<td>14.8</td>
</tr>
<tr>
<td>Males 15-29</td>
<td>9.4</td>
<td>12.4</td>
<td>13.4</td>
</tr>
<tr>
<td>Females 15-29</td>
<td>13.8</td>
<td>11.1</td>
<td>10.5</td>
</tr>
<tr>
<td>Dependency ratios(c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youthful (0-14)</td>
<td>962</td>
<td>1023</td>
<td>899</td>
</tr>
<tr>
<td>Age 15-29</td>
<td>147</td>
<td>69</td>
<td>152</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1109</td>
<td>1092</td>
<td>1051</td>
</tr>
<tr>
<td>Child-woman ratio(d)</td>
<td>745</td>
<td>812</td>
<td>551</td>
</tr>
</tbody>
</table>

\(a\) Census figures for the years cited
\(b\) Derived from recorded census data for 1956 and 1966 and from the project survey, May 1976 (excluding government station households)
\(c\) Per 1000 population aged 15-59 years
\(d\) Children 0-4 years per 1000 women 15-49 years

others returned to their villages from towns on Vitil Levu. In addition, the devastation of coconut groves during Hurricane Val meant that many farmers could not afford to send sons to Suva or Levuka for further education or training as they might have done in a 'normal' year.

Estimates of net emigration, 1966-1976

The extent to which the young adult female age group was affected by net emigration between 1966 and 1976 can be estimated using a simple, if rather crude, projection technique. Assuming no people left Tubou-Levuka for residence elsewhere (or moved into the villages to live), the population aged 15 years or more that should have been present in 1976 can be calculated from the 1966 age-sex distribution using life table survival ratios. As reliable recent life tables for Fijians are not available, one of the numerous model life tables prepared by Coale and Demeny (1966) was the source of the required ratios. Considerations which governed selection of this life table have been outlined elsewhere (UNESCO/UNFPA Project, 1977). It is sufficient to note here that the mortality schedule on which the model life table is based probably overstates the probability of dying among Fijians in the 5 to 45 year age groups. The figures on net migration are likely therefore to be conservative estimates.

The enumerated population aged between 15 and 29 in Tubou-Levuka in May 1976 was considerably below that which might have been expected if there had been no movement into or out of the communities (Table 8.4). The female component was seriously depleted; older cohorts of men and women had suffered less significant losses through net emigration since 1966. In fact, for those aged 45 to 59 years in 1976 the enumerated population was larger than expected on the basis of survival of residents aged 25 to 49 years in 1966. There seems to have been some net immigration among this group, probably following the hurricane (Table 8.4).

The broad structural trends identified for these Lakeba villages are rather unusual for a population experiencing rising fertility and high levels of net emigration. The most common scenario is for proportions of young men to fall, as school-leavers and those in their early 20s leave to seek wage employment elsewhere. Dependency ratios rise as a shrinking economically active and reproductive population produces babies at a faster rate owing to rising fertility levels. The small elderly component is artificially inflated in ratio terms as a result of accelerating net emigration among the 15 to 59 year group. In Tubou-Levuka the balance between population movement and fertility change has been such that this 'normal' pattern of structural development did not occur. For these two communities, the impact of recent demographic events on age-sex composition has been somewhat distinctive.

RESIDENTS AND ABSENTEES, 1976

It was noted earlier that the population enumerated during the project survey in May 1976 in Tubou-Levuka included 65 persons in households headed by government employees. The majority of these people had been born outside Lakeba, and most had spent the greater part of their lives living in other parts of Fiji. At the same time, however, they were not all short-term residents; many of the children under the age of five in these households had been born on Lakeba, and 22 per cent of the immigrants over the age of 15 had spent more time in the two communities than in any other locality. Among the village population proper 89 per cent had been resident in Tubou-Levuka for most of their lives.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15-29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>103</td>
<td>132</td>
<td>-29</td>
</tr>
<tr>
<td>Females</td>
<td>81</td>
<td>127</td>
<td>-46</td>
</tr>
<tr>
<td>TOTAL</td>
<td>184</td>
<td>259</td>
<td>-75</td>
</tr>
<tr>
<td>30-44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>54</td>
<td>65</td>
<td>-11</td>
</tr>
<tr>
<td>Females</td>
<td>54</td>
<td>57</td>
<td>-3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>108</td>
<td>122</td>
<td>-14</td>
</tr>
<tr>
<td>45-59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>42</td>
<td>29</td>
<td>+13</td>
</tr>
<tr>
<td>Females</td>
<td>41</td>
<td>38</td>
<td>+3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>83</td>
<td>67</td>
<td>+16</td>
</tr>
<tr>
<td>15-59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>199</td>
<td>226</td>
<td>-37</td>
</tr>
<tr>
<td>Females</td>
<td>176</td>
<td>222</td>
<td>-35</td>
</tr>
<tr>
<td>TOTAL</td>
<td>375</td>
<td>446</td>
<td>-73</td>
</tr>
</tbody>
</table>

a Project survey, May 1976, excluding the 65 people in 16 households associated with the government station to ensure comparability of age-sex data with 1966 census results.


even though less than two-thirds had actually been born in the two communities. Over ten per cent of these younger village residents were born in Suva; other communities on Lakeba and in Lau Province were cited as places of birth for a further 15 per cent. Although no attempt was made to compile detailed migration histories in Tubou-Levuka it is believed that over 80 per cent of those more than 15 years of age would have made at least one trip from the island.

The recent history of emigration from Lakeba ensured that all households had kinfolk living in or near Suva by May 1976. Indeed, over half (53 per cent) of the resident households had one or more family members absent at the time of the May enumeration. Over 80 per cent of the absentees were under the age of 25, two-thirds were in Suva, and just under half (49 per cent) were attending schools or tertiary training institutions (Table 8.5). Most of these absentees had been born in Tubou-Levuka and had spent more time in these communities than elsewhere. However,
given the fact that over twenty per cent had wage employment it was unlikely that they would all return to the villages. Many would undoubtedly follow the example of fellow-Leakeans and remain in residence in towns on Vua Levu. Wage employment opportunities on Lakeba, while more numerous than in any other Lau Island, were still severely limited in 1976. For most of those who wished to work outside agriculture it was necessary to leave the island to find employment.

**TABLE 8.6: CHARACTERISTICS OF ABSENTEES FROM TUBOU-LEVUKA HOUSEHOLDS, MAY 1976**

(Percentages)

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>MALES</th>
<th>FEMALES</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 15</td>
<td>21.5</td>
<td>26.4</td>
<td>23.5</td>
</tr>
<tr>
<td>15-24</td>
<td>64.6</td>
<td>66.0</td>
<td>65.2</td>
</tr>
<tr>
<td>25+</td>
<td>13.9</td>
<td>7.5</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>Place of residence</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suva</td>
<td>68.4</td>
<td>66.0</td>
<td>67.4</td>
</tr>
<tr>
<td>Other Lau</td>
<td>8.9</td>
<td>9.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Other Fiji</td>
<td>22.8</td>
<td>24.5</td>
<td>23.5</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education/training</td>
<td>46.8</td>
<td>52.8</td>
<td>49.2</td>
</tr>
<tr>
<td>Wage employment</td>
<td>26.6</td>
<td>15.1</td>
<td>21.9</td>
</tr>
<tr>
<td>Staying with relatives</td>
<td>22.8</td>
<td>32.1</td>
<td>26.5</td>
</tr>
<tr>
<td><strong>Place of birth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubou-Levuka</td>
<td>64.6</td>
<td>84.9</td>
<td>72.7</td>
</tr>
<tr>
<td>Other Lau</td>
<td>17.7</td>
<td>7.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Suva</td>
<td>10.1</td>
<td>3.8</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Place spent most of life</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubou-Levuka</td>
<td>72.2</td>
<td>86.8</td>
<td>78.0</td>
</tr>
<tr>
<td>Other Lau</td>
<td>7.6</td>
<td>5.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Suva</td>
<td>12.7</td>
<td>1.9</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>NUMBER</strong></td>
<td>79</td>
<td>53</td>
<td>132</td>
</tr>
</tbody>
</table>

Date: Project survey, May 1976.

---

V - FAMILY PLANNING: LAKEBA IN THE LEAD

The fall in Fijian fertility levels during the 1960s accompanied initiation of a government-sponsored family planning programme. Although programmes of Fijians married under the age of 25 years has tended to fluctuate over a small range since 1936, changes in Fijian fertility during the 1960s and 1970s have been caused by decisions to limit family size and not by any shift in marriage patterns. The family planning programme in Fiji has been discussed at length by the Nulds (1973); it is not necessary to review the history of early successes in the promotion of contraception and reduction in birth rates. By 1970 it was estimated that about 23 per cent of women aged 15 to 44 years were protected from the risk of pregnancy by some 'modern' family planning method (Bedford, 1978, p. 131). This national level was marginally higher than the protection rates estimated for parts of the eastern region, especially the Lakeba Medical Area which incorporates the islands of Naya, Vanua Vatu, Omatea, Moce and Komo as well as Lakeba within its boundaries (Table 8.6).

THE CONTRACEPTION DRIVE IN THE 1970s

While Lau was trailing in the protection rate stakes at the beginning of the decade, the situation changed markedly during the early 1970s. There was a concerted drive among Medical Department personnel, in the Lakeba Medical Area in particular, to improve protection rates. From 1972 Eastern Division records reported consistently higher levels of contraceptive usage for this area than were common elsewhere in the Division or, indeed, for the population of Fiji as a whole (Table 8.6). By 1972 35 per cent of the women in the reproductive age span in the Lakeba Medical Area were considered to be protected compared with a level of 25 per cent of the Division and the nation. Accompanying this rate of contraceptive protection was a decline in the birth rate. Over the first five years of the 1970s the crude birth rate in the eastern islands was well below that for the country as a whole. However, this should not be taken to imply significantly lower fertility in Lau; as noted earlier, emigration has by influencing the age-sex structure of the population in small islands, had an important impact on the nature and direction of change in birth rates.

The much higher level of protection reported in the Lakeba Medical Area statistics than elsewhere in eastern Fiji is of interest. In April 1975, when data were collected on family planning at the hospital in Tubou, it was apparent that the campaign to disseminate information on contraception and family limitation had been promoted enthusiastically by Medical Department staff. This contrasted sharply with impressions gained in other parts of the eastern periphery. In Taveuni and Kabara, for example, protection rates were much lower, and the family planning programme was not being actively encouraged in the villages (Bedford, 1978; Bedford, McLean and Macpherson, 1978). While acknowledging that there are a number of limitations to the family planning data compiled by the Medical Department, information collected during the World Fertility Survey in Fiji in 1974 indicated that use of modern contraceptive methods was more extensive among women in the smaller eastern island sample than among the total Fijian female population exposed to the risk of pregnancy (Table 8.6). Examination of Table 8.7 shows that much higher proportions of women with one or two children, a critical group in a family planning context, were protected in the Eastern Division.

By the mid-1970s contraceptive protection rates were falling again. In September 1976 the Medical Department in Lakeba recorded a level of 23
### TABLE 8.6: CRUDE BIRTH RATES AND THE INCIDENCE OF CONTRACEPTIVE USAGE, 1970-1974

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude birth rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lakeba Medical Area</td>
<td>28.7</td>
<td>20.8</td>
<td>20.4</td>
<td>20.0</td>
<td>23.0</td>
</tr>
<tr>
<td>Lakeba Subdivision</td>
<td>25.9</td>
<td>22.8</td>
<td>20.7</td>
<td>17.0</td>
<td>19.7</td>
</tr>
<tr>
<td>Eastern Division</td>
<td>24.5</td>
<td>20.4</td>
<td>21.6</td>
<td>18.3</td>
<td>22.7</td>
</tr>
<tr>
<td>Fiji (Fijians)</td>
<td>28.9</td>
<td>29.6</td>
<td>28.2</td>
<td>26.8</td>
<td>30.1</td>
</tr>
<tr>
<td>Fertility protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lakeba Medical Area</td>
<td>20.4</td>
<td>30.5</td>
<td>34.2</td>
<td>32.4</td>
<td>30.9</td>
</tr>
<tr>
<td>Lakeba Subdivision</td>
<td>20.6</td>
<td>21.8</td>
<td>28.4</td>
<td>25.3</td>
<td>27.2</td>
</tr>
<tr>
<td>Eastern Division</td>
<td>21.9</td>
<td>21.7</td>
<td>25.4</td>
<td>25.2</td>
<td>23.2</td>
</tr>
<tr>
<td>Fiji (Total population)</td>
<td>22.7</td>
<td>23.0</td>
<td>25.5</td>
<td>23.8</td>
<td>23.3</td>
</tr>
</tbody>
</table>

* a Births per 1000 population

* b Percentage of women aged between 15 and 44 using the pill or loop, together with those who had a tubal ligation and those whose husbands were using condoms.

Data: Records held at Lakeba hospital, Tubou and the Medical Department's Divisional headquarters in Levuka, Ovalau.

### TABLE 8.7: THE PERCENTAGE OF FIJIAN WOMEN EXPOSED TO PREGNANCY USING A 'MODERN' METHOD OF CONTRACEPTION, WFS 1974

<table>
<thead>
<tr>
<th>NUMBER OF LIVING CHILDREN</th>
<th>EASTERN DIVISION WOMEN SURVEYED</th>
<th>USING CONTRACEPTION</th>
<th>WOMEN SURVEYED</th>
<th>TOTAL FIJIAN WOMEN USING CONTRACEPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO.                %</td>
<td>No.</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>17                 5.9</td>
<td>156                5</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>16                 5</td>
<td>166                29</td>
<td>17.5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>11                 6</td>
<td>148                43</td>
<td>29.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>18                 5</td>
<td>148                58</td>
<td>39.2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>14                 6</td>
<td>126                54</td>
<td>42.9</td>
<td></td>
</tr>
<tr>
<td>5+</td>
<td>32                 21</td>
<td>373                210</td>
<td>56.3</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>105                44</td>
<td>1171               359</td>
<td>35.7</td>
<td></td>
</tr>
</tbody>
</table>

5.9 Lakeba, The Eastern Islands and the Work of the Project in Retrospect

H. C. Brookfield
(University of Melbourne)

I. COMPARISON OF FIVE ISLANDS
   Introduction: the purpose of this paper

II. ECOLOGY, GEOMORPHOLOGY AND RESOURCES
   Ecological and geomorphological questions
   Resources and their dynamics

III. ECONOMY, SOCIETY AND POPULATION
    Differentiation within a peripheral archipelago
    Demographic change

IV. THE ISLANDS IN A WIDER SETTING
    Small islands in a wider world
    The issues in island development
    Conclusion

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9.1 Eastern Islands: some physical characteristics
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I - COMPARISON OF FIVE ISLANDS

INTRODUCTION: THE PURPOSE OF THIS PAPER

The need for a retrospective review

Whether or not it becomes the last formal paper of the project to be published this paper is the last to be written. A gap of fully three years separates this final publication from the drafting of our first general report (UNESCO/UNEP A Project, 1972) and the first detailed Island Reports (McLean, 1977; Bayliss-Smith, 1979a; 1979b; M. Brookfield, 1977; Campbell, 1977) which followed it quite quickly. During 1977 and early 1978 project members were occupied in completing our major reporting on Taveuni and the small islands (Brookfield, 1978; Denis, 1978; Beddard, 1978; Nankivell, 1978; Brookfield and Hardaker, 1978; Beddard, McLean and Mapherson, 1978; Bayliss-Smith, 1978; Salvat et al., 1978), and in the latter part of 1978 and early 1979 with the preparation of the second and third 'general reports' (Brookfield, Ed., 1979, Latham, Ed., 1980). Reporting on Lakeba required a large amount of data analysis and was not completed until 1979. This final report has also been delayed by severe pressure of other and newer work.

It is only now, therefore, that the reporting of the project is complete. In particular, it is only now that the ecological and other physical studies of the project are fully reported. Since Lakeba took up so large a proportion of the time of the project, and since the intensive and interrelated ecological studies of the project were heavily concentrated on this one island, completion of this work alone warrants a review by the team leader. Moreover, it now becomes possible also to compare the social and economic findings of the project on its five 'Islands of concentration', to relate these with one another and with a wider re-thinking of conclusions which we reached freshly out of the field in 1975. This paper sets out, therefore to present our only comparative discussion of the environmental findings of the project, to review and compare some principal findings in the social, economic and demographic fields, and finally to offer some personal revisions of the project recommendations offered in 1977. The latter is perhaps timely in view of the recent appearance of a general report on agricultural development in the Pacific (Ward, Ed., 1979) prepared for the Asian Development Bank, and referred to here in its draft version.

The Islands of concentration in a wider context

First it may be as well to review the basis of our selection of five islands for detailed work, and of two of these for more intensive team research; and the reasons why these two islands absorbed 70 per cent of the field time of the project. Our plan of work underwent significant changes during the early months in the field, partly from necessity, and partly in order to gain access to a wider range of ecological and economic conditions. Our original intention had been to work on four islands of wholly rural economy, two in Lomaiviti and two in Lau (Fig. 9.1). This was a plan in line with the mainly rural nature of previous research in human ecology, especially in the Pacific. Initial work in 1974 followed this plan, on the Islands of Koro and Batiki in the Lomaiviti group, but soon after my own arrival in the field in November 1974 I decided to vary the plan by working also on the young volcano Island of Taveuni, adjacent to Vanua Levu, which represented by an estate-dominated but mixed economy, and with a quasi-town of some 2000 people. In mid-1975 the project was permitted to work on Lakeba in central Lau, which we wished to study because of its great ecological interest; in so doing we
also found ourselves studying a second island with strong internal socio-economic differentiation and a smaller quasi-town of 600 people. Logistic difficulties of access prevented us from carrying out detailed work on more than one other island, and we selected the 'rural' island of Kabara in southern Lau. We were not able to do more than reconnoitre other islands, partly because budget restrictions limited our expenditure in 1975. By 1976 it became obvious that it was necessary to concentrate all effort on islands where work had already been initiated, in order to complete the field programme within the remaining time. A number of other islands were, however, visited; they ran the full length of the Lau chain from Kerelebu in the north to Omo-I-Lau in the south (Fig. 9.1).

The 'islands of concentration' thus included four volcanic islands and one limestone island, though the reef-lagoon systems of two other limestone islands were examined. We worked on two of Fiji's islands of most recent volcanism, in two of the four urban or quasi-urban centres in the outer islands, and on two of the three 'chiefly' islands which once dominated the whole of eastern Fiji. The selection did not represent the whole range of variation, and the limestone islands and the very small islands were both under-represented; it did, however, offer a great deal of variety.

II - ECOLOGY, GEOMORPHOLOGY AND RESOURCES

ECOLOGICAL AND GEOMORPHOLOGICAL QUESTIONS

The variety of terrestrial and reef-lagoon ecosystems

No two islands in eastern Fiji are even closely similar, and all this variety is built on only four basic geological elements: basalt and basaltic, raised limestone and modern reef. Climate plays a part, and is discussed below, but the fundamental differentiating factors are more probably geological age and tectonics. Fig. 9.2 summarizes the principal events in the origin and evolution of the islands; a semi-logarithmic time scale is used to compress the older events and give more prominence to the recent period. Though as a project concerned with man and the biosphere, our proper period of interest begins only 3000 years ago when man arrived in eastern Fiji. Interpretation of the human environment requires an understanding of much earlier events, extending back to the origin of the islands.

Some of the eastern islands, including Lakeba, are almost as old as any part of Fiji, having been created by volcanism in the Late-Miocene and early-Pliocene, between nine and six million years ago. On this base were laid limestones, during two periods when the islands were wholly or partly below the sea. In the mid-Pliocene, three to four million years ago, there was further volcanism, and the southern islands of Lomalaki, including Batiki, seem also to have originated during this period. After this time most of the present islands emerged finally above the sea during a period of active deformation in the Lau-Tonga region. Islands were tilted and uplifted to different heights, and possibly moved laterally (McLean, 1979a). Atillo, (1976) and Katz, (1977) as Lau and Tonga drifted apart. The Pleistocene limestones indicate this distortion most clearly, lying at a range of altitudes, sometimes being tilted as much as 45 degrees; they form a limestone cap, as on Nausori. Despite the pioneer work of Ladd and Hoffmeister (1945) and Twyford and Wright (1965) in Lau and the more recent work reviewed by McLean, no comprehensive survey of the origin and
landforms of these islands is yet possible.

Problems of the volcanic and the limestone islands.

It is fairly easy to generalize about the volcanic islands. There is a clear and expectable correlation between age and ecological complexity. Lakeba, the oldest of the four by several million years, is by far the most complex. Batiki, constructed in the Pliocene, has considerable variety of native life and, like Lakeba, has large areas of volcanic soils. While it is not certain whether or not Koro and Taveuni first originated in the Pliocene, it is clear that the greater part of the formation of these mainly-basaltic islands took place in the Pleistocene, within the past one million years. In both islands there are areas of well-eroded volcanics with deep gorges entering narrow flood-plains close to the sea and probably extending below these deposits to below present sea level. Both islands also have more recent anodesic ash-cones and pediment areas formed by ash around the cones. On Koro post-volcanic erosion is evident all around the island; the ash cones, themselves eroded, are confined to the central plateau. Recent research suggests that vulcanism ended on Koro within the Pleistocene (F. Coulson, pers. comm.). On Taveuni, on the other hand, deeply-eroded landforms are confined to the north-east of the island, and all the remainder is overlain by recent basaltic flows and ash falls. Between and three hundred craters, mostly very fresh, run the length of the island, and recent craters are also found in adjacent Yaruca and Motatia; north of Qamea. In Taveuni the most recent volcanic activity produced ash which covers human occupation sites, and can be dated to between 2000 and 1000 years ago. Because its formation continued actively within the whole Pleistocene and into the Holocene, this largest of the east-Fijian Islands is also ecologically the simplest.

The problem of the limestone islands is much more complex, even though all of them except the sea-level atoll/nucti islands in the far north of the chain (Fig. 3.1) are composed of Pliocene limestones, uplifted at least a million years ago. A few, like Vatao, have a clear system of raised-reef terraces; in others, steep-sided limestone blocks stand above the general level; in still others the raised limestone is only a few metres above the sea. There is also the question of karstic (solution-formed) hollows now submerged below the sea, in the reef-lagoon systems (Salvat et al., this volume); whether or not these are contemporary with low-lying karst on other islands is a question that can be determined only by specialized research.

In terms of present-day ecology the variation in the soil cover of these limestone islands is a question of greater interest. There is tentative indication that there is more soil cover on the atoll/nucti limestone islands than in the north, where Qelelevu, for example, is almost completely bare of soil cover. While it is possible that the depth of soil may be related to the period of time during which the surface has been exposed to subaerial weathering, it is more probable that it is related to ash falls from volcanoes. This is the case in the West Indies, where Barbados is the best-known case of a limestone island supplied with soil by ash from distant volcanoes. The same is also true in Tonga (Widowson, Ed., 1957) where the deep and fertile soils overlying limestone on Tongatapu are attributed to heavy falls of volcanic ash. It is perhaps worthy of remark that the deepest soil on limestone in Lai is on Vatao, closest of the islands to Tonga. The project (Latham, pers. comm., in Bedford, Mclean and Macpherson, 1976) noted that the presence of manganeuse on Kabara indicates volcanic

activity since the uplift of the island, but whether on Kabara itself -- which has a small volcanic hill -- or at greater remove, is unknown. On Fig. 9.2 a Pleistocene date is tentatively indicated, but it could well be more recent.

The question of climatic change.

It is clear from the preceding discussion that vulcanism, and possibly differential uplift and tillting also, have been active in shaping these islands and their soil cover until very recent times. None the less, all but a small part of total land surface of the islands has been exposed to forest conditions in the atmospheric environment during the past 50 000 years, while some land surfaces may have been exposed to the atmosphere for two million years or even much longer. In the world as a whole, this has been a period of major climatic variation, and knowledge concerning the nature of that variation during the past 120 000 years is accumulating rapidly.

It is therefore of particular interest that Latham, in his principal paper in this volume, finds it necessary to call on several periods of climatic change to account for the interrelated soil and landform conditions encountered on Lakeba. Periods in which weathering has dominated have alternated with periods of erosion and deposition, especially of the massive quantities of colluvium which cover a large part of the lower slopes and valleys. There are also mature soils of great depth not in harmony with present climatic conditions. Our limited palaeobotanic work in the Lakeba swamp does not illuminate this problem, since the swamps seem to belong only to the late Pleistocene, and are in some measure protected from human interference. A deep core in the larger Tubu valley might yield more information, and there may also be evidence in the lake-bed deposits of the small lake at low altitude on Unea, or the high-altitude caldera lake in central Taevuni. The date of formation of these features is not, however, known; both lakes may be of quite recent origin.

At the present time there is a fairly well-marked climatic gradient down the length of the Lau chain. Mean rainfall diminishes and liability to drought increases from north to south, so that we pass from permanently wet conditions in the north to the margins of a sub-humid zone in the far south (Fitzpatrick, Hart and Brookfield, 1966). Given this marginal location under present-day conditions, there are good prima facie grounds to anticipate that the major changes in pluvial conditions which affected the Australian continent during the late Pleistocene (Bowler et al., 1976; Bowler, 1978) might have had some reflection in these islands of comparable latitude. An objection is that the CLIMAP Project Members (1976) place Fiji in the heart of an area where sea-surface temperatures at 18 000 B.P. were much as they are today, but this is an extrapolation based on deep-sea cores several thousand km from Fiji.

Latham's evidence is strong, but there exist no means of dating the changes which he seeks. On other islands there is also evidence to suggest that there have been periods of much greater erosion in the past -- in the Pleistocene on Taveuni and Koro, and there is comparable evidence from Viti Levu and New Caledonia. At the present stage we can only describe this evidence as hypothesis-generating, but an area for research is clearly indicated.

Changes during the late Holocene: the sea-level question.

Our solid evidence is confined to the much shorter period within
which sea level had attained its approximate present position, probably about 4500 years in eastern Fiji. While there is only limited evidence of submergence in this period (Hughes et al., this volume), there is clear evidence of major changes at the land-sea interface, and of erosion rates greatly differing through time in the Lakeba interior. If the period of rapid erosion around 2000 B.P. identified in Lakeba was of wide occurrence in the region, it would have added large quantities of terrestrial material to coastal zones still actively aggrading under the protection of vigorous coral growth adjusting to the higher sea level. Tentatively, the creation of such submergence ramps in Lakeba or elsewhere may be correlated with the in-filling of beach-protected areas on Batiki, Toluta and other islands where off-lying islets became joined into larger islands. Subsequently, coastal progradation in Lakeba and elsewhere has given way to a period of erosion (McLean 1979b; Tautou 1977), and the periphery is being actively used for agriculture, notably by the indigenous Fijians, to extend the habitable territory in the region, to assess the nature of the risk and to take remedial action (McLean, 1977). For some settlements re-location on higher ground may be the only means of ensuring safety.

RESOURCES AND THEIR DYNAMICS

The changing nature of resources

The resource complex of an area can only properly be defined in relation to the conditions of human use and human expectation on the one hand, and of the processes involved in sustaining, renewing or extinguishing the resource on the other. Though they must be mapped and evaluated in the context of conditions at a given point in time, it is essential to recall that these conditions are under constant change.

When man first entered eastern Fiji some 3000 years ago with a limited tool-kit and set of skills, the environment differed in many respects from that of today. The islands themselves were smaller, and without their present coastal flats. If coral growth was then more active than today, marine resources were probably more abundant. At least on Lakeba, the land had already undergone considerable erosion, and it seems probable that areas of impoverished soil and vegetation were already in existence. A thousand years later the impact of fire and cultivation had become so heavy as to initiate a period of extremely rapid erosion; swamps were created or enlarged and coastal deposition was accelerated. Adoption of more conservationist forms of land use certainly followed, and a thousand years further on we find erosion rates diminishing. In the same period in Taveuni we encountered the first construction of large fortified sites (Frost, 1970), and un-dated fortified sites of similar form are found on all islands. Not only does this indicate the presence of a larger and more mobile population, but also of earth-moving skills of a high order. So far as can be judged, increased contact between islands, or characterized the final millennium, leading to creation of a complex interdependence, the emergence of centres of power, and the beginning of a shift of settlement toward the coast that was fully accomplished only in the early colonial period. Reduction of pressure on the island interiors, due to this shift and also to population decline, led to reforestation especially on the fertile islands of young olivine basalt, and even on a Lakeba catchment subject to intense erosion in the past. Most recently, new market opportunities have led to renewal of forest clearance in some inland and coastal areas. Some modern developments in these areas, while at the same time the small-scale cultivation systems have perished on some islands, and have declined very greatly on others. On Lakeba and some other islands, even the barren lands are being planted under Phoenix sylvestris.
Resources in an uncertain environment

There is also short-term variability in the environmental conditions of these islands; damaging hurricanes may strike any island in any year and approximately 80 such storms passed through eastern Fiji in the century 1875-1975 (McLean, 1977). As many as 30 years may pass between two storms which do major damage on any one island, or an island may be hit twice in one season as was Kabara in 1936. Except on Taveuni and Koro drought is a more regular visitor, occurring two or three times per decade in much of Lau, where one year's rainfall may be half or twice that of the succeeding year. This is a condition that has probably not changed greatly during the period of human occupation, but the external man-made environment has undergone several radical changes since the 19th century. Now and more violent forms of warfare had a devastating effect upon the early 1860s, and overlapped in impact with a wave of introductions of new diseases of people and plants which peaked in the later 19th century. Plant introductions themselves, including weeds, continued almost uncontrolled into the early 20th century. These innovations, and the changes they wrought have now become entrenched within island ecosystems.

More devastating has been the new form of variability introduced by attachment of the islands to the world economic system. Vulnerability to fluctuating market prices for tropical crops destroyed several early cash-crop initiatives. Increasing dependence on imported goods surged forward during economic boom periods, and increased the vulnerability of island welfare to fluctuations in the price of export crops and to imported inflation. In the 1970s variability in external economic conditions attained an unprecedented scale when violent fluctuations in the price of copra coincided with steep inflation in the price of imports and an abrupt decline in the profitability of inter-island shipping. The coincidence of these events had very serious effects on the islands at the time of project field work and were causing many to doubt the continuing viability of the island economies. Subsidies in one form or another were provided by Government, so that the eastern region was coming to be seen increasingly as a burden on the State. In turn, this new condition creates vulnerability to variations in the condition of the national economy of Fiji, and in the policy of Government toward its competing areas of responsibility.

The contemporary period is one of rapid change in these islands, and though variability in the natural environment remains important, the major force has become variability in man-made environmental conditions. The islanders have no more control over the latter than they have over the former, and retain very limited ability to determine their own future. Considerable numbers of people have left the islands to seek more rewarding conditions of life in and close to the growing towns, but on the islands themselves a number of initiatives have been taken aimed at finding new income sources, especially in the urban market. Resources are thus again being re-evaluated. There have been previous periods of rapid change in the islands, but perhaps none so comprehensive as the present. Its understanding absorbed a major part of the efforts of the project.

III - ECONOMY, SOCIETY AND POPULATION

DIFFERENTIATION WITHIN A PERIPHERAL ARCHIPELAGO

Bases for comparison

All the islands of eastern Fiji have become part of the national periphery under a process of centralization that has accelerated greatly in recent years. Depending on definition, between a third and a half of the Fijian population now lives in and around urban areas, and the proportion of the national population living in the outer islands has declined greatly. In each of one of its island studies, the project traced both the manner of this 'marginalization' and its effects, and examined also the ways in which the islanders' responses. The deteriorator in the conditions of welfare is not equally distributed. While the terms of trade have moved against all islands, some have suffered worse than others. Thus the received price of grade 1 copra at different places in the Islands varied from 14 to as much as 30 per cent below the price payable in Suva, after allowance for freight, while the shelf price of a standard basket of goods ranged from ten to 40 per cent above the prices in central Suva (UNESCO/UNIPA Project, 1977, p. 279).

There have always been differences between the islands. The Fijian chiefly system has required a measure of division of labour, surplus production and unequal distribution of assets for its support since its inception in prehistoric times. When the chieftains were at war, large war-canoes had to be built and manned, and armies raised and maintained. The chiefly is not only a burden on itself but also an expensive way of ensuring that warriors do their duty. The chiefs had to maintain their prestige by demanding tribute in large quantities from their subjects. The Lomalaki islands paid tribute to the maritime states of eastern Viti Levu from at least the 10th century, first to Vereva Chiefl to Bau, Koro supplied yams, taro and fermented breadfruit (Bayliss-Smith, 1976), Batiki pandanus mats and coconut oil (Bayliss-Smith, 1976). Later both provided coconut oil and help finance the Bauan war. This situation did not end until the second decade of this century. Taveuni and Lakeba were themselves chiefly islands, but produced an agricultural surplus traded against goods from other islands. Kabara had a distinctive role in Lau, using its hardwood forest resources to provide canoes, house-posts, head-rests, yagona bowls and other wooden products; Kabarans imported food, and some even had land on Lakeba (Hocart, 1929, p. 26). In most of Lau distinct groups of people bore the names of 'food-producers', 'carpenters' and 'seafoaters' in a highly organized ranking system of mutual support.

Some elements of the old tributary system remain alive in Lau even today, but elsewhere the system has all but perished. All connections are with Suva, and in the outer-island region only Taveuni has a 'central place' in the modern commercial sense of providing a sale point for produce and a buying place for imported goods, with a hinterland extending beyond its own shores. It also retains a centre of District Administration, recalling the days when the Taveuni planters were among the most powerful pressure groups in Fiji, and remains an important centre of the medical and agricultural services. Lakeba has a similar administrative role, confined to the Provincial system, and to the medical and agricultural services. Both these islands remain important centres of secondary education for their surrounding island regions.

As a result, Taveuni and Lakeba each offer significant wage employment
and on Taveuni there is also a large number of estates which offer some local employment but depend mainly on a resident work-force, Fijian and Indo-Fijian. There are nine wholly-assimilated islands in eastern Fiji most of which are also worked as estates, with a similar labour force, and there are small estates on most of the islands of Lonaviti and northern Lau. On the other islands, however, wage-earning opportunities are extremely limited. It would, however, be wrong to describe the other islands as subsistence-orientated even though they produce much of their own food. They are trading economies, dependent on trade for a proportion of their food, all their clothing and most of their furniture, some building materials, all cooking and lighting fuel other than wood, and all cigarettes. In order to obtain these commodities they must export, or else rely on remittances from islanders at work elsewhere. Island incomes are thus an important basis for comparison of welfare conditions.

A comparison of cash-income levels

Project members collected data on cash incomes as an element in their inquiries on every island where they worked. In Taveuni District the project collaborated with Government in a household survey which collected these data along with a range of demographic and other information; elsewhere the collection of data was individual, relying to varying degrees on household survey and on the records of the local Co-operative Societies. Data obtained from these various sources are summarized in Table 9.1. They cover different periods of time, and unfortunately the years to which data refer coincided in part with the most violent fluctuation in the copra price ever experienced in Fiji, during 1973-75. This has a major effect on those income figures which relate largely or wholly to sales of copra.

Incomes on the rural islands: Although there are serious problems of comparison, some interesting conclusions may be drawn from Table 9.1. The poverty of Kabara is outstanding, and makes clear the plight of this island in 1975 when copra production was minimal after the damage wrought by two successive cyclones, and when the prices of both copra and handicrafts were depressed. Kabara always receives substantial support from remittances, and from wages brought back to the island by returning migrants, but in the first nine months of 1975 no less than $10 000 were withdrawn from the Post Office Savings Bank to help sustain store purchases at a full-year per capita level of only $42, and meet other obligations (Bedford, Mclean and Macpherson, 1978, p. 37-42). Obviously this could not have continued without the introduction of a subsidized fixed price for copra, which was applied throughout Fiji on 26 June of that year.

Koro is in complete contrast. With large plantings of yamona and tano on its fertile soils, and frequent vessels sailing to Suva and Levuka (Gaua), the villagers of Nakamaki managed to achieve a slightly higher level of per capita cash income in 1975-76 than in 1973-74, when copra prices were at peak levels. The people of this fertile, 'inner' island had a choice, and on the basis of sample data Bayliss-Smith (1977b, p. 66-68) calculated that input-hours/year in copra production fell from 175 to 100 per adult, while input-hours/year applied to yamona production rose from 32 to 75. There was also an increase in time spent on subsistence production.

Batiki is both smaller and less fertile. There was limited opportunity to substitute for copra as prices declined, notwithstanding the proximity

<table>
<thead>
<tr>
<th>PLACE</th>
<th>PERIOD</th>
<th>TOTAL INCOME $</th>
<th>COEFFICIENT OF VARIATION (S.D./MEAN)</th>
<th>INCOME DERIVED FROM LOCAL PRODUCE $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabara</td>
<td>Co-operative 1973</td>
<td>22</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Societees 1974</td>
<td>34</td>
<td>-</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>12</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Koro</td>
<td>Nakamaki 1973-74</td>
<td>134</td>
<td>0.52</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>1975-76</td>
<td>141</td>
<td>-</td>
<td>112</td>
</tr>
<tr>
<td>Batiki</td>
<td>Island 1973-74</td>
<td>159</td>
<td>1.20</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>1974-75</td>
<td>127</td>
<td>1.39</td>
<td>69</td>
</tr>
<tr>
<td>Taveuni</td>
<td>Island 1975-76</td>
<td>129</td>
<td>1.09</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Taveuni District</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Villages 1975-76</td>
<td>117</td>
<td>1.16</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Settlements 1975-76</td>
<td>139</td>
<td></td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Estate workers 1975-76</td>
<td>185</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Qamea Island 1975-76</td>
<td>135</td>
<td>1.47</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>Lauca Island 1975-76</td>
<td>489</td>
<td>2.06</td>
<td>102</td>
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<tr>
<td></td>
<td>Whole estate 1975-76</td>
<td>166</td>
<td>0.90</td>
<td>77</td>
</tr>
<tr>
<td>Yacata-Kabu</td>
<td>Island &amp; estate 1975-76</td>
<td>265</td>
<td>0.68</td>
<td>184</td>
</tr>
<tr>
<td></td>
<td>Yanuca Island 1975-76</td>
<td>239</td>
<td>0.64</td>
<td>193</td>
</tr>
<tr>
<td></td>
<td>Qellevu Island 1975-76</td>
<td>319</td>
<td>-</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td>Lakeba Copra 1974; Other 1976</td>
<td>378</td>
<td>-</td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>Rest of Island 1975-76</td>
<td>278</td>
<td>240</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1 No comprehensive data available for Kabara on income sources other than local produce.

2 Tubou and Levuka villages, together with the Government Station.

3 1974 copra production is valued at the 1976-79 fixed prices according to grade; all other data from 1976 survey. For details see M. Brookfield (this volume).
Table 9.1: continued.

Data: Kabara: Bedford, McLean and Macpherson, 1979, p. 38-42.
Koro: Bayliss-Smith, 1976b, p. 54. Batiki: Bayliss-Smith, 1978,
Lakeba: M. Brookfield, this volume.

to Suva, and the presence of a fishing business strongly supported by island-
exportation in the city. In a year of low copra prices, marginal income
was gained from shell and holothurians, pandanus nuts and root crops increased,
but Bayliss-Smith, 1976, p. 121 comments:

The balance between centralist and anti-centralist tendencies seemed, in
1974, to be favouring a somewhat increased autonomy for Batiki. The
rising copra price and the success of the fishing company ventures seemed
to suggest that higher standards of living and more local control in
decision-making were both feasible. On the other hand, the fatal depend-
ence on copra (highlighted by the crash in price in 1976 and 1976), con-
tinued inflation in the price of imported goods, and the financial
frailty of the fishing companies suggest otherwise. Only a substantial
modification in the centralist ideology of the Fiji state will prevent
Batiki from soon becoming an almost unmanned satellite of Suva.

Outermost islands and absentee farms: A grim prospect faces the very small
talanoa of the outer islands. If we examine Table 9.1 closely, it will be noted
that per capita incomes, on outlying islands of Taveuni District (Yanuca,
Gelelevu) seem remarkably high, and that the contribution from local produce
is also high. These values are deceptive; they reflect a situation that has
not been beyond the general among the small islands, many of whose
inhabitants make a living by working abroad. The number of such
people is substantial in Gelelevu (p. 121) but not in Yanuca. The
situation in Yanuca seems worse because outside the state the latter
are in school. At Gelelevu something like a 'shift system' is
in operation. A minimally-sufficient population to work the farm remains
on the island, and Gelelevu people living elsewhere take turns to share in
work from which all gain some profit. At Yanuca arrangements are more
individual. On a number of other east-Fijian islands there is no 'resident
population, but a few people from nearby islands are usually 'at home'
on the clan territory for periods of weeks or months, working the coconut
groves for the profit of all. More than a decade ago, Ward, 1967, p. 95
predicted that many small Polynesian islets would become 'absentee farms'
of this type. In eastern Fiji the pattern is now becoming widespread, and
will doubtless extend further if present trends in withdrawal of shipping
This project has re-iterated, and re-iterates again, an old recommendation
of Lord Strickland (1869): people who are increasingly absent from the
small size of their island homes and by rising transport costs should be
aided by the planned allocation of land on larger islands having the
resources to justify investment; this recommendation assumes key importance
in our concluding argument.

Taveuni: an island tragedy: By contrast with small islands where income
is related to only a proportion of the beneficiaries, the total per-capita-
income of Taveuni island itself is among the most surprising features of
the country. It was necessary to analyze data on the island economy excluding
the population of the government station, the larger planters
and most of the traders. Even so, we have a representation of the income-
earning potential of the ordinary people of Taveuni in a period in
cluded fairly-high copra prices, and it is not encouraging.1

We must remind ourselves that in the central Pacific region the only
islands of natural fertility comparable to that of Taveuni are the main
islands of Western Samoa, and possibly Tongatapu. Taveuni has, moreover,
a very low population density. In Fiji, it has seen pioneering efforts
in sugar and tea production, salt-making, and since the 1940s in the
wholly-commercial production of fresh vegetables for the Suva market.
It has a relatively complex economy, with a real but un-recognized town
growth larger than many 'legal' towns in the country. Yet it has always been too
small for real developmental interest, too far from Suva to be regarded as
more than a reserve supplier for the Suva market, and as a regional centre
itself subordinate to Suvasavu on much-larger Yanuca Levu. Taveuni
remains an island in the periphery, and modern developments are increasing
its marginality.

With a Gini coefficient of 0.86 for the distribution of land-holding
blocks by size (Brookfield, 1978, p. 61), Taveuni ranks high on any scale
of inequality in distribution of rural land. The largest of the island's
estates is, in fact almost equal in area to the whole island of Lakeba; its
land is mainly humic andosols with varying extent of stoniness but of
moderate to high fertility. Allowing for non-resident workers, it supports
about 300 people and produces about 450-500 tonnes of copra, respectively
15 and 40 per cent of the values for Lakeba. It also supports about a thousand
cattle. On this and several other estates large areas are most wholly
unproductive at the present time. On the same island, some crowded Indo-
Fijian subdivisions are populated close to capacity (Bedford, 1978, p. 226),
and the people encountered some Taveuni blocked the land tenancy-at-will
cultivating for the market on land separated by two gorges from the nearest
road.

On this island, the project recorded some of the highest tuberous-crop
yields ever measured under traditional production systems (Haynes, 1976).
Taveuni is, however, treated as only a reserve supplier by the National
Marketing Authority because of its remoteness, and the frequency of spoilage
due to poor handling and inadequate shipping (Hardaker, 1976). On this
island of contrasts estate land of high fertility is being subdivided for
residential development at low rates, and some of these subdivision lots
have already been the subject of land speculation among buyers outside Fiji.
At the same time many estate workers and some villagers who wish to farm
in their own right are unable to obtain access to land, and still others are so
poor, and ill-educated, that they cannot even contemplate the alternative of
migration.

1 Subsequent analysis of data confirms our earlier estimate that the total
value of Taveuni island copra production, from all sources at current prices,
is about $900 000. During the year 1974-75, to which part of our data refer,
the received income was almost exactly twice this figure. Exported yamone,
breadfruit and minor produce are estimated to yield a further $500 000,
while wages and salaries, plus purchases, paid from external sources (Government
services, companies and hotel) are estimated at between $900 000 and
1 million. In addition, approximately $125 000 is paid to islanders by the
Public Works Department. This estimate yields a gross income for Taveuni of
approximately $2 500 000, or $327.50 per capita of the whole population.
While this estimate provides no indication of per capita GDP, it is clear that this
value must be well below the national level of $919 in 1976 or $837 in 1975.
Lakeba: hope and experience: Lakeba is an island wholly in Fijian ownership, though it had estates in the past. Much less fertile than Taveuni, it nonetheless has important natural resources. The strength of the Lakeba economy is very evident from the data in Table 9.1, and in the account given above by M. Brookfield. There is a vigour about the Lakeba search for wealth which contrasts with the lethargy and poverty syndrome of Kavara and Bati. It is only on the settlement blocks of Taveuni that greater entrepreneurial vigour is displayed in the eastern islands.

The data in Table 9.1 provide evidence of this vigour, and also of the comparative advantage of its soybean from the city to grow any major export crop but copra under present conditions.

There are, however, two Lakebas, as M. Brookfield makes clear above. There is a Tabua-centered Lakeba where incomes are as solidly bolstered by wage employment as those of central-west Taveuni. Outside this area wage employment is available only to a few. The other Lakeba - the 'other side' of the island to use a common Fijian expression - is in a very different position. This is the Lakeba that was studied by Bony (Bayliss-Smith, 1979), which is as rural, and as much prone to the vagaries of natural and economic hazard as any rural outer island - even Kavara. Lakeba taken as whole is relatively rich, but the population contains individuals as poor as Kavaraans, the Taveuni estate workers, or those old women on Nama who could not afford to collect their welfare payments from the Taveuni Post Office, since the cost of collection exceeded the value. Most of the range encountered in eastern Fiji is to be found on this one island, which contains centre and periphery, rich and poor, great and small. Individualism is less than on Taveuni, or even Kora and Batik, but is present and is growing. Above all, the existence of rural Fijians for a stable income is as clearly demonstrated on Lakeba as anywhere else in Fiji.

DEMOCRATIC CHANGE

Population change: variation through time and space

Before the project began work it was already known that migration was far more significant than either fertility or mortality in determining population changes in Fiji. All subsequent evidence has confirmed this view. The fertility studies carried out by project members on Taveuni and Lakeba (Bedford, 1978; Bedford and M. Brookfield, this volume) revealed some interesting variations in detail, but in general nothing contrary to the findings of the pilot inquiry of the World Fertility Survey, conducted

2 Settlement-block holders in Taveuni, both Fijian and Indo-Fijian, have always shown great adaptability in their choice of cash crops, and have always been ready to use fertilizers in order to improve their yields. On some new blocks farmers have invested in Gramoxone (Paradigm) equipment to reduce the weeding component in cash-crop production even before building themselves proper houses. A third of the active block-holders are immigrants from outside Taveuni, with a significant proportion drawn from Kavara (Bayliss-Smith, 1979). Many of these immigrants are from Vanua Levu or the eastern islands, where they share the same experience of widespread depopulation of the estate workers (themselves 56 per cent immigrant). Among Fijian block-holders many are Luans, mainly from Nakau Lava and the southern islands; most of the remainder are from Vava Levu. Indo-Fijian immigrants are not an important group in Lakeba, but are a major part of the mixed-race population, with people from southern Lau among the 2000 - 3000 Luans settled along the Rewa-Seqi trade route in eastern Vitia Levu, north of Suva. Established originally to grow bananas, and offered free transport home in 1969, the town has almost all stayed to become the main suppliers of taro to the Suva market. Some family members commute to work in Suva, from as far as 60 km from the city.

in Fiji in 1974. There are some important differences in the degree to which contraceptive practices have been adopted: Indo-Fijian women in Taveuni receive far more contraceptive advice than Fijian women. The contraceptive advice in protection in the early 1970s is revealed as the temporary consequence of a surge in effort on the part of the authorities. In general, however, there seems to have been ready acceptance of family planning up to a certain level; beyond this level, more fundamental social changes are likely to be required before the simple merchandizing of contraceptives is likely to achieve significant further advance. The growing individualization of Fijian society in the absence of a comprehensive system of social insurance is seen as a major reason for the continued ignorance. Any new concept of the 'family' in several islands the project and its Fijian associates were disturbed by the quite widespread incidence of destitution among individuals without family support.

The general decline in fertility has accentuated the effects of migration, and migration itself is changing in nature. The circularity pattern of a former period still continues, in that many of the fertile islands that return home after periods of work away, but this pattern is increasingly overrun by whole-family migration of a more permanent nature. In his several reports for the project Bedford (in UNESCO/UNFPA Project, 1972; 1978; 1979; Beddard and McLean, 1978; this volume with M. Brookfield) has both attempted to measure migration over the past three decades and also to offer a series of projections based on varying assumptions concerning the future. In the region as a whole net migration has hitherto been less than the natural increase, but in Lau has exceeded this value since 1966 while in certain small islands the loss of young population has been sufficient to eliminate the possibility of any further natural increase even without continued emigration.

Regionally, there is evidence of a substantial increase in migration in recent years, though some important exceptions are noted. Population on three land settlements in Taveuni increased by 77 per cent between 1956 and 1966 while that of 14 villages increased by only 2.5 per cent; on the Taveuni estates the principal mobility has been between estates, since so few have the capital or education to move further afield in the hope of betterment; Lakeba, almost alone in Lau, has sustained its population during the early 1960s and 1976. There is continued evidence of reluctance to abandon even the most depressed of islands, and by inference the 'absentee farm' system discussed above no island in eastern Fiji has in fact become wholly depopulated in the entire period of demographic record; such islands as were once populated and are now vacant were evacuated in the period before records began.

Population and the Fijian land system

Up to the present time we have mentioned a few of the population rather than migration leading toward evacuation of islands. In evaluating this fact, which is of significance for projection of future trends, two considerations are of major importance. First, our studies of population carrying capacity, carried out in considerable depth especially on Batik (Bayliss-Smith, 1979), indicate that under a trade-dependent economy carrying capacities are lower than under a subsistence economy, and that the greater the dependence on trade the lower is the carrying capacity. Of contrary effect is the relative importance of land rights in this region, as in Fiji as a whole. People with rights to land will sustain these rights by at least token occupation, and the smaller the land available to a particular group the greater is the determination to sustain these rights. The rigidities
of the Fiji land tenure system thus act as a brake on migration, while commercialization is a contrary force.

Both these 'law-like' statements are valid only in the context of the present political economy of Fiji. Carrying capacities are lower under a trade-dependent system than under a subsistence-dependent system because of the labour-intensive nature of the present trade-dependent economy. Even now, some Indo-Fijian areas carry higher densities than the calculated regional 'capacity' either by intensive market-crop production or by wage-employment supplementation of rural incomes. By the standards of central Java, or Bangladesh, the islanders of eastern Fiji are rich in land beyond the dreams of avarice. In the West Indies, islands very similar in resources-endowment to those of eastern Fiji carry far higher population densities than those which this project calculated as 'maxima'; the difference lies in economic structure.

Within the Fijian context, however, the rigidities of the land tenure system are a two-edged sword. If there were anything resembling a free market in land in Fiji it is not likely that land-holding groups would so value their tiny, remote estates as to sustain production on them rather than investing their efforts more Rewardingly elsewhere. While population is thus retained on such unproductive pieces of land as Kabara, Beleleleu, Yanuca or even Batiki, the same rigidities prevent the closer occupation of naturally rich lands such as Koro, Gau, Lakeba and especially Taveuni. The production system and the land-tenure system combine to spread population thinly, creating or exacerbating a dependency problem both for the large migrant populations who now live elsewhere, and also for the nation as a whole. This institutional aspect of the outer-island problem cannot be ignored; in some ways it is crucial.

Forward projections and hard decisions

It is not easy to make projections of population in a situation which contains so many variables, and Bedford recognizes this difficulty. All that is possible is to project along a range of assumptions. Success in measures to revitalize the economies of some better-endowed islands could, even under present land-tenure conditions, lead to renewed immigration in response to new economic opportunities. On the other hand, greater availability of some ecologically inferior but better-located land in south-eastern Viti Levu to migrants could lead to accelerated emigration from the islands, and possible evacuation of some of the most-poorly endowed. A policy which created industrial and service employment in much greater quantity in the towns would have the same effect. Provided that transport services continued to be provided even a policy of simple neglect is likely to see increasing individualization of production on those few islands suited both by resources and location to be able to profit from opportunities created by urban growth. Further population decline is, however, a certain consequence of any policy that does not seek actively to improve and stabilize island incomes, and solve the transport problem. Such population decline would increase the burden of welfare provision, for it will be a long time indeed before islands come to be abandoned in the absence of any deliberate action to evacuate them.

IV - THE ISLANDS IN A WIDER SETTING

SMALL ISLANDS IN A WIDER WORLD

A comparison of trading economies

It has been stressed above that all islands of eastern Fiji must be regarded as trading economies, dependent on trade for the maintenance of the requisite standards of living. All consideration of the national use and development of the islands must take the island's place in the external trade picture, must take the fact into account. Dependence on trade is certainly greater on some islands than on others, but it is interesting that in the absence of any serious financial constraint when copra prices were high in 1973-74, the mean expenditure in villages shops reached $515 per household in Nacanaki, Koro (Bayliss-Smith, 1977, p. 87) and as much as $370 per household even in Nakelava, Kabara (Bedford, Mclean and Macpherson, 1978, p. 42).

Because of the unusual concentration of a high proportion of its external trade through a single channel, it has been possible to estimate the trade of Lakeba as though it were an independent state, comparable with island countries in the Pacific (M. Brookfield, this volume). Such a comparison is essayed in Table 9.2. On a per capita basis, Lakeba's participation in its external trade is much below the level of the Fijian nation as a whole, but is comparable with that of less-developed island countries in the Pacific. Trade imbalance is smaller with than with whole national economies, but Government spending on wages and supplies in Lakeba compares with the 'invisible' receipts of whole countries in sustaining imports at levels higher than those of national exports. The weakness of an un-diversified single-crop economy is, however, made very evident by comparing export earnings for 'notional 1977' with those of 1974.

It is particularly noteworthy that the level of food imports is comparable with that of whole countries, and that the level of petroleum-product imports is also comparable -- remarkably so considering the small number of vehicles and small amount of power generation on Lakeba. The high level of beverage and tobacco imports is especially striking. The essential conclusion to be drawn is that these islands are trading economies at a low level of development, unusually vulnerable to variation in their terms of trade. The aims of any policy designed to raise welfare levels must therefore include improvement in the terms of trade as well as more intensive production of goods and services less vulnerable to price fluctuation.

Island economies and island resources

In discussing land resources, Latham (this volume B; Latham and Denis, 1979) stresses the need to consider investment needs and to evaluate the chances of success. To undertake the latter requires more than a cost/benefit analysis, for marketing costs and possibilities are as important as production costs, and social attitudes are of major importance. Moreover, our review of

3 Though not fully comparable because they cover only individual store purchases at shelf price, Bayliss-Smith's (1977, p. 87) data for Nacanaki village, Koro, provide an interesting comparison with Table 9.2. In US dollars, per capita purchases in 1973-74 were as follows: Foodstuffs $51; cigarettes and tobacco $23; Petroleum products $4; Total purchases $90. Per capita income from exported goods was $156.
project results from different islands suggests that the 'resources' that are important include also access to land, the assurance of a steady income through local as well as export sales, and most significantly of all, access to adequately-paid employment. Our islands can be ranked in very different ways along these scales:

<table>
<thead>
<tr>
<th>LAND CAPABILITY</th>
<th>ACCESS TO LAND</th>
<th>ASSURANCE OF MARKETING</th>
<th>ACCESS TO LOCAL EMPLOYMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVEUNI</td>
<td>Excellent</td>
<td>Poor</td>
<td>Variable</td>
</tr>
<tr>
<td>KORO</td>
<td>Very good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>LAKENA</td>
<td>Good and</td>
<td>bad</td>
<td>Fair</td>
</tr>
<tr>
<td>BATIKI</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>KABARA</td>
<td>Very poor</td>
<td>Fair</td>
<td>Very poor</td>
</tr>
</tbody>
</table>

None of these conditions is immutable, for even land can be upgraded, or rules, but in the short term the main possibilities for change lie in the other three variables. To improve access to land in these five islands requires measures ranging from minor redistribution to a major reform. Assurance of marketing depends on access to the continued success of the STABEX and other international agreements, and for domestic crops on national pricing and buying policies. It also depends on what has increasingly become the weakest link in the whole chain, the transport system. Access to secure employment can be created by infra-structure changes, but also demands active intervention to create non-agricultural or skilled-agricultural employment. It is only in Taveuni that such can be expected in the short term from the private sector; elsewhere Government intervention is involved at all stages. Even on Taveuni we would anticipate little growth without achievement of the often-promised but long delayed improvements to the airfield, and the provision of a road transport connexion to the Vanua Levu road system by means of a car-ferry. On this island some real intervention is necessary to resolve the paradox of institutionalized land shortage in the presence of natural abundance.

We can look for significant changes on Koro following completion there of an airstrip with support from the European Economic Community and establishment of a wharf. This island has excellent natural resources, but its road system is ill-designed to carry heavy traffic, and the present 'centred' at Nasau is remote from both airstrip and marina terminal sites. Koro has great potential for the supply of food, as well as yaqona -- its present main crop. This was its historical role in east-central Fiji, and it could be restored. Hihora Koro people have been wise to adopt the 'risk minimizing' approach praised by Bayliss-Smith (1977b, p. 71), in which the varied options of copra production, yaqona and subsistence farming have all received varying inputs in accordance with the condition of the market. But as Bayliss-Smith points out, this is an unstable equilibrium: indeed, it seems rather to smack of the 'terminal development' written of elsewhere in the Pacific region by Howlett (1973), for there has been no significant increase in welfare.

Kabara and Batiki are 'marginal' islands, with respectively under 600 and 300 people, very limited natural resources, and great difficulty of access from the main airstrip. A new airstrip is proposed for Kabara (Apit and Wall, 1978) and this would undoubtedly aid its handicraft industry based on large hardwood resources, but both islands have for a long time relied heavily on support --
or initiatives -- from former islanders now resident elsewhere. It is not easy to see how investment can provide much more than a supportive function on either island.

Lakeba, however, is different. There is already an infrastructure of wharf, airstrip and a centralized transport and distribution system. The fate of the pine scheme remains to be determined, as M. Brookfield stresses above, but the formidable separation of most food crops from the cash crop area provides opportunity for ready experiment in the latter, and there are strong indications of entrepreneurship among the people of this island. Its central political role in Lau is important and it would not be difficult to make it a central place for nearby islands in a more real sense, given an adequate marine infrastructure. There has, however, been much disappointment in the past, and there will be more without sustained initiative backed up by sound technical advice.

THE ISSUES IN ISLAND DEVELOPMENT

The scale of the problem

There are three basic desiderata for island development. All are costly. First is the greatly increased provision of strong and sustained technical assistance, not only with agronomic problems, but also with the related problems of farm layout, land improvement, and the introduction of new technology. Second, and of no less importance in the modern context, is planning for large-scale deficits in the larger economic sector, not only in public works, but also in the continuing activities of production, processing and handling, and in services. The second desideratum is closely linked with the third, which is provision of reliable marketing outlets at remunerative prices, coupled with regular supply of imported goods at reasonable prices. None of this will come about without improvements in transport which is the most critical area of all.

Transport policy and the islands

In our first report (UNESCO/UNFPA Project, 1977) we described the growth of Government involvement in transport, both by sea and air, since 1972. We applauded a growing de facto recognition that the provision of 'sea roads' in an archipelago falls within the domain of public responsibility, as do vehicular roads on land. Matters have since gone further, with additional wharves, more Government involvement in commercial shipping, and especially an accelerated programme of airstrip construction employing foreign aid (Aplin and Wall, 1978). Meanwhile, however, the position of private operators in the ageing fleet still provides most of the inter-island services has grown more precarious, and it is becoming evident that rising operating costs and cargo-handling costs are fast rendering the present fleet obsolete.

Present policy is, however, moving increasingly toward a modal split between passengers (so far as possible by air) and cargo (almost all by sea). To this end parallel networks of air services and shipping services, the latter based on a network of jetties with barge ramps, are under construction or consideration. Only very limited consideration has been given to the problems of islands with neither airfield nor jetty, but it is assumed that local feeder services can be developed. Progress on air services is rapid; jetty construction of barge sea has hardly begun. Airfields on Vanua Balavu, Moala and Koro have been added, or are being added, to the existing airfields on Taveuni, Lakeba and Gau, and further construction has been proposed (Aplin and Wall, 1978) at Kabara, Cicia, Matuku, Ono-Itau and Kadavu, in that order. For Kabara, where the only possible site is on the beach-head, it is argued that the island is a cluster of a group of islands. Yet Kabara has no jetty and is extremely difficult to approach by sea; none of the islands around it have jetty, and there is no seagoing shipping based in the vicinity.

In another paper (Brookfield, 1979) the writer has argued that a lower-cost approach to island transport can be achieved by the use of seagoing landing craft-type barges requiring only beach ramps and transport jetty, operating as lighters to a new and larger class of inter-island vessel either of modified conventional type with equipment for the efficient handling of unitized cargo, or of barge-carrying type capable of lifting loaded lighter aboard. Such larger vessels would enter few island ports, and where the need for expensive shore installations could achieve more adequate and regular service for passengers as well as cargo. Airfields could then be limited to those places capable of generating an economic payload, or having special needs. Rapid service to inner islands, or between islands, could be provided by new types of vessel such as the shallow-draught semi-submersible catamaran, while larger ro-ro ships would be linked by ro-ro vessels; in Fiji this latter step has already been taken by the introduction of a roll-on/roll-off service from Suva to Savusavu, with great success.

In this approach emphasis is placed on a two-tier replacement, minimizing the need for shore facilities except at the busiest places. The number and size of lighters used, and the frequency with which ship connections are made, can vary according to need. The ships, interconnecting with lighters at beach ramps, would spend more time at sea handling voyage wages. Frequent voyages with fewer vessels. Unitized cargo handling would be possible with minimal shore equipment, and passenger traffic could be handled in greater comfort and safety than at present. The need for costly and marginal investments would be greatly reduced. Although these proposals were made in a wider context than that of Fiji, development on these lines would be adaptable to a group of islands differing greatly in volume of traffic, while at the same time providing better service to more places at lower cost, and in particular less difference in cost between places.

A revision of ideas on island development

It is probably only by means such are suggested above that the further marginalization of more islands can be avoided, while at the same time adequate service can be provided to places with larger potential for development. The problem of scale shifts onto the land, where its proper belongs. Here some hard conclusions, latent in the whole argument of this paper, must now be faced. In its 1977 recommendations the project sought the spread of development stimulus through as many islands as possible, but this no longer seems feasible or even desirable. Transformation of the transport network needs to be accompanied by the introduction of new production systems and new technology on land, and in the more intensive use of marine resources. It needs also to be accompanied by transformation of marketing and distribution, increased provision of dry and cold storage, and the development of both agricultural and marine service centres. Given present attitudes to labour intensive work on the land, it must be assumed that only a limited amount of agriculture is likely to succeed. The reluctant conclusion of Ward, Ed. (1979, p. 56) that the 'traditional' combination of subsistence and 'plantation' modes of production on small holdings is no longer capable of satisfying the aspirations of islanders is, with equal reluctance, agreed.
Development services of the type required cannot be provided everywhere, yet without them there can be no real development anywhere. Division of labour is required, and the generation and support of employment; these demand a certain minimum scale. Moreover many islands have much useless land, and only poor marine resources. It follows that some measure of concentration of effort is unavoidable, and that island population, too, must become more concentrated.

**Concentrated development and its implications**

The implications of such a strategy are considerable. In the first place a more complete subdivision of the land is required, on the line of the Taveuni settlement blocks (Brookfield, 1978), but backed by loans and extension services to enable such farms to operate more productively. Agro-service centres need to be created, and the range of crops widened. Where the scale of production warrants it, more complete use needs to be made of the coconut and its timber. Packaging is required for fruit and vegetable crops to speed cargo handling. Freezers are required for meat and fish, and frozen imports. If the copra industry is to persist it must modernize its harvesting and processing methods, while at the same time replanting with higher-yielding palms and making effective use of the land under the trees. All this needs larger-scale operation, and can only be achieved on the larger and more fertile islands.

It cannot be emphasized too strongly that eastern Fiji has such islands, and that they constitute a national resource which is under-utilized. Taveuni, Kadavu and the two larger Lamalaiti Islands of Koro and Gau compare with West Indian Islands in their size and potential. Lakeba, Moala and Vanua Balavu in Lau are smaller in size and perhaps marginal, but have important resources. The cluster of islands in south-central Lau has an amalgam of agricultural, hardwood and marine resources capable of integrated development if served by a good system of local marine transportation, but individually are not viable.

Beyond these are the 'small islands' of limited potential under present conditions, unless their location makes them of national value in relation to the Exclusive Economic Zone, as in the case of Ono-i-Lau. Even though provision of airfields and jetties is planned for some of these islands, it must be argued that extension of development efforts beyond the islands listed above, or even to all of them, can be achieved only by means of a dilution of effort that will weaken any chance of success on islands of larger resources and population. Where the line is to be drawn is a matter for political rather than economic decision, but if a major effort is not made

To call for a more capital-intensive agriculture is not to call for the high energy use that characterizes western agriculture. There is a place for leguminous crops, organic fertilizer and the use of horses, as well as for manufactured fertilizer, herbicides and weedicides, tractors and hand-operated farm machinery. There is a need for more electricity to provide cold storage also does not necessarily mean inefficient diesel generation. A few islands have limited capacity for hydro-electric generation; there is also scope for both wind and solar energy use in these sunny and almost constantly windy islands. On some islands while others are simply provided with basic transport services and no more. The marginalization and under-utilization of all the eastern islands will continue, and Fiji's 'mainland syndrome' (Alpin and Wall, 1978, p. 9) will become still more firmly established.

**Conclusion**

Very different ecological consequences for different islands would follow from a policy of 'concentrated development'. The humid use of soy would be greatly intensified; on a few it would remain much as now, while on many others it would decline. Since this volume is concerned with Lakeba as a tropical island and not just as a Fijian island, and since this discussion is concerned with our islands as illustrative of a larger group of islands, it should be added that a much less selective policy might have been adopted in a more highly-populated region. Even though its economic structure gives it a labour-surplus economy (Fisk, 1970), Fiji is not over-populated, and resettlement on the two main islands of the 37 500 people now in the eastern islands would not strain the resources of the former.

The case for island development is partly social and political, but it rests more securely on the valuable natural resources of the islands than on any other ground. The 'guidelines for rational management' that we have proposed assume that resources should be used productively, to the benefit of both the island people and that of the nation and region to which they belong.

Finally, it should be remarked that the gloss on the work of the project is that the volume is to be published by ORSTOM (Latham, Ed., 1980) and in our first report. What I have done with their work in this review is my own responsibility, and I hope both my colleagues and my readers will bear with it. 

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