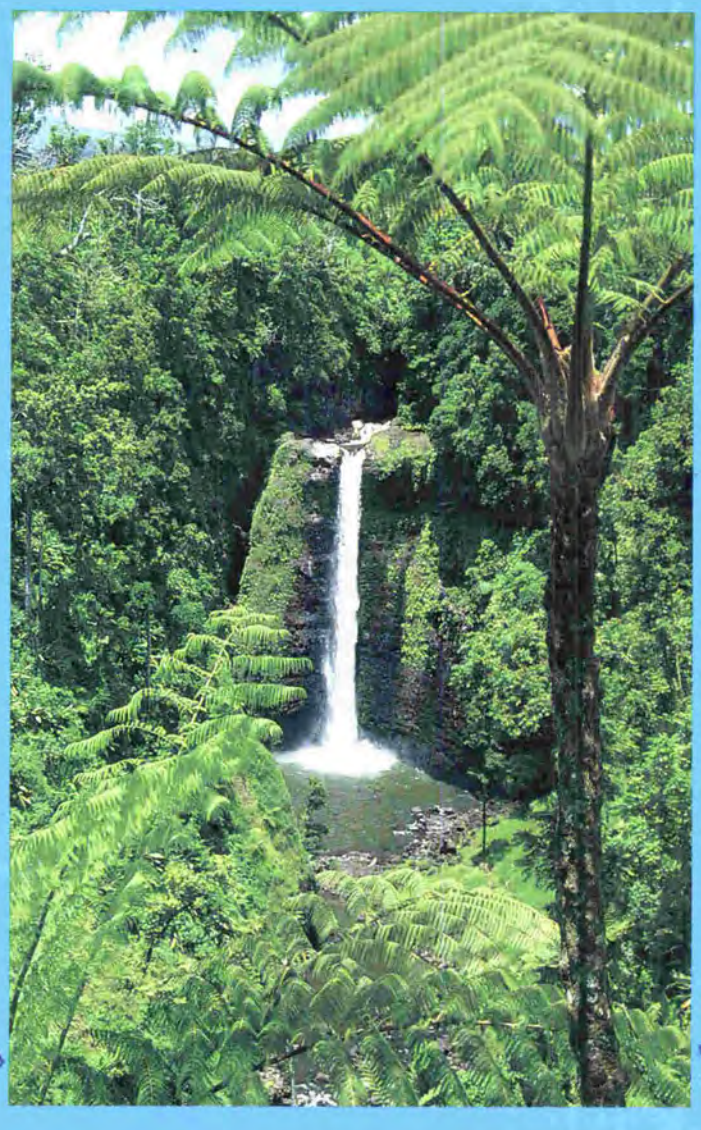
soe

State
Of the
Environment
Report

Western Samoa



Western Samoa

S*tate*
O*f the*
E*nvironment Report*

USP Cataloguing-in-Publication data:

Taule'alo, Tu'u'u Ieti
Western Samoa : state of the environment report / by Tu'u'u Ieti Taule'alo.—Apia, Western Samoa : SPREP, 1993.

xx, 76 : 29cm.

ISBN 982-04-0001-5

1. Human ecology—Western Samoa
2. Western Samoa—Environmental conditions
3. Environmental protection—Western Samoa
I. South Pacific Regional Environment Programme
II. Title

GF852.S33T38 304.2'099614

Prepared for publication by the South Pacific Regional Environment Programme, Apia, Western Samoa

Editor
Barbara Henson

Design and production
Peter Evans

Artwork for symbols
Catherine Appleton and Momoe von Reiche

Cover design based on an original design by Catherine Appleton

Typeset in New Baskerville and Gill Sans
Printed on 110 gsm Tudor R. P. by ABC Printing, Brisbane, Australia

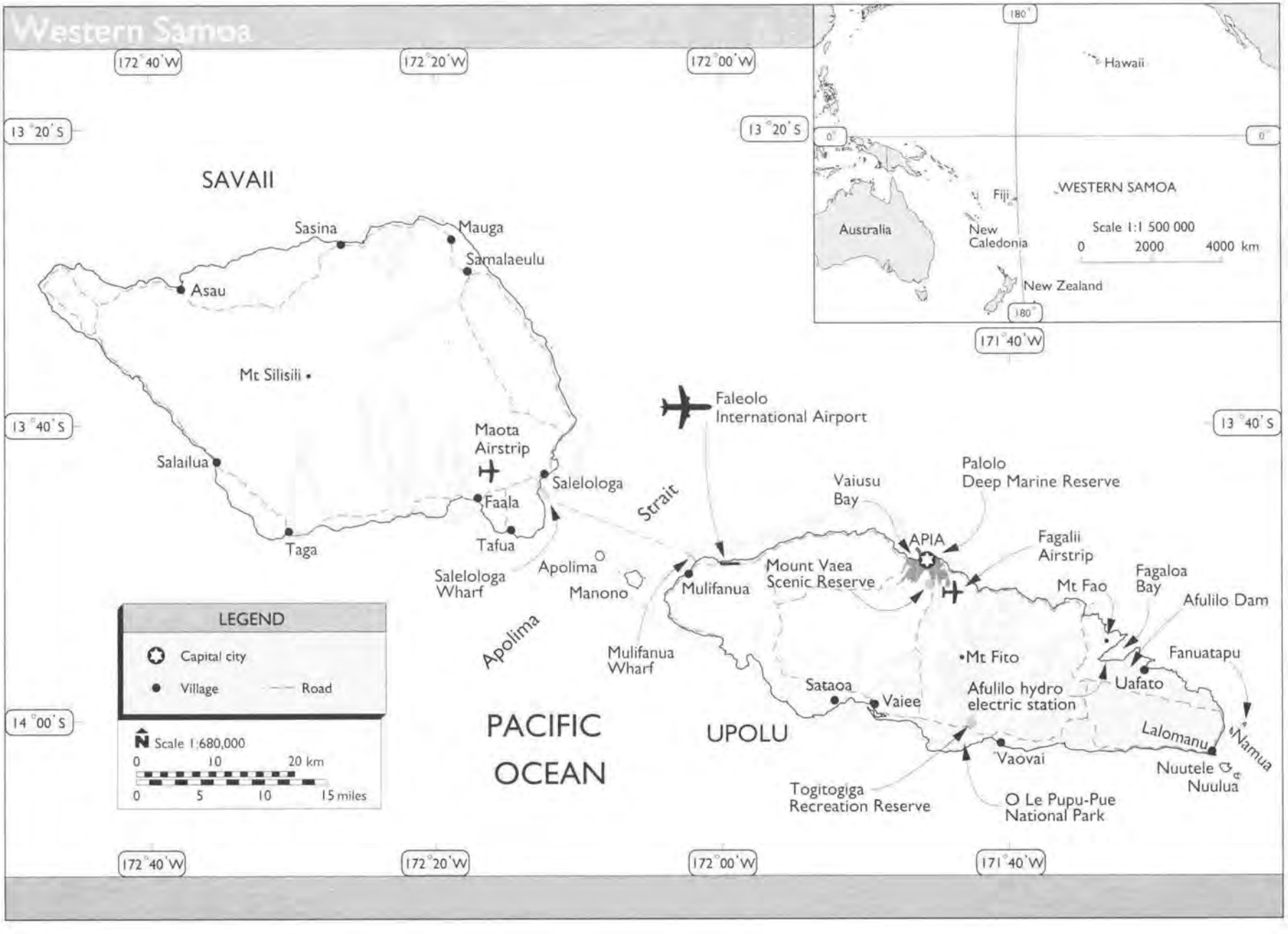
Produced with financial assistance from the United Nations Development Programme (UNDP).

Cover photograph:
Sopoaga Falls (photo: A. C. Robinson, reproduced courtesy of DLSE)

Western Samoa

State Of the Environment Report

by Tu'u'u Ieti Taule'alo
Local NEMS Consultant
Western Samoa 1993


Western Samoa
172°40'W
172°20'W
172°00'W
171°40'W
13°20'S
13°40'S
14°00'S
SAVAII
Sasina
Mauga
Samalaeulu
Asau
Mt Silisili
Salailua
Taga
Maota Airstrip
Faala
Tafua
Salelologa
Salelologa Wharf
Apolima
Manono
Apolima Strait
Faleolo International Airport
Mulifanua
Mulifanua Wharf
Vaiusu Bay
Palolo Deep Marine Reserve
APIA
Mount Vaea Scenic Reserve
Fagalii Airstrip
Mt Fao
Fagaloa Bay
Afulilo Dam
Mt Fito
Fanuatapu
Uafato
Afulilo hydro electric station
Sataoa
Vaiee
Lalomanu
Namua
Vaovai
Nuutele
Nuulua
Togitogiga Recreation Reserve
O Le Pupu-Pue National Park
PACIFIC OCEAN
UPOLU
LEGEND
Capital city
Village
Road
Scale 1:680,000
0 10 20 km
0 5 10 15 miles
180°
Hawaii
0°
Fiji
WESTERN SAMOA
Australia
New Caledonia
New Zealand
Scale 1:1 500 000
0 2000 4000 km

Foreword

This document represents a concise but nevertheless comprehensive report on the State of the Environment in Western Samoa. It was prepared as supporting documentation to the National Environment and Development Management Strategies document and process which culminated in Cabinet-endorsed strategies aimed at ensuring that present and future development activities within Western Samoa are undertaken with all due consideration for sustaining environmental quality. This State of the Environment Report was one of several documents prepared for this process. It is obviously a most important publication because it brings together available information about Western Samoa's natural resources, cultural heritage, existing processes and practices, as well as institutional and administrative mechanisms. This information is vital when developing ongoing strategies aimed at environmental protection. As well, it is valuable to have an up-to-date document which is useful not just to policy makers but also to the wider community. This State of the Environment Report has thus been written in a style which will make it accessible to a wide Western Samoan audience.

Financial assistance for the preparation of this report and for the process of National Environment and Development Management Strategies production within Western Samoa has been generously provided by the United Nations Development Programme (UNDP) through the NEMS Project within the South Pacific Regional Environment Programme (SPREP).

This report summarises the current state of knowledge about the environment of Western Samoa. It covers the terrestrial, marine, urban and rural environment, the socio-economic situation and institutional responses to development trends, and provides valuable information and base data to act as a gauge against which to measure the future state of Western Samoa's environment. Such a measuring stick will ensure that quick action can be taken should there be signs of environmental degradation.

I would like to pay particular tribute to the work of Tu'u'u Ieti Taule'alo, the Local NEMS Consultant who prepared both the State of the Environment Report and the draft National Environment and Development Management Strategies document, the latter being produced through a broad consultative process which drew on the diverse views of a wide cross-section of Western Samoan society. I would also like to acknowledge the assistance provided by Julia Haska of Western Samoa's Department of Lands, Survey and Environment in the final report preparation stages.

SPREP looks forward to working with Western Samoa and with other regional and international organisations in tackling the environmental issues identified in this State of the Environment Report.

Vili A. Fuavao
Director

Contents

Figures

Tables

Notes The units of currency of Western Samoa are the 'tala' (dollar) and 'sene' (cent). All amounts are in $WS.
A financial year spans the period 1 July to 30 June.

Acronyms

ADB	Asian Development Bank
CFC	chloro-fluorocarbon
DAFF	Department of Agriculture, Forests and Fisheries
DEC	Division of Environment and Conservation
DLSE	Department of Lands, Surveys and Environment
DOS	Department of Statistics
DP7	Western Samoa's Seventh Development Plan 1992–1994
EIA	Environmental Impact Assessment
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GWS	Government of Western Samoa
MFAT	Ministry of Foreign Affairs and Trade (New Zealand)
NEMS	National Environment and Development Management Strategies
NGO	non-governmental organisation
PSC	Public Service Commission
PWD	Public Works Department
SOPAC	South Pacific Applied Geoscience Commission, Suva, Fiji
SPAFH	South Pacific Alliance of Family Health, Port Moresby, Papua New Guinea
SOE	State of the Environment Report
SPC	South Pacific Commission, Noumea, New Caledonia
SPREP	South Pacific Regional Environment Programme, Apia, Western Samoa
TEC	Target Environmental Component
UNCED	United Nations Conference on Environment and Development
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNDP	United Nations Development Programme
USP	University of the South Pacific
WSTEC	Western Samoa Trust Estate Corporation

Glossary

Samoan words

aiga	Extended family
alia	Twin-hulled craft
fale	Traditional Samoan house
faa-Samoa	Samoan way of life
fono	Village council of **matais**
matai	Holder of traditional title, and head of extended family
paopao	Traditional outrigger canoe
pulenuu	Government-appointed village representative
siapo	Traditional cloth made from mulberry bark
taamu	Giant taro
vaa-alo	Traditional outrigger canoe for tuna fishing

General

aggregate	Pieces of stone, gravel etc. used in making concrete.
algae	Non-flowering, stemless water-plant, especially seaweed and phytoplankton.
alluvium	A deposit of sand, mud etc. formed by flowing water.
aquaculture	The farming of marine or freshwater plants and animals.
artisan	Someone skilled in an industrial or applied art; a craftsperson. Adj. **artisanal**.
balance of payments	Earnings from exports compared with overall spending on imports.
basalt	The dark, dense rock formed from a volcano's liquid flow.
bilateral, multilateral	Bilateral aid or trade agreements are made between two governments or organisations. Multilateral agreements are made between more than two countries or organisations.
biodiversity	The variety of plants and animals in an area. Biodiversity refers not only to the number of different species but to the full range of genetic variation within each species.
CFCs	Chloro-fluorocarbons. Compounds of carbon, hydrogen, chlorine and fluorine used in refrigerants, aerosol propellants etc., and thought to be harmful to the ozone layer in the earth's atmosphere.

commercialisation, corporatisation, privatisation	Processes whereby an activity or enterprise previously operated and owned by government under public funding progressively becomes operated and owned on a private and profit-making basis.
conservation	Managing the way people use natural resources so that they give the greatest sustainable benefit today, while keeping their full potential to meet the needs and aspirations of future generations.
consumption	Spending on everyday items, for example, food petrol, rent, clothing etc.
cost–benefit analysis	Comparison between benefits derived from a project and its cost.
customary land	Land owned through traditional rights, often communally.
deforestation	Clearing of trees or forest.
degradation	The result of poor resource use which pollutes, damages or reduces the quality of resources available to future generations.
demography	Measures of change in size and age structure of a population.
development	The introduction of new ways to use natural resources to meet human needs and wants.
disturbed	Change in the natural order as the result of human activities or climatic change.
ecology	Branch of biology which deals with the relation of plants and animals to their environment.
economic growth	The increase in the value of goods and services produced in a country, usually measured over a year.
ecosystem	A community of plants and animals and the environment they inhabit.
effluent	A liquid flow.
endangered species	Species that are in danger of disappearing.
endemic	An animal or plant which is found only in one region or country and is not present naturally in any other part of the world.
environment	All the living and non-living things in a particular place or on the earth generally, and the way they interact or work together.
erosion	The wearing away of the earth's surface (for example, soil) by the action of water, wind etc.
exports	Goods and services sold to overseas countries and foreigners.
extension	Providing specialised knowledge to community groups, for example, agricultural expertise to farmers.
eutrophication	The process in which high levels of nutrients encourage the growth of small plants called algae which use up so much oxygen that nothing else grows.
fauna	Animals.
feasibility study	A study of the practicability of a proposed project.
flora	Plants.
food-chain	A series of organisms each dependent on the next for food.
genus/genera	Scientists group similar animals and plants into a genus or family. Genera is the plural of genus.
geology	The science of the earth, including the composition, structure and origin of its rocks.
geomorphology	The study of the physical features of the earth's surface and their relation to its geological structure.

greenhouse effect The trapping of the sun's warmth in the lower atmosphere of the earth caused by an increase in carbon dioxide due to increased pollution. Carbon dioxide is more transparent to solar radiation than to the reflected radiation from the earth.

gross domestic product The money value of all goods and services produced in a country. This value is used to measure a country's national income over a year.

groundwater Water found in soil or in the pores and crevices in rock.

habitat The natural home of a plant or animal species.

herbaceous Herb-like; a herb is a flowering plant whose stem above the ground does not become woody and persistent.

herbicide A chemical that kills plants.

heritage A nation's historic buildings, monuments, countryside etc., especially when regarded as worthy of preservation.

hydrological Something to do with water, whether surface water in rivers or groundwater available in wells.

imports Goods and services purchased from overseas countries and foreigners.

indigenous Something that originally occurred in a particular area.

infrastructure The basic structural foundations of a society or enterprise. Also refers to basic facilities such as roads, airports, electricity and communication systems; typically, their development is costly and is undertaken by governments.

inorganic Not arising by natural growth, for example, minerals.

intercensal Between two censuses.

introduced species A species which does not naturally occur in a particular area but rather has been brought in from outside.

investment Spending on projects or activities which are expected to provide long-term benefit.

leachate Water carrying impurities which has percolated through the earth, a rubbish tip, mine waste etc.

littoral The area of land between the highest high tide level and the lowest low tide mark.

management Controlling the way something is used or done.

merchantable Able to be sold.

montane Of mountains, for example, the vegetation.

natural resource A naturally occurring stock or supply which can be used to help meet human needs and wants.

nutrient A substance providing essential nourishment for the maintenance of life.

organic Relating to plants, animals or other living matter.

ozone layer A layer of ozone in the stratosphere which absorbs most of the sun's ultraviolet radiation.

pelagic fish Fish that live in the open ocean rather than close to shore.

permeable Able to be penetrated, for example, by water.

pesticide Chemical that kills unwanted organisms.

planning Developing a detailed method by which something is to be done.

primary sector Activities relating to agriculture, fishing, forests, mining etc.

private sector Activities and enterprises run by individuals or groups on a profit-making basis.

productive, productivity The capacity to produce something of benefit, for example, crops, goods, services, craft, art etc.

public sector	Activities and enterprises run by government.
reclaim	To bring land into a condition for cultivation or other use.
recycle	To convert something to reusable material instead of throwing it away.
remittance	Money transferred between countries, for example, Samoans abroad sending money to their families at home.
resource	A stock or supply which can be used to help meet human needs and wants.
reticulation	A system of pipes carrying water.
sediment, sedimentation	Matter which settles to the bottom of a liquid.
service sector	Activities provided on a commercial basis which do not involve the exchange of goods, for example, haircuts, banking, professional advice.
sewage	Waste matter, especially from toilets, conveyed in sewers.
sewerage	System of pipes to carry toilet waste.
soft-term loan	Loan provided (generally to a country) at a concessional interest rate.
species	A scientific name given to each different type of animal or plant.
strategy	A plan to help achieve certain goals.
stratosphere	The layer of atmospheric air extending from 19 to 50 kilometres above the earth's surface.
subsistence	Producing mostly for own consumption, for example, farming which directly supports the farmer's household without producing a significant surplus for trade.
sustainable	Using a resource in such a way that its supply and quality are maintained indefinitely into the future.
terrestrial	Relating to the earth.
toxic	Poisonous.
traditional	Based on past custom.
trolling	To fish by drawing bait along in the water.
tuff	Rock formed by the consolidation of volcanic ash.
vascular plant	A plant with conducting tissue.
vegetation community	A commonly occurring grouping of plants and trees.
vertebrate	Animal with a backbone or spinal column, including mammals, birds, fishes and amphibians.
water catchment	The area from which a river or lake collects water.
wetland	Swamp or other damp area of land.

Executive summary

Introduction

Western Samoa became independent in 1962 after a period of administration by New Zealand as a trust territory of the United Nations. Its Legislative Assembly is elected through universal suffrage by all citizens over 21 years of age. Only holders of traditional titles can stand for election. The indigenous population is Polynesian, living mainly along the coast in over 320 villages. The total population recorded in 1991 was 161,298 persons.

The climate is generally hot and humid with only small variations in temperatures (average annual temperature is 26.5°C). Average humidity for the capital Apia is 83 per cent. The annual rainfall is about 3,000 mm with about 75 per cent of the precipitation occurring during November-January. Western Samoa is affected by tropical storm patterns with the cyclone season in December-February. Air pressure averages 1,010 mbs.

There are four types of land ownership in Western Samoa with over 80 per cent of total land under customary ownership. A growing trend in customary land tenure is the increased individualisation of customary land, that is, land is passed from parents to their children. The long-term effects of this change of land ownership are not clear at this stage.

Western Samoa's economy is dominated by subsistence agriculture and related activities, which support around 75 per cent of the total population including almost the entire rural population. The economy is also dominated by external aid and by remittances from Samoans working overseas. Over the years, there has been growing concern that very little of the remitted capital goes into productive investment. Reliance on remitted funds is also given as one of the main factors contributing to the decline of primary production. Western Samoa's economy has suffered in recent years from tropical cyclones Ofa and Val which struck in 1990 and 1991 respectively. The destruction of tree crops, forests and infrastructure have badly affected economic performance, especially primary production.

The terrestrial environment

The Samoan islands are composed almost wholly of basic volcanic rocks with most of the soils formed from basaltic volcanic flows. A study by ANZDEC in 1990 produced comprehensive land capability maps of the whole country, in relation to soils and other physical features. A coral reef surrounds the islands except where there are steep cliffs and where young lava flows have filled the lagoon. There is quarrying for fill material and concrete aggregate, and the lagoon near Apia is also mined for fill material and coral sand.

There has been no comprehensive national water resource survey, and therefore it is difficult to estimate water flows across different catchment areas. The Samoan islands are small, and despite high rainfall, some of the water resources dry up for 3–6 months of the year (due largely to the high permeability of younger rock formations). During this time only three major rivers run and these have been almost fully developed for water catchment. However, cyclone damage and continuing land clearing for agriculture are now the major threats to the capacity of catchment areas for holding water. Groundwater harvesting has been on the increase as new sources of water are explored. No management plan is in place for groundwater utilisation, and boreholes are expensive to develop and operate. The development of rainwater harvesting, especially where natural surface water is not available, needs to be strongly encouraged.

The native plant flora of Western Samoa comprises 96 families, 298 genera and nearly 500 species. There are no designated endangered or threatened plant species in Western Samoa. However, 136 species have been identified as being potentially threatened or endangered. Five broad vegetation categories have been identified: Littoral, Wetland, Rainforest, Volcanic and Disturbed Vegetation.

The native vertebrates comprise 35 resident land birds (ten of which are found nowhere else) and 14 reptile species (eight skinks, five geckos and one snake). Three of the skink species are restricted to Western Samoa and a few nearby islands. No amphibians occur in Western Samoa. Apart from 21 butterfly species (one is found nowhere else), little other information is available on native invertebrates. No species of reptiles are considered to be endangered, while the gray duck is seriously threatened, and the 'manumea' Samoan toothbilled pigeon and the 'mao' are threatened.

Of the total land area of Western Samoa of approximately 292,670 hectares, about 37 per cent is covered by remaining forest (36 per cent indigenous, 1 per cent plantation). The current rates of forest depletion are high (and similar) on Savaii and Upolu, estimated at about 1,500 ha per year. Twenty per cent of forest clearing is attributed to logging, with the remaining 80 per cent the result of agriculture and other activities. The annual logging intake of the sawmills is now almost exclusively used in Western Samoa. The current rate of deforestation is a serious environmental issue.

The protection and conservation of the terrestrial environment is a matter of top priority for Western Samoa, with implications for its land, water, forest, plant and animal resources. With deforestation having wide ramifications for most other aspects of the environment, sustainable forest management is seen as one of the most pressing needs for environmental protection and conservation. The main option for future action is to promote, encourage and support community efforts for long-term conservation of the remaining areas supporting unique ecosystems. The body of the text details the key conservation areas.

Marine resources

Samoan marine fauna comprises a total of 991 species. Of these, 890 are considered shallow-water or reef-inhabiting species, 56 are deeper bottom fishes and 45 are pelagic surface species. About 40 fishes are known only in Samoa. Little information is available on marine flora.

Western Samoa is not well endowed with coral reefs, partly because the islands consist of deep-sided volcanic cones set in deep waters, and partly because recent volcanic flows covered previous reef areas and left rocky coasts with no reef. While little information is available on reef and coral ecosystems, recent studies have raised serious concerns about damage to the lagoons and reef areas. Coastal habitats have been damaged by the illegal use of dynamite and poisons to catch fish. Coral has been seriously reduced by outbreaks of crown-of-thorns, cyclone damage and siltation.

Coastal lagoons are also being subjected to industrial and domestic pollution. Sediment and nutrient pollution of lagoons is damaging the reef system, and contributing to the collapse of the inshore fisheries. Although mangroves and wetlands are the main feeding and nursery habitats for fisheries, wetlands have been progressively filled in for land reclamation, and the mangrove swamps are under pressure from land clearance and agricultural development.

While it is not possible to make accurate estimates of existing stocks, it is estimated that the maximum sustainable yield has been exceeded in many parts of the country. The possible reasons for inshore stock declines are:

(1 overfishing due to increased demand;
(2) use of effective and modern, but non-selective, fishing techniques;
(3) use of destructive techniques such as poisons and dynamite;
(4) loss of fish habitat through reclamation, coral sand mining and surface runoffs; and
(5) nutrient pollution and sedimentation.

Over two-thirds of households are engaged in fishing activities at the subsistence level. Most subsistence fishing is done on an artisanal basis in near-shore and lagoon waters. Commercial fishing involves offshore trolling or handline bottom fishing outside reefs, but with modest catches. More research is needed to assess the extent and characteristics of fish stocks in Samoan waters.

All the evidence points to the urgent need to protect remaining mangrove areas and coastal lagoons. The pressure of population growth and marine pollution will exacerbate the depletion of resources and degradation of marine habitats.

Already, some reef shellfish and fish are over-exploited and endangered. One of the problems facing Western Samoa is the limited technical capability of the Fisheries Division, which affects the promotion of marine research and development.

Urban and rural environment

No planning legislation currently exists, and this has resulted in poor coordination of programmes, unnecessary environmental degradation and the fragmentation of development activities. The proposed Apia Municipal Authority and planning legislation will provide the focus for urban and rural development.

Little is known about the patterns and nature of waste generation nationwide. In the Apia urban area, the estimated 3,000 t of solid waste disposed annually covers only the areas under the public collection system. Among the management strategies for the new landfill site now in use are the separation of waste at source, and the promotion of recycling activities at allocated space on site.

Sewage disposal is also a growing problem in Western Samoa. In more populated areas along the coast, wastewater from toilets and pit latrines, assisted by high percolation rates, is likely to pollute groundwater. In the low-lying areas of Apia, groundwater is being affected by effluent from many of the domestic sewage disposal facilities which regularly overflow during surface flooding. Stagnant water is evident in some areas, providing the ideal breeding grounds for worms, mosquitoes and various forms of pathogens. Future options for local waste management include:

(1) the reduction, reuse, recycling and recovery of resources;
(2) the provision of proper treatment and disposal facilities; and
(3) promoting more public participation in waste management strategies.

Comprehensive studies have recently been conducted for a proposed sewerage system for Apia.

Land use is dominated by subsistence agriculture, apart from indigenous forests. About 77 per cent of land holdings is under agricultural use, 3 per cent each under fallow and bush, and 17 per cent in non-agricultural use (buildings, roads etc.). Of the land under cultivation, 46 per cent is under coconuts, 13 per cent cocoa, 29 per cent taro, 6 per cent 'taamu', and 4 per cent bananas. Of agricultural holdings, 22 per cent use fertilisers, 15 per cent use compost, and 41 per cent use chemicals (for example, pesticides and herbicides).

The proper utilisation of land resources according to their appropriate capabilities holds the key to future land use management. With pressure on villagers to develop new lands from remaining virgin forest, there is the danger that more and more land is being required as fertility declines. As already seen, uncontrolled land clearance has caused severe soil erosion and flash flooding during the wet season. Of immediate concern is the effect of increased agricultural activities (including the use of fertilisers and agricultural chemicals) on water resources.

While Western Samoa's contribution to global pollution and control is minute and will have little overall effect, any actions by small nations such as this will have a significant symbolic and moral effect in international forums. Future responses may include:

(1) provision of comprehensive transport policies to address not only the importation of petroleum products, but also the management and operation of the national vehicular fleet, the encouragement of more fuel-efficient vehicles, and a review of vehicle testing standards;
(2) promotion of alternative sources of energy, including solar energy, wind and wave power; and
(3) development of more efficient wood-burning stoves.

As for atmospheric pollution, Western Samoa can do little to reduce the impact of global climate change. Only the industrialised countries can control the emission of greenhouse gases at the sources. However, appropriate local policies can signal that this country is seriously concerned about the threats due to climate change. Specific risks under greenhouse warming include:

(1) coastal inundation;
(2) tidal effects on estuaries and harbours;
(3) shoreline retreat;
(4) severe and frequent storm and wave conditions;
(5) increased coastal sedimentation;
(6) threats of damage to coastal infrastructure;
(7) damage to marine resources; and
(8) pollution of groundwater.

Socio-economic situation

The Western Samoan population is strongly influenced by general improvements in health conditions, resulting in a decreased mortality rate and increased longevity, as well as high international migration. The crude death rate fell from 7.4 per 1,000 of population to 4.3 in 1990. Life expectancy rose from 40 to 63 (for males) and 58 to 65 (for females) during 1961–1989. High international migration has kept population growth very low but indications are that the global economic recession will limit future emigration. At a growth rate of two per cent, the 1986 population of 157,000 is likely to double by the year 2021.

The main issues in relation to population trends are (1) the integration of demographic issues into national development planning, and (2) the attainment of a national population growth rate that available resources can sustain. An integrated approach to population management is required in which a sustainable population growth is directly related to the success of national efforts in primary health care, community education and economic development.

The preservation of cultural and heritage resources is an important environmental issue. A national museum and cultural centre has been under consideration for some time, and the government has recently approved the establishment of the national archives in the Prime Minister's Office Building. As well, a number of buildings, historical sites and archaeological places have already been identified for conservation. The interest shown by international visitors in the traditional Samoan environment may help expand such conservation activities.

While education plays a very important role in human resource development, local spending in education has been virtually fixed at about 10 per cent of the national budget since 1981. With about 95 per cent of the Education Department budget spent on recurrent expenditure, there is very little left for capital development. Although there is some local tertiary training, much of the advanced and professional training of Western Samoan students is done overseas.

In the absence of more detailed employment data, it is difficult to determine the patterns of employment and the labour market situation in Western Samoa. The 1991 census shows that 41 per cent of the total population aged 15 years and over are classified as economically active (compared to 47 per cent in 1986). Of those who are economically active, 89 per cent are in the workforce. An interesting trend is the 37 per cent increase in the number of unpaid workers from 1986 to 1991.

The Western Samoan economy declined in real terms during 1987–1991, and Cyclone Ofa in 1990 further reduced Gross Domestic Product (GDP) by about 5 per cent. Apart from Cyclones Val and Ofa, the main reasons for the poor performance of the economy are low commodity prices and poor agricultural sector management. The subsistence sector continues to be an important factor, consistently generating nearly 30 per cent of real GDP.

Western Samoa has experienced high rates of gross investment but very low domestic savings, with the resultant resource gap being financed from remittances and foreign aid. External aid in the form of grants and soft-term loans is a major contributor to the financing of the balance of payments and the funding of development projects in the public sector. Total aid to Western Samoa is about $65m per year. Given fairly flat levels of aid at present, and the uncertainty of future trends, foreign aid cannot be relied upon as a sustainable source of development funds. The main feature of the country's balance of payments is the growing overall surplus, achieved from very high levels of remittances, external grants and government loans.

The current economic development strategies include:

(1) the consolidation of past investments;
(2) efficiency improvements;
(3) employment creation; and
(4) revitalisation of the primary sector.

The underlying principle of these strategies is the achievement of sustainable development. Previous investments favoured the development of infrastructure, especially for transport and energy. The new priorities involve the proper maintenance and efficient use of existing infrastructure facilities. Private sector participation is encouraged to improve economic efficiency. Support for research, extension and marketing services in the primary sector is likely to improve production and create new jobs in the rural areas.

Responses to environment and development trends

The most significant government environmental initiative was the establishment of the Division of Environment and Conservation (DEC) in 1990. Included in DEC's activities are:

(1) draft legislation for Environmental Impact Assessment (EIA);
(2) waste management strategies;
(3) conservation of biodiversity;
(4) protection of catchment areas; and
(5) preparation of the Western Samoa National Environment and Development Management Strategies (NEMS).

Other important developments include:

(1) Ministry of Women Affairs;
(2) a new water authority;
(3) draft policies on forestry and population; and
(4) the proposed Apia Municipal Authority.

The South Pacific Regional Environment Programme (SPREP) was relocated to Apia in early 1992. In mid 1992 a delegation from Western Samoa attended the United Nations Conference on Environment and Development (UNCED). In his address to the conference, the Prime Minister stated: "For the purpose of addressing environmental issues comprehensively, my Government is in the process of formulating a National Environmental Management Strategy" (Tofilau 1992).

Western Samoa in recent years has shown interest in becoming a party to various international conventions and treaties on the environment. Its participation in international conventions and treaties is important, as they provide an international forum in which to voice local concerns over global environmental issues which are beyond the country's control. The country, however, needs to demonstrate its willingness to implement measures that will minimise the effects of global environmental impact.

The most important environmental legislation is the *Lands, Surveys and Environment Act 1989*, administered by the Department of Lands, Surveys and Environment (DLSE). The other important government departments dealing with environmental resources are the Public Works Department (PWD) and the Department of Agriculture, Forests and Fisheries (DAFF). The Public Works Department is responsible for the administration of water resources under the *Water Act 1965*, and building development under its principal Act, while the *Forest Act 1967* administered by DAFF has provisions for declaring 'protected areas'. The Department of Agriculture, Forests and Fisheries under the *Forestry Act 1967* administers forest resources, while the *Agriculture, Forests and Fisheries Ordinance 1959* provides for the protection of the marine environment.

The government initiative which most strongly reflects its concern for environmental management is the establishment of the Division of Environment and Conservation (DEC). Although many environmental responsibilities have been taken on by DEC, many related activities are still scattered among a number of government agencies. In the non-government sector there are now two environmental organisations in operation.

A number of programmes have been implemented to promote the protection and conservation of the environment. They include:

(1) the Vaisigano Pilot Watershed Management Project to make local villagers more aware of the benefits of integrated watershed management;
(2) private conservation agreements with four villages on Savaii to protect indigenous forest and wildlife;
(3) establishment of national parks and reserves, including the Togitogiga Recreation Reserve; the Mount Vaea Scenic Reserve (52 ha), the Robert Louis Stevenson Memorial Reserve (0.4 ha), the Vailima Botanical Gardens (12 ha), the Palolo Deep Marine Reserve (22 ha) and the 2,833 ha O Le Pupu-Pue National Park which is Western Samoa's only national park;
(4) survey of the terrestrial environment to assess local biological diversity;
(5) conservation of endangered plant and animal species;
(6) improvement of water resource management; and
(7) fisheries development programmes.

Long-term planning, in its broadest sense, has not been widely practised in Western Samoa, but the state of the environment indicates that the integration of environment and development concerns is now required. Improved techniques for economic analysis are also enabling more realistic assessment of the monetary values of environmental

resources. In this way the cost of environmental degradation, for instance, can be fully considered in the feasibility studies of development projects. Cabinet has recently (July 1993) approved the drafting of planning legislation, and Environmental Impact Assessment regulations are currently being drafted under the Lands, Surveys and Environment Act.

Conclusion

The state of Western Samoa's environment is cause for concern. Many critical environments exhibit levels of degradation and exploitation that are in excess of the capacity of natural processes to tolerate over the long term without significant impairment. Although many programmes have been initiated and are in place to address environmental issues, it is clear that an integrated approach to environmental management is required for Western Samoa. Based on issues rather than the traditional sectoral approach, the following have been identified as the major environmental issues to be considered in the development of the National Environment and Development Management Strategies:

(1) Management of population dynamics and change.
(2) Protection of the quality and supply of fresh water.
(3) Protection of the sea and marine resources.
(4) Management of waste.
(5) Combating deforestation.
(6) Development of appropriate land use practices.
(7) Conservation of biological diversity.
(8) Protection of the atmosphere.
(9) Planning for climate change.
(10) Preservation of traditional arts, culture and history.
(11) Development of human resources.
(12) Promoting sustainable economic development.

Chapter 1

Introduction

1.1 General

Western Samoa is a small South Pacific Island nation which became independent in 1962 after a period of administration by New Zealand as a trust territory of the United Nations. It has a Head of State, and a Legislative Parliament of 49 elected members. While all citizens over 21 years of age are eligible to vote, only 'matais' (holders of traditional titles and heads of extended families) are entitled to stand for parliamentary elections. The Prime Minister is elected by Parliament while the other eight Cabinet Ministers are selected by the Prime Minister from the Members of Parliament. Under the provisions of the Constitution, the next Head of State will be elected by Parliament.

The indigenous population is Polynesian, living in over 320 villages mainly along the coast. Traditional social and cultural institutions are very strong, and the driving force of 'faa-Samoa' (Samoan way of life). Samoan society is based on the 'aiga' (extended family) system. Each 'aiga' is headed by a 'matai' who is responsible for its welfare, especially in relation to customary family land. Samoan villages are well structured. The village 'fono' (village council of 'matais') controls village affairs, keeps order and provides direction for village development. The results of the 1991 census according to the Department of Statistics (DOS) show a total national population of 161,298 persons (DOS 1993).

1.2 Geography

As the larger and western part of the Samoan Archipelago, Western Samoa lies in the south-west Pacific between 13° 25' and 14° 05' south of the equator, and between 171° 23' and 172° 48' west longitudes. It comprises two main islands, seven smaller islands, and islets and rocks. Its total land area is about 2,820 sq km, with the two main islands of Upolu and Savaii containing 1,115 and 1,700 sq km respectively. The capital Apia is located about

Volcanic crests, clothed in forest, are a feature of the Samoan landscape (photo: A. C. Robinson, reproduced courtesy of DLSE)

midway on the north coast of Upolu, and lies about 130 km from Pago Pago, American Samoa, 3,000 km from Auckland, New Zealand, and 4,500 km from Sydney, Australia.

The topography of Western Samoa is rugged and mountainous, with about 40 per cent of Upolu and 50 per cent of Savaii characterised by steep slopes descending from volcanic crests. The interior of both main islands is still covered with montane forests and, in the case of the highest altitudes on Savaii, cloud forest. These areas also contain volcanic peaks with the Upolu crestal ridge rising to 1,100 m. Savaii has more and younger volcanic cones with the highest peak reaching 1,848 m at Mt Silisili. West Savaii and north-west Upolu are almost devoid of surface streams, corresponding to the rain shadow areas as mentioned below.

It should be noted that a standard topographical map series at 1:20,000 scale covers the islands of Western Samoa in 28 map sheets. This map series is currently being revised at 1:50,000. Aerial photography done from 1954 to 1990 at approximately ten-year intervals is available. The most recent aerial photography (black and white) was completed in July 1990 with 100 per cent coverage at 1:50,000 and 80 per cent coverage of coastal areas at 1:15,000. Land resource maps of Western Samoa are also available (scale 1:50,000 in six maps to cover Western Samoa) and are classified into (1) land capability, (2) soil and (3) land use/tenure.

The two main islands are well served by ring and cross-island roads. The completion of the current roads improvement programme should see all the main roads upgraded and tar-sealed. The main international port is Apia with an inter-island ferry service operating between Mulifanua at north-west Upolu, and Salelologa at south-east Savaii. The islands are also linked by air service between Fagalii near Apia and Faleolo near Mulifanua on Upolu, and Maota near Salelologa on Savaii. The main international airport is Faleolo, but Fagalii is also used for travel to neighbouring American Samoa.

1.3 Climate

The climate is generally hot and wet, marked by a distinct wet season (November to April) and dry season (May to October). However, due to its equatorial location, Western Samoa has only small variations in temperature. The average annual temperature is 26.5°C in coastal areas, with a decrease in temperature as the land rises inland. Cloudiness and relative humidity are higher inland than at the coast, with the average figures for Apia of 5.3 and 83 per cent respectively.

Due to the predominance of moisture-bearing, south-easterly trade winds (more than 80 and 50 per cent of the time during the dry and wet seasons respectively), the north-west parts of the main islands as well as the south-east side of Savaii are rain shadow areas, receiving about half the rainfall of the highland areas. The annual rainfall is about 3,000 mm (varying from 2,500 mm in the north-west parts of the main islands to over 6,000 mm in the highlands of Savaii) with about 75 per cent of the precipitation occurring during November-January.

Storm patterns affecting Samoa originate from three main sources: tropical easterlies cause winds from the south-east; cold fronts from Australian systems cause cold air flows and rain; and storms from the south-west Pacific generate cyclones at the contact zones of the easterlies and westerlies. Air pressures are relatively stable with a maximum in August of 1,012 mbs and a minimum in January of 1,008 mbs.

1.4 Land ownership

There are four types of land ownership in Western Samoa as shown in Table 1.1 and illustrated in Figure 1.1. The greater proportion of land is owned by extended families under customary ownership, and the alienation of customary land is prohibited by law. Traditionally, the ownership of land is determined by a combination of awarded titles and genealogy and the land is under the trusteeship of the 'matai'. Its use is determined by consensus among the extended family. This customary land cannot be transferred nor made freehold, although lease arrangements are possible. The *Taking of Lands Act 1964*, however, does allow the government to take or exchange any type of land for public purposes. With the current privatisation of the operations of the Western Samoa Trust Estate Corporation (WSTEC), some of the land under its control has either been sold or leased to the public. This has increased the amount of freehold land, especially on Upolu. The remaining WSTEC land is used for commercial plantations. Government of Western Samoa (GWS) land is being utilised for plantation

Table 1.1 Land ownership

Type	Upolu		Savaii		Total	
	ha	%	ha	%	ha	%
Customary	76,166	27	153,490	54	229,656	81
Government	19,758	7	10,626	4	30,384	11
WSTEC	9,499	3	4,476	2	13,975	5
Freehold	7,800	3	1,037	(a)	8,837	3
Total	113,223	40	169,629	60	282,852	100

Source: GWS 1991

(a) Insignificant

farming, national reserves, public buildings and infrastructure.

A growing trend in customary land tenure is the increased individualisation of customary land (O'Meara 1990). This is particularly so with agricultural land that individuals or families have claimed from inland areas. In nearly all rural villages, it is accepted practice that a piece of land can be used by any person or family which first develops it from virgin forest. It seems that more and more land acquired in this way is continuing to be used by people and subsequently by their children. With the authority of the 'matais' to control family land under threat, it will be interesting how 'faa-Samoa' can cope with this fundamental social change.

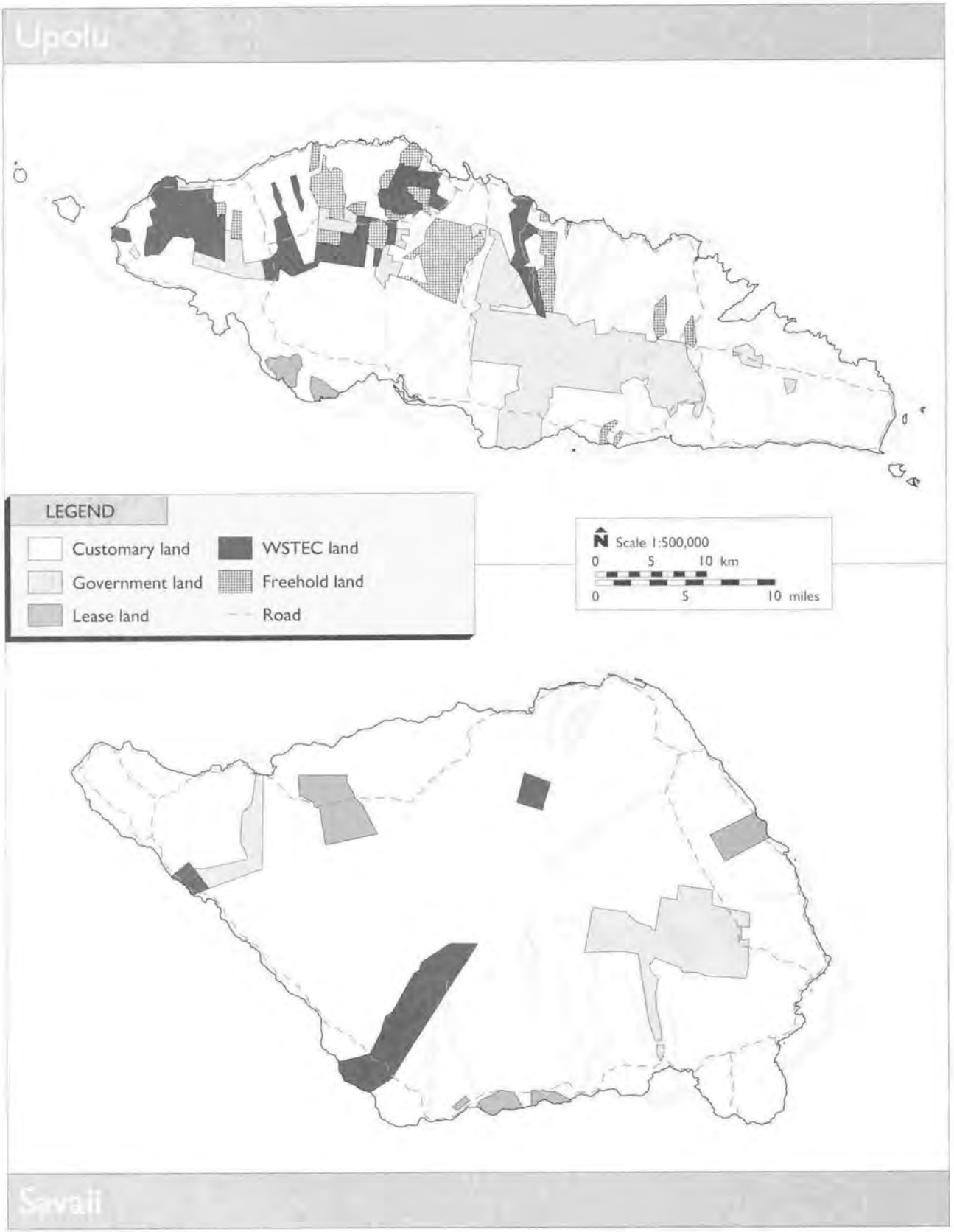
1.5 Economy

Like many of the small South Pacific Island nations, Western Samoa since independence has endeavoured to develop a modern economy from traditional subsistence agriculture. Agricultural and related primary sector activities support around 75 per cent of the total population including almost the entire rural population (Fairbairn 1993). The significance of the primary sector to the national economy is indicated by the fact that related activities account for 50 per cent of Gross Domestic Product (GDP), 60 per cent of the workforce, and about 80 per cent of export earnings (World Bank 1991).

The economy is also dominated by external aid and by remittances from Samoans working overseas. While remittances from overseas workers have been a very important source of foreign exchange, there has been growing concern that very little of the remitted capital goes back into productive investment but is spent mainly on consumption and social infrastructure (Shankman 1976; ADB 1985; Ahlburg & Levin 1990). The disincentive effect of substantial remittances received from overseas relatives is given in Western Samoa's Seventh Development Plan (DP7) as one of the main contributing factors to the decline of primary production (Fairbairn 1993; GWS 1992a). Out-migration has also drained the country of a large proportion of its

'Esi' (pawpaw) and 'taamu' (giant taro). Agriculture and related primary sector activities support around 75 per cent of the population, including almost the entire rural population. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Figure 1.1 Land ownership



Source: After GWS 1993

Cyclone damaged areas are more susceptible to invasion of exotic weeds. These cyclone damaged trees in O Le Pupu-Pue National Park are now covered in the introduced mile-a-minute, Mikania micrantha. *(photo: Paddy Ryan, reproduced courtesy of MFAT)*

skilled workforce, which is currently in short supply (Miles et al. 1992).

Western Samoa's economy has suffered major setbacks from the devastating effects of tropical Cyclones Ofa and Val which struck the country in 1990 and 1991 respectively. As a consequence of the massive destruction of crops, forestry and infrastructure by Cyclone Ofa, real GDP fell by nearly five per cent in 1990. The external current account deficit also increased from two to five per cent of GDP, reflecting a major decline in exports and increase in imports (World Bank 1992). Unfortunately, the full impact of the cyclones on the natural environment was not assessed and the total economic cost of damage to the natural environment will never be known. A general survey done after Cyclone Val reported severe devastation of critical lowland sites, tree crops and forests, with profound impact on natural ecosystems and biological diversity (Park et al. 1992).

1.6 Structure of the report

While this is a State of the Environment Report, an attempt has been made to broaden its scope to explore both the implications of the environmental conditions documented here and to identify some future options for addressing the problems. Where it is thought that there is limited local understanding of particular issues (for example, atmospheric pollution, greenhouse effects and heritage conservation), some background information has been provided.

The Report attempts to review the current status of the Western Samoan environment. Chapter 2 discusses the terrestrial environment covering geology and geomorphology, and fauna and flora. Chapter 3 looks at the marine environment including marine ecosystems and resources. The urban and rural environments are covered in Chapter 4, which includes an overview of the global issues of atmospheric pollution and climate change. Chapter 5 reports on the socio-economic situation, examining the main economic indicators including population trends, cultural and human resources, and economic development. Chapter 6 assesses the local responses to development and environment issues. It covers government policies and legislation, institutional arrangements, and identifies the current major environment and development issues confronting Western Samoa.

Chapter 2

Terrestrial environment

2.1 Geology and geomorphology

2.1.1 Geology

The Samoan islands are composed almost wholly of basic volcanic rocks such as olivine basalt, picrite basalt and olivine dolerite of the alkaline basalt suite. The main volcanic formations are: Fagaloa; Salani; Mulifanua; Lefaga; Puapua; Aopo; and Vini Volcanics, which are summarised in Appendix 1 (Kear & Wood 1959).

Most of the soils are formed from basaltic volcanic flows including pahoehoe and aa lava types, scoria, and volcanic ash. Soils are generally clay in texture, free draining, porous and relatively shallow. Appendix 2 shows the influence of basalts on landscape and soils, listed in order of age (ANZDEC 1990).

A coral reef surrounds the islands for nearly half of the coastline, except where there are steep cliffs and where young lava flows have filled the lagoon. Coral sand is found along most of the coastline, up to 5 m from sea level. Alluvium is not common, but forms the parent material for the most versatile soils. Table 2.1 categorises the soils

A coral reef, with its shallow lagoon, surrounds the islands for nearly half of the coastline. (photo: A. C. Robinson, reproduced courtesy of DLSE)

The Samoan islands are composed almost wholly of basic volcanic rocks. The last lava flow occurred in 1910–1911 on Savaii. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Table 2.1 Land classification in terms of natural fertility (ha)

Class	Description	Savaii	Upolu	Total
1	Soils of high fertility	1,223	1,206	2,429
2	Soils of moderate to high fertility	19,696	1,777	20,473
3	Soils of moderate fertility	13,802	21,696	35,498
4	Soils of moderate to low fertility	25,567	19,672	45,239
5	Soils of low fertility	21,033	13,300	34,333
6	Soils of low to very low fertility	56,826	24,757	81,583
7	Mineral soils of moderate to low fertility	960	2,032	2,992
8	Peaty soils of low fertility	32	20	52
9	Coastal lands of moderate fertility	567	1,729	2,296
10	Steep soils of moderate, moderate to low, and low to very low fertility	14,790	28,555	43,345
	Barren lava fields	11,433	–	28,290
	Total	165,929	114,744	280,673

Source: After Wright 1963

of Western Samoa into ten classes, on the basis of parent materials and natural fertility.

2.1.2 Minerals

There are no known oil deposits nor any mineral production. A recent Australian exploration programme found no useful mineral deposits except titanium which despite its high concentrations (3 per cent) is not economically extractable. Development in the near future is unlikely, given the high costs involved.

2.1.3 Construction materials

The Public Works Department (PWD) operates a rock quarry at Alafua near Apia, where fill materials for roads and concrete aggregate are produced for government works. This quarry has large quantities of hard basalt rocks. Private operators also produce aggregate for concrete-product manufacturing but these are crushed from loose rocks. Coral material, which is dredged from the lagoon near Apia, makes excellent road and reclamation fill, or it can be screened to produce coral sand.

While construction in the vicinity of Apia creates a large demand for beach and lagoon materials, they are widely used by local communities all around the coastline for a variety of purposes. It is now recognised that, collectively, sand mining from most beaches of Western Samoa has exceeded the rate of supply. Certain beaches closest to the largest demand have chronic erosion problems resulting from overmining. It is also probable that long-term subsidence of the Western Samoan landmass contributes to a general susceptibility towards coastal erosion.

Coral fill material is dredged from the lagoon near Apia. (photo: Jennie Cary, reproduced courtesy of DLSE)

Some extraction of coral material occurs from the floor of lagoons, particularly in the entrance to Vaiusu Bay in Apia and in conjunction with recent coastal roading projects. As with beach mining, knowledge of sources and the rates of supply of materials is necessary before proper management of such activities can be attempted. As a general

principle, however, it is likely that greater volumes of aggregates may be available with less environmental impact from lagoons rather than beaches.

Data is needed on the rate of supply of coral sands. Approval has just been received for a South Pacific Applied Geoscience Commission project to assess the resource at key sites of demand. Licences are also being issued stipulating conditions for sand mining that will reduce coastal erosion.

2.2 Water resources

2.2.1 Current situation

Although Kear and Wood (1959) mapped the hydrology of Western Samoa, there has been no comprehensive national water resource survey, and therefore it is difficult to estimate water flows across different catchment areas. The Samoan islands are small, and despite high rainfall, some of the water resources dry up for 3–6 months of the year (due largely to the high permeability of younger rock formations). At this time only three major rivers run and these have almost been fully developed for water catchment. However, cyclone damage and continuing land clearing for agriculture are now the major threats to the ability of catchment areas to hold water. Results of a recent Food and Agriculture Organization (FAO) study at the Vaisigano watershed area (near Apia) indicate that streamflow only accounts for 48 per cent of annual precipitation with 29 per cent being added to groundwater and the rest being taken up by plants or lost through evaporation (FAO 1990).

With continuing development of land, the water quality of the remaining streams has been affected by agricultural chemicals. This is evident from the traces of certain chemicals found in shellfish from Vaiusu Bay. As government attempts to protect catchment areas, large parts of these areas have already been cleared for plantations. In many regions, water supplies are insufficient to meet local domestic demand. In the Apia urban area, water quality is declining because of greater runoff from cleared catchment areas. Despite an expensive new water supply system for the town, shortages and dirty supply are not uncommon.

About two-thirds of the population now have access to water drawn from surface resources, the other third relying on borewater or rainwater. Because Samoans regard water as God's gift and therefore expect that it should be free, there has been over-exploitation and inefficient use of existing supplies. For example, while the normal requirement for water is 250 litres per person per day, the Public Works Department reports current use of 600 litres per person per day in the Apia area.

Hydroelectricity generation accounts for about 50 per cent of electricity production on Upolu. Until the recent (July 1993) commissioning of the Afulilo hydroelectric power scheme, hydro-electric power generation came from small 'runs of the river' plants. Afulilo is a water storage scheme consisting of an impoundment in the upstream plateau of eastern Upolu and a power station at the coast in Fagaloa Bay.

The environmental costs of Afulilo have been high — in particular, the loss of regionally significant montane swamp forest. The significance of the Punataemoo Basin was only assessed after the construction of the scheme had begun. The impact of later development adjacent to the impoundment is also potentially significant.

2.2.2 Water supply programmes

The operation and maintenance of water supplies is the responsibility of PWD although plans are in progress to establish an independent government water authority. All recurrent expenditures are met from PWD budgetary provisions. Development funding for small projects, and counterpart funding for aid-funded programmes are also provided. As seen in Table 2.2, only about ten per cent of local expenditure is recovered annually from consumers, which highlights the absence of appropriate policies for effective cost recovery.

Table 2.2 Local funding for water supply ($'000)

Item	1988	1989	1990
Expenditure			
Recurrent	1,294	1,025	1,780
Development	3,489	844	1,266
Total	4,783	1,869	3,046
Revenue	211	189	305

Source: PWD

The most expensive water supply project to date has been the mid 1980s Apia Water Supply Scheme costing over $30m. The scheme was

planned to provide filtered water to the town, improve water pressures and expand urban reticulation. However, due to a number of reasons, the objectives of the project have not been totally fulfilled, with recurring problems of water shortages and dirty supply. Catchment damage from agricultural and residential encroachment and cyclones Ofa and Val have further compounded problems.

Groundwater harvesting has been on the increase as PWD explores new sources of water, although there is no management plan in place for groundwater utilisation. Boreholes are expensive to develop, costing about $1,000 per m to drill, and 20–40 'sene' per cubic m to operate, depending on the bore depth.

While considerable funding has been allocated under European Community economic assistance (Lomé IV) for water supply development, this is subject to the completion of a national masterplan. Such a plan will guide future development of the water sector, especially the effective management of available resources and including the impacts of hydroelectricity generation.

2.2.3 *Water development strategies*

A coordinated approach is needed for the future development of water resources. The proposed water authority should be the main focus of development and resource management, including groundwater investigations (currently under the Observatory Office), and sewage disposal development. The new authority will have to work closely with the Electric Power Corporation for water allocation, and the Water Catchment Unit of the Forestry Division, with the assistance of the Division of Environment and Conservation (DEC), for the protection of catchment areas.

The main issues for water resources are the protection of supplies and the sustainable provision of clean water to all consumers. The Food and Agriculture Organization (1990) identifies five of the twelve main catchment areas as either having water supply problems or the potential for problems to emerge, and recommends watershed protection measures. The main problem relates to land clearance for agriculture. The watershed areas affected include: Vaisigano and Fuluasou (near Apia); Falefa (north-east Upolu); Faleaseela (south-west Upolu); and Faleata and Vaiola (south Savaii) (identified in Figure 2.3). The development of rainwater harvesting, especially where natural surface water is not available, is a priority and needs to be strongly promoted. It is currently not very widely practised even in areas which are critically short of water.

As previously mentioned, future Lomé IV funding for local water supply development will be guided by the proposed national masterplan. The importance of a masterplan cannot be overemphasised as the present fragmented approach has led to a lack of proper understanding of related issues and the waste of resources. It is hoped the plan will coordinate all the important water resource issues including:

(1) resource utilisation and conservation;
(2) catchment area protection;
(3) public awareness;
(4) staff training; and
(5) institutional development.

Continuing land clearance in catchment areas is a threat to water quality. The Division of Environment and Conservation is monitoring replanting of hillsides in the Fuluasou Water Catchment. (photo: A. C. Robinson, reproduced courtesy of DLSE)

Allophyllus timorensis, *a widespread Polynesian coastal plant. (photo: A. C. Robinson, reproduced courtesy of DLSE)*

The native flora of Western Samoa is the most diverse in tropical Polynesia, except for Hawaii, even though almost half the plant species are introduced.

Below: Calanthe triplicata. *Orchids are one of the largest of the plant families in Western Samoa. (photo: Paddy Ryan, reproduced courtesy of MFAT)*

Left: 'Luofao', Heliconia laolao. *This plant is used to make a washing fibre, much like a scourer, and was probably a Polynesian introduction. (photo: A. C. Robinson, reproduced courtesy of DLSE)*

Right: Freycinetia reineckei. *One of the many plants found only in Western Samoa. (photo: Paddy Ryan, reproduced courtesy of MFAT)*

Left: Ruelia prostrata. *A native of tropical Africa first recorded in Samoa in 1955, now an abundant weed of disturbed places. (photo: A. C. Robinson, reproduced courtesy of DLSE)*

There are five broad vegetation categories in Western Samoa.

Littoral: Lalomanu Beach with Nuutele Island in the distance. (photo: A. C. Robinson, reproduced courtesy of DLSE)

Wetland: coastal wetlands throughout Western Samoa are threatened by human activity. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Rainforest: the most diverse vegetation community in Western Samoa, rainforests are now rare in the lowlands. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Volcanic: small plants like ferns are the first to re-establish in the cracks in the lava. (photo: A. C. Robinson, reproduced courtesy of DLSE)

Disturbed vegetation: almost every plant in this photograph is introduced, including much of the secondary forest on the hillsides. (photo: A. C. Robinson, reproduced courtesy of DLSE)

2.3 Flora

2.3.1 State of knowledge

A number of significant studies of the flowering plants of Samoa have been published since the turn of the century. However, none of the older studies of Western Samoan floras were comprehensive, either because of insufficient collection or failure to review or cite existing works (Whistler 1992a). One of the most useful publications is Smith's work (1979–) on the flora of Fiji which includes many of Samoa's species, while Parham (1972) and Whistler (1984a) list plants by their Samoan names. The ferns of Samoa have been treated by a number of authors, with the most recent and comprehensive being Christensen (1943).

The native flora of Western Samoa comprises 96 families, 298 genera, and nearly 500 species (Whistler 1992b), making it the most diverse flora in tropical Polynesia, except for Hawaii. Thirty-two per cent of the species and one genus, *Sacropygme* (*Rubiaceae*, 2 spp.) are endemic to the Samoan islands. The largest families are *Orchidaceae* (Orchid family: about 100 native species); *Rubiaceae* (Coffee family: 45); *Urticaceae* (Nettle family: 24); *Fabaceae* (Pea family: 20); *Myrtaceae* (Myrtle family: 20); *Gesneriaceae* (*Cyrtandra* family: 20), and *Euphorbiaceae* (Spurge family: 19). The largest genera are *Psychotria* (*Rubiaceae*: 20 species); *Cyrtandra* (*Gesneriaceae*: 20); *Syzygium* (*Myrtaceae*: 16); *Elatostema* (*Urticaceae*: 12–14); *Dendrobium* (*Orchidaceae*: 12); and *Bulbophyllum* (*Orchidaceae*: 11).

The native ferns comprise 21 families, 71 genera, and nearly 200 species (Whistler 1992a). The fern allies (*Psilotum*, *Selaginella*, *Lycopodium* and *Tmesipteris*) comprise 14 species. The most diverse and interesting groups of plants are the orchids and ferns.

Many of the plant species that are now well established in the forests of Samoa are thought to have been introduced by the early Polynesian settlers of these islands, but since European settlement the introduction of new plant species has accelerated tremendously. Many of these post-European plant introductions have become significant and aggressive weeds both of agricultural areas and within the forest. A typical example includes the twining vine mile-a-minute (*Mikania micrantha*) introduced sometime before 1924 and now found throughout the Samoan islands. It is a significant weed of agriculture and, particularly since the recent cyclones, covers vast areas of the remaining forests. *Mikania* is a climbing weed which has the ability both to overwhelm trees and to inhibit the growth of the seedlings of many forest plants, due to the light inhibiting effect of the weed mat.

2.3.2 Endangered plant species

There are no 'designated' endangered or threatened plant species in Western Samoa. However, Dahl (1980) lists twelve rare or endangered plant species, while Whistler (1992a) proposes a list of 136 species that he considers potentially threatened or endangered. Appendix 3 gives Whistler's list of endangered plant species.

2.4 Vegetation

2.4.1 State of knowledge

The study of local vegetation is more recent than the study of flora but is well advanced, although that of American Samoa has been studied more than the Western Samoan. A number of ecological studies have looked at cloud forest (Whistler 1978) and volcanic vegetation on Savaii (Uhe 1974b; Whistler 1978); lowland plant communities on the Aleipata islands (Nuutele, Nuulua, Namua and Fanuatapu Islands) (Whistler 1984b); and the O Le Pupu-Pue National Park (Ollier et al. 1979).

The first national ecosystem study produced ecosystem maps of the remaining areas of natural vegetation in Western Samoa, including details of dominant species found at each area (Pearsall & Whistler 1991). The most recent national ecosystem study examined lowland vegetation and recommended key areas for conservation (Park et al. 1992).

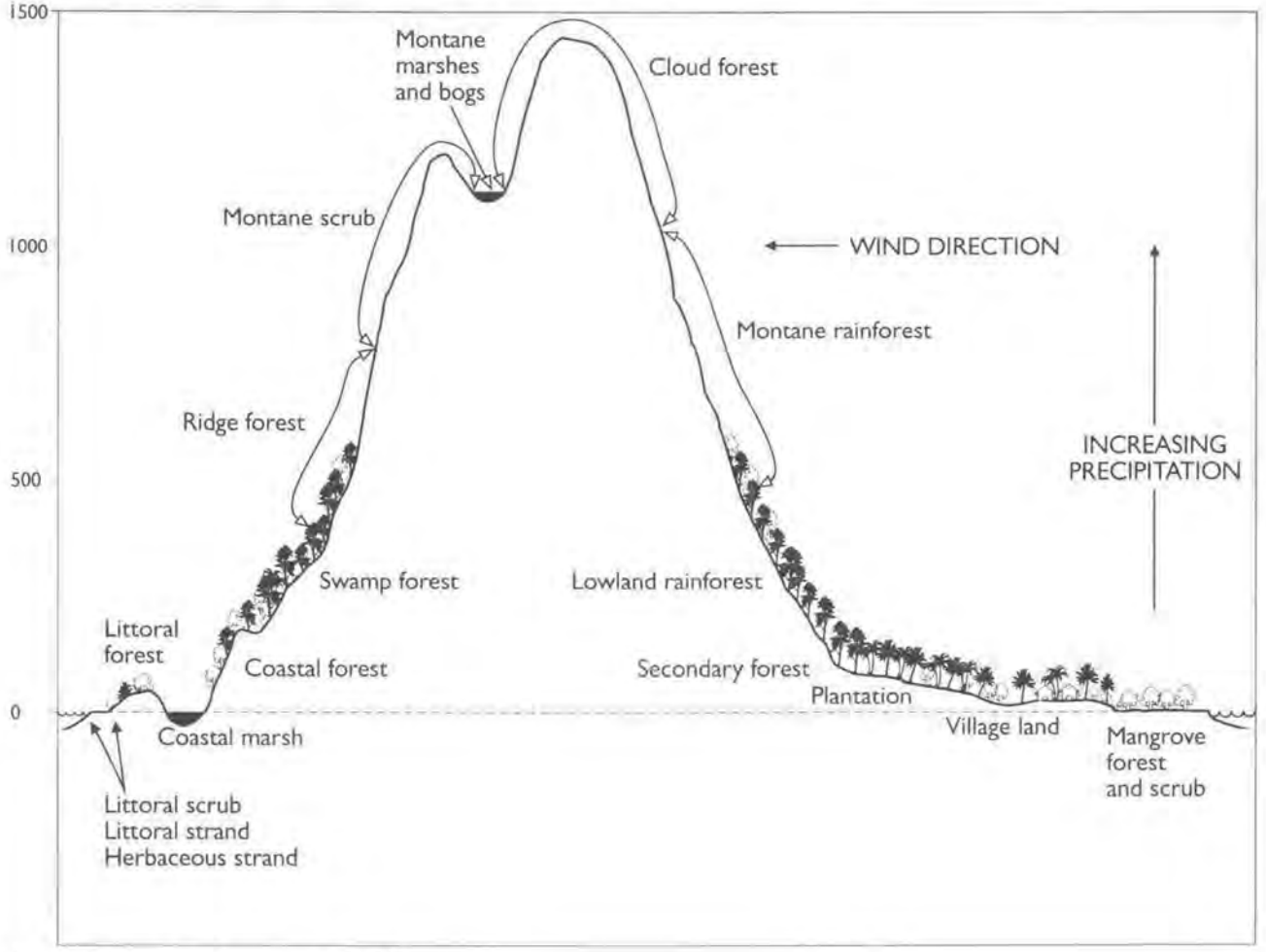
Whistler (1992c) synthesised all this information into a regional study of the vegetation of Samoa and Tonga and divided the vegetation of Samoa into five broad categories: Littoral, Wetland, Rainforest, Volcanic, and Disturbed Vegetation. The following descriptions of these categories are based on Whistler (1992a). Figure 2.1 depicts characteristic vegetation communities.

2.4.2 Vegetation communities

Littoral vegetation

The littoral zone is that area just above the high tide mark where land vegetation first appears.

Figure 2.1 Vegetation communities of Western Samoa



Source: Adapted from Amerson et al. 1982

This category comprises four plant communities: (1) herbaceous strand or beach; (2) littoral shrubland; (3) *Pandanus* scrub; and (4) littoral forest. They are all situated on the seashore. The best remaining littoral vegetation in Western Samoa is found on the Aleipata islands (Nuutele, Nuulua, Namua and Fanuatapu), and the south-central coasts of both Upolu and Savaii. Littoral vegetation, though low in species diversity, is important for many birds and for coastal protection.

Wetland vegetation

This category comprises five communities:

(1) coastal marsh, consisting of herbaceous wetland situated on the coast;

(2) montane or mountain marsh, occurring in montane craters and depressions;

(3) mangrove scrub, dominated by 'togo fafine' (*Rhizophora mangle*) which are small-sized trees;

(4) mangrove forest, dominated by 'togo tane' (*Bruguiera gymnorrhiza*) which are large trees forming closed-canopy forests; and

(5) swamp forest, occurring where fresh water saturates the soil.

Wetland vegetation, except for the swamp forest, is generally low in plant species diversity. Mangrove communities are dominated by salt-tolerant trees and are important in erosion control and the maintenance of inshore fisheries.

Rainforest vegetation

Rainforest can be divided into five communities:

(1) coastal forest;

(2) lowland forest;

(3) ridge forest;

(4) montane forest; and

(5) cloud forest.

Coastal forest is restricted to coastal areas, mostly on tuff cones (a particular type of volcanic

rock), and is found on the Aleipata islands and Apolima. Lowland forest once covered most of Samoa from sea level to 400–600 m elevation. Remaining areas of lowland forest, although extensively damaged in the recent cyclones, are also located at Tafua and Falealupo villages on Savaii.

Montane forest occurs on both Upolu and Savaii and is the most poorly studied vegetation type in Western Samoa. It extends from 400–600 m to over 1,000 m elevation, with a transitional zone containing elements of both communities, and has probably the greatest diversity of flora of any community in Samoa. Cloud forest occurs at the highest elevation of Savaii. These rainforest ecosystems are now of critical importance for the vast majority of native plants and animal species.

Volcanic vegetation

Volcanic vegetation comprises two communities:
(1) lowland volcanic scrub (below 650 m); and
(2) upland volcanic scrub (above 1,200 m elevation).

Recent lava flows will only support a few colonising plants species. However, as the soil develops, a greater variety of species can become established.

Disturbed vegetation

Disturbed vegetation is a consequence of human activities or climatic factors. It comprises four communities:
(1) managed land, used for human activity (for example, plantations and roads);
(2) secondary scrub, dominated by weeds, shrubs and vines;
(3) secondary forest, developed when secondary scrub is left for long periods; and
(4) fernlands, dominated by 'asaua' (*Dicranopteris linearis*) which occurs only at Luatuuu on north-central Upolu, and Amaile at east Upolu.

2.4.3 Conservation strategies

A number of areas of government land have been proclaimed as reserves. The largest and most significant being the O Le Pupu-Pue National Park established in 1978 and covering approximately 2,830 ha from the south coast to Mt Fito, the highest peak on Upolu (see Figure 2.3).

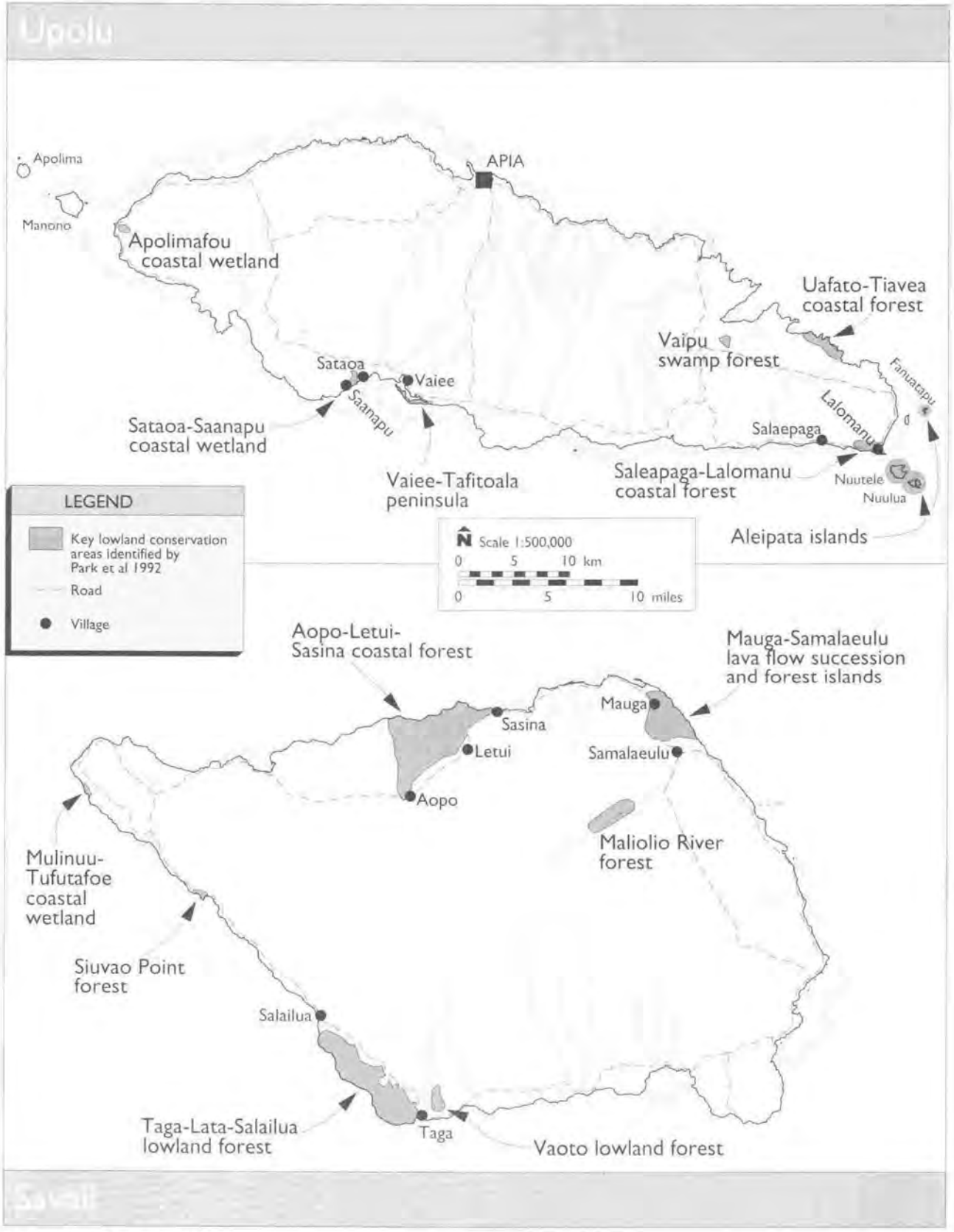
The earliest conservation survey using modern ecological methods was carried out in 1974 by Holloway and Floyd (1975) who recommended a Conservation Reserve system for Western Samoa consisting of 6 National Parks, 24 Nature Reserves, 18 Historic Reserves, 5 Wildlife Sanctuaries and 6 Recreational Reserves. Apart from the existing government reserve system, the remaining areas recommended for conservation by Holloway and Floyd were all on customary land, and conservation management for these areas has consequently entailed long and complex negotiations with the village landowners.

The first attempts at this form of nature conservation management resulted in:

- Conservation Covenants being developed for two natural areas on Savaii, the Falealupo Rainforest Preserve and Tafua Rainforest Preserve (Figure 2.3). These have been negotiated between overseas conservation organisations and local 'matai', and have involved overseas funding to provide developmental aid such as school buildings in an agreement over 50 years to manage the natural environment on these customary lands.
- A pilot programme of complete catchment mangement has met with some success within the Vaisigano Catchment above the town of Apia (Figure 2.3). This approach looks at improving total land management in close consultation with customary land owners, in addition to attempting the conservation management of the natural areas remaining in the catchments. The project has focused on improvements to farming and road building practices and rehabilitation of degraded areas to achieve better overall management of the catchment's water resources. Work has recently been extended to the Fuluasou Catchment and, under a recently approved ADB project, will be further extended to all critical catchments in the near future.

The main option for future action in forest conservation is to promote, encourage and support community efforts for long-term conservation of the remaining areas supporting unique Samoan ecosystems. The linkages between various ecosystems and the requirements of different species should also be firmly established and understood so that the full potential of existing biodiversity can be protected and realised. To safeguard the basic range of natural ecological diversity, Park et al.

Figure 2.2 The fourteen key lowland conservation sites identified by Park et al.



Source: After Park et al. 1992

(1992) propose fourteen key sites throughout the coastal lowlands as the very minimum to protect (Figure 2.2). These are:

- Uafato-Tiavea coastal forest, Upolu
- Sataoa-Saanapu coastal wetland (mangrove forest), Upolu
- Nuutele, Nuulua, Fanuatapu Islands, Upolu
- Aopo-Letui-Sasina coastal forest, Savaii
- Vaoto lowland forest, Savaii
- Apolimafou coastal wetland, Upolu
- Saleapaga-Lalomanu coastal forest, Upolu
- Vaiee-Tafitoala peninsula, Upolu
- Vaipu swamp forest, Upolu
- Taga-Lata-Salailua lowland forest, Savaii
- Siuvao Point forest, Savaii
- Mulinuu-Tufutafoe coastal wetland, Savaii
- Mauga-Samalaeulu lava flow succession and forest islands, Savaii
- Maliolio River forest, Savaii.

Pearsall and Whistler (1991) also identify key highland areas for conservation, including:

- Lona-Punataemoo forests, Upolu
- Fusiluaga forest, Upolu
- Highlands of Savaii
- Central Upolu uplands
- Eastern Upolu uplands
- Mt Fao rainforests, Upolu.

Since that report the Punataemoo forest was essentially destroyed by the Afulilo hydroelectric project and other areas suffered extensive damage in the cyclones.

2.5 Forest resources

2.5.1 Remaining forests

Of the total land area of Western Samoa of 292,670 ha, about 37 per cent is covered by remaining forest (36 per cent indigenous, 1 per cent plantation). Table 2.3 shows the breakdown of forest areas between Upolu and Savaii. The remaining forest comprises 47 and 23 per cent of the total land areas on Savaii and Upolu respectively. The Forestry Division of the Department of Agriculture, Forests and Fisheries (DAFF) estimates that of the remaining indigenous forest, only five per cent is merchantable while 31 per cent is non-merchantable (DAFF 1992).

The current rates of forest depletion are similar on both Savaii and Upolu, and are estimated at

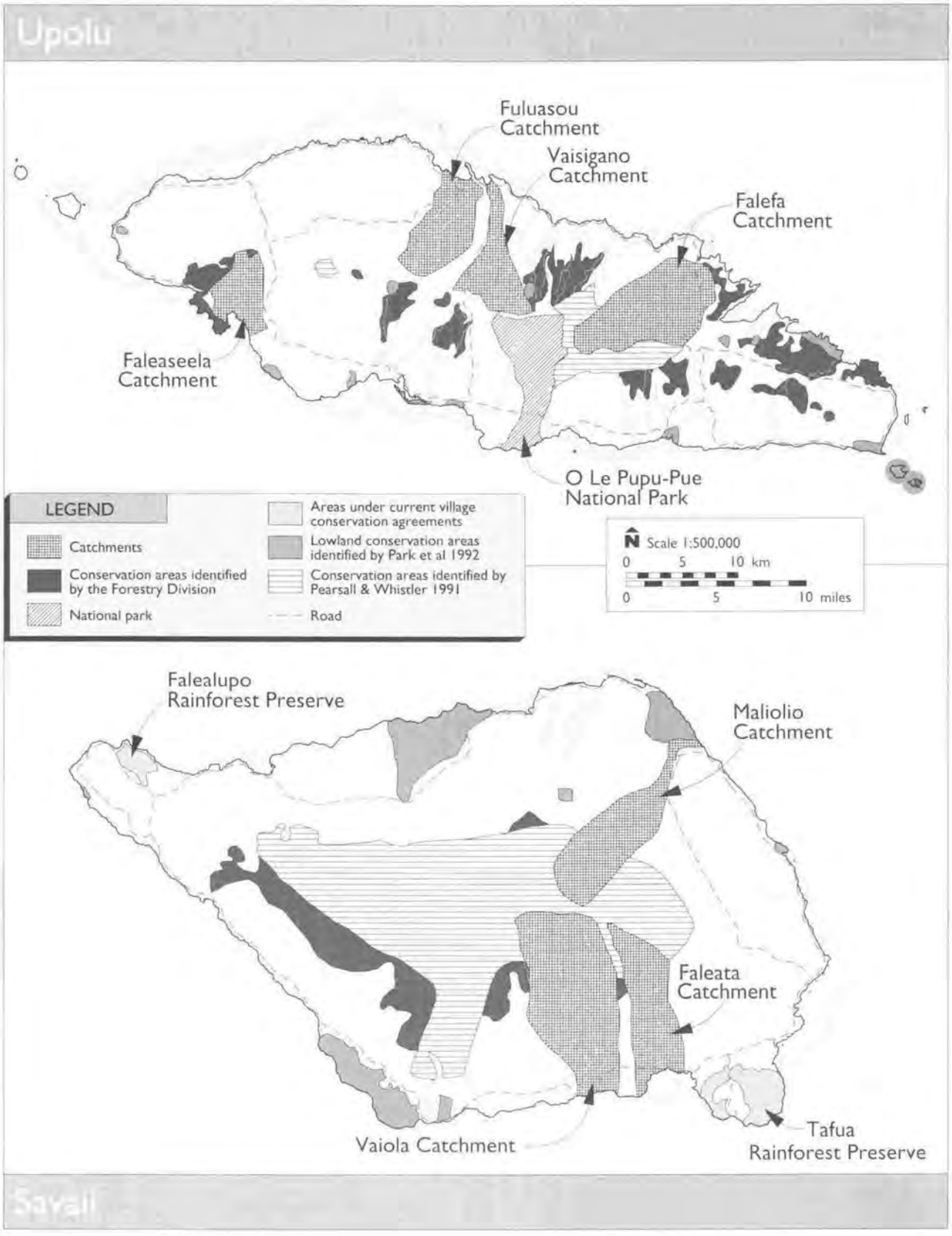
Table 2.3 Remaining forest areas

Forest area	Savaii (ha)	Upolu (ha)	W Samoa (ha)
Merchantable – indigenous	15,134	789	15,923
Non-merchantable – indigenous	62,874	24,522	87,396
Total indigenous	78,008	25,311	103,319
Established – plantation	1,689	594	2,283
Total remaining in Western Samoa	79,697	25,905	105,602

Source: DAFF 1992

A top priority conservation area at Saanapu, Upolu. (photo: A. C. Robinson, reproduced courtesy of DLSE)

Figure 2.3 Important conservation areas



Source: After GWS 1993

Timber cutting is an important local industry, but the quantity of merchantable timber is rapidly declining. (photo: Paddy Ryan, reproduced courtesy of MFAT)

about 1,500 ha per year, 1,600 ha for Upolu and 1,517 ha for Savaii (GWS 1993). Forty per cent of clearing on Savaii is due to logging, less on Upolu. Overall, 20 per cent of forest clearing is attributed to logging with the remaining 80 per cent a result of agriculture and other activities (DAFF 1992). On the other hand, the depletion rates of merchantable forest on Savaii and Upolu are about 1,000 and 50 ha per year respectively. On Savaii, 40 per cent is attributed to logging and 60 per cent to agriculture and other non-logging activities. There is only one logging operation on Upolu. At the current rates of depletion, all remaining merchantable timber will be gone in 6–7 years (GWS 1993). Figures 2.4 and 2.5 illustrate the rate of destruction of native forests in the period 1954–1990 (including cyclone damage).

2.5.2 Timber supply and demand

The present forest-based industry consists of four saw-milling companies, the largest being Samoa Forest Corporation at Asau in north-west Savaii. The annual logging intake of the sawmills over the past seven years has been between 24,000 and 36,000 cubic m. In addition, there were log exports of 9,500 cubic m during 1985–1987 (GWS 1993). Exports of sawn timber have steadily declined from 23 per cent of local production in 1983 to zero today.

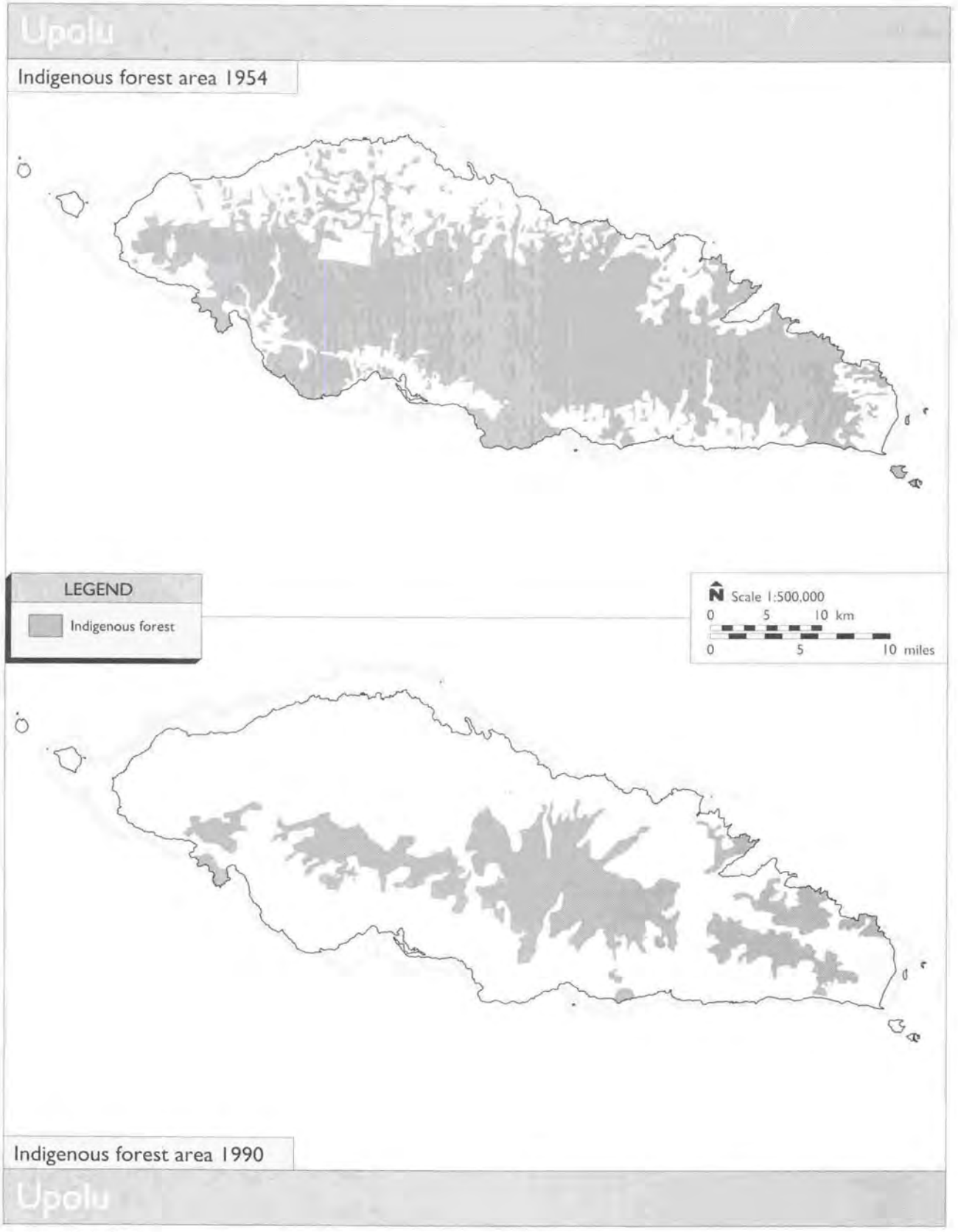
Local demand for sawn timber has ranged from 10,400 to 15,000 cubic m (GWS 1993). Demand in 1992 was 50 per cent higher than previous years, largely due to building repairs after cyclones Ofa and Val. Imports of sawn timber have supplied only five per cent of local demand up to 1989. With less restrictions on imported timber, volumes have increased to about 15 and 25 per cent in 1991 and 1992 respectively.

2.5.3 Non-timber forest resources

The value of forests for the provision of resources other than timber is often underestimated. Forests

'Fetau', Callophyllum inophyllum. A native plant commonly used medicinally. (photo: A. C. Robinson, reproduced courtesy of DLSE)

Figure 2.4 Indigenous forest clearance, Upolu, 1954–1990



Source: GWS 1993

are necessary for water and soil conservation and conservation of biodiversity. Forest trees, shrubs and other plants, including species introduced by the Polynesians, were used and are still used for house and boat construction, household items, firewood and medicines. Forests also supplied some foods. Prior to the cyclones, pigeons and bats were important foods.

At least 150 species of Samoan plants have been used for traditional medicinal purposes alone (Uhe 1974a), in addition to the other traditional uses. Whistler (1992d) lists over 90 medicinal uses of Samoan plants.

Recently, the extract of one of Samoa's native species has shown promise during tests for a cure for the AIDS virus. A second species is currently being tested as a treatment for cancer. A third species, an "endangered" endemic vine, is related to the vine whose extracts have shown promise in AIDS treatment (Park et al. 1992).

2.5.4 Forest development strategies

As proposed in the draft Forestry Policy Statement (GWS 1993), the most important functions of forest are:

(1) to protect and conserve the environment (including soil, water and biodiversity resources);
(2) to produce wood and other forest products; and
(3) to provide recreation and tourism opportunities.

With deforestation having wide ramifications for most other aspects of the environment, sustainable forest management is seen as one of the most pressing issues in environmental protection and conservation.

Future strategies for the sustainable management of forests are based on minimising the uncontrolled clearance of forests. Appropriate measures would include:

- forest conservation (to protect further loss of ecosystems and species);
- watershed conservation (to protect water resources);
- forest education (to create public awareness of the need to protect forests);
- an indigenous forest production policy (whether to restrict logging or completely cut remaining merchantable forests);
- control of agricultural clearance of forests (develop better land use practices);
- plantation and community forests (encourage public participation in forestry);
- institutional arrangements (establish a stand-alone agency responsible for forests); and
- information for decision making (promote forestry research and development).

The draft Forestry Policy Statement has identified important conservation areas (Figure 2.3). This map represents existing reserves and preserves, water catchment areas and conservation areas identified by Forestry Division from a synthesis of Pearsall and Whistler, Park et al. and their recent surveys.

2.6 Fauna

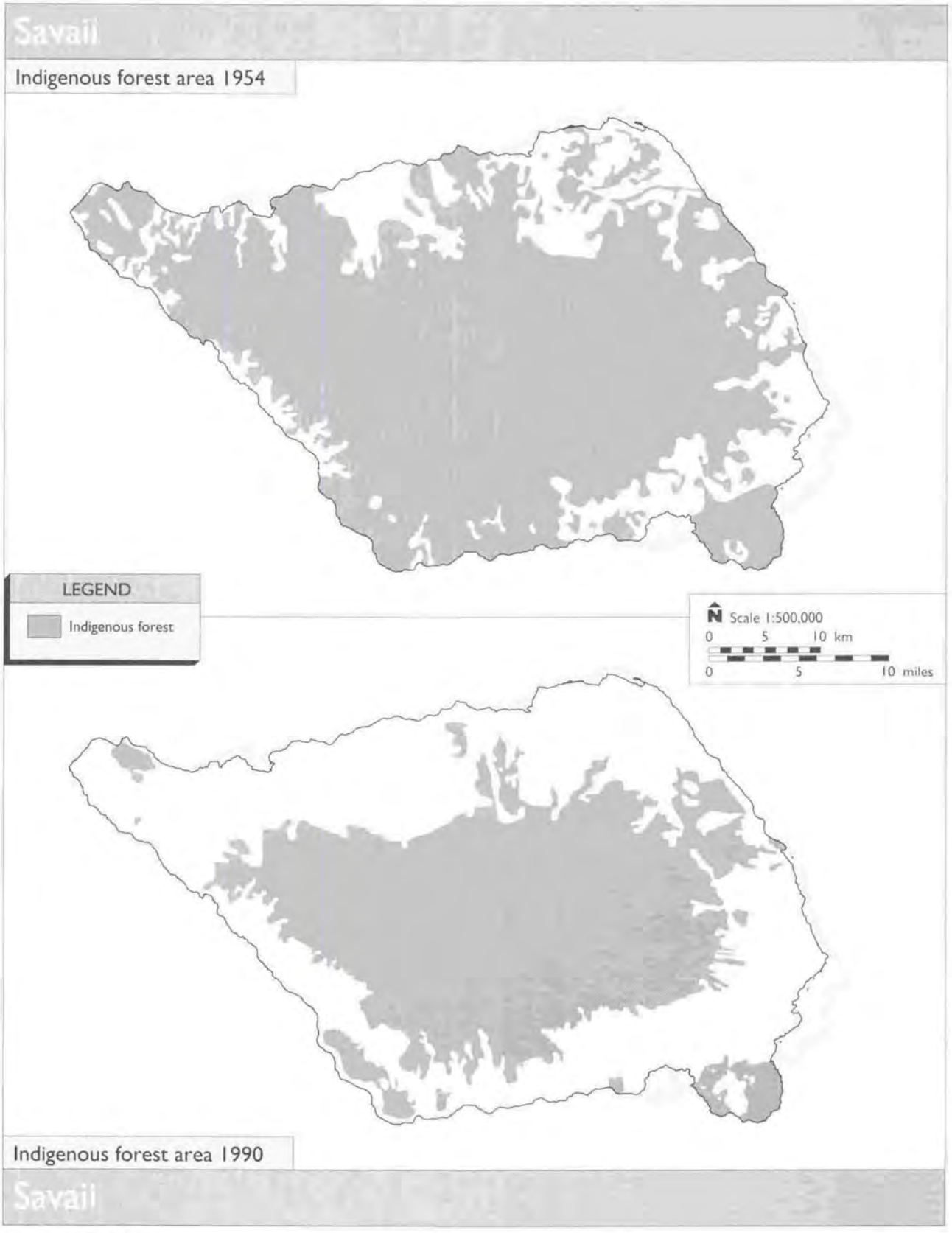
2.6.1 State of knowledge

In the late 1800s and early 1900s a large amount of collection and taxonomic study was carried out on the insects of Samoa. Much of the work now needs updating although the work of Comstock (1966) on butterflies and moths, while mostly relating to American Samoa, is also a good reference to the species of Western Samoa. From this work Dahl (1986) identified 21 butterfly species in Western Samoa (of which *Hypolimnas thompsoni* is found nowhere else). The other invertebrate group that has been studied in some detail are the land snails which have evolved many endemic species on Pacific islands. The most recent summary can be found in Cowie (1992).

In American Samoa the plant eating giant African snail (*Achatina fulica*) was accidentally introduced in 1975, and in 1979 a carnivorous snail (*Euglandina rosea*) was deliberately introduced to control it. The carnivorous species appears to have had a disastrous impact on the endemic Samoan snail species but little effect on the African snails it was introduced to control. There has been one outbreak of the giant African snail in Western Samoa in 1993 but it was believed to have been exterminated before it became established on Upolu.

Freshwater invertebrates have also been little studied. Brief surveys conducted as part of Environmental Impact Assessments of the Afulilo Hydroelectric Power Project (Winders et al. 1987; Waugh et al. 1991) noted a relatively sparse insect fauna

Figure 2.5 Indigenous forest clearance, Savaii, 1954–1990



Source: GWS 1993

with some very common crustaceans. Western Samoa has one species of freshwater shrimp (*Macrobrachium lar*) which is of some importance in the subsistence diet.

For native vertebrates, Pratt et al. (1987) records 35 resident land birds, ten of which are found nowhere else. Gill (1993) reports 14 reptile species. No amphibians occur in Western Samoa although the cane toad (*Bufo marinus*) is present in American Samoa. Further details of the local vertebrates under the three groups of reptiles, birds and mammals are summarised below. See Appendix 4 for a list of Samoan vertebrates.

2.6.2 Reptiles

Eight skinks, five geckos and one snake (the Pacific boa *Candoia bibroni*) have been recorded in Western Samoa. Most of the lizards appear reasonably abundant and only one (the Samoan skink *Emoia samoensis*) is endemic to the Samoan Archipelago.

2.6.3 Birds

Thirty-five species of land birds and 21 sea and shore birds have been recorded from Western Samoa. Ten of the land birds are endemic at the species or sub-species level while four species have been introduced, the most recent being the common myna (*Acridontheres trisis*), released in Apia in the late 1960s and now spreading through cultivated areas on Upolu.

One native species 'punae', Samoan wood hen (*Pareudiastes pacificus*) is probably extinct though a population may persist on upland Savaii. The 'taio', Samoan storm-petrel, a dark form of the white-throated storm-petrel (*Nesofregetta albigularis*) has only been recorded as a single specimen in recent years. Further work is needed to determine the current status of many other species, but of the 14 listed as "rare and endangered" (Dahl 1980), the following are apparently of most concern: 'maomao' (*Gymnomyza samoensis*); 'tuaimeo', friendly ground dove (*Gallicolumba stairi*); 'tutu malili', island thrush (*Turdus polocephalus samoensis*); 'mata papae', Samoan white-eye (*Zosterops samoensis*); 'vai', white-browed rail (*Poliolimnas cinereus*); and the sooty rail (*Porzana tabuensis*).

Jungle myna, Acridotheres tristis. *One of the four introduced species of birds. (photo: Paddy Ryan, reproduced courtesy of MFAT)*

'Pea vao', Pteropus samoensis, *the Samoan flying fox. (photo: Paddy Ryan)*

2.6.4 Mammals

There are thirteen species of terrestrial mammals now present in Western Samoa and of these only three are native: two fruit bats (or flying foxes), 'pea vao' the Samoan flying fox (*Pteropus samoensis*) and 'pea fai taulaga' the Tongan flying fox (*P. tonganus*); and 'tagiti', the sheath-tailed bat (*Emballonura semicuadata*). The fruit bats are important for the

long-term survival of the forests for they pollinate the flowers of many species and disperse seeds of the fruits that they eat through the forests.

Of the introduced species, the early Polynesian voyagers brought 'isimu', the Polynesian rat (*Rattus exulans*), pigs and dogs to the islands. Cattle, horses, goats, cats, two more species of rats (*Rattus norvegicus* and *R. rattus*) and the house mouse (*Mus musculus*) have arrived with Europeans.

2.6.5 Freshwater fish

There has not been a detailed study of the native freshwater fish fauna. Brief surveys conducted as part of the Environmental Impact Assessment of the Afulilo Hydroelectric Power Project (Winders et al. 1987; Waugh et al. 1991) noted a relatively sparse fish fauna. A study of wetlands in American Samoa identified 17 species of finfish (Biosystems 1992) and most of these may occur in Western Samoa.

In recent years four species have been introduced to Western Samoa: mosquito fish (*Gambusia* spp.) and topminnows (*Poecilia mexicana*) were introduced early in the twentieth century for mosquito control purposes. Goldfish (*Carassius auratus*) have an established population in the crater Lake Lanotoo. African tilapia (*Orechromis mombassdica*) were originally introduced for aquaculture as a tuna bait fish and have now established populations in most bodies of fresh water (Zann 1991d).

2.6.6 Conservation strategies

Increased demand for land and forest resources is putting tremendous pressure on natural ecosystems, threatening the survival of existing terrestrial fauna. As in the conservation strategies for plant species and vegetation, the same critical sites are also vital habitats for animal species. As proposed in the Forest Policy document (GWS 1993), the implementation of the network of conservation areas (Figure 2.3), which includes many of the lowland areas identified by Park et al. (1992) and the highland areas identified by Pearsall and Whistler (1991), will further strengthen the conservation of plant and animal habitats.

Chapter 3

Marine resources

3.1 State of knowledge

Samoan fishes have been collected and studied since the middle of the nineteenth century. The first comprehensive survey of Samoan fish fauna based on previous studies was conducted by Jordan and Seale (1906). Their report "The fishes of Samoa" describes the fish fauna of Samoa as the richest on the globe, and they obtained specimens of 475 species of which 92 were considered at the time to be new to science. A second listing of Samoan fishes was compiled by Schultz (1943), based on 270 species collected from Tutuila, Tau and Rose Island, American Samoa. He listed 171 additional species from earlier studies for a total of 441.

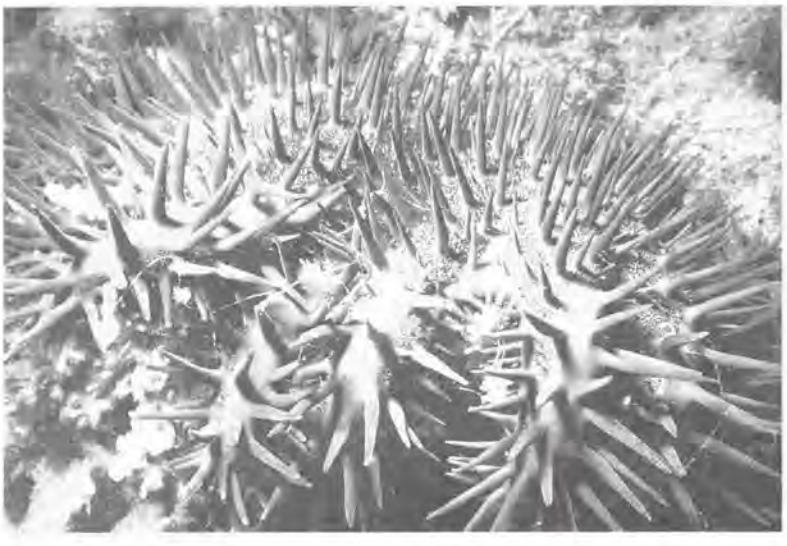
The latest listing of all known inshore and pelagic surface species was produced by Wass (1984) from collection efforts during 1974–1979. Wass listed a total of 991 species (including 78 species identified only to family or genus): 113 families are represented, and 284 species had not been previously recorded from Samoa. Eight hundred and ninety are considered shallow-water or reef-inhabiting species, 56 are deeper bottom fishes, and 45 are pelagic surface species. About 40 fishes are known only from Samoa.

3.2 Marine environment

3.2.1 Coral reefs and lagoons

Western Samoa is not well endowed with coral reefs compared with other Pacific countries. This is partly because the islands consist of steep-sided volcanic cones set in deep waters, and partly because recent volcanic flows covered previous reef areas and left rocky coasts with no reef. Only one marine reserve exists, Palolo Deep, on the outskirts of Apia.

Little information is available on the nature of coastal reef and coral ecosystems. However, recent



Coral has at times been seriously affected by 'alamea', the crown-of-thorns starfish, Acanthaster planci. *(photo: Ed Lovell, reproduced courtesy of SPREP)*

studies (Zann 1991a, 1991b) have raised serious concerns about damage to the lagoons and reef areas. Zann concludes that the Western Samoan reefs and lagoons are among the most degraded in the Pacific. Coastal habitats have been damaged by the illegal use of dynamite and poisons to catch fish, the reclamation of inter-tidal areas and lagoons, coral sand mining, nutrient pollution and surface run-off. Coral has also been seriously reduced by outbreaks of 'alamea' (crown-of-thorns starfish *Acanthaster planci*) and cyclone damage. The Fisheries Division of DAFF estimates that 90 per cent of coral reef around Apia is dead (pers. comm.).

Coastal lagoons are also increasingly being subjected to industrial and domestic pollution. It is evident from the literature that sediment and nutrient pollution of lagoons is damaging the Western Samoa reef system, and contributing to the collapse of the inshore fisheries (Taylor 1991).

Deforestation has increased the volume of soil and nutrients washed to the sea. This can result in eutrophication and changes to ecosystems. An oversupply of sediments may even kill the corals by either smothering or light inhibition (Zann 1991a). Due to the shallowness of the lagoons, there is little ocean exchange, with minimum capacity to dilute waste.

3.2.2 Mangroves

Mangroves are not a large community in Western Samoa, but where they occur they are important to local communities for supplies of fish and shellfish, fuel and wood for many uses. Mangroves also play an important role in the protection of the land from the sea and in the life cycle of many lagoon and reef fish.

According to Whistler (1992a), two mangrove communities can be distinguished in Samoa: mangrove swamp and mangrove forest. The best remaining examples of mangroves are at Sataoa-Saanapu on the south-central coast of Upolu, and at the west end of Lefaga Bay, on the south-west coast of Upolu. A small unique mangrove forest dominated by 'leilei' *Xylocarpus moluccensis* is found east of Salailua, on the south coast of Savaii.

Vaiusu Bay in the Apia area is the largest area of lagoon in Samoa, containing the largest area of mangroves in Eastern Polynesia (GWS 1991). These mangroves and wetlands are the main fish feeding and nursery habitats for Samoa. Unfortunately, the wetlands have been progressively filled in for land reclamation, and the mangrove swamp until recently was used as the refuse disposal site for Apia. The other remaining mangrove areas are under considerable pressure from land clearance and agricultural development. A large area of mangroves at Taumeasina, near Apia, was also reclaimed for a hotel development that never eventuated.

3.3 Marine fauna and flora

3.3.1 Subsistence fishing

According to the 1989 agricultural census, 59 per cent of agriculturally active households engaged in fishing and reef gleaning activities, and 67 per cent

'Kuku', Carpilius macalutus, the three-spot crab forms part of the subsistence harvest. (photo: Ed Lovell, reproduced courtesy of SPREP)

'Paopaos', traditional outrigger canoes, are still commonly used for lagoon fishing. (photo: Jennie Cary, reproduced courtesy of DLSE)

of households used all their catch for home consumption (DOS/DAFF 1990). Most subsistence fishing is done on an artisanal basis at near-shore and lagoon waters — collecting shellfish and trapping, spearing, and trolling fish. Traditionally, both men and women engaged in these fishing activities, using the 'paopao' (traditional outrigger canoe), diving in the lagoons, or going on foot along the coral reefs. No longer seen are the groups of fishermen using 'vaa-alo' (traditional outrigger canoe for skipjack tuna fishing) fishing outside the reef for skipjack, using home-made hooks (without barbs) and lures.

3.3.2 Existing inshore stocks

While it is not possible to make any valid estimates of the existing inshore stocks or maximum sustainable yield for Western Samoa's varied and complex fishery stocks, it is evident from the reports of fishermen, available catch/effort data from different areas, and declines in market landings, that the maximum sustainable yield has been exceeded in most parts of Upolu (Zann 1991a). A decline in fish stocks is probably responsible for the decline in inshore landings in Upolu.

Zann (1991b) gives the possible reasons for inshore stock declines as:

(1) overfishing due to increased demand;
(2) use of effective and modern, but non-selective, fishing techniques;
(3) use of destructive techniques such as poisons and dynamite; and
(4) loss of fish habitat through reclamation, coral sand mining and surface runoff.

3.3.3 Commercial fishing

About 1977, a new development took place in commercial fishing, with the introduction of bigger 'alia' (twin-hulled aluminium craft with outboard motors) under a FAO assistance programme. Fish aggregating devices were installed at selected locations outside the reef. The 'alia' crews fish around the aggregating device as well as engaging in offshore trolling or handline bottom fishing outside the reef. The initial average catch rate for 'alia' crews was estimated at about 100 kilograms per fishing day (ADB 1985).

'Alia' are now commonly used for fishing outside the reef. (photo: A. C. Robinson, reproduced courtesy of DLSE)

A research fishing vessel was supplied to the Fisheries Division of DAFF under Japanese government assistance. This provided the facilities to assess the extent and characteristics of fish stocks in Samoan waters. However, a number of problems were encountered, and the vessel is no longer in operation.

3.3.4 Tuna

Two species of tuna, 'atu' (skipjack *Katsuwonus pelamis*) and 'asiasi' (yellowfin tuna *Thunnus albacares*) are found in Western Samoan waters. A South Pacific Commission (SPC) tagging and stock assessment regional programme during 1971–1981 indicated that the offshore tuna populations in Samoan waters are not local but migrate broadly. As reported in the 1985 Asian Development Bank (ADB) Agricultural Sector Study, the SPC survey also established the abundance of stocks, recording the highest skipjack concentration of any area surveyed in the region (average about two schools sighted per hour compared to survey average of 0.75 per hour) (ADB 1985).

3.3.5 Turtles

Two species of sea turtle, the green turtle (*Chelonia mydas*) and the hawksbill (*Eretmochelys imbricata*) inhabit the seas off Western Samoa. The latter breeds on the Aleipata islands and occasionally on remote beaches on Savaii. Turtles and turtle eggs are still collected in Western Samoa but the numbers of both have severely declined.

Until 1983, the Fisheries Division of DAFF operated a turtle hatchery project at Aleipata on Upolu's east coast. This was an attempt to increase survivorship of young turtles (Zann 1991c). The eggs were collected from the nearby offshore islands and hatched at the site. The young turtles were reared until they reached a certain age before being released to the sea.

A revised programme of turtle management is proposed for the 1993–1994 turtle breeding season. It has five objectives:

(1) To reduce the take of turtles — ultimately to a sustainable level — through a turtle conservation and education programme for Western Samoa to raise public awareness leading to legislative action.
(2) In cooperation with villages, to examine known turtle nesting areas in Savaii and the Aleipata district on Upolu.
(3) To train appropriate Samoan staff of the Division of Fisheries and the Division of Environment and Conservation (DEC) in standard turtle research techniques.
(4) To re-survey hawksbill turtle nesting areas in the Aleipata islands.
(5) To purchase, tag and release turtles from the Apia and Salelologa fish markets.

This project is being funded by a grant from the South Pacific Biodiversity Conservation Programme administered by SPREP.

A sight no longer seen: 'a catch of turtles', Samoa c. 1900. (photo: Tattersall's Studio, reproduced courtesy of Alexander Turnbill Library)

3.3.6 Marine invertebrates

Various marine invertebrates are, or have been, part of the traditional Samoan diet. An export industry in beche-der-mer has recently been initiated. Western Samoa has two species of giant clams, *Tridacna squamosa* and *T. maxima*. A third species *Hippopus hippopus* is recently extinct. The existing clam stocks have been very heavily fished and numbers have been so severly depleted in most areas that they are also approaching local extinction.

The large trochus shell 'aliao' *Tectis pyramis* was of some importance in the subsistence fishery but has been depleted by heavy fishing pressure.

3.3.7 Aquaculture

Various attempts have been made to establish aquaculture industries in Western Samoa. Several attempts have been made to breed giant clams at Aleipata using the introduced species *T. derasa*; whilst successful, they have been hampered by the effects of cyclones Ofa and Val. Currently, the Fisheries Division has established a small-scale hatchery using *T. squamosa* for stocking a clam farm at Aleipata, as well as an introduced species of *Trochus niloticus*. Oyster trials are continuing to find new species that breed successfully under local conditions. The development of the Philippine green mussel (*Perna viridis*) at Asau harbour on northwest Savaii was discontinued when Cyclone Ofa damaged the local sites.

3.4 Future options

The future options for local fisheries should focus on:

(1) the protection and conservation of coastal lagoons and habitats;
(2) monitoring of stocks and replenishment of stocks through the development of stock hatcheries;
(3) aquaculture; and
(4) development of commercial fishing to harness offshore resources.

All the evidence points to the urgent need to protect remaining mangrove areas and coastal lagoons. The pressure of population growth and marine pollution will exacerbate the depletion of resources and degradation of marine habitats. Already, some reef shellfish and fish are overexploited, endangered and, in the case of at least one species, extinct (ADB 1985; Zann 1991a). One of the problems facing the Fisheries Division of DAFF is its limited technical capability.

Western Samoa's Exclusive Economic Zone (EEZ) is one of the smallest in the Pacific region (95,800 sq km). However, due to the comparatively limited exploitation of offshore resources, there would appear to be good potential for commercial harvesting. For example, the Pasco Banks (and other similar shallow banks) at depths of 80–120 m have excellent potential for bottom fish.

Chapter 4

Urban and rural environment

4.1 Urban and district development

4.1.1 General

No planning legislation currently exists; without this there is no framework within which to coordinate national development policies and, subsequently, the use of natural resources across government sectors and urban and district level. As a consequence some projects have resulted in degradation of the environment for short-term economic gain. Current development programmes are not well coordinated, with individual government sectors promoting their own programmes, often in isolation from other efforts and sometimes in conflict with them. This ad hoc approach leads to the fragmentation of development efforts and waste of limited resources. Efforts in 1972, 1979 and 1983 to promote urban and district planning legislation were unsuccessful. At the district and village level there is still little coordination of land use. Recent government decisions are now attempting to address some of these issues.

In many ways, the very structure of Samoan society makes it difficult to apply conventional urban and district planning concepts and institutions, and implement efficient land use practices. People live in over 320 villages which are virtually autonomous political entities. The customary land tenure (covering over 80 per cent of total land area) ensures that there is firm local control over land resources and developments on them. Traditional life proceeds with, by Western standards, a limited amount of forward planning as resources have in the past been abundant on a year-round basis.

The purpose of the introduction of new forms of legislation, policies and procedures is to manage development in such a way to ensure that resources are used to the greatest advantage for the whole community and not in ways that degrade the particular resource and/or its environmental context. At the same time the planning process should ensure that, while local communities have control over their own affairs, the wider interests of the whole society and those of future generations are also considered.

4.1.2 Urban development

A former town planner with the Public Works Department has documented the numerous attempts to institute a town plan for Apia (Sturms 1984). While the concept was discussed as early as 1934, the first sustained effort began with the formation of a Town Planning Committee in 1954. Since then several plans have been prepared and parts of these plans implemented. At various times lack of information, lack of town planning expertise, the need for legislation and administrative arrangements, lack of finance and concerns over the rights of customary landowners in the Apia area have prevented the development of a long-term town plan.

The most recent effort to provide urban planning was in 1992 when Cabinet approved a development plan for Apia. The main features of that plan include: traffic planning measures to control congestion; pedestrian malls; relocation of Savalalo market and provision of public open space. Some of the elements of that scheme have been enacted, for example, road upgrading, and traffic flow and control measures. Preparations have begun for the relocation of the Savalalo market.

Today, despite recent efforts, the Apia area still illustrates the need for proper planning. While the road pavements have been upgraded, limited provision has been made for pedestrians. Behind

Problems like traffic jams and traffic fumes face modern Apia. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Beach Road, 'fales' (traditional Samoan houses) are increasingly jammed together with less and less open space around them. Throughout the urban area, workshops and small factories are located next to residential and office buildings, providing a classic example of the lack of land use zoning. Although surface drainage has improved as a result of a PWD project (principally German-funded), large parts of Apia still have insufficient drainage. This is a continuing health hazard especially during the wet season.

4.1.3 Future options

Urban and district planning legislation is included in the list of Western Samoa's Seventh Development Plan (DP7) proposals. Planning involves the encouragement, guidance and, where necessary, control of development. In Apia where problems are entrenched, a careful use of planning controls and incentives is required to prevent further deterioration. For example, a control which prohibits the location of industries in a certain area will not be easily enforceable unless an attractive alternative site is offered.

The government has now proposed the establishment of an Apia Municipal Authority to be responsible for the management of urban Apia, and new planning legislation to guide development both in Apia and elsewhere. The planning legislation will establish a Planning Council and the Department of Lands, Surveys and Environment will service the Council. Proposed EIA regulations should also ensure that individual development proposals are assessed for their impact on the environment. The NEMS document will provide a strategic planning framework for integrated and planned effort towards sustainable development. This framework will constitute the output of the Phase 2 policy development activity now beginning. Policies and activities will be proposed for each of the twelve key environmental issues of Target Environmental Components (TECs).

4.2 Waste disposal

4.2.1 Solid waste

Little is known nationwide about the present patterns and nature of waste generation. This is because there is no public collection in the rural areas, and collection in Apia covers only part of the urban area. The majority of households dispose of their rubbish by throwing it down banks, into

stream beds, or along the coast. Some rubbish is buried, burned or composted.

In Apia, it is estimated that approximately 17,000 cubic m or 3,000 t of waste annually were disposed of at the former disposal site at Vaiusu Bay. The closing of the site in the mangrove area west of Apia marked a big step forward in the conservation of mangrove swamps and wetlands in Western Samoa, as well as the protection of the surrounding marine environment. However, all rainfall runoff from the site discharges directly into the bay, and with no control on leachate or the types of waste disposed of, the site still poses serious threats to the marine environment and to the health of consumers of seafood from the adjoining bay and lagoon areas. This threat will only gradually reduce, apart from expensive remedial measures being taken to prevent rainfall percolating through the old dump.

The new landfill site is an area of approximately 100 acres inland near Apia. The collection of refuse, control of litter and the management of the disposal site is the responsibility of the Department of Lands, Surveys and Environment (DLSE). At present, collection is done by private contractors. Among the management strategies planned for the new landfill site are the separation of waste at source and the promotion of recycling activities at allocated space on site. One of the immediate problems for the new site is the prevention of leachate seeping into the groundwater downslope from the dump.

A recent positive development in Apia has been the emergence of private sector interest in recycling and waste management. This has been in part a response to government initiatives in putting waste collection in Apia to contract, but more significantly to the commercial potential of recycling. A number of largely small-scale enterprises are now operating with one particularly significant development being the establishment of a waste oil recycling plant.

In the rural areas the quantities of waste produced are small but nonetheless significant. While scavenging pigs, chickens and dogs remove much of the elible organic waste, and other organic waste rots into the ground, the products of the Western consumer society are increasingly prevalent. Materials such as plastic bags and containers, cans, and automotive waste (oils, batteries, tyres and wrecks) have been in Samoa for a long time now and their cumulative effect is noticeable in rural areas. This

Cans sorted for recycling. (photo: Paddy Ryan, reproduced courtesy of MFAT)

is principally because traditional disposal practices have not adjusted to the new realities, with burying of rubbish less common than simple disposal on heaps, often inappropriately sited in stream beds, mangroves and beaches.

4.2.2 Sewerage

Sewage disposal is a growing problem in Western Samoa. With no public sewerage systems, private homes are served by on-site systems which can be classified into four broad categories: septic tanks with soakage facilities; pour-flush toilets; pit latrines; and primitive toilets on drains or over the sea without pits.

It is evident in the low-lying areas of Apia that groundwater is being polluted by effluent from many of the sewage disposal facilities (GWS 1992d). Flooding often causes severe damage to toilet and shower houses and pit latrines. This leads to faeces being washed out of damaged pits and other domestic wastewater discharging directly to surface

waters. Pools of stagnant water remain in many areas, providing the ideal breeding grounds for worms, mosquitoes and various forms of pathogens.

The big commercial and public institutions in the urban area operate their own wastewater treatment, and most systems need remedial work to improve their performance. The sewerage system at the national hospital has been recently upgraded and is operating well. It consists of an Imhoff tank with a trickling filter and a separate sedimentation tank to treat excess sludge. Effluent from final sedimentation is chlorinated to prevent potential health risks. The main problem with the new system (as with the old system) relates to the lack of routine maintenance to ensure that the treatment plant is operating properly.

In densely populated areas along the coast, wastewater from toilets and pit latrines, assisted by high percolation rates, is considered a very likely pollutant of groundwater and hence (via normal coastal discharges of groundwater) the lagoons. Some basic latrines discharge directly into streams and the sea. Over time these are very likely to result in the contamination of near-shore water and thereby the pollution of the traditional seafood supplies in the lagoons. In some areas the accelerated growth of marine algae and eelgrass provides clear evidence of the effects of existing nutrient pollution of lagoon waters.

4.2.3 Other waste

One of the only sources for information about potential waste problems as discussed below comes from the studies being conducted for the Apia sewerage project (GWS 1992d). Water samples from offshore and sampling of shellfish give some indication of the organic chemicals that are making their way into the ocean food-chain from land. For example, the study shows the presence of polynuclear aromatic hydrocarbons, resulting from incomplete combustion.

Commercial waste

In the urban area, most solid waste from commercial premises (shops, stores, offices and hotels) is collected through the public collection system. Shopkeepers in particular appear to make liberal use of the litter bins provided for waste on the roadsides to dispose of their shop refuse. There is a need for separate collections of commercial waste.

Industrial waste

Relatively little industrial waste is generated in Apia with many materials, which might in other countries be discarded, being salvaged for reuse. For example, offcuts of timber, sawdust and coconut shells are collected for firewood. Similarly, the sheets of rubber from which footwear is stamped out are used as seating for the trays of pick-up trucks. Western Samoa has a large-volume system of reusing glass bottles which is operating very efficiently.

There is an increase in industrial activity in Apia, however. Most of the resulting waste is in the form of discarded packaging or nutrient-loaded liquid effluent. This effluent, in addition to domestic drainage, has been a principle cause of the severe degradation of the lagoons and reefs adjacent to Apia, with Vaiusu Bay being particularly degraded.

The evidence for the chemical pollution comes from studies of water quality and shellfish contamination conducted as part of the assessment of the proposed sewerage system for Apia. The main organic compounds are polychlorinated biphenyls (PCBs), perhaps from low quality transitors as well as old electricity transformers (M. Lascombe, pers. comm.), and pentachlorophenol. Both, however, are at very low levels in shellfish, well below those recommended for safe human consumption. There is also a disused copper/chrome/arsenic timber treatment facility at the Samoa Forest Corporation timber mill at Asau and an abandoned sump from a similar facility at Vaitele that are likely sources of unmonitored chemical pollution.

Hospital waste

This presently constitutes a significant problem in terms of public health with wastes such as discarded sharps (needles, scalpels) and contaminated bandages and dressings being inadequately disposed of at the national hospital and district hospitals. At the national hospital in Apia incineration in a high temperature incinerator and burial of ash (including unburnt needles etc.) was previously carried out, but the incinerator has not been functioning properly for several years, and burial has lapsed into dumping on site and over a bank at the rear of the hospital. There is also inadequate separation and collection of such wastes in the ward, and the lack

Some industrial wastes are discharged into the lagoon. (photo: Jennie Cary, reproduced courtesy of DLSE)

of such systems results in frequent casual disposal of all items concerned about the grounds and into drains. The situation is generally similar at district hospitals.

Chemical waste

The main pesticide residues found in shellfish (and well below recommended safe consumption levels) are DDT (and degradation products of long deposition), dieldrin, chlordane and g-BHC/Lindane.

There is growing public concern about the use and disposal of chemicals, agricultural pesticides and herbicides, and related empty containers. In 1989 during the Agricultural Census, over 41 per cent of households reported using agricultural chemicals (DOS/DAFF 1990). The high rate of suicides using the weed killer paraquat shows the need for improved policies on the overall management of toxic chemicals. This is being addressed by the Pesticide Technical Committee, chaired by the Director of Agriculture, Forests and Fisheries, with representatives from DLSE, the Health Department and importers.

4.2.4 Future options

Future options for local waste management include:

(1) the reduction, reuse, recycling and recovery of resources;
(2) the provision of proper treatment and disposal facilities; and
(3) promoting more public participation in waste management strategies.

Apart from the few individual, 'package' sewage treatment plants in major buildings and institutions in Apia, the most sophisticated sewage disposal systems in Western Samoa are septic tanks, most of which are not constructed adequately and allow infiltration of largely untreated effluent to groundwater. The very high porosity of soils, high rainfall and rapid movement of groundwater to lagoons and streams, in combination with a significantly high population density along coastal margins, result in a high level of nutrient contamination of lagoons and estuaries.

This is a particular problem in Apia where the greatest concentration of population exists, largely

situated on coastal swamps and otherwise flood-prone land with high water-tables. Investigations are well advanced for a sewerage scheme for the low-lying town areas and key industrial and institutional sources. This will remove a significant source of pollution from town drains and lead to improvement in the quality of adjacent lagoons and Vaiusu Bay. The current proposal also calls for minimal treatment of effluent (only milliscreening) and a long ocean outfall. Running and maintenance costs will be significant and this raises a question of equity, given that the scheme will only serve a part of the main town of Western Samoa.

The Department of Lands, Surveys and Environment, the National Beautification Committee, and the 'Pulenuu' (government appointed village representative) Committee are currently coordinating national programmes to promote a clean environment. Villagers are encouraged to keep the roadsides in their villages clean, and to beautify the grounds around their homes. These programmes could be expanded to include the proper disposal of plastics and special waste at appropriate local sites. The disposal of sewage and animal waste also needs to be addressed in the rural areas, due to the potential to pollute the sea and water supplies, increasing the risks of diseases.

4.3 Air pollution

4.3.1 Sources of atmospheric pollution

Atmospheric pollution has been defined as:

> ... the presence in the atmosphere of substances or energy in such quantities and of such duration likely to cause harm to human, plant, or animal life, or damage to human-made materials and structures, or changes in the weather and climate, or interference with the comfortable enjoyment of life or property or other human activities (Elsom 1987).

The common pollutants worldwide include suspended particulate matter (soot, sulphur dioxide, smoke); and exhaust emissions (oxides of nitrogen, hydrocarbons, carbon dioxide, lead). Other types of pollutants are anthropogenic heat (increases in temperature of the air from human causes), toxic chemicals and ionising radiation. During the 1970s, the increase in atmospheric concentration of carbon dioxide and other gases is claimed to have caused a depletion of the stratospheric ozone, creating global pollution.

The widespread use of the car is a considerable contributor to the emission of carbon dioxide (Bunker 1990), where transport fuels account for about 25 per cent of carbon dioxide, as well as other 'greenhouse' gases (Lowe 1990a).

4.3.2 Local implications

According to government records (DOS 1991), imports of mineral fuels and lubricants more than doubled (from about $9.5m to over $20m) during 1980–1990. Between 1985 and 1991, the number of registered vehicles and new vehicles increased by 36 and 340 per cent respectively. In electricity generation, the amount of diesel generated energy increased by nearly 200 per cent. The huge increase in national petroleum consumption is costing the country dearly in foreign earnings, with the same amount earned from exports spent in petroleum imports during 1990.

The other main local activity creating pollution is the uncontrolled use of fuel wood for local cooking and the burning of garden waste. Little information is available on fuel wood consumption but it is evident, especially in the urban area, that people are moving further and further inland to collect firewood. The clearance of forest catchment areas for firewood is leading to other environmental problems such as soil erosion and water pollution.

The adverse health effects of the burning of fuel wood and garden waste are not well established, but are generally inferred to be significant. Western Samoa has a disproportionally high incidence of respiratory stress and disease.

Western Samoa uses a small amount of methyl bromide on quarantine. This chemical is even more damaging to the atmosphere than CFCs and, globally, may be banned by the year 2000.

While Western Samoa's contribution to global pollution and control is minute and will have little overall effect, any actions by small nations like Western Samoa to combat atmospheric pollution will have significant symbolic and moral effect in international forums. Perhaps more importantly, recognition of personal responsibility for both the causes of air pollution problems and their remedy is a significant first step in public awareness and resolution of wider environmental problems in Western Samoa.

4.3.3 Future response

Comprehensive transport policies are required to address not only the importation of petroleum products, but also the management and operation of the local vehicular fleet. More incentives should be given for the procurement of more fuel-efficient vehicles, and testing standards should be reviewed to include such requirements as well-tuned engines.

The country cannot afford to rely on diesel generation for the bulk of its electricity supplies. With the completion of the Afulilo hydropower station, other more sustainable systems should be studied including solar energy, wind and wave power. More importantly, price distortions in the sales of electricity should be removed.

A more efficient wood-burning stove appropriate to Western Samoan conditions should be developed to provide better utilisation of fuel wood. This will have the added advantage of easing the task of food preparation and improving hygiene standards. Plantations with fast growing trees for firewood should continue to be developed.

4.4 Climate change

4.4.1 The greenhouse effect

The theory that increasing the concentration of carbon dioxide (mainly from the burning of fossil fuels) in the earth's atmosphere will alter the climate has been known to scientists for more than a hundred years. The current name 'greenhouse effect' was given to this phenomenon by the Swedish chemist Arrhenius late last century. The main greenhouse gases are carbon dioxide, methane, nitrous oxide, ozone and some chlorofluorocarbons (CFCs); of which carbon dioxide is the dominant contributor to climate change (Lowe 1990b).

Globally, only twenty countries account for 85 per cent of the world's carbon dioxide emissions; with the United States (24 per cent), Soviet States (19 per cent) and China (9 per cent) producing over 50 per cent.

There are many uncertainties in relation to predictions of the magnitude of global warming and the associated local effects on climatic variables. These include the rate of increase of concentration of greenhouse gases, the generating and dispersing of gases, and the effect of changes in cloud cover (Pittock 1990). Current knowledge is imprecise and no-one can be sure of the exact magnitude of effects due to greenhouse (Connell & Lea 1992), as well as the nature of human response (Bunker 1990). However, the weight of scientific evidence points to an increase in atmospheric carbon dioxide and warming of the globe (Troy 1990).

4.4.2 Risks due to greenhouse

One of the main potential effects of greenhouse is sea-level rise, largely due to warming of the upper layers of the ocean, the melting of glaciers, and vertical movement of the earth's crust. The most significant effects of rising sea levels are: increased frequency of extreme tides; more severe storm damage and more coastal erosion (Hains 1990); and increased frequency and severity of tropical cyclones as the temperatures of the oceans increase (Connell & Lea 1992). According to Bryant (1991), the specific risks under greenhouse warming include:

- coastal inundation;
- tidal effects on estuaries and harbours;
- shoreline retreat;
- severe and frequent storm and wave conditions;
- enhanced coastal sedimentation;
- threats to coastal infrastructures;
- damage to marine resources; and
- pollution of groundwater.

Agriculture and coastal vegetation may also be affected.

All of these effects are significant to Western Samoa where the great majority of the population live within a kilometre of the coast. Given that one of the best protections from the effects of sea-level rise is the characteristic resilience of natural systems, notably coral reefs, mangroves and beaches, the high degree of degradation and low resilience of Western Samoan coastal systems is of considerable concern.

4.4.3 Local implications

While little research has been done on local sea-level changes and tidal patterns, it is clear that any increase in sea levels will undoubtedly affect Western Samoa quite significantly. Villages, buildings, roads, water and electricity supplies, and international air and sea ports, will all be affected as the majority of these facilities and infrastructure are

located along the coast (Kay et al. 1993). Waves and sea over-wash are likely to affect groundwater and damage coastal vegetation and lowland agriculture.

Natural hazards, tropical storms and associated high seas are likely to accelerate the erosion of coral reefs affecting the inshore and lagoon marine resources. Mangrove swamps and wetlands may be also damaged affecting the marine breeding areas and food supplies. Strong cyclonic winds (as experienced with Cyclones Ofa and Val in 1990 and 1991) will severely damage agriculture and forestry, affecting the country's economic welfare. Buildings will also suffer as during Cyclone Val when 90 per cent of local buildings were either completely destroyed or suffered some form of damage.

There are also likely traditional, cultural and social implications where village locations and family ancestral sites of residence may be destroyed or completely washed away. Many Samoans are attached to these sites (including ancestral tombs, historical monuments and archaeological places) which give meaning to their family genealogies and cultural ceremonies, and enhance their social well-being. They may not be easily convinced to abandon these high risk coastal areas.

4.4.4 Future response

Unfortunately, as mentioned earlier, there is little that Western Samoa can do to reduce the impact of global climate change, although local deforestation will make a contribution to greenhouse gases, and better management of natural coastal systems will improve our defences. Only the industrialised countries can control the emission of greenhouse gases at the sources. However, Western Samoa through appropriate policies can do its share to minimise the dangers of global warming. This will show that vulnerable nations like Western Samoa are seriously concerned about the threats due to greenhouse, and could be effective in exerting pressure on the developed countries through regional and world organisations. Restoring to maximum health the mangroves, reefs and lagoons, and beach systems will increase the natural defences of the country.

Much research is required on the local sea level and tidal variations. Presently, the latest sea-level Fine Resolution Acoustic measuring equipment for measuring greenhouse energy, sea-level changes and other meteorological parametres is installed in Apia and intended to remain there for twenty years. The output of this research will benefit the policy makers and planners in developing appropriate policies and response strategies. To eliminate the risks altogether by relocating facilities and infrastructures from risky coastal areas is not practical because of difficulties in securing land to rebuild villages and infrastructures. Other alternatives include reducing the risks by providing sea walls and beach replenishment. Some technical solutions may be too expensive for the country to afford from its own resources (Connell & Lea 1992). The Japanese government is currently funding the construction of a sea wall along Apia's foreshore.

Some planning options that could be considered, especially in the urban areas, include:

- zoning;
- time-limited constraints;
- proper assessment and justification of development;
- public acquisition of high-risk areas;
- land use and building codes; and
- engineering designs to minimise damage (Bryant 1991).

Other important planning aspects include functional urban and district planning and the need for local communities to be more self-sufficient (Troy 1990).

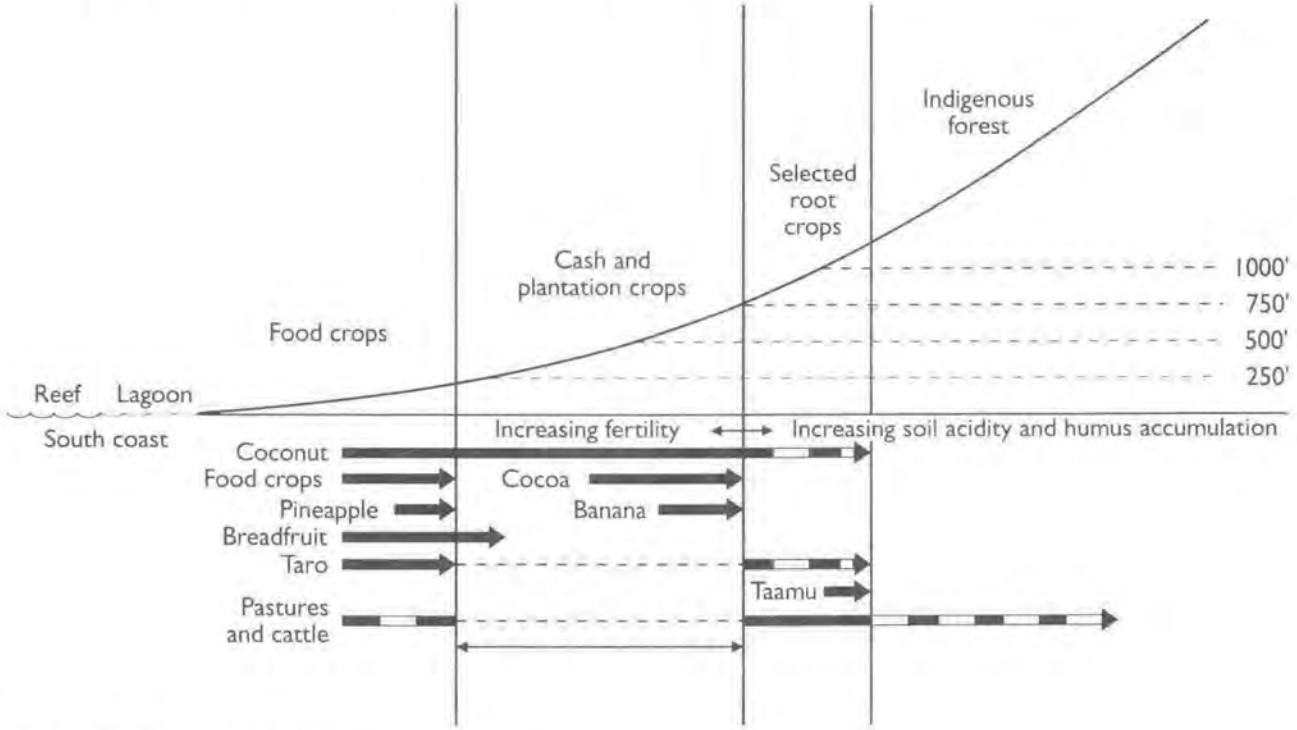
4.5 Patterns of land use

4.5.1 Existing land use

The predominant land use apart from indigenous forests is agriculture, as shown in Table 4.1. A common land use pattern in the villages consists of: coconut plantations along the coastal zone; next inland is a mixed cropping zone of cocoa, bananas, and some coconuts; and further inland is the third zone of root crops (taro and 'taamu'). Agriculture is mainly confined to areas up to 200 m. Only where the slopes are gentler as in north-west Upolu does agricultural cultivation extend to 300 m. Figure 4.1 shows the typical pattern of crops with elevation and slopes.

According to the 1989 Census of Agriculture (DOS/DAFF 1990), 77 per cent of land holdings is under agricultural use, three per cent each under fallow and bush, and 17 per cent in non-agricultural use (buildings, roads etc.). The small proportion of holdings under fallow and bush shows the

Figure 4.1 Typical pattern of vegetation and land use



Source: Fox & Cumberland 1972

strong demand for land for agriculture. Such constant usage will affect the fertility of the land in the longer term.

Of the land under cultivation, 46 per cent is under coconuts, 13 per cent cocoa, 29 per cent taro, 6 per cent 'taamu', and 4 per cent bananas. Twenty-two per cent of agricultural holdings use fertilisers, 15 per cent use compost, and 41 per cent use chemicals. The increased use of fertilisers supports the earlier comments on increased demand for land, while the more common use of chemicals may be due either to shortages of farm labour or to pressure to produce more from existing holdings.

The 1989 Agricultural Census shows that 91 per cent of all households keep some type of livestock: 42 per cent have cattle; 83 per cent have pigs; and 86 per cent have chickens. It would seem that livestock is primarily raised for home consumption and for ceremonial occasions.

4.5.2 Potential land use

The land use potential indicated from studies by Wright in 1963 and Pak-Poy & Associates in 1972 are summarised in Table 4.2. Both studies generally agreed, indicating approximately 70 per cent of total land being suitable for agriculture.

More recently in the study by ANZDEC (1990), comprehensive land use capability maps were produced for the whole country. Land use capabilities were also categorised into four classes:

(1) land with few limitations to agricultural use (39,600 ha);
(2) land with moderate limitations to agricultural use and few limitations to forestry (121,700 ha);
(3) land with severe limitations to agricultural use and moderate to severe limitations to forestry (59,400 ha); and
(4) land unsuitable for agriculture or forestry (62,900 ha).

4.5.3 Future options

The proper utilisation of land resources according to their appropriate capabilities holds the key to future land use management. At present most cropping and livestock activities are undertaken on soil types suitable for agriculture. However, over 30 per cent of total agriculture and forestry activities is carried out on soils with severe or very severe limitations. Over 42 per cent of the indigenous forest on these sensitive soils has been cleared for agriculture and forestry purposes (GWS 1991).

Table 4.1 Land use in Upolu and Savaii: percentage of total land

Type	Upolu		Savaii		Total	
	ha	%	ha	%	ha	%
Indigenous forest	49,407	17	109,304	39	158,711	56
Plantation forest	34	(a)	5,345	2	5,379	2
Livestock	7,267	3	2,644	1	9,911	3
Cropping (b)	56,515	20	53,173	19	109,688	39
Total	113,223	40	170,466	60	283,689	100

(a) Insignificant
(b) Includes cultivated land, land left fallow, land now overgrown, and Apia district and other residential land areas.

Source: GWS 1991

There are many and varied pressures on villagers to develop land from virgin forest. The availability of land and the desire for certain crops are the current, primary determinants of the pattern of land use, rather than the suitability of land for the purpose.

As land is developed from remaining virgin forest, there is the danger that as more and more land is required (as fertility declines), cultivation occurs higher and higher inland. As already seen, uncontrolled land clearance has caused severe soil erosion and flash flooding during the wet season. Of immediate concern is the increase in agricultural activities including the use of fertilisers and agricultural chemicals in catchment areas and upstream from water supply intakes.

The local custom whereby land is claimed from the virgin bush by the first person clearing the forests has already resulted in the clearance of inland areas that are unsuitable for agriculture. Much of the local support behind the construction of village plantation access roads deep into the upland areas seems to be driven by the villagers' desire for access so they can clear the bush and claim new lands.

These factors combine to present a growing threat to the biodiversity of Western Samoa, and a reduction in the forest available for cultural uses, such as the collection of medicinal plants, timber for buildings and canoes, and local crafts. Now that the lowland forests are all but gone, mid-level and upland forests are a vital refuge for plant and animal species. Retaining forests maintains or increases future options, cutting them down decreases them.

The main option for future land use is to approve, then promote, national land capability

Table 4.2 Land potential (ha)

Potential	Upolu	Savaii	Total
According to Wright (1963)			
Cropping	55,000	69,000	124,000
Cattle grazing	26,000	45,000	71,000
Unsuitable for agriculture	32,200	56,400	88,600
Total	113,200	170,400	283,600
According to Pak-Poy (1972)			
Intensive agriculture	61,000	80,000	141,000
Cattle ranching	26,000	39,000	65,000
Unsuitable for agriculture	26,200	51,400	77,600
Total	113,200	170,400	283,600

Source: Adapted from ADB 1985

guidelines to promote improved development of land resources. Traditional practices that conserve soil and soil fertility also need encouragement, as do new techniques such as contour planting. Incentives for land utilisation should be clearly linked to appropriate uses of land. Agricultural research, extension services and related infrastructure should also be strengthened to encourage appropriate uses of land.

Chapter 5

Socio-economic situation

5.1 Population and demography

5.1.1 Population structure

As previously mentioned, the population of Western Samoa from the preliminary results of the 1991 Census of Population and Housing is 161,298. Table 5.1 shows that the total population grew by 41 per cent during the 1961–1991 period, and growth declined during each successive intercensal period except the last. This decline is due mainly to a fall in the fertility rate and the high rate of overseas migration. The small increase during 1986–1991 perhaps reflects either lessened international migration (due to tougher conditions for entry to the traditional overseas destinations for Western Samoan citizens) or more migrants returning home (due to the economic recession affecting overseas employment).

The general improvement in health conditions has resulted in decreased mortality rate and increased longevity. The crude death rate fell from 7.4 per 1,000 in 1961 of population to 4.3 in 1990. Life expectancy improved from 40 to 63 and 58 to 65 for males and females respectively during 1961–1989. Table 5.2 shows a decline in young dependents (0–14 years) due to a fall in the fertility rate and an increase in adult dependents (60+ years) due to higher life expectancy. The working population (15–59 years) increased until 1986 where it remained steady at about 53 per cent of the total population.

Table 5.1 Population growth, 1961–1991

Year	Total population	Av. annual growth (%)
1961	114,427	3.3
1966	131,377	2.8
1971	146,627	2.2
1976	151,983	0.7
1981	156,341	0.6
1986	157,158	0.1
1991	161,298	0.5

Source: DOS 1993

5.1.2 Internal migration

While there has been limited inter-regional mobility within the country, there has been a general movement from rural to urban areas. This is a result of people looking for work and students attending schools in the more developed Apia and north-west Upolu areas. As shown in Table 5.3, there was a net

Table 5.2 Population age structure, 1981–1991

	1981		1986		1991	
Age	Total	%	Total	%	Total	%
0–14	69,635	44.5	64,595	41.1	65,469	40.6
15–59	79,071	50.8	83,776	53.3	86,029	53.3
60+	7,635	3.7	8,787	5.6	9,800	6.1
Total	156,341	100.0	157,158	100.0	161,298	100.0

Source: DOS 1981, 1986, 1991

Table 5.3 Regional migration, 1981–1986

Region	Stayers	In-migrants	Out-migrants	Net-migrants
Apia urban area	24,178	3,344	1,546	1,798
North-west Upolu	30,509	2,907	1,613	1,294
Rest of Upolu	34,232	846	2,233	−1,387
Savaii	38,144	504	2,209	−1,505
Total	127,063	7,601	7,601	0

Source: DOS 1986

inflow of people during 1981–1986 into the Apia urban area and north-west Upolu from the rest of Upolu and Savaii. It is expected that the same trends would have accelerated during 1986–1991 with many of the migrants to the Apia urban area moving into the new government subdivisions at Vaitele-uta and Vailele-uta.

5.1.3 International migration

The information in Table 5.4 on international migration is compiled from migration cards which travellers arriving and leaving Western Samoa are required to complete. However, due to the high proportion of unanswered questions by travellers, there has been concern about the usefulness of this data (Pak-Poy & Kneebone 1981). The general trends are such that out-migration has declined from a peak in 1988, which corresponds with global economic recession and tougher requirements for entry into the traditional destinations for Western Samoan migrants. International migration is mainly to American Samoa and New Zealand which attracted 75 and 12 per cent of travellers during 1991 (DOS 1991).

5.1.4 Projected population

Between 1906 and 1991, the population increased more than four-fold from 37,320 to 161,298, representing an average annual population growth rate of about 3.8 per cent. As shown in Table 5.5, for the intercensal period 1982–1986 the net out-migration rate increased from 16.7 per 1,000 to 28.0. Therefore, despite the stable high birth rates and declining death rates, the high emigration rates give a net decline in population growth rate during the same period.

Table 5.4 International migration, 1982–1991

Year	Arrivals	Departures	Out-migration
1982	77,890	78,844	954
1983	74,142	76,571	2,429
1984	81,043	85,857	4,814
1985	85,634	88,746	3,112
1986	88,551	92,413	3,862
1987	93,212	96,242	3,030
1988	91,517	96,795	5,278
1989	102,592	103,378	786
1990	103,972	104,774	802
1991	96,933	99,820	2,887

Source: DOS 1991

Table 5.5 Population vital statistics for the intercensal period, 1982–1986

Year	Birth rate*	Death rate*	Net out-migration rate*	Annual population growth rate (%)
1982	31.0	7.4	16.7	6.9
1983	31.0	7.4	16.7	6.9
1984	30.5	6.3	28.0	−3.8
1985	30.0	5.2	24.3	0.5
1986	29.5	5.0	28.0	−3.5

* per 1,000 population

Source: DOS 1986

Table 5.6 shows population projections for three different annual growth rates. The first scenario is the annual growth rate of 0.6 per cent given by DOS; the second is the estimated growth rate of 1.06 per cent published by the South Pacific Alliance of Family Health (SPAFH 1991); and the third is the current estimated natural growth rate of

about 2.0 per cent. According to the latter, if the safety valve of emigration is tightened, the 1986 population is likely to double by the year 2021.

Table 5.6 Population growth projections

Year	DOS (0.6%) annual pop.	SPAFH (1.06%) annual pop.	Birth-Death (2%) annual pop.
1986	157,000	157,000	157,000
1991	161,766	165,499	173,340
1996	166,677	174,458	191,382
2001	171,737	183,903	211,301
2006	176,951	193,858	233,293
2011	182,323	204,353	257,574
2016	187,859	215,416	284,383
2021	193,562	227,077	313,981

Source: GWS 1992b

5.1.5 Future options

There are three main issues of concern to Western Samoa if the national population is allowed to continue to increase at the current rates. These are identified in the draft Population Policy as: (1) limited land resources; (2) depletion of other natural resources; and (3) strain on existing economic and social infrastructure (GWS 1992b). In order to maintain a high standard of living with all the amenities of civilisation, it is estimated (based on total available agricultural land and human needs) that the optimum population for Western Samoa is 130,000 people (Marshall 1950). The effects of reduced international migration and the likelihood of some unemployed Samoans returning home will exacerbate the local demand for limited resources.

With continuing migration from the rural areas, it is important to ensure that there is orderly development of infrastructure and proper provision of services in the Apia urban area. The government proposal to establish the Apia Municipal Authority with appropriate legislation should provide the institutional framework for urban planning to occur.

As recognised in the country's Fourth Five Year Development Plan, family planning, while agreed to in 1971, was not integrated with economic, environmental or social development objectives (GWS 1980). Today, it seems that the same is still true. The main obstacles faced by family planning programmes include religious beliefs, the apparent advantages of large families within the traditional ethos, and lack of public awareness.

The main options therefore in relation to population issues are (1) the integration of demographic dynamics and trends into national development planning, and (2) the attainment of a national population growth rate that available resources can sustain. However, the first priority is to finalise the draft National Population Policy for Cabinet approval. The policy proposes a strategic integrated approach to population management, where a sustainable population growth is developed in relation to the success of national efforts in primary health care, community education (particularly women's education), and economic development.

5.2 Cultural and heritage resources

5.2.1 Samoan culture

Samoan culture and customs have been discussed in many publications since the arrival of the Christian missionaries (Turner 1884; Watson 1891; Stevenson 1901; Kramer 1901; Gratton 1948). The emphasis of studies since the 1960s has been on the effects of 'faa-Samoa' on development (Pitt 1970; Lockwood 1971; Shankman 1976; O'Meara 1990).

While the most visible arts relate to wood carving and construction for functional and ceremonial purposes and the making of cloth ('siapo') from mulberry bark, the pinnacle of Samoan art is expressed in its strong tradition of oratory.

Traditionally, Samoan culture was strongly linked to the natural world, and traditional laws governing the use of forest and lagoon resources demonstrate an intimate knowledge of that world. Samoan plants, animals and places feature in many legends and proverbs.

The Samoan way of life is based on its social institutions (family, village council, women's committee, church) which provide direction for individual or group behaviour and responsibilities, as well as overall village organisation. Many of the traditional roles and obligations especially during ceremonies have been so for generations. Today, the majority of Samoans see these day-to-day activities as their 'living' culture. This may explain local reservations about the need for a national cultural centre and museum.

Samoans still use scourers made from natural fibres, in this instance, a native herb. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Ceremonial traditions remain strong in Western Samoa. (photo: Paddy Ryan, reproduced courtesy of MFAT)

Skills in 'fale' (traditional Samoan house) construction and boat building have declined over the years. The 'fale' with its unique architectural design is built less and less due to the lack of traditional building materials and tradespeople, and the convenience of other types of construction. The functional aspects of aluminum fishing boats are now preferred to the traditional 'paopao' and 'vaa-alo'. Techniques for making 'siapo' (traditional cloth made from mulberry bark) have also changed with the use of commercial paints and plastic stencils. Many of the traditional recreational games are no longer practised, with a national preference for modern ball games especially rugby. Apart from the use of carbon soot instead of traditional plant dye, the art of tattooing is still very popular, and is one of the few cultural activities that has changed very little over the years. As Samoan culture is affected by outside influences, the understanding of the natural environment declines.

To promote cultural understanding and awareness, the government has for some time initiated the teaching of Samoan culture at schools and later at the National University of Samoa. There is no information available on the success of these programmes but many young people can benefit from them, especially those living in the urban areas where changes to 'faa-Samoa' are more evident. It is interesting that in New Zealand with a large Samoan population, the Samoan language is offered at schools and at university level.

5.2.2 Archaeological and cultural resources

Heritage conservation contributes to the heightening of perceptions of our environment, the strengthening of our knowledge and understanding of history, and helps to confirm our identity as people (Proudfoot 1991). There have been a number of studies of the archaeological sites in Western Samoa (Green & Davidson 1969a, 1969b; Jennings et al. 1976, 1980). Due to the terrain and the vegetation growth, sites are difficult to locate and many more probably remain to be discovered. Only one of these sites, the Tia Seu Ancient Mound on Savaii, is currently assessible and a tourist destination, although the national tourism masterplan has identified others. Archaeological sites include:

- Prehistoric villages and sites — the earliest known site (about 3,000 years ago) is that at Mulifanua on Upolu, a site associated with

Interior of Samoan house. (London Missionary Society Collection, reproduced courtesy of Alexander Turnbill Library) Skills in 'fale' construction have been declining.

the Lapita people who left many pieces of broken Lapita pottery. Often located inland, some of the prehistoric villages were occupied over 2,500 years ago. The location of these sites is often not known by modern Samoans.

- Star mounds — rock and earthen structures with projecting arms or rays.
- Prehistoric forts — hilltop sites comprising strategically placed terraces, walls and defensive ditches. Samoan oral tradition contains extensive references to a period of wars with, and occupation by, Tongan islanders (AD 950–1,250). Some of these sites may provide evidence about this period of history.

While there is little knowledge of these sites by modern Samoans, there is considerable importance attached to legendary sites that are referred to in Samoan legends and mythology.

A heritage study by Pringle (1989) documents the architectural history of Apia and recommends strategies for the conservation of the urban environment.

The Robert Louis Stevenson Foundation has started renovation work on the author's former residence just outside Apia. It is intended that the home and surrounding gardens will become the Stevenson Museum. The role of the private sector in heritage conservation can be quite effective, and as promoted by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the economic aspects of this scheme are quite compatible with its cultural objectives (de Andrade 1968). However, it is important for the government to establish some guidelines for conservation to

Portion of star mound (photo: A.C. Robinson, reproduced courtesy of DLSE)

ensure that the significant aspects, such as authenticity of buildings and structures, are not compromised or destroyed.

For historical and archaeological sites, "one of the major features of these landscapes is not only their beauty but also their association with human beings and events" (Galbreath 1975). The National Tourism Development Plan identifies a number of existing and potential historical locations and archaeological sites for preservation, as well as areas with significant cultural and natural attributes (GWS 1992c). As in the case of the built environment, "criteria for identifying lands with specific cultural amenities must be processed and accepted" (Galbreath 1975).

5.2.3 Future options

While the archaeological sites of Western Samoa have been documented, there is a need to make them more accessible to both locals and tourists and to interpret their significance. Lack of knowledge and appreciation of these sites has led to some unintentional damage, such as road building through sites or collection of rocks for new dwellings.

Since the late 1970s, Western Samoa has tried to encourage the provision of national facilities for arts and culture. Two reports were prepared for the government of Western Samoa: Specht (1978) and Neich (1987). In fact, a national museum was set up in the early 1980s at Mulinuu, but failed through lack of funds and public support.

In early 1992, a workshop was conducted to revive the idea of a national museum and cultural centre. At the workshop, the wide functions of these facilities including their role in tourism development were discussed (Fiame 1992) as well as the need to preserve traditional culture for future generations to appreciate (Leleisiuao 1992). Cultural priorities are seen as:

(1) to formulate a policy on Samoan cultural and historical heritage; and
(2) to establish a cultural centre and museum facilities as the focus of efforts to preserve and develop Samoan culture.

A cultural centre on one hand will be the focus for teaching and learning of Samoan cultural activities including recreational, skills, and ceremonial programmes. It will also provide opportunities to stage cultural performances and exhibit visual arts and crafts.

A museum on the other hand will provide the facilities for the preservation of local historical artefacts. Many foreign collectors have indicated that they will return some of the local exhibits they possess if proper provisions are provided for their keep and security. The centre will also promote research by local and visiting scholars into all aspects of Samoan culture. In the case of German-Samoan documents, the government has recently approved the use of the present Prime Minister's Department building when vacant as the new national archives centre.

5.3 Human resources

5.3.1 Education and training

Education plays a very important role in human resource development. The government emphasis in the DP7 is to fit people for the economic opportunities which are available to them, through the upgrading of education resources. The government has also approved compulsory free education for primary schools. The education budget has been virtually fixed at about 10 per cent of the national budget since 1981. With about 95 per cent needed for recurrent expenditure, there is only limited local funding for educational capital development.

The government in recent years has promoted programmes for the training of teachers, nurses, laboratory technicians and tradespeople. Vocational skill training is also offered by a number of private organisations. To improve the teaching of vocational skills, the Western Samoa Technical Institute was upgraded to the level of a Polytechnic in early 1993. The National University of Samoa provides pre-university programmes for senior secondary school students, as well as degree and diploma courses in arts, science and accounting. The local centre for the University of the South Pacific also provides a range of extension study courses.

Much of the advanced and professional training for Western Samoan students is provided through overseas scholarships. There were about 246 students studying overseas in 1991, but many more local people also attend short in-service training courses overseas.

5.3.2 Employment

The preliminary results of the 1991 census (DOS 1993), shows a seven per cent reduction in the workforce from the 1986 levels. Forty-one per cent

Table 5.7 Economically active population by industry, 1981–1991

Industry	1981	%	1986	%	1991	%
Agriculture, forestry & fishing	25,050	60.4	29,023	63.6	26,777	63.0
Mining	–	–	22	<0.5	87	0.2
Manufacturing	757	1.8	1,565	3.4	1,194	2.8
Electricity & water	447	1.1	855	1.9	645	1.5
Construction	2,279	5.5	62	0.1	2,025	4.8
Wholesale & retail trade	1,821	4.4	1,710	3.8	1,862	4.4
Transport & communications	1,353	3.2	1,491	3.3	1,900	4.5
Financial services	1,305	3.1	842	1.8	1,373	3.2
Social & personal services	8,216	19.8	9,436	20.7	6,631	15.6
Other	278	0.7	629	1.4	0	–
Total employment	41,506	100.0	45,635	100.0	42,494	100.0

Source: DOS 1981, 1986, 1993

of the total population aged 15 years and over are classified as economically active (compared to 47 per cent in 1986). Of those who are economically active, 89 per cent are in the workforce. Eighty-three per cent of the workforce are men while 65 per cent of those out of work are also men. Participation rates in the workforce differ greatly for men and women, accounting for 57 and 13 per cent respectively during 1991.

Table 5.7 gives the breakdown of employment by industry during 1981–1991. The majority of the workforce (63 per cent) are employed in the primary sector. Manufacturing jobs declined by 23 per cent but with Yazaki (electrical car parts assembly factory for export) starting their operations in Western Samoa, a large gain in manufacturing jobs is expected by the end of 1993.

In the absence of more detailed employment data, it is difficult to determine the patterns of employment and the labour market situation, the nature of underemployment in the subsistence sector, and the impact of international migration and 'brain drain' on employment trends. An interesting trend, as shown in Table 5.8, is the 37 per cent increase in the number of unpaid workers from 1986 to 1991.

In late 1991, the Public Service Commission (PSC) estimated that about 6,000 workers were employed in the government sector. This estimate did not include those employed by government corporations, the largest of those being the Electric Power Corporation, Western Samoa Shipping Corporation, Airport Authority and WSTEC. Based on previous employment surveys, it is assumed that about 50–60 per cent of all employees (including casuals) are likely to be employed in the government sector and government corporations (Miles et al. 1992).

In the recently completed PSC human resources plan for the public sector, one of the main objectives is improved retention of qualified staff (PSC 1992). This is one of the main concerns relating to human resources and includes the 'brain drain' or loss of skilled workers to overseas

Table 5.8 Employment by status, 1981–1991

Status	1981	%	1986	%	1991	%
Employer	259	0.6	114	0.2	700	1.6
Employee	18,045	43.5	15,870	34.8	15,592	36.7
Self-employed worker	8,503	20.5	11,935	26.2	2,647	6.3
Unpaid worker	14,526	35.0	17,221	37.7	23,553	55.4
Not stated	173	0.4	495	1.1	2	<0.5
Total	41,506	100.0	45,635	100.0	42,494	100.0

Source: DOS 1981, 1986, 1993

Table 5.9 Savings and investment, 1987–1989 ($m)

	1987	1988	1989	1989 (% GDP)
At current prices				
GDP	219	240	248	100
Consumption (private & government)	237	254	266	107
Gross investment	74	77	83	33
Domestic savings	-17	-13	-17	-7
Resources (savings/investment) gap				
(1989=100)	91	90	100	40

Source: World Bank 1991

countries. In response, the government in 1991 re-introduced the scholarship bond, to oblige those who had undertaken overseas training to work in Western Samoa for a specific period. However, in the long term the government needs to provide appropriate incentives to entice qualified and skilled workers to remain and work in Western Samoa.

Curriculum development is one of the most important components of the education system. During the 1970s and 1980s, the Education Department developed the primary and junior secondary education curricula. Programmes for trades and vocational were all upgraded. At the present time, plans are in progress to develop the senior secondary school curriculum.

In general, however, the concept of human capital needs to be considered in order to arrive at a comprehensive and integrated policy on local investment in education.

5.4 Patterns of economic growth

5.4.1 Growth of the economy

In terms of current prices, Gross Domestic Product (GDP) was 23 per cent higher in 1991 compared to 1987. However, when allowance is made for inflation, GDP actually contracted over this period. Cyclone Ofa in 1990 reduced real GDP by about 5 per cent. In contrast, GDP grew by about 3 per cent a year from 1982 to 1987 (GWS 1992a). For the decade 1982 to 1991, Western Samoa's performance was similar to that of other economies in the region: in recent years all have been affected by the global recession.

Apart from the effects of Cyclone Ofa (and Cyclone Val in 1992), the main reasons for the poor performance of the local economy are low commodity prices and poor management in the agricultural sector (Fairbairn 1991). As shown in Appendix 5, about 21 per cent of current GDP in 1989 was generated by agriculture and other related primary sectors. The service sector (distribution, restaurants, hotels, transport and other services) also generated 21 per cent.

The share of manufacturing in real GDP remained at about 12 per cent from 1985 to 1989. The main growth occurred in the service sector whose contribution to real GDP grew by 16 per cent over 1985–1989. Another important factor to note in Appendix 5 is the continuing importance of the subsistence sector, consistently generating nearly 30 per cent of real GDP. Gross Domestic Product per capita is estimated to be $1,590 in 1990 (GWS 1992a).

5.4.2 Savings and investment

As shown in Table 5.9, Western Samoa has experienced high rates of gross investment but very low domestic savings. The resultant resource gap has been financed from remittances and foreign aid. Personal transfers consisted mainly of remittances from Samoan migrants who have settled overseas, which grew at an average rate of 13 per cent per annum from 1984 to 1989 (GWS 1992a) and totalled $91m in 1990 (Fairbairn 1991).

Although the present high levels of investment are expected to promote economic growth, the minimal growth achieved in recent years must raise doubts over the choice of investment projects. The heavy reliance on remittances and aid as the main sources of national savings may also be unsustainable in the long term, due to uncertainties in the future nature of foreign aid, and the effects of the global recession on levels of remittances.

Table 5.10 External grants, 1986–1991 ($m)

Source	1986	1987	1988	1989	1990	1991[1]
Project grants						
New Zealand	3.2	5.0	5.6	5.1	5.3	4.3
Australia	2.6	8.8	10.8	8.1	8.6	5.3
European Development Fund	–	1.3	0.2	0.5	2.8	2.1
Federal Rep. of Germany	2.7	3.2	2.6	3.4	2.2	1.5
Japan	18.0	9.0	8.8	13.7	16.6	6.1
UNDP	0.3	1.2	1.0	2.4	1.0	0.8
Other	0.3	0.6	2.7	1.8	1.1	2.4
Total	27.1	29.1	31.7	35.0	37.6	22.5
(of which: expenditures abroad[2])	(3.9)	(4.8)	(4.4)	(5.6)	(3.5)	(4.8)
Cash & commodity grants						
EEC[3]	8.8	8.3	4.8	4.66	4.7	7.40
Other	0.1	–	6.1	0.23	2.0	2.75
Total	8.9	8.3	10.9	4.89	6.7	10.15
Total external grants	36.0	37.4	42.6	39.89	44.3	32.65

[1] Based on January-June data plus 50 per cent for FY 1991–1992
[2] Includes payments for scholarships and consultancies
[3] Stabex (export price stabilisation scheme)

Source: Central Bank of Samoa 1992

5.4.3 External aid

External aid in the form of grants and soft-term loans is a major contributor to the financing of the balance of payments and the funding of development projects in the public sector. Total aid to Western Samoa is about $65m per year (28 per cent of GDP or $400 per capita) (Fairbairn 1991). As the bulk of external aid is spent on infrastructure and human resource development, its benefits will not become apparent immediately.

Table 5.10 shows an overall decline in total external grants of nearly 10 per cent during 1986–1991, although the level of project grants declined by 17 per cent during the same period. With present levels being fairly flat and future trends uncertain, foreign aid cannot be relied upon as a sustainable source of development funds for Western Samoa.

5.4.4 The balance of payments

The main feature of the country's balance of payments as shown in Table 5.11 is the growing overall surplus achieved from very high levels of remittances, external grants and government loans. This has increased seven-fold (at current prices) during 1985–1990. This is despite a 43 per cent decline in exports (including re-exports) and a 68 per cent increase in imports.

5.4.5 Government finance

As shown in Table 5.12, government revenue and grants increased from 49.4 to 60.0 per cent of GDP during 1985–1990, while expenditure also increased from 51.8 to 63.1 per cent of GDP during the same period. Since 1986, the government has consistently achieved a balanced budget except in 1990 when the effects of Cyclone Ofa increased current and development expenditures to 25 and 36 per cent of GDP respectively. At the end of 1990, the total government debt was $195m of which 93 per cent was foreign debt (GWS 1992a).

5.5 Economic development strategies

5.5.1 General

The current development strategies for Western Samoa are proposed in the Seventh Development Plan (DP7) where the main components include:

Table 5.11 Balance of payments, 1985–1990 ($m at current prices)

Items	1985	1986	1987	1988	1989	1990
Capital account						
Merchandise trade						
Domestic exports	32.4	22.3	23.1	29.7	27.9	19.4
Re-export	3.8	1.2	1.8	1.7	1.3	1.1
Imports	-115.1	-105.4	-131.0	-159.1	-174.6	-193.4
Travel						
Credit	29.7	35.6	36.4	39.9	47.5	42.2
Debit	-2.9	-3.6	-3.4	-3.0	-3.8	-4.6
Investment income						
Credit[1]	1.5	2.7	7.2	6.0	10.2	15.5
Debit	-6.3	-5.2	-4.9	-4.7	-5.5	-3.5
Other services						
Credit	8.5	10.7	14.8	20.2	26.2	34.8
Debit	-11.7	-17.8	-18.0	-17.4	-21.1	-28.6
Private transfers						
Net	45.7	54.6	68.1	76.8	83.6	92.0
Balance	-14.2	-4.9	-5.8	-10.0	-8.1	-25.1
Capital account						
Government grants						
Net	25.7	34.1	35.7	41.1	37.8	36.1
Government loans						
Disbursements	5.6	5.8	12.5	8.3	10.5	29.1
Repayments	-8.0	-7.2	-6.8	-7.1	-8.4	-7.6
Balancing items[2]	-3.7	-3.1	-10.0	-0.6	0.7	5.2
Balance	19.5	29.6	31.4	41.6	40.6	62.7
Overall balance	5.3	24.6	25.7	31.7	32.6	37.6

[1] Government investment income only
[2] Private capital flows plus errors and omissions

Source: GWS 1992a

(1) consolidation of past investments;
(2) efficiency improvements;
(3) employment creation; and
(4) revitalisation of the primary sector.

Experience learned since the country's first development plan was introduced in 1966, and the recent devastation from tropical cyclones has prompted the government to reassess its development priorities. With growing concern for the damage to the natural environment, increased population growth and reduced emigration opportunities, the underlying thrust of current strategies is sustainable development.

Sustainable development allows progress and growth without risking constraints from overpopulation, resource depletion and ecological breakdown. It is defined as a process in which "the exploitation of resources, the direction of investment, the orientation of technological development and institutional change, are all in harmony and enhance both current and future potential to meet human needs and aspirations" (World Commission on Environment and Development 1987). Alternatively, it means "using, conserving, and enhancing the community's resources so that ecological processes on which life depends, are

Table 5.12 Government finance, 1985–1990

Items	1985	1986	1987	1988	1989	1990
Current prices ($m)						
Revenue & grants	97.7	113.5	128.9	148.4	149.4	159.8
Revenue	71.2	77.5	91.5	105.8	109.5	121.1
External grants	26.5	36.0	37.4	42.5	39.9	38.7
Net loan disbursements	4.7	-5.5	-0.8	-18.3	-5.7	-6.7
Expenditure	102.5	108.1	128.1	130.1	143.7	166.5
Current	41.9	48.0	49.8	54.4	58.2	64.8
Development[1]	49.9	48.6	63.8	59.0	66.3	93.9
Other[2]	10.7	11.4	14.5	16.7	19.2	7.8
Constant 1982 prices ($m)						
Revenue & grants	66.3	77.1	83.6	87.6	85.4	83.4
Revenue	48.3	52.7	59.3	62.5	62.6	63.2
External grants	18.0	24.4	24.3	25.1	22.8	20.2
Net loan disbursements	3.2	-3.7	-0.5	-10.8	3.3	3.5
Expenditure	69.5	73.4	83.1	76.8	82.1	86.9
Current	28.4	32.6	32.3	32.1	33.3	33.8
Development[1]	33.8	33.0	41.4	34.8	37.9	49.0
Other[2]	7.3	7.8	9.4	9.8	10.9	4.1
Percentages of GDP						
Revenue & grants	49.4	54.7	58.6	61.5	60.0	60.0
Revenue	36.0	37.4	41.6	43.9	44.0	45.9
External grants	13.4	17.3	17.0	17.6	16.0	14.7
Net loan disbursements	2.4	-2.6	-0.4	-7.6	-2.3	-2.5
Expenditure	51.8	52.1	58.3	53.9	57.7	63.1
Current	21.2	23.2	22.7	22.6	23.4	24.5
Development[1]	25.2	23.4	29.0	24.5	26.7	35.6
Other[2]	5.4	5.5	6.6	6.9	7.7	3.0

[1] Including non-capital items amounting to perhaps one-third of the total in an average year
[2] Including net loans and advances to, and purchase of shares in, public enterprises; in effect, subsidies

Source: GWS 1992a

maintained, and the total quality of life now and in the future, can be increased" (Commonwealth Government of Australia 1990). Underpinning sustainable development is the existence of, and reliance on, a healthy environment with an abundance of natural resources, where key natural processes can occur without significant adverse impact.

In the Samoan context many natural resources are already seriously depleted (for example, reef, lagoon and rainforest). The change towards sustainable use of resources involves some significant changes in attitudes and practices at individual, village and government levels. Clearly, some established practices are already unsustainable and alternative strategies need to be found and agreed to at a fundamental level within the community, not simply by official decision makers.

Central to the achievement of sustainable development is thus the process of change which is, in turn, dependent upon a government commitment to public information/education and involvement.

5.5.2 Consolidation of past investments

Throughout the 1980s, Western Samoa invested heavily in public development programmes at an average of about 26 per cent of GDP annually (GWS 1992a). Investments favoured mainly the

construction of infrastructure in the transport and energy sectors. Notwithstanding some cyclone-damaged facilities which are yet to be repaired, the country is generally well provided with infrastructure. That is, infrastructure is not a constraint to development in the short to medium term. The emphasis taken in DP7, therefore, is on the maintenance and efficient use of existing infrastructure facilities.

Policies aimed at improving the efficiency of government activities have already been implemented including the commercialisation of a number of government operations. These include civil aviation and shipping and the proposed corporatisation of the Apia port, water and sewerage authorities. Telecommunications is yet to be commercialised although the necessary legislation has been passed for some time. Land transport is the one sector where, despite repeated commitment of substantial investments, the government is yet to provide a consistent policy for its long-term development.

5.5.3 Efficiency improvement

The main requirement for improving efficiency is the development of human resources. The economic decline despite large-scale investments is a direct consequence of the lack of skilled workers in the labour force. Technical, managerial and financial qualifications are among the key skills that are always in short supply in the local labour market.

As the private sector is considered to have a better chance of operating more efficiently than the public sector, it is important that necessary opportunities are promoted to provide the necessary investment climate and boost business confidence. As well as financial incentives, a number of institutional issues such as research and development, and marketing will need urgent policy directions.

Other financial areas that need to be addressed include the taxation and import duty policies. For the first time, as of January 1994, all citizens of Western Samoa will pay a consumption tax through a value added and goods and services tax. Taxing consumption instead of production will promote efficiency. While a reduction in the levels of income and business taxation rates is expected through the restructuring which will follow implementation of the new tax, it is also very important that the import duties are reviewed so as not to adversely affect those in the subsistence sector and on low incomes.

5.5.4 Employment creation

The primary sector will continue to provide the backbone of the Western Samoan economy in the long term, and the main source for employment growth. Other areas with good prospects for job creation include tourism, resource-based manufacturing and low-wage export processing. However, it is important to provide sustainable employment where jobs will not only improve people's lives (through wages and learning new skills) but also promote self-reliance.

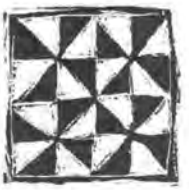
The creation of local jobs should be considered a top priority in external aid-funded programmes. This should not only create employment in the short term but will also improve the chances of success of these projects.

5.5.5 Revitalisation of the primary sector

The importance of the primary sector to the local economy has already been highlighted, with agriculture, forestry and fisheries holding the key to future economic and employment growth. As well as being critical to Western Samoa in its own right, the primary sector also impacts directly on most other environmental resources including population, land, water, forests and marine resources. It seems therefore that effective environmental management is only possible through improved performance in the primary sector. That is, people are more likely to protect the environment if by doing so they are satisfied that their outputs have been maximised.

While traditional customary land tenure and 'faa-Samoa' has often been considered an impediment to progress and development (Stace 1954; Fairbairn 1985; Pak-Poy & Kneebone 1981; GWS 1991; GWS 1992c), the experience of international development organisations such as the World Bank has shown that traditional farmers will respond more to the right economic incentives and opportunities than the demands of their traditional cultures. Innovative ways of improving the factors of production and marketing in the primary sector are needed.

Chapter 6



Responses to environment and development trends

6.1 Government policies

The GWS through recent policy initiatives and institutional measures has shown some commitment to the conservation and protection of the local environment. Perhaps the most important of these was the enactment of the *Lands, Surveys and Environment Act 1989*, which set up the Division of Environment and Conservation (DEC) within the Department of Lands, Surveys and Environment, and consolidated the law in respect to environment protection and planning. The lands and environment legislation contains a broad mandate encompassing natural resource protection, environmental management and pollution control. It also incorporates the responsibilities of the *National Parks and Reserves Act 1974* and the conservation of wildlife aspects of the *Animals Ordinance 1960*. Another recent significant development has been the establishment of a stand-alone Ministry of Women Affairs.

Included in DEC's current programmes are:

(1) promotion of draft legislation for Environmental Impact Assessment (EIA);
(2) establishment of waste management strategies (including the development of a new landfill site for solid waste disposal);
(3) identification and conservation of critical ecosystems and biodiversity;
(4) information and education programmes;
(5) 'taking over' of lands in water catchment areas; and
(6) preparation of the Western Samoa National Environment and Development Management Strategies (NEMS) "for addressing the country's environmental problems comprehensively" (Tofilau 1992).

Other important recent government policies which will impact significantly on the local environment include:

- the establishing of the Samoa Water Authority to manage national water resources;
- the preparation of draft national policies on forestry and population; and
- proposals to establish the Apia Municipal Authority to manage the urban environment.

The Seventh Development Plan (DP7) released in March 1992 puts much emphasis on environmental protection and sustainable development (GWS 1992a). This is the first national attempt to integrate environmental and economic issues to achieve sustainable development. One of the plan's objectives is to achieve a GDP rate exceeding the population growth rate, and to achieve it through sustainable development. The need to carry out EIA is recommended for all major projects. In the Foreword, the Prime Minister conceded that "it has become evident in recent years that much apparent development, especially in agriculture, has been achieved at the expense of the long-term health of the environment. We have, in effect, been consuming our natural capital". He promised, "This will stop" (GWS 1992a).

Early in 1992, the South Pacific Regional Environment Programme (SPREP) office was relocated to Apia from Noumea, New Caledonia. SPREP's presence also seems to have increased local interest and awareness in environmental issues.

A delegation from Western Samoa led by the Prime Minister attended the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in mid June 1992. In his address to the conference, the Prime Minister stated: "For the purpose of addressing environmental issues comprehensively, my Government is

in the process of formulating a National Environmental Management Strategy" (Tofilau 1992).

Both DP7 and NEMS propose government policy development as the next part of both processes. Formal development of government policy is not common to date. The completion of these phases of both processes, and their implementation, will be particularly significant.

6.2 Environmental conventions and treaties

Since UNCED, there has been a sudden upsurge of interest shown by the Government of Western Samoa in becoming a party to various international treaties on the environment. Western Samoa signed the *Climate Change Convention 1992* and the *Biological Diversity Convention 1992* at the Rio Summit in June 1992, and has expressed its intention to ratify both conventions. Although not an original signatory, Western Samoa acceded to the *Vienna Convention on the Protection of the Ozone Layer 1985* and the *Montreal Protocol on Substances that Deplete the Ozone Layer 1987* in December 1992. It has not yet ratified the *London Adjustments and Amendments to the Montreal Protocol 1990.*

The United Nations Convention on the Law of the Sea, Montego Bay 1982 was signed by Western Samoa in September 1984, but has yet to be ratified. At the regional level, Western Samoa is a party to the *Convention on the Prohibition of Driftnet Fishing in the South Pacific 1989*; *Convention for the Conservation of Nature in the South Pacific 1976*; *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region*; and the *South Pacific Nuclear Free Zone Treaty.* Submissions for accession to the *Cites Convention* and a number of conventions dealing with marine pollution are presently being considered by Cabinet.

Western Samoa's participation in international conventions and treaties is important. They provide an international forum to voice local concerns over global issues (atmospheric pollution, greenhouse, and international toxic waste disposal) that are beyond the country's control.

6.3 Legislation

Since the coming into force of the *Lands, Surveys and Environment Act 1989*, a number of legislative reviews (Harding 1992; Warren & Sisarich 1992; Peteru 1993) have been conducted on the laws of Western Samoa to assess the adequacy of current legislation on the environment and to streamline the provisions of the various statutes. The Lands, Surveys and Environment Act is yet untested but its creation provides the potential to unify environment and development legislative requirements into a single, coordinated Act.

Land resources are administered by the DLSE under the *Lands, Surveys and Environment Act 1989* (by which any public land can be protected to maintain soil and water) and the *Taking of Lands Act 1964* (where the government can take or exchange for public purposes). Apart from DLSE, the other two most important government departments dealing with environmental resources are the Public Works Department (PWD) and the Department of Agriculture, Forests and Fisheries (DAFF).

The Public Works Department is responsible for the administration of water resources. The *Water Act 1965* prohibits cultivation within 60 m of streams and provides for the taking of land to protect water and soil. The *Forest Act 1967* administered by DAFF has provisions for declaring 'protected areas'. The Public Works Department is also responsible for the control and monitoring of building standards through the *Public Works Ordinance 1959* and the Board of Health Regulations. However, there are no provisions for planning requirements in relation to building development.

The Department of Agriculture, Forests and Fisheries under the *Forestry Act 1967* administers the conservation, resource management and exploitation of forests. However, criteria for sustainable harvesting of the forest resources are not provided in the Act. While DAFF under the *Agriculture, Forests and Fisheries Ordinance 1959* is responsible for the protection of the marine environment, the specific *Fisheries Protection Act 1972* does little more than restrict resource exploitation by foreign vessels; and the *Exclusive Economic Zone Act 1977* prohibits foreign crafts from fishing in the Western Samoan EEZ. No provisions exist for the conservation of marine resources.

Agriculture, Forests and Fisheries Amendments (1989 and 1993) and Pesticide Regulations (1990 and 1993) deal with pesticide registration.

There is an apparent conflict between resource management and development objectives. For example, forest protection provisions cannot be fully

implemented due to government policies on logging; and water and soil conservation is ineffective due to uncontrolled land use practices. Obviously, there is an urgent need to consolidate existing legislation and to identify clear lines of environmental responsibilities. Provisions should be included in legislation to promote the sustainable use of marine resources and to control marine pollution. Similarly, the requirements of the *Water Resources Act 1985* need to be enforced for the planning and implementation of water resource development, pollution control, and the conservation and protection of watersheds. Readers are referred to the legislative review that forms part of the series of NEMS publications (Peteru 1993) for further information.

Both DP7 and NEMS have identified conflicting sector objectives as a key problem. Some legislative amendment may assist the resolution of this problem, but it is the integration of sector objectives that is presently the missing link. The policy development programmes established by DP7 and NEMS are essential to make this linkage, in addition to the development of adequate monitoring and enforcement mechanisms within government. Both the DEC and the fledgling planning function within the DSLE will be significant in this regard.

6.4 Institutional arrangements

As mentioned earlier, the government initiative which most strongly reflects its concern for environmental management was the establishment of the Division of Environment and Conservation in May 1990. DEC is organised into three functional units: the Environment Planning Unit, the National Parks and Reserves Unit, and the Education and Training Unit.

Although environmental conservation efforts have begun to focus around DEC, many of the related activities are still scattered among a number of government agencies. Each government department or corporation conducts its own programme planning and implementation, and the Treasury Department deals with economic planning through the National Planning Office. The fragmented nature of the current system has resulted in only limited interdepartmental interactions, poor exchange of information, and duplication and/or conflict of responsibilities.

Non-governmental organisations (NGOs) can provide vital support for environmental management, especially in the key areas of education and the creation of public awareness. There are now two environmental NGOs in Western Samoa, the O le Siosiomaga Society and Faasao Savaii, but a number of other organisations are also involved in programmes relating to environmental issues. Government policies on NGOs are unclear at present, especially its position on aid funding for NGO programmes. As more and more of related international assistance is channelled through private sector organisations, the government must encourage the role of NGOs in environmental management and national development.

6.5 Specific programmes

Watershed management

The Vaisigano Pilot Watershed Management Project, supported by the United Nations Development Programme (UNDP) and FAO, started in 1988 through the Forestry Division of DAFF. Its primary objective is to make local villagers aware of the benefits of integrated watershed management. The process includes the establishment of trial agricultural plots using conservation farming practices, through close consultation with village organisations and individuals. The programme has recently been extended and expanded to other watershed areas with ADB funding.

Conservation agreements

The 'matais' of Falealupo village at north-west Savaii signed a conservation agreement with private donors to protect its indigenous forest and wildlife for a period of 50 years, in exchange for funds to build a school. Similar agreements were signed between the 'matais' of Tafua village and the Swedish Nature Conservation Society and, more recently, similar arrangements have been made for Faala and Salelologa villages (and also for the Tafua Peninsula).

Reserves

Five reserves have been established:

- Togitogiga Recreation Reserve
- Mount Vaea Scenic Reserve (52 ha)
- Robert Louis Stevenson Memorial Reserve (0.4 ha)
- Vailima Botanical Gardens (12 ha)

- Palolo Deep Marine Reserve (22 ha).

The 2,833 ha O Le Pupu-Pue National Park is Western Samoa's only national park.

National inventory of terrestrial and marine resources

An ecosystem survey, supported by SPREP and The Nature Conservancy (TNC), was conducted during 1988–1990 to systematically collect information for the conservation of biodiversity. A second survey of lowland terrestrial and marine resources, supported by the New Zealand Government and the World Wide Fund for Nature was completed in 1992. An upland terrestrial survey is planned.

Fisheries management

A recent assessment of inshore fisheries and marine resources was conducted in 1989, supported by UNDP and FAO.

Species conservation

In early 1989, Cabinet passed a ban on the export of the two local species of fruit bats, which had been exported at the rate of 7,000 each year since 1985 (GWS 1991). Current DEC activities include the identification of endangered ecosystems, the conservation of natural habitats, and proposed turtle and bird conservation programmes.

Water resources management

To improve the management of water resources, the government is to promote legislation to establish a Water Supply Authority which will be independent of PWD. Plans for water metering and better cost recovery are currently being implemented following recent amendments to the water supply legislation. The preparation of the national masterplan is in progress, which will guide future investment and development in water resources.

Waste management

Given the current problems, the management of waste is recognised as a high profile issue. A programme is under way to resolve the problems as well as to raise public awareness and bring about change. As with most environmental problems in Western Samoa, causes as well as solutions rest with individual members of the community. This is seen as a key programme for general environmental awareness as well as for the specific problems of waste management.

Legislative amendment and regulations

Reviews of environmental and related legislation are under way and a programme of preparing key regulations has begun. The preparation of EIA regulations has been undertaken and a draft now awaits government approval. Pollution control regulations are in the early stages of development.

National Environment and Development Management Strategies (NEMS)

This is the principal programme for integration of environment and development at a national level. Phase 1 has been completed, Phase 2 is now under way which includes the significant task of cross-sectoral policy development for the key environment issues identified in Phase 1.

It is clear that an integrated approach to environmental management needs to be promoted in Western Samoa. The NEMS has therefore deliberately focused on issues rather than taking the traditional sectoral approach. By this means the Strategies aim to involve the different players dealing with any environmental issue in the planning and implementation of related programmes.

The following issues have been identified as the major environmental issues to be considered in the proposed NEMS:

- Management of population dynamics and change.
- Protection of the quality and supply of fresh water.
- Protection of the sea and marine resources.
- Management of waste.
- Combating deforestation.
- Development of appropriate land use practices.
- Conservation of biological diversity.
- Protection of the atmosphere.
- Planning for climate change.
- Preservation of traditional arts, culture and history.
- Development of human resources.
- Promoting sustainable economic development.

Chapter 7

Conclusions

As identified in the body of this report, the state of the Western Samoan environment is cause for considerable concern. Most critical environments exhibit levels of degradation and exploitation that are in excess of the capacity of natural processes to sustain.

While recent years have seen some significant responses by government and village authorities, it is clear that time is now short. Much more remains to be done if standards of living and the quality of life of the current generation is to be maintained, let alone if restoration of degraded environments is to be undertaken to achieve levels of environmental health and natural resource abundance enjoyed by former generations.

The overall trend in the state of the environment in Western Samoa is one of progressive decline of a way of life that is sustainable and based on indigenous natural resources. This trend is towards a way of life that is only sustainable with continued and increasing inputs of capital and products from external sources (notably remittances and aid).

Western Samoa presently stands at the crossroads. If no conscious change is made, the current trend is likely to continue with concomitant further loss and degradation of the natural capital which constitutes the essential base for truly sustainable national development. This would represent a fundamental break with the 'faa-Samoa' which had developed in the context of an abundant natural environment. The challenge of the NEMS process, and indeed for Western Samoa itself, is to deal appropriately with these issues and decide on a national direction and strategy to achieve it.

As NEMS has identified, the key requirement is to manage a process of change which must reach from government and village decision makers to individuals thoughout Western Samoa. This process of change, and implementation of the strategies proposed to achieve it, is dependent upon the adoption of an integrated environmental assessment and long-term planning process which has no real precedent in Western Samoa.

Traditionally, life in Samoa proceeded with, by Western standards, a very limited amount of forward or long-term planning. Resources have traditionally been abundant and a lack of distinct seasons has meant that many basic foods are available all year round. This absence of a need to plan is challenged by the need now to plan for the long term to resolve resource conflicts, and to avoid the degradation and overexploitation of vital resources brought about by increasing population pressures and increasing demands. It is a major challenge to Samoans to adapt their way of life to incorporate a long-term view of resource use. It will require coordination and cooperation among government agencies and the decision making of ministers. It will also require a commitment to a mechanism for integration and cooperation between government and villages, between villages, and between families within the village structure, to manage economic activities (for example, land use). It will also require adoption of and commitment to new approaches such as town and district planning and EIA. This represents a major undertaking for public education and information processes. It also demands a level of national debate involving villages that has rarely, if ever, been achieved before.

Development without consideration at the outset of the wider costs to both the community and the natural environment means that the burden of repair falls on the community/future generations. Many of these costs could have been avoided if they had been taken into account at the design stage. It is now recognised that in development planning a wider framework needs to be used. Potential

environmental and social costs must be assessed and allowed for at the design stage. Where development projects are still desired and such costs are inevitable, trade-offs should be openly acknowledged and provided for in the planning process with the active involvement of all likely to be concerned. Recent developments in environmental economics provide ways of better assessing the costs involved so that they can be incorporated into initial cost-benefit analyses.

The most critical immediate development, however, for the conservation of the environment of Western Samoa and for shifting national development towards a truly sustainable base, is the completion and implementation of the NEMS process. It is most important that the government make a solid commitment to the implementation of NEMS, both in terms of government decision-making processes, and of adequate resourcing for key implementing agencies.

The stakes are high. Not only is the health of the Western Samoan national environment at issue, but, even more significantly, so too is the well-being and quality of life for future generations of Samoans, and the very foundation of the 'faa Samoa' itself.

Chapter 8

References

ADB. 1985. Western Samoa Agriculture Sector Study, vol. 2, Background and Sector Review. Asian Development Bank, Manila, Philippines.

Ahlburg, D. & Levin, M.J. 1990. The North East Passage: A Study of Pacific Islander Migration to American Samoa and the United States. Australian National University, Canberra, Australia.

Amerson, A.B., Whistler, W.A. & Schwaner, T.D. 1982. Wildlife and Wildlife Habitat of American Samoa, vol. 1, Environment and Ecology. U.S. Fish and Wildlife Service, Washington, DC, USA.

ANZDEC Limited Consultants. 1990. Land Resources Planning Study: Western Samoa. Final report. Asian Development Bank TA no. 1065-SAM, New Zealand, January.

Biosystems Analysis Inc. 1992. A comprehensive Wetland Management Plan for the islands of Tutuila and Anuu, American Samoa. Economic Development Planning Office, American Samoa, Coastal Management Program, American Samoan Government, Pago Pago, American Samoa.

Bryant, E. 1991. Sea level and greenhouse. Australian Planner, vol. 29, no. 1, March.

Bunker, R. 1990. Greenhouse planning and urban affairs. Paper presented to the 1990 Planning Ministers' Conference on Greenhouse Effect, Cairns, Australia, June.

Central Bank of Samoa. 1992. Bulletin. December, 1992, Apia, Western Samoa.

Christensen, K.C. 1943. A Revision of the *Pteridophyta* of Samoa. Bernice P. Bishop Museum Bulletin 177, Honolulu, Hawaii.

Commonwealth Government of Australia. 1990. Ecologically sustainable development. Discussion paper, Australian Government Printing Service, Canberra, Australia.

Comstock, J.A. 1966. *Lepidoptera* of American Samoa with particular reference to biology and ecology. Pacific Insects Monograph II, Bernice P. Bishop Museum, Honolulu, Hawaii.

Connell, J. & Lea, J. 1992. My country will not be there: Global warming, development, and planning response in small states. Cities, November.

Cowie, R. 1992. Evolution and extinction of *Portulidae*, endemic Pacific Island land snails. Philosophical Transactions of the Royal Society of London, vol. 335, pp. 167–191.

Dahl, A.L. 1980. Regional Ecosystem Survey of the South Pacific. South Pacific Commission technical paper 179, Noumea, New Caledonia.

Dahl, A.L. 1986. Review of the Protected Areas System in Oceania. World Conservation Union (IUCN), Gland, Switzerland, and Cambridge, England.

de Andrade, R.M.F. 1968. The conservation of urban sites. In The Conservation of Cultural Property. UNESCO, Paris, France.

Department of Agriculture, Forests, & Fisheries. 1992. Western Samoa: Forest Area Statement. Apia, Western Samoa, April.

Department of Statistics. 1981. Report of the Census of Population and Housing 1981. Apia, Western Samoa.

Department of Statistics. 1986. Report of the Census of Population and Housing 1986. Apia, Western Samoa.

Department of Statistics. 1991. Annual Statistical Abstracts 1991. Apia, Western Samoa.

Department of Statistics. 1993. 1991 Census

Population and Housing: A Special Release of Selected Tables. Apia, Western Samoa.

Department of Statistics/Department of Agriculture, Forests, & Fisheries. 1990. Report on the 1989 Census of Agriculture Western Samoa. Apia, Western Samoa.

Elsom, D.M. 1987. Atmospheric Pollution: Causes, Effects and Control Policies. Basil Blackwell, New York, USA.

Fairbairn, Te'o. I.J. 1985. Island Economies: Studies from the South Pacific. University of the South Pacific, Suva, Fiji.

Fairbairn, Te'o. I.J. 1991. The Western Samoa Economy: Prospects for Recovery and Long-Term Growth. Australian International Development Assistance Bureau, Canberra, Australia.

Fairbairn, Te'o. I.J. 1993. Western Samoa's Census of Agriculture: Major Features and Implications for Development. Centre for Pacific Studies, University of New South Wales, Sydney, Australia.

FAO. 1990. Water Quantity and Quality Monitoring Programs for the Vaisigano Catchment in Particular, and Western Samoa in General. Report written by J.D. Stednick, Field Document no. 3, 8851-SAM, September.

Fiame, N. 1992. The implications of a cultural centre. Keynote address at the Cultural Centre Workshop, Apia, Western Samoa, 24 April.

Fox, J.W. & Cumberland, R.B. (eds). 1962. Western Samoa: Land, Life and Agriculture in Tropical Polynesia. Whitcombe & Tombs, Auckland, New Zealand.

Galbreath, C.J. 1975. Criteria for defining the historic and cultural landscapes. Paper presented at the Conference on Conserving the Historic and Cultural Landscape, Denver, Colorado, USA, May.

Gill, B. J. (1993). The land reptiles of Western Samoa. Journal of the Royal Society of New Zealand, vol. 23, pp. 79–89.

Government of Western Samoa. 1980. Fourth Five Year Development Plan for Western Samoa. Department of Economic Development, Apia, Western Samoa.

Government of Western Samoa. 1991. National Report for United Nations Conference on Environment and Development: Western Samoa. Prepared by South Pacific Regional Environment Programme, Noumea, New Caledonia.

Government of Western Samoa. 1992a. Western Samoa Seventh Development Plan 1992–1994. National Planning Office, Prime Minister's Department, Apia, Western Samoa, March.

Government of Western Samoa. 1992b. Population Policy. First draft. Apia, Western Samoa, May.

Government of Western Samoa. 1992c. Western Samoa Tourism Development Plan 1992–2001. Prepared by the Tourism Council of the South Pacific, Apia, Western Samoa, April.

Government of Western Samoa. 1992d. Apia Sewerage Project Review of Master Plan 1992. Report prepared by GKW Consultants and Associates, Apia, Western Samoa, August.

Government of Western Samoa. 1993. Western Samoa Forestry Policy Review. Revised draft Forestry Policy Statement. Prepared by the Joint Government of Western Samoa Forestry Division and Groome Pöyry Forestry Review Team, Apia, Western Samoa, April.

Gratton, F.J.H. 1948. An Introduction to Samoan Customs. Republished by R. McMillan, 1985, Papakura, New Zealand.

Green, R.C. & Davidson, J.M. (eds). 1969a. Archaeology in Western Samoa, vol. 1. Bulletin of the Auckland Institute and Museum, no. 6.

Green, R.C. & Davidson, J.M. (eds). 1969b. Archaeology in Western Samoa, vol. 2. Bulletin of the Auckland Institute and Museum, no. 7.

Hains, S. 1990. Response strategies: Sea level rise. Paper presented to the 1990 Planning Ministers' Conference on Greenhouse Effect. Cairns, Australia.

Harding, E. 1992. Strengthening operations of the Division of Environment and Conservation within the Department of Lands and Environment, Western Samoa. Draft report, T.A. no. 1235-SAM. Asian Development Bank, Manila, Philippines, May.

Holloway, C.W. & Floyd, C.H. 1975. A National Parks System for Western Samoa. UNDAT-IUCN.

Jennings, J.D., Holmer, R.N., Janetski, J.C. & Smith, H.L. 1976. Excavations on Upolu,

Western Samoa. Occasional paper no. 3. Utah Museum of Natural History, Salt Lake City, Utah. Pacific Anthropological Records no. 25, Bernice P. Bishop Museum, Honolulu, Hawaii, October.

Jennings, J.D. & Holmer, R.N. 1980. Archaeological excavations in Western Samoa. Pacific Anthropological Records no. 32. Bernice P. Bishop Museum, Honolulu, Hawaii, September.

Jordan, D.S. & Seale, A. 1906. The fishes of Samoa. Bulletin of the Bureau of Fisheries, Washington. DC. USA.

Kay, R., Elisara, F.M, Cole, R.C. & Yamada, K. 1993. Western Samoa: A case study in coastal vulnerability and resilience to climate change and sea-level rise. South Pacific Regional Environment Programme report, Apia, Western Samoa, March.

Kear, D., Camber, D., & Brands, C.D.L. 1979. The Hydrogeology and Water Supply of Western Samoa. New Zealand Department of Scientific and Industrial Research, Wellington, New Zealand.

Kear, D. & Wood, B.L. 1959. The geology and hydrology of Western Samoa. New Zealand Geological Survey Bulletin, n.s. 63, Wellington, New Zealand.

Kramer, A. 1901. Die Samoa-Inseln, Band I & II. Republished by R. McMillan, Papakura, New Zealand.

Leleisiuao, P. 1992. Samoa's cultural environment. Paper presented at the Cultural Centre Workshop, Apia, Western Samoa, 24 April.

Lockwood, B. 1971. Samoan Village Economy. Oxford University Press, Oxford, England.

Lowe, I. 1990a. The greenhouse effect and future planning. Paper presented to the 1990 Planning Ministers' Conference on Greenhouse Effect, Cairns, Australia, June.

Lowe, I. 1990b. The science of greenhouse. In Greenhouse: What's to be Done, ed. K. Coghil. Pluto Press, Leichhardt, New South Wales, Australia.

Marshall, C. 1950. Forestry in Western Samoa. Report for the Government of Western Samoa, Apia, Western Samoa.

Miles, R., Alam, M., Boyle, J. & Larhed, T. 1992. Employment in Western Samoa: Present and Potential. Draft report on Employment Promotion, Manpower Planning, and Labour Administration in the Pacific, for ILO/UNDP/AIDAB, March.

Neich, R. 1987. A Feasibility Study for the Development of a National Museum and Cultural Centre of Western Samoa. A UNESCO consultancy report, March.

Ollier, C., Whistler, W.A. & Amerson, A.B. 1979. O Le Pupu-Pue National Park, 2 vols. United Nations Development Advisory Team for the South Pacific, Suva, Fiji.

O'Meara, J.T. 1990. Samoan Planters: Traditional and Economic Development in Polynesia. Holt, Rinehart & Winston, Fort Worth, USA.

P.G. Pak-Poy & Associates Pty Ltd. 1972. Pre-investment study for road development, Western Samoa. Report prepared for the Government of Western Samoa and Commonwealth of Australia, Department of Foreign Affairs, Canberra, Australia.

Pak-Poy & Kneebone Pty Ltd & Associates. 1981. Western Samoa Transportation Study. Report prepared for the Government of Western Samoa and the Australian Development Assistance Bureau, Australian Development Assistance Bureau, Canberra, Australia.

Parham, B.E.V. 1972. Plants of Samoa. New Zealand Department of Scientific & Industrial Research Information Series 85, Wellington, New Zealand.

Park, G., Hay, R., Whistler, A., Lovegrove, T. & Ryan, P. 1992. The National Ecological Survey of Western Samoa: The Conservation of Biological Diversity in the Coastal Lowlands of Western Samoa. Report compiled by the Department of Conservation, New Zealand.

Pearsall, S.H. & Whistler, W.A. 1991. Terrestrial Ecosystem Mapping for Western Samoa: Summary, Project Report, and Proposed National Parks and Reserves Plan. Prepared for the Government of Western Samoa by South Pacific Regional Environment Programme, Apia, Western Samoa and the East-West Centre, Environment and Policy Institute.

Peteru, C. 1993. Western Samoa Legislative Review Draft Report May 1993. Report prepared for NEMS, South Pacific Regional Environment Programme, Apia, Western Samoa.

Pitt, D. 1970. Tradition and Economic Progress in Samoa: A Case Study of Traditional Institutions in Economic Development in Western Samoa. Oxford University Press, Oxford, England.

Pittock, A.B. 1990. Current understanding of the enhanced greenhouse effect. Paper presented to the 1990 Planning Ministers' Conference on Greenhouse Effect, Cairns, Australia.

Pratt, H.D., Bruner, P.L. & Berret, D.G. 1987. A Field Guide to the Birds of Hawaii and the Tropical Pacific. Princeton University Press, Princeton, New Jersey, USA.

Pringle, G. 1989. Heritage assessment, Apia, Western Samoa. MSc (Architecture) thesis, University of Sydney, Sydney, Australia.

Proudfoot, H. 1991. The dangers of environmental fundamentalism. Australian Planner, vol. 29, no. 1, March.

Public Service Commission. 1992. Human resources plan for the Public Service of Western Samoa. Apia, Western Samoa, May.

Schultz, L.P. 1943. Fishes of Phoenix and Samoan Islands. (Collected in 1939.) United States National Museum Bulletin, vol. 180, pp. 1–316.

Shankman, P. 1976. Migration and Underdevelopment: The Case of Western Samoa. Westview Press, Boulder, Colorado, USA.

Smith, A.C. 1979–. *Flora vitiensis nova*: a new flora of Fiji. National Tropical Botanical Garden, Lawai, Kauai, Hawaii.

SPAFH. 1991. Tables of Demographic Data for the SPAFH Member Countries. South Pacific Alliance of Family Health, Port Moresby, Papua New Guinea.

Specht, J.R. 1978. A Basic Plan for the Development of a National Cultural Centre in Western Samoa. UNESCO Contract no. 590106, January.

Stace, V.H. 1954. The Pacific Islander and Modern Commerce. South Pacific Commission technical paper, Noumea, New Caledonia.

Stevenson, R.L. 1901. A Footnote to History: Eight Years of Trouble in Samoa. Charles Scribner's Sons, New York, USA.

Sturms, M.M. 1984. Apia Town Plan 1984, Collection of Planning Documents for Public Works Department, Apia, Western Samoa.

Taylor, L.M. 1991. Western Samoa: An investigation into the sources and regulations of marine pollution. July, unpub.

Tofilau, E.A. 1992. Address at the United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June.

Troy, P.N. 1990. The greenhouse effect and the city. Australian Planner, vol. 28, no. 1, March.

Turner, G. 1884. Samoa: A Hundred Years and Long Before. London Missionary Society, republished by R. McMillan, 1983, Papakura, New Zealand.

Uhe, G. 1974a. Medicinal plants of Samoa. Economic Botany, vol. 28, pp. 1–30.

Uhe, G. 1974b. The composition of the plant communities inhabiting the recent lava flows of Savaii, Western Samoa. Tropical Ecology, vol. 5, pp. 140–150.

Warren, P. & Sisarich, W. 1992. Legal Consultancy for Division of Environment and Conservation, Western Samoa. Department of Conservation, Wellington, New Zealand.

Wass, R.C. 1984. An Annotated Checklist of the Fishes of Samoa. National Oceanic and Atmospheric Administration, U.S. Department of Commerce, technical report SSRF-781.

Watson, R.M. 1891. History of Samoa, Whitcombe & Tombs, Wellington, New Zealand.

Waugh, J., Lawless, P. & Chadderton, L. 1991. Afulilo Hydroelectric Power Project: Environmental Impact Assessment. South Pacific Regional Environment Programme/Department of Conservation, New Zealand. Wellington, New Zealand, December.

Whistler, W.A. 1978. Vegetation of the montane region of Savaii, Western Samoa. Pacific Science, vol. 32, no. 1, pp. 79–94.

Whistler, W.A. 1984a. Annotated list of Samoan plant names. Economic Botany, vol. 38, no. 4, pp. 464–489.

Whistler, W.A. 1984b. Vegetation and flora of Aleipata islands, Western Samoa. Pacific Science, vol. 37, no. 3, pp. 227–249.

Whistler, W.A. 1992a. National Biodiversity Review of Western Samoa. In An Overview of

the Terrestrial Biodiversity of Pacific Islands: Including those Islands Covered by the Biodiversity Programme of SPREP, ed. D.R. Given. Global Environmental Facility, SPREP, Apia, Western Samoa.

Whistler, W.A. 1992b. Draft biodiversity data sheet. Submitted to Centre of Plant Diversity, World Conservation Union.

Whistler, W.A. 1992c. The vegetation of Samoa and Tonga. Pacific Science, vol. 46, no. 2, pp. 159–178.

Whistler, W.A. 1992d. Polynesian Herbal Medicine. National Tropical Botanical Garden, Lawai, Kauai, Hawaii.

Winders, Barlow & Morrison Pty Ltd. 1987. Environmental Impact Assessment. Hydropower Project at Afulilo, Upolu, Western Samoa, report no. 3469, 30 October.

World Bank. 1992. Western Samoa Cyclone Val Infrastructure Rehabilitation Needs Assessment Report. Report prepared for the Government of Western Samoa.

World Bank. 1991. Towards Higher Growth in Pacific Island Economies: Lessons from the 1980s, vol. 2, Country Surveys. Washington, D.C.

World Commission on Environment and Development. 1987. Our Common Future. Brundtland Report, United Nations, Oxford University Press, Oxford, England.

Wright, A.C.S. 1963. Soils and land use of Western Samoa. New Zealand Department of Scientific and Industrial Research Soil Bulletin no. 22, Wellington, New Zealand.

Zann, L. 1991a. The Inshore Resources of Upolu, Western Samoa: Coastal Inventory and Fisheries Database. Field report no. 5, FAO/UNDP project SAM/89/002.

Zann, L. 1991b. Fishery resources assessment for management, project findings: Recommended actions. Second draft of terminal report, FAO/UNDP project SAM/89/002.

Zann, L. 1991c. The Status of Sea Turtles in Western Samoa. Field report no. 9, FAO/UNDP project SAM/89/002.

Zann, L. 1991d. A Review of Introductions of Aquatic Species into Western Samoa and an Assessment of their Environmental Impacts. Field report no. 10, FAO/UNDP project SAM/89/002.

Western Samoan rock formations

Name	Cover of vegetation	Weathering zone and soil	Present reef	Boulders on uneven land	Alteration to cone form	Surface water	Olivine nodules	Age
Aopo Volcanics	None or poor	None	None	Very common	None	None	Rare	Historical
Tafagamanu Sand								Post-Glacial: 5ft sea level
Nuutele Sand	Sedimentary formations approximately contemporaneous with Puapua Volcanics							Post-Glacial: 15ft sea level
Lalomauga High-level Alluvium								Post-Mulifanua
Puapua Volcanics	Normal	Very thin	None	Very common	None	Virtually none	Rare	Middle to late Holocene
Lefaga Volcanics	Normal	Intermediate	Close inshore	Very common	Little	Virtually none	Rare	Early Holocene
Mulifanua Volcanics	Normal	Intermediate	Far offshore	Common, weathered angular	Crater filling	Rare	Uncommon	Late Glaciation
Erosional unconformity, with canyon formation								
Salani Volcanics	Normal	Thick (over 12" soil)	Far offshore	Very weathered, rounded	Gorges cut in flanks	Sometimes	Present	?Penultimate Glaciation or Last Interglacial, to early Last Glaciation
Vini Tuff	Marine tuff rings, definitely pre-Lefaga, post-Fagaloa, and probably early Salani							Last Interglacial (about +30 ft sea level)
Great erosional unconformity, beneath younger volcanics								
Fagaloa Volcanics	Can be poor (leaching)	Very thick	None or close inshore	Rare	Up to complete destruction, dykes exposed	Always	Common	Pre-Penultimate Glaciation — possibly late Pliocene

Source: Kear & Wood 1959

Appendix 2

Relationship between geological formations and soils

Geological formation	Dissection of landscape	Average depth of soil	Soil surface	Soil texture
Fagaloa Volcanics	strong	> 100 cm	few to many boulders	clay, silty clay
Salani Volcanics	moderate	50–100 cm	few to many stones and boulders	clay, silty clay
Mulifanua and Lefaga Volcanics	slight	15–50 cm	boulders and stones	clay, silty clay silty clay loam
Puapua Volcanics	very slight	15–50 cm	boulders, stones and rock	silty clay loam silt loam silty clay
Aopo Volcanics	very slight	0–25 cm	rock, boulders, and stones	sandy gravels silt loam
Vini Tuffs	moderate	> 100 cm	few stones	clay, silty clay loam

Source: ANZDEC 1990

Potentially endangered or threatened vascular plant species of Samoa

Plant family	Species	Times collected	Last collected	Status	Elevation range
DICOTYLEDONS					
ANNACARDIACEAE	Dracontomelon vitiense	5	1921	I?	lowlands
ANNONACEAE	Polyalthia *sp.* nova	1	1974	E	600 m
APOCYNACEAE	Cerbera odollam	4	1974	I	600 m
ASTERACEAE	Blumea milnei	5	1907	I	n.a.
	Centipeda minima	5	1989	I	1–700 m
	Dichrocephala integrifolia	1?	1839	A?	n.a.
	Sigesbeckia orientalis	5	1929	A	lowlands
BORAGINACEAE	Cordia aspera	4	1991	I	30–250 m
BURSERACEAE	Haplolobus floribundus	3	1968	I	150–375 m
CAPPARACEAE	Crataeva religiosa	3	1925	I	40 m
CERATOPHYLLACEAE	Ceratophyllum demersum	2	1895	I	nr. sea level
CHRYSOBALANACEAE	Parinari insularum	8	1931	A	lowlands
CONVOLVULACEAE	Ipomoea indica	3	1931	I	100 m
CUCURBITACEAE	Benincasa hispida	5	1972	A	lowlands
	Cucumis melo	11	1991	A	lowlands
	Trichosanthes reineckeana	4	1989	E	200?–800 m
EBENACEAE	Diospyros christopersenii	4	1991	E	50–600 m
EUPHORBIACEAE	Macaranga reineckei	4	1931	E	1,200–1,300 m
	Macaranga *sp.* nova	4	1980	E	650–1,300 m
FABACEAE	Pongamia pinnata	2	1968	I	nr. sea level
	Serianthes melanesica	1	1875	I	lowlands
	Sophora tomentosa	8	1991	I	nr. sea level
FLACOURTIACEAE	Caesaria *sp.* nova	1	1989	E	400 m
GESNERIACEAE	Cyrtandra campanulata	4	1905	E	n.a.

Plant family	Species	Times collected	Last collected	Status	Elevation range
	Cyrtandra funkii	4	1895	E	n.a.
	Cyrtandra gurkeana	3	1905	E	uplands
	Cyrtandra mamolea	2	1895	E	600 m
GYROCARPACEAE	Gyrocarpus americanus	4	1989	I	nr. sea level
LAMIACEAE	Leucas decemdentata	15	1931	I	2–150 m
LAURACEAE	Crytocarya turbinata	4	1991	I	30 m
LOGANIACEAE	Strychnos vitiensis	1	1974	I	300 m
LYTHRACEAE	Pemphis acidula	3	1990	I	nr. sea level
MALVACEAE	Abutilon whistleri	2	1975	E	1,140–1,400 m
MELIACEAE	Xylocarpus moluccensis	12	1991	I	nr. sea level
MENISPERMACEAE	Stephania forsteri	11	1991	I	1–750 m
MYRTACEAE	Metrosideros gregoryi	2	1931	E	1,500 m
	Syzygium effusum	2	1895	I	uplands
	Syzygium graeffei	2	1905	E	uplands
	Syzygium neurocalyx	14	1974	I	10?–700 m
	Syzygium vaupelii	2	1931	E	900 m
NYCTAGINACEAE	Boerhavia albiflora	3	1980	I	nr. sea level
OLEACEAE	Chionanthus vitiensis	2	1991	I	50–150 m
PIPERACEAE	Peperomia pallida?	1	1973	I	800 m
PITTOSPORACEAE	Pittosporum samoense	4	1975	E	900–1,650 m
RUBIACEAE	Ixora elegans	3	1991	I	c. 100 m
	Psychotria chlorocalyx	6	1974	E	350–500 m
	Psychotria juddii	2	1931	E	1,000–1,100 m
	Psychotria sclerocarpa	4	1973	E	700 m
SAPINDACEAE	Guioa rhoifolia	2	1931	I	300 m
SAPOTACEAE	Manilkara dissecta	4	1977	I	1–200 m
	Manilkara samoensis	1	1875	E	n.a.
	Northiopsis hoshinoi	4?	1991	I	30 m
SCROPHULARIACEAE	Limnophila fragrans	10	1991	I	1–700 m
SOLANACEAE	Solanum amicorum	1	1875	I	nr. sea level
	Solanum repandum	3?	1905	A	lowlands
	Solanum viride	19	1991	A	lowlands
STERCULIACEAE	Waltheria indica	3	1905	I?	c. 200 m
SURIANIACEAE	Suriana maritima	1	1979	I	nr. sea level

Plant family	Species	Times collected	Last collected	Status	Elevation range
ULMACEAE	Celtis vitiensis	3	1989	I	5–30 m
URTICACEAE	Boehmeria *sp. nova*?	1	1978	E?	1,080 m
MONOCOTYLEDONS					
ORCHIDACEAE	Bulbophyllum longiflorum	3	1989	I	300 m
	Bulbophyllum trachyanthum	2	1931	I	400–1,030 m
	Calanthe nephroglossa	3	1931	E	1,000 m
	Chrysoglossum ornatum	1	1973	I	600 m
	Corybas betchei	1	1881	E	n.a.
	Cryptostylis archnites	4	1976	I	600–1,200 m
	Dendrobium macrophyllum	3	1977	I	600 m
	Geodorum densiflorum	2	1907	I	lowlands
	Habenaria monogyne	7	1931	E	300–900 m
	Luisia teretifolia	3	1931	I	500–600 m
	Microtatorchis samoensis	3	1989	I	800 m
	Pomatocalpha vaupelii	4?	1985?	I	400–600 m
	Schoenorchis micrantha	3	1978?	I	50–1,600 m
	Spiranthes sinensis	1	1975	I	1,550 m
	Tropidia effusa	2	1972	I	400 m
POACAEAE	Cenchrus calyculatus	6	1907	I	lowlands
	Erianthus maxima	3	1989	I	700 m
	Heteropogon contortus	2	1905	I?	c. 200 m
	Microstegium glabratum	4	1985?	I?	150–400 m
RUPPIACEAE	Ruppia maritima	1	1862	I	nr. sea level
TACCACEAE	Tacca maculata	2	1973	I	100–300? m
FERNS AND FERN ALLIES					
ADIANTIACEAE	Cheilanthes tenuifolia	2	1974	I	30 m
	Doryopteris concolor	9	1990	I	nr. sea level
ASPIDIACEAE	Dryopteris decomposita	1	1931	I	1,400 m
	Dryopteris hirtipes	6	1907	I	800–1,500 m
	Dryopteris samoensis	8	1895	E	600 m
	Tectaria crenata	6	1905	I	200–700 m
ASPLENIACEAE	Asplenium lobulatum	6	1905	?	600?–1,700 m
	Asplenium powellii	2	1922	E	montane
	Asplenium sphenolobium	2	1907	I	1,500 m

Plant family	Species	Times collected	Last collected	Status	Elevation range
ATHYRIACEAE	Athyrium oosorum	5	1931	E	800–1,400 m
	Diplaziopsis javanica	5	1931	I	750–1,300 m
	Diplazium esculentum	6	1905	I	lowlands?
BLECHNACEAE	Blechnum procerum	5	1931	I	1,500–1,700 m
CYATHEACEAE	Cyathea subsessilis	3	1931	I	900 m
DAVALLIACEA	Oleandra christophersenii	1	1931	E	700 m
DENNSTAEDTIACEAE	Dennstaedtia samoensis	5	1980	E	300–500 m
GRAMATIDIACEAE	Ctenopteris deltoideophyllum	3	1907	E	900 m
	Grammitis monicola	1	1965	E	1,080 m
HYMENOPHYLLACEAE	Hymenophyllum feejeense	2	1907	I	n.a.
	Hymenophyllum samoense	7	1907	I	1,300 m?
	Trichomanes bimarginatum	9	1931	I	400–500 m
	Trichomanes caudatum	3	1895	I	600 m
	Trichomanes maximum	4	1931	I	550–600 m
	Trichomanes nymani	1	1907	I	800 m
	Trichomanes pallidum	5	1907	I	n.a.
	Trichomanes powellii	3	1991	E	500–820 m
	Trichomanes samonese	3	1907	E	n.a.
	Trichomanes taeniatum	4	1905	I	500 m
LINDSAEACEAE	Lindsaea repens	3	1881	I	n.a.
	Lindsaea tetragona	11	1905	I	500 m
	Microlepia nudisora	3	1905	E	lowlands
LOMARIOPSIDACEAE	Scleroglossum sulcatum	5	1895	I	1,000 m
	Teratophyllum wilkesianum	5	1931	I	1,000 m
MARATTIACEAE	Marattia smithii	8	1905	I	50?–600 m
OPHIOGLOSSACEAE	Botrychium daucifolium	3	1905	I	700–800 m
POLYPODIACAEAE	Calymmodon latealatus	4	1905	I	montane
	Polypodium reineckei	5	1931	E	500–700 m
THELYPTERIDACEAE	Christella adenopelta	2	1965	I	600 m?
	Christella arida	?	?	I	n.a.
	Christella pacifica	2?	1921	I	n.a.
	Christella subpubescens	?	?	I	n.a.
	Plesioneuron attenuatum	5	1931	I	400 m

Plant family	Species	Times collected	Last collected	Status	Elevation range
	Plesioneuron savaiense	1	1865	I	n.a.
	Pneumatopteris bryanii	6	1965	E	200–300 m
	Pneumatopteris costata	3	1931	I	400–500 m
	Pneumatopteris rodigasiana	7	1920	I	50–600? m
	Pneumatopteris transversaria	9	1921	I	150–600? m
	Pseudophegopteris persimilis	3	1965	E	1,220 m
	Sphaerostephanos heterocarpus	2	1965	I	n.a.
	Sphaerostephanos hochreutineri	5	1905	E	600–700 m
	Sphaerostephanos polycarpus	4	1881	I	n.a.
	Sphaerostephanos pycnosorus	4	1965	E	n.a.
VITTARIACEAE	Antrophyum subfalcatum	4	1931	I	500–750 m
LYCOPODIACEAE	Lycopodium phlegmarioides	2	1931	I	720 m
PSILOTACEAE	Tmesipteris tannensis	3	1931	I	1,300 m

E endemic

I indigenous

P polynesian introduction

n.a. information not available

Source: Whistler 1992a

Appendix 4

Samoan vertebrates

Landbirds of Western Samoa

Species	Common name	Samoan name	Islands	Extinction risk	Endemism	Cultural significance	Tourism significance
Anas superciliosa	Grey duck	Toloa	S,U,T,Au,O, Ol,Ta	Medium	7 Medium	High	Low
Gallus gallus	Jungle fowl	Moaai vao	S,U,T,Au,O, Ol,Ta	Low	- Low	Medium	Low
Rallus philippensis	Banded rail	Vea	S,U,N,T,Au, O,Ol,Ta	Low	7 Medium	Medium	Low
Poliolimnas cinereus	White-browed rail	Vai	S,U	?	9 Low	Very low	Low
Porzana tabuensis	Sooty rail		S,?Ta	?Med/High	10 Low	Very low	Low
Pareudiastes pacificus	Samoan woodhen	Punae	?S	High	1 High	Medium	Medium
Porphyrio porphyrio	Purple swamphen	Manualii	S,U,T,Au,O, Ol,Ta	?	10 Low	Low	Low
Columba vitiensis	White-throated pigeon	Fiaui	S,U	?Low/Med	6 Medium	Medium	High
Columba livia	Rock pigeon	Lupe	U,T	Low	- Low	Very low	Low
Didunculus strigirostris	Tooth-billed pigeon	Manumea	S,U	?High	3 High	High	High
Ducula pacifica	Pacific pigeon	Lupe	S,U,N,T,O, Ol,Ta	Low	10 Low	High	High
Ptilinopus perousii	Many-coloured fruit dove	Manulua	S,U,T,O,Ol,Ta	Low	7 Medium	High	High
Ptilinopus porphyriaceus	Crimson-crowned fruit dove	Manutagi	S,U,N,T,Au, O,Ol,Ta	Low	7 Medium	High	High
Gallicolumba stairii	Friendly ground dove	Tuaimeo	?S,?U,N,O,?Ol	?Med/High	7 Medium	Medium	High
Vini australis	Blue-crowned lory	Sega vao	S,U,N,O,Ol,Ta	Low	8 Low	High	High

Species	Common name	Samoan name	Islands	Extinction risk	Endemism	Cultural significance	Tourism significance
Eudynamis taitensis	Long-tailed cuckoo			Low	*	Very low	Low
Tyto alba	Barn owl	Lulu	S,U,T,Au,O, Ol,Ta	Low	10 Low	Medium	Low
Collocalia spodiopygia	White-rumped swiftlet	Peapea	S,U,N,T,Au, O,Ol,Ta	Medium	7 Medium	Very low	High
Halcyon recurvirostris	Flat-billed kingfisher	Tiotala	S,U,N	Low	3 High	Medium	Medium
Lalage maculosa	Polynesian triller	Miti tai	S,U,N	Low	6 Medium	Very low	Medium
Lalage sharpei	Samoan triller	Miti vao	S,U	?Medium	2 High	Very low	Medium
Pycnonotus cafer	Red-vented bulbul	Manu papalagi	S,U,T	Low	- Low	Very low	Low
Turdus poliocephalus	Island thrush	Tutumalili	S,U	?Medium	6 Medium	Low	Medium
Petroica multicolor	Scarlet robin	Tolaiula	S,U	Low	6 Medium	Medium	Medium
Myiagra albiventris	Samoan broadbill	Tolai fatu	S,U,N	Low	3 High	Medium	High
Rhipidura nebulosa	Samoan fantail	Seu	S,U	Low	2 High	Medium	High
Pachycephala flavifrons	Samoan whistler	Vasavasa	S,U,N	Low	3 High	Very low	High
Zosterops samoensis	Samoan white-eye	Mata papae	S	?Medium	1 High	Very low	High
Gymnomyza samoensis	Mao	Maomao	S,U,?T	?Med/High	4 High	Medium	High
Foulehaio carunculata	Wattled honeyeater	Iao	S,U,N,T,Au, O,Ol,Ta	Low	9 Low	Medium	Medium
Myzomela cardinalis	Cardinal honeyeater	Segasega-mauu	S,U,T	Low	7 Medium	Medium	Medium
Erythrura cyaneovirens	Red-headed parrot finch	Manuai pau laau	S,U	?Low	5 Medium	Very low	Medium
Aplonis tabuensis	Polynesian starling	Miti ula	S,U,N,T,Au, O,Ol,Ta	?Low	6 Medium	Very low	Medium
Aplonis atrifusca	Samoan starling	Fuia	S,U,N,T,Au, O,Ol,Ta	Low	4 High	Very low	High
Acridotheres fuscus	Jungle myna		S,U	Low	- Low	Very low	Low
Acridotheres tristis	Common myna		U	Low	- Low	Very low	Low

Endemism: A form of ranking according to endemism as follows:
1 Species endemic to one island

2 Species endemic to Western Samoa, different races/sub-species recognised on Upolu and Savaii
3 Species endemic to Western Samoa, no different races recognised within the group
4 Species endemic to Samoan archipelago
5 Sub-species endemic to one island in Western Samoa
6 Sub-species/race endemic to Western Samoa
7 Sub-species/race endemic to Samoan archipelago
8 Species endemic to Fiji/Tonga/Samoan region
9 Sub-species/race endemic to Fiji/Tonga/Samoan region
10 Indigenous but none of above
* Migrant only
– Introduced species

Islands (including American Samoa):
S — Savaii, U — Upolu, A — Apolima, M — Manono, N — Nuutele
Nu — Nuulua, Na — Namua, F — Fanuatapu
T — Tutuila, Au — Aunuu, O — Ofu, Ol — Olesega, Ta — Tau
R — Rose, Sw — Swains

Tourism Significance: Higher ranks were given to endemic species and to larger more colourful species as tourists are likely to wish to see these in particular.

*Waders and seabirds **

Species	Common name	Samoan name	Islands	Extinction risk	Cultural significance	Tourism significance
Nesofregetta albigularis ?	Samoan storm-petrel	Taio		? Medium	Very low	Low
Puffinus pacificus	Wedge-tailed shearwater	Taio		Low	Low	Low
Puffinus l'herminieri	Audubon's shearwater	Taio		Low	Low	Low
Phaethon rubricauda	Red-tailed tropicbird	Tavae ula		Low	High	Medium/High
Phaethon lepturus	White-tailed tropicbird	Tavae		Low	High	Medium/High
Sula leucogaster	Brown booby	Fuao		Low	High	Medium
Sula sula	Red-footed booby	Fuao		Low	High	Medium
Fregata minor	Great frigatebird	Atafa		Low	Medium	High
Sterna fuscata	Sooty tern	Gogo uli		Low	High	Medium
Sterna lunata	Spectacled (Grey-backed) tern	–		Low	Very low	Medium
Sterna sumatrana	Black-naped tern	Gogo sina		Low	Low	Medium
Procelsterna cerulea	Blue-grey noddy	Laia		Low	Low	Medium
Anous stolidus	Common (Brown) noddy	Gogo		Low	Medium	Medium
Anous minutus	Black noddy	Gogo		Low	Medium	Medium

Species	Common name	Samoan name	Islands	Extinction risk	Cultural significance	Tourism significance
Gygis alba	White (Fairy) tern	Manusina		Low	Medium	Medium/High
Pluvialis dominica fulva	Lesser golden plover	Tuli		Low	Very low	Low
Numenius tahitiensis	Bristle-thighed curlew	–		Med/? High	Very low	Medium/High
Heteroscelus incanus	Wandering tattler	Tuli alomalala		Low	Very low	Low
Arenaria interpres	Ruddy turnstone	–		Low	Very low	Low
Egretta sacra	Pacific reef heron	Matuu		Low	Medium	Low

Notes

*List excludes rarer vagrants. For full list refer to Whistler (1992a).
Islands: The distribution of many species is poorly defined in Western Samoa.
Endemism: No ranking by endemism is given. Most species score low as they are closely related to others in the genus and occur on many island groups. However most Samoan forms are not well enough described to assign them to sub-species. The Samoan storm-petrel would score more highly as it appears to be a form endemic to the Samoan archipelago.
Ecological significance: No rankings are given as this is difficult to assess. All seabirds might score relatively highly being at the top of the food chain. Those that are most numerous will have the most significant impact on prey populations, but these will also be the ones with the lowest risk of extinction.

*Native land mammals**

Species	Common name	Samoan name	Islands	Extinction risk	Endemism	Cultural significance	Tourism significance	Ecological significance
Pteropus samoensis	Samoan flying fox	Pea vao	S,U,T,O, Ol,Ta	Med/High	Low	High	High	High
Pteropus tonganus	Tongan flying fox	Pea fanua; Pea fai taulaga pea	S,U,T,Au, O,Ol,Ta	Medium	Low	High	High	High
Embalonura semicaudata	Sheath-tailed bat	Tagiti	S,U,T,Au, O,Ol,Ta	Med/High	Low	Low	Medium	?Medium

* Refer to the text for the non-native mammals.

Marine mammals

Species	Common name	Samoan name	Extinction risk	Cultural significance	Tourism significance
Balaenoptera edeni	Blue whale	Tafola	High	Low	High
Balaenoptera physalus	Fin whale	Tafola	?Medium	Low	High
Eubalaena australis	Southern right whale	Tafola	?Medium	Low	High
Megaptera novaengliae	Humpback whale	Tafola	?Medium	Low	High
Physeter catadon	Sperm whale	Tafola	?Medium	Low	High
Stenella longirostris	Tropical spinner dolphin	Manua?	Med/High	Low	High

Marine reptiles

Species	Common Name	Samoan Name	Islands	Extinction Risk	Endemism	Cultural Significance	Tourism Significance	Ecological Significance
Laticauda *spp.*	Sea snake	Gata sami						
Chelonia mydas[1]	Green turtle	Laumei	?S				High	
Eretmochelys imbricata[2]	Hawksbill turtle	Laumei	S,U,N,?R				High	
Lepidochelys olivacea[3]	Olive Ridley turtle	Laumei	?U				High	

1 The most common turtle in Western Samoa waters but may not nest
2 Nests on Nuutele, Nuulua and occasionally Namua and main islands. No more than 45 females believed to nest on Aleipata islands as a whole
3 Unconfirmed reports from Western Samoa

Native land reptiles

Species	Common name	Samoan name	Islands	Extinction risk*	Endemism	Cultural significance	Tourism significance	Ecological significance
Gehyra mutilata	Stump-toed gecko		U,S	Low	Low	Medium		
Gehyra oceanica	Oceanic gecko		U,S	Low	Low	"		
Hemidactylus frenatus	House gecko		U,S	Low	Low	"		
Hemidactylus garnotii	Fox gecko		?S	?(May not occur)	Low	"		
Lepidodactylus lugubris	Mourning gecko		U,S	Low	Low	"		
Nactus pelagicus	Pacific slender-toed gecko		U,S	Low	Low	"		
Cryptoblepharus poecilopleurus	Snake-eyed skink		U	Low	Low	"		
Emoia adspersa	Micronesian skink		U,S	?Medium	Low/Medium	"		
Emoia murphyi	Murphy's skink		U,S	Low	Low/Medium	"		
Emoia nigra	Pacific black skink		U,S	Low	Low	"		
Emoia samoensis	Samoan skink		U,S	Low	Medium/ ?High	"		
Emoia impar	Blue-tailed skink		U,S	Low	Low	"		
Emoia cyanura	Cryptic skink		U,S	Low	Low	"		
Lipinia noctua	Moth skink		U,S	Low	Low	"		
Candoia bibroni	Pacific boa		U,S	?Medium	Low	"		

* Derived from Gill (1993) who noted the following: the fox gecko is stated to occur on Savaii arriving in the 1970/1980s but no specimens are known to confirm this; all species except *Emoia adspersa* and *Candoia bibroni* are common and widespread, the absence of *Cryptoblepharus poecilopleurus* records from Savaii is thought to be only due to lack of surveys for it there.

Source: Biodiversity Strategy, Internal Report, Department of Lands, Surveys and Environment

Appendix 5

Gross Domestic Product, 1984–1989

Industry	1984	1985	1986	1987	1988	1989
GDP at current prices ($m)	179.0	196.9	208.3	219.4	240.3	248.4
Subsistence	47.4	51.6	57.9	58.7	62.5	64.9
Agriculture, forestry and fishing	39.8	42.9	43.5	44.2	43.8	52.2
Manufacturing	29.0	32.0	28.9	31.1	36.5	31.6
Electricity	8.7	8.6	8.0	9.0	11.0	11.0
Construction	2.0	2.9	4.1	7.0	9.8	4.6
Distribution, hotels and restaurants	13.2	15.7	18.8	20.0	22.4	25.6
Transportation	6.6	7.0	5.1	5.6	5.1	5.2
Other services	14.8	16.5	17.5	18.7	20.8	22.3
Government	17.5	19.4	24.5	24.9	28.4	31.0
GDP at 1982 prices ($m)	129.5	134.1	140.9	142.6	142.4	142.3
Subsistence	37.9	37.6	39.6	39.0	38.0	39.5
Agriculture, forestry and fishing	26.9	25.8	29.5	27.7	25.1	27.6
Manufacturing	15.4	18.2	18.8	19.1	19.4	17.4
Electricity	4.6	4.9	5.2	5.5	5.9	6.0
Construction	2.0	2.9	3.8	5.9	7.4	3.4
Distribution, hotels and restaurants	10.2	11.0	12.5	12.9	13.1	14.2
Transportation	5.4	5.4	4.9	5.4	5.6	5.7
Other services	11.2	11.5	11.7	12.0	12.1	12.5
Government	15.9	16.8	14.9	15.1	15.8	16.0
GDP deflator (1982=100)						

Source: World Bank 1990

soe

State
Of the
Environment
Report

South Pacific Regional Environment Programme