Malo o Samoa

# State of the Environment

## REPORT 2006

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

MNRE UNDP GEF SLM

# STATE OF THE ENVIRONMENT REPORT 2006

Ministry of Natural Resources and Environment

Government of Samoa



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I would, therefore, also like to acknowledge the assistance provided by all staff of the Ministry of Natural Resources and Environment who assisted in the final preparation of this Report. There is now, throughout this document, a sense of urgency to respond to some major global issues: climate change impacts being only one of them.

The 2006 SOE is a document that be can be relied on when addressing environmental sustainability.

Tu'u'u Dr. Ieti Taule'alo
Chief Executive Officer
Ministry of Natural Resources and Environment

## Map of Samoa


Samoa
National capital
District boundary
Road
Administrative districts are used only in the operation of government services and have no capitals.
0 10 20 Kilometers
0 10 20 Miles
Lambert Conformal Conic Projection, SP 9 20S/14 40S
KIRIBATI
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
SAMOA
Coral Sea
VANUATU
FIJI
Am. Samoa (U.S.)
TONGA
New Caledonia (FRANCE)
SOUTH PACIFIC OCEAN
AUSTRALIA
Tasman Sea
NEW ZEALAND
SOUTH PACIFIC OCEAN
SAMOA ISLANDS
Falealupo
Asau
A'opo
Safotu
Fagamalo
Sasina
Samalae'ulu
VAISIGANO
GAGAIFOMAUGA
GAGA'EMAUGA
Neiafu
Falelima
Savaii
1856 meters
Pu'apu'a
SALEGA
FA'ASALELEAGA
Samata
PALAULI
Salelologa
Sala'ilua
Vailoa
Gautavai
Taga
Tafua
ferry
Apolima Strait
Apolima
Manono
AIGA-I-LE-TAI
GAGA'EMAUGA
Sale'imoa
Fate'ula
Apia
Leulumoega
Mulifanua
A'ANA
Aleisa
TUAMASAGA
Upolu
1115 meters
Lauli'i
Solosolo
VA'A-O-FONOTI
Fagaloa Bay
Falefa
Falelatai
Samamea
Falease'ela
ATUA
Sataoauta
Ti'avea
Matautu
Si'umu
Poutasi
Samusu
Lalomanu
Namu'a
Lotofaga
Nu'utele
Nu'ulua
Base 802623 (B00928) 12-98

**Foreword**

The 2006 State of Environment Report (SOE) Report illustrates very clearly Samoa's environmental vulnerabilities and challenges, as well as supporting the creation of a more enabling sustainable development environment. Much of this Report, however, summarizes the current state of knowledge about the environment of Samoa. It instigates the move towards identifying Sustainable Environmental Management (SEM) indicators, and then covers them separately in the areas of climate change and ozone depletion, coastal and marine resources, water resources, land resources, tourism resources, forestry resources, biodiversity resources, even Samoa's socio-economic situation, as well as institutional responses to natural resource management and development trends. This Report provides valuable information and base-data to act as a gauge against which to measure the future state of Samoa's environment.

This Report will hopefully ensure that quicker action can now be taken should there be signs of further on-going and unnecessary environmental degradation and delays in restoration and/or responses. Also included in the 2006 SOE Report is a pertinent discussion of cross-cutting issues (such as tourism development and waste management) which provides some interesting perspectives on the challenges that are impinging even further on the quality of Samoa's economic environment, sometimes unbeknown to us. It has been written in a style which will make it accessible to a wider Samoan audience, even encouraging individuals to take responsibility themselves for things such as air quality, water quality and biodiversity conservation, to mention a few.

As well, it is valuable to have such an up-to-date document as the 2006 SOE Report which is useful not just to policy-makers, but also to the wider rural community. This Report thus builds on the initial 1993 SOE Report providing also available information to date with the hope of increasing capacity development at all levels of stakeholders. This latest information is, therefore, vital when developing on-going strategies aimed at environmental protection and sustainable development.

The MNRE, in collaboration with all Ministries, Government Corporations and the private sector will be seeking some modern innovative steps, including renewable energy and food security projects, these being implemented urgently if we are to address the vast array of increasing environmental challenges before us. Obtaining the alternate (as well as traditional) technologies and investments needed remains a challenge for Samoa. Also, putting a traditional *'tapu'* on all trees and forests within Samoa may be a further interim and innovative step that Samoa can seriously consider because of the severity, urgency and compounding future impacts as outlined in this Report. Every village within Samoa is now invited to play an intimate role in achieving this goal: attaining sustainable livelihoods for all before 2015. This 2006 SOE Report tells us:

(i) exactly what steps need to be taken right now,
(ii) how we can improve our capacity to respond more quickly to on-going environmental and developmental challenges before us, and
(iii) how further long-term environmental research and monitoring is required in order to take full advantage of the global funds being targeted for environmental restoration and protection within Pacific Island Countries ( PICs ).

The Government of Samoa ( GoS ) is committed to sound environmental management because this translates directly into sound socio-economic development for all, addressing especially Samoa's rural communities which are currently ill-equipped to tackle increasing and costly global climate change impacts, on-going and severe consequences of land degradation and deforestation, increasing pollution and further loss of potable water supplies, not to mention increasing energy demands and increasing energy costs, worsened by energy inefficiencies (estimated to be 16%) and an increasingly less viable subsistence existence as invasive species continue to cripple our livelihoods.

Also, we need all the regional and international environmental organisations tackling the environmental and sustainability issues, as identified in this 2006 SOE Report, in harmony. We all need to take a collective approach as sustainable livelihoods for all Samoans and all Pacific Islanders are our goal.

This Report, therefore, can be used to help guide Samoa towards attaining sustainable livelihoods for all within the shortest possible period. However, it requires increased commitment levels from the The Government of Samoa, under-pinned by an on-going innovative capacity development initiative which is still required by all key stakeholders, especially the private sector and our international development partners.

Samoa, finally, is committed to emitting more oxygen, absorbing more carbon dioxide, filling its carbon sinks and hopefully move towards a 'green' economy. 'Going Clean and Green' is not only good for economic competitiveness in the long run, but a green economy can also help attract new kinds of renewable industries to Samoa and so may result in further job creation and new export markets (e.g. for valued adding goods; ecologically-packaged and processed organic food products; biofuels; etc.).

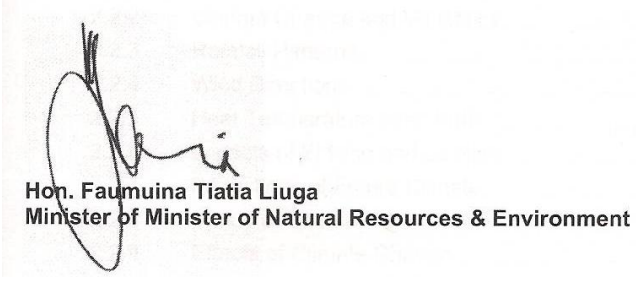
Finally, we need to learn from the 'environmental and developmental successes' highlighted in this 2006 SOE Report.

Because of past non-sustainable practices in fisheries, forestry and agriculture in Samoa, Samoa's future environmental restoration costs will be excessive. Take into consideration the current high cost of water reticulation infrastructure management in Samoa today, primarily because of serious damage being caused to our water catchments in the past and further impacted even today. The Government is now seriously looking at mainstreaming all natural resources holistically, including agriculture and fisheries resources that remains to be sustainably managed.

To also help guide the responses expected from the MNRE, and all other stakeholders, over the next 10 years or more, the MNRE would like to encourage a national monitoring programme of all the different parameters (Sustainable Environmental Management Indicators [SEMIs]) that are relevant to environmental management, sustainable development, as well as monitoring such parameters within individual sectors such as agriculture, education, forestry, health, rural communities, tourism, etc. Unless the awareness of these issues is raised significantly amongst all stakeholders, and unless their relationship with each other is realized and accepted, and unless immediate actions are being holistically taken, then further delays will be indeed costly for all future generations. This 2006 SOE Report endeavours, therefore, to offer this option, guiding the readers, and all the stakeholders, through all the different development scenarios. This 2006 SOE Report is, therefore, a development blueprint and your support is paramount to its success.

So, what will it take to make us all take notice, to act now, to think globally and act locally? First, you will need to read and understand this latest SOE Report on the status of Samoa's delicate and vulnerable environment, and then assist the Government of Samoa as best you can to put in place a system to ensure our heritage is protected for all generations to come.

As Samoa's human resource development continues to evolve, and as the benefits of long-term monitoring of SEMIs are realized, the next 3rd SOE Report should hopefully show some marked improvements across-the-board in all sectors. On behalf of the Government of Samoa, I would like to thank you all for your patience and all your welcomed contributions to date. And without the assistance of the community-based organizations and the non-government organizations, this task would have been very difficult indeed.



**Hon. Faumuina Tiatia Liuga**
**Minister of Minister of Natural Resources & Environment**

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## Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| BPOA | Barbados Programme of Action |
| CBD | Convention on Biological Diversity |
| CFC | chloro-fluorocarbon |
| CIMS | Coastal Infratrscuture Manament Strategy |
| CIMP | Coastal Infratrscuture Manament Plan |
| DBS | Development Bank of Samoa |
| DEC | Division of Environment and Conservation |
| DOS | Department of Statistics |
| EEZ | Exclusive Economic Zone |
| EIA | Environmental Impact Assessment |
| ENSO | El Nino Southern Oscillation |
| EPC | Electric Power Corporation |
| FAO | Food and Agriculture Organization |
| FSA | Faasao Savaii Inc. |
| GDP | Gross Domestic Product |
| GOS | Government of Samoa |
| IUCN | International Union of Conservation Nations |
| MAF | Ministry of Agriculture and Fisheries |
| MEAS | Multi-lateral Environment Agreements |
| MESC | Ministry of Education, Sports & Culture |
| METI | Matua i le Oo Environment Trust |
| MFAT | Ministry of Foreign Affairs and Trade |
| MNREM | Ministry of Natural Resources Enviornment and Meteorology |
| MOF | Ministry of Finance |
| MOH | Ministry of Health |
| MWCSD | Ministry of Women, Community & Social Development |
| MWTI | Ministry of Works Transport and Infrastructure |
| NBC | National Beautification Committee |
| NCSA | National Capacity Self-Assessment Project |
| NCW | National Council of Women |
| NDMP | National Disaster Management Plan |
| NEMS | National Environment and Development Management |
| NGO | Non-Governmental Organisation |
| NUS | National University of Samoa |
| OLSSI | O le Siosiomaga Society Inc. |
| PGRC | Pacific Genetic Resource Centre |
| PSC | Public Service Commission |
| PICs | Pacific Island Countries |
| PUMA | Planning and urban Management Agency |
| SBEC | Small Business Enterprises Corporation |
| SCC | Samoa Chamber of Commerce |
| SDS | Strategy for the Development of Samoa |
| SES | Statement of Economic Strategy |
| SLC | Samoan Land Corporation |
| SIDS | Small Island Developing State |
| SOE | State of the Environment Report |
| SOPAC | South Pacific Applied Geoscience Commission, Suva, Fiji |
| SPAFH | South Pacific Alliance of Family Health, Port Moresby, Papua New Guinea |
| SPC | South Pacific Commission |
| SPCZ | South Pacific Convergence Zone |
| SPREP | South Pacific Regional Environmental Programme, Apia, Samoa |
| SPRIG | South Pacific Regional Indigenous Forest Genetic Regeneration Program |
| SUNGO | Samoa Umbrella for Non-Governmental Organizations |
| SWA | Samoa Water Authority |
| TEC | Target Environmental Component |

| | |
|---|---|
| UNCCD | United Nations Convention for Combating Desertification |
| UNCED | United Nations Conference on Environment and Development |
| UNESCO | United Nations Educational, Scientific, and Cultural Organization |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USP | University of the South Pacific |
| SLC | Samoa Land Corporation |
| WIBDI | Women in Business Development Inc |

## 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. |
| | 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 aid or trade agreements are made between two governments or organisations. Multilateral agreements are made between more than two countries or organisations. |
| **Bilateral, Multilateral** | |
| **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. |
| | Clearing of trees or forest. |
| **Deforestation** | The result of poor resource use which pollutes, damages or reduces the quality of resources available to future generations. |
| **Degradation** | |
| **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. |

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| **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 |

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| | long-term benefit. |
| **Leachate** | Water carrying impurities, which have 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 does not involve the exchange of goods, for example, haircuts, banking, and 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. |
| **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, |

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| | birds, fishes and amphibians. |
| **Water catchments** | The area from which a river or lake collects water. |
| **Wetland** | Swamp or other damp area of land. |

## Executive Summary

How clean are Samoa's natural resources, including its air, rainforests, potable water supplies, coral lagoons and farming lands? How healthy are its people and its ecosystems? And how can we better measure the success of our national environmental and development policies and programmes which are being designed to better protect both the health and the environment of all living things, especially with people as the central focus? Also, how important is climate health to us all in the context of growing climate change impacts on Samoa, and especially with rising global greenhouse gas (GHG) emissions, the highest being recorded in 2006?.

The 2006 State of Environment Report (SOE), therefore, provides the Government of Samoa (GOS), through the Ministry of Natural Resources and Environment (MNRE), the latest up-to-date account of the status of Samoa's environment with the sole aim of attracting a much broader multi-sectoral dialogue about how best to attain sustainable livelihoods for all in Samoa within the foreseeable future. "Equality for All" is the main objective of the Strategy for the Development of Samoa (SDS) 2005-2007 and this SOE Report explains how MNRE and all its stakeholders are working towards achieving this main SDS objective.

This Report, therefore, has two key purposes:

1. To describe what the MNRE and its stakeholders know, and don't know, about the current state of the environment at the national level, and how Samoa's vulnerable environment is rapidly changing under mounting threats, and also

2. To identify measures that can be used to track the status of and trends in environmental management and natural resource management, and to define the challenges to improving our ability to attaining sustainable livelihoods for all in Samoa.

This SOE Report (2006) is also being used as a first step in the MNRE's strive towards developing a Sustainable Environmental Management Indicators Initiative (SEMII) for ease of measurement and comparison of different states in the environment from time to time. This initiative seeks to develop an improved set of Sustainable Environmental Management Indicators (SEMIs) that will enable the MNRE and its stakeholders to better monitor and manage the subsequent results, and better communicate the status of the environment and human health to all of Samoa's key environmental stakeholders. These SEMIs will provide critical tools for the MNRE to define environmental management goals and measure progress over time towards attaining those goals, and also take into consideration the Outcome Indicators as highlighted in the Strategy for the Development of Samoa (SDS) (2005-2007).

In many cases, however, national-level indicators do not yet exist or are not supported by adequate data. In some of these cases, local and regional indicators do exist and are featured as examples in this SOE Report. However, these local and regional indicators are valuable for a number of reasons:
(i) they serve as examples of what national indicators might look like in the future,
(ii) they provide an important perspective on conditions at the local and regional levels,
(iii) they are critical to understanding cause-and-effect relationships in the environment, and
(iv) they provide an important tool for local decision-making.

Samoa's initial State of Environment Report (1993), its follow-up National Environmental Management and Development Strategy (NEMS) (1994) and its Target Environment Components, of which numerous national policies have already been formulated, have all been collectively helpful in developing Government's strategic development plans, including its most recent SDS (2005-2007).

### Samoa's Environment for Sustainable Development

Samoa has been doing its best to participate in international and regional efforts to address key issues related to environmental conservation and sustainable development. Domestically, the GOS has also implemented successful conservation programmes in an integrated manner with its

economic and governance reforms. Samoa continues its participation in regional and international collective efforts to address environmental and sustainable development issues and pursues cooperative arrangements between the Government, private sector and non-governmental organizations (NGOs). All these efforts, provided they are carefully designed and monitored, should hopefully culminate in advancing environmental integrity and achieving sustainable development for the benefit of future generations.

Samoa has, however, learnt some valuable lessons in incorporating environmental values into decision-making and development activities, particularly in areas of infrastructure development and resilience building within coastal areas. Despite these efforts, mainstreaming of environmental issues remains an on-going challenge, particularly in relation to the most recent SDS (2005-2007) at the national level. While it is recognized that no single approach can be adopted universally to achieve sustainable development, selective application would yield tangible benefits by integrating the three pillars of sustainable development; namely (i) socio-political aspects of the country, (ii) economic features and (iii) environment aspects and aspirations.

**State and Trends in the Environment**

Sustainable Environmental Management (SEM) indicators are long-term measures of the state of and pressures on the environment. Their aim is to raise awareness of the environment and show progress towards attaining sustainable development, and showing particularly the overall state of a country's environment over time. These SEM indicators generally embody 3 basic functions that are simple, achievable, quantifiable and easily communicated because they are specific and scientifically sound, relevant and easily understood, time-bound and show trends over time, sensitive to change, easily measurable and are readily available.

Whichever SEM indicators are applicable and appropriate, given Samoa's current situation, they have been used in the following assessments of the environment reported in this 2006 SOE Report.

( i ) Climate Change and Ozone Depletion
The vulnerability of Samoa to the impacts of climate change and ozone depletion is of serious concern, particularly as about 70% of its population and infrastructure are located on low lying coastal areas. Also, Samoa's economy largely depends on its natural resources remaining intact: these resources rely on good stable climatic conditions for growth and sustenance. Therefore, the following points must all be considered if we are to better understand Samoa's past and current climate trends in order to get a better indication of the future direction in relation to global climate change and ozone levels:

- Climate and weather characteristics - dry season (April to September), rainy/wet period (October to March), vulnerable to anomalously long dry spells that coincide with the El Nino Southern Oscillation (ENSO) phenomenon;
- Climate change and variability - meteorological data over the past 102 years show trends that mean ambient temperature has increased by 0.59°C, maximum and minimum temperature increased 0.67°C and 0.18°C, respectively, and decrease in precipitation levels by 49.28mm, sea level rise is likely to have increased by 36 cm (Climate Risk Profile, 2007). The observed long term trend in relative sea level for Apia is 5.2 mm/yr, but the maximum hourly sea level is increasing by approximately 8 mm/yr, a rate far in excess of the observed local and global trends in mean sea level;
- Rainfall patterns - increasingly influenced by El Nino which brings dryness and below normal rainfall;
- Wind directions - dominated by the south-easterlies which are directly associated with the meridianal migration of the South Pacific Convergent Zone (SPCZ);
- Ambient temperature over time - mean island near-surface air temperature increasing between 0.3 – 0.8°C during the 20$^{th}$ century;
- Impacts of El Nino and La Nina - Strong El Nino has significant effect on rainfall patterns and duration in Samoa, while La Nina favours cyclogenesis and producing average to above average rainfall;

- Projections of future climate - changes over time reflect the influence of global warming;
- Impacts of Climate Change - direct and indirect impacts on sectors identified and considered most vulnerable in Samoa are vital to promote awareness and preparedness for future extreme climatic events; and
- Status of ozone in Samoa - Samoa has taken steps towards the reduction of Ozone Depleting Substances (ODSs);

(ii) Marine and Coastal Resources

Traditionally, Samoans rely on marine and coastal resources for their well-being and daily required sustenance. Fisheries play an extremely important role in the economy of Samoa, as well as contributing significantly to the health and nutrition of the people. The following takes into consideration the important aspects of Samoa's current state of knowledge for the marine and coastal environment:

- Reef cover – There has been gradual improvement from the impacts of the past cyclones. Corals have grown back among the rubbles and the on-going establishment of the Village Fisheries Reserves (VFRs), Marine Protected Areas (MPAs) and 'No Take Zones' (NTZs) around the country has facilitated this.
- Diversity of Marine Species - increasing over time, especially where MPAs, VFRs and NTZs exist. Listings of Samoan fish fauna, as documented by previous authors, are now included in FISH BASE™, developed by the International Centre for Living Aquatic Resource Management. Furthermore, the status of important marine fauna and flora resources of Samoa is now well documented.
- Marine Conservation Areas - The Palolo Deep Reserve, Aleipata and Safata Marine Protected Areas (MPAs). 72 villages have established VFRs, 43 in Upolu, 25 in Savaii and 4 in Manono.
- Endemic, Extinct and Endangered Marine Species - Endemic species are not well documented. Endangered species include most marine flora and fauna species in the inshore and coral reef areas which are targeted by the fishing population. This includes the grey mullet, milkfish, maori wrasse, mangrove crab, spiny lobster and a few more crustacean and gastropod species. In addition, turtles, whales, dolphins, whale sharks, etc. are also endangered, Extinct species include the scaly giant clam (*Tridacna squamosa*) and the horse's hoof giant clam (*Hippopus hippopus).*
- Introduced Species - Marine organism introductions into Samoa for aquaculture, reef seeding and other purposes have been recorded. The known species include some species of gian clams, trochus, pearl oysters and tilapia. Those that were introduced unintentionally include among others a number of seaweeds and barnacle species.**)**.
- Impacts of climate change and cyclone damage outline how Samoa's marine and coastal environment will be affected by future extreme climate-related risks of sea level rise, increased seawater and air temperatures, increased frequency of cyclones and coral bleaching, not to mention acidification of the ocean due to carbonic acid levels increasing.

( iii ) Water Resources

The integrated and sustainable management of Samoa's water resources is vital for the health and social well-being of its people, the protection of its environments and the development of the national economy. The very limited nature of water resources in Samoa enhances its vulnerability to natural disasters, over-exploitation and pollution. The challenge, therefore, is to ensure the sustainable management of water resources. Water is a high priority especially as Samoa is currently experiencing high demands for freshwater due to expanding populations and, in some cases, tourism, industry and agriculture. A clear understanding of the following indicators is essential:

- Sources – groundwater is mostly from coastal springs, harvested rainwater in dry areas and surface water abstracted from catchments areas;
- Quality - treated water supplies are considered to receive 'clean drinking water status', according to WHO standards, on a reliable basis. Issues stem from deforestation of catchments areas and grazing of stock;
- Population Access to Water Supply – Samoa Water Authority's (SWA) service covers 68% of the population and the remaining 32% receive water from independent village schemes or their own small sources;
- Flowing Streams and River Systems - Upolu Island rivers, namely Fuluasou, Vaisigano, Namo, Mulivai, Salani, Tafitoala, Nuusuatia, Leafe or Lotofaga and Faleseela Rivers, and

- Savaii Island, namely Sili (or Vaiola), Palauli (or Faleata), and the upper reaches of the Maliolio River; are all suffering altered river flows;

- Catchments Areas and Changes over Time - The forest clearance of watershed areas affects water supply and leads to water quality degradation;
- Water Resources Issues and Concerns – deforestation of water catchments for plantations and from cyclone damage, discharges of untreated wastewater with associated pathogenic organisms into streams, rivers and coastal estuaries;
- Salinization - major vulnerability for many low-lying coastal villages;
- Boreholes - Upolu has 31 and Savaii has 23 boreholes, generally untreated, and is of good quality chemically and bacteriologically.

( iv ) Land Resources

The proper utilization of land resources, according to their appropriate capabilities, as well as vulnerabilities, holds the key to sustainable land use management. There have been numerous changes in the way land is used in Samoa in the last decade, particularly in land under agricultural development, utilization of land for residential purposes (both urban and rural lands), reclaimed and lost land areas and the overall capability of land to sustain development.

- Area of total land under cultivation - agricultural lands in the form of plantations and mixed cropping was estimated to be 28,621 ha in Savaii and 34,476 ha in Upolu;
- Residential land coverage - Vaitele, Vaiusu, Fuluasou West, Fuluasou East, Mt Vaea, Vaisigano East and Mt. Fiafia; east at Vailele and Vaivase-uta, Faleula; Fuluasou catchments villages to the south have all experienced major residential growth;
- Urban and rural land coverage - Apia and urban expansion along west coastal plain to the south Fuluasou and Vaisigano river valleys and Mt. Vaea foothills while supported by 330 smaller rural villages;
- Land loss to sea level intrusion and erosion - destructive action of storm surges, coupled with sea level rise and further exacerbated by sand dredging and sand mining, has resulted in a significant loss of land along the coast;
- Land gained by reclamation - process includes maintaining water and air quality, minimizing flooding, erosion and damage to land properties, wildlife and aquatic habitats caused by surface mining and finally topsoil replacement, and re-vegetation with suitable plant species; and
- Land capability allocation - Ward and Ashcroft (1998) drew on the land capability information from a study conducted in 1990 (ANZDEC) producing land use capability maps of the whole country.

( v ) Forestry Resources

Samoa's forestry resources are currently being refined to reflect the dominating environmental considerations of the time. Deforestation is identified as one of the key environment and development issues in Samoa since the start of the last decade (1993). Timber production and agricultural expansion remained the main considerations for the utilization of the remaining indigenous rainforest, along with the development of exotic forest plantations for the provision of a substitute source of timber. However, with the impact of cyclones in the 1990s, and the rising public concern with the degrading consequences of forest clearance, this development focus was challenged and the direction of the Government's forest development programmes is being transformed for more sustainable management. The Forestry Division (FD) and joint FAO Samoa Forest Resource Inventory System (SamFRIS) Project began in 2003 and has now completely re-mapped the country's forest resources, based on 1999 aerial photographs, into a MapInfo based Geographic Information System (GIS). This was a necessary planning technique to help manage Samoa's natural forest resources and plantation forests in a more sustainable way. This Project provided the FD with the necessary equipment and training to upgrade its capacity to assess, manage and monitor the remaining forest resources of Samoa. In addition, a comprehensive forest survey, involving more than 400 survey plots, has been conducted to gather detailed data about the structure and quality of Samoa's forests (providing the much needed ground-truthing for the aerial/satellite interpretations). This important tool provides relevant information on the total forest areas of Samoa, types of forests and coverage, conservation forest areas, diversity of tree species, natural forest regeneration for new forests and the changes of total forest cover over time.

( vi ) Biological Diversity

Samoans rely heavily on biological resources for their economic, social and cultural well-being. The use of natural resources for food, artisan and medicinal purposes is an essential expression of the Samoan culture. The challenge is to achieve protection for biodiversity resources within the context of sustainable resource use. This is best done with the cooperation of those living in the area and who are the main resource owners and users of these resources. Therefore, the biodiversity of Samoa is particularly important in the context of the South Pacific. The importance of the country's birdlife, particularly the proportion of endemic species (23%), and the increasing threats to them, have been recognized by the International Council for Bird Preservation (ICBP) which has listed the Samoan Islands as one of the world's 'Endemic Bird Areas' that is in need of urgent conservation attention (ICBP, 1992). Because of the potential danger of losing our heritage, there continues to be concerted efforts to ensure that Samoa sustains its wealth of biodiversity for socio-economic, cultural and ecological developments. The characteristics that are indicative of Samoa's critical biological diversity resources include;

- Number and types of species - flora is one of the most diverse in Polynesia with about 33% of the native plants endemic (with a further possible 150 plant species to be listed as endangered and added officially to the IUCN Red List of Endangered Species);
- Invasive species – comprehensive listing of invasive species in Samoa classified by taxonomic species and life form;
- Conservation/Protection Areas - review of the conservation value of a total of 226 South Pacific Islands ranked three of the islands of Samoa highly, Savai'i at number 23, the Aleipata islands at 30 and Upolu at 46;
- Living and genetically modified organisms - Biotechnology has been used by Samoan farmers for many years to crossbreed plants and animals. However, modern biotechnology, where genes are transferred between species, is a relatively new concept and a potential risk to Samoa.
- Rejuvenation project outcomes – recovery planning for the conservation of Samoa's endangered endemic *Manumea* (Samoan Tooth-billed Pigeon) and *Ma'oma'o* (Giant Honeyeater) birds.

**Responses to Development and Environment Trends**

Many significant Government and non-government environmental initiatives have taken place since the first State of the Environment Report in 1993. Of most significance are the achievements made in progressing the National Environment and Development Management Strategy (NEMS). More recently, detailed action-oriented strategies and action plans have been developed and implemented to address key environmental concerns such as Conservation of Biological Diversity (NBSAP), Management of Forestry Resources, Land Use Management and Protection, National Adaptation to Climate Change (NAPA), Scarce Water Resources, Persistent Organic Pollutants (POPs) and Ozone Protection. Environmental protection directed policies have also been invoked by the PUM Act 2004 which included the National Parking Policy, (Environmental Impact Assessment) EIA Policy, Development Consents Policy and National Building Guidelines. Moreover, a National Coastal Infrastructure Management (CIM) Strategy is in place with its own policy statements, as well as CIM Plans for all 41 districts that contain plans of action for each village in the district.

The two remaining policies of the NEMS for Planning for Sustainable Economic Growth and Sustainable Human Resources Development have been addressed in both the Statement of Economic Strategies (SES) of the 1990s and Strategy for the Development of Samoa (SDS) since the beginning of the current century, as well as the Public Service Reforms started by Government in 2000.

There have also been major changes undertaken by Government through its Public Sector Reform Programme, and the strengthening of partnerships with the private sector in terms of outsourcing some Government activities to be implemented by private operators. Although MNRE (previously Department of Lands Survey and Environment [DLSE]) is the focal Ministry spearheading overall management of most activities concerning the environment, there is growing involvement of other government Ministries, non-governmental organisations (NGOs) and the private sector to equally address these environmental issues. The refinement of responsibilities and mandates within Government itself has given birth to new agencies and more human resources working on the

environment. The Division of Environment and Conservation (DEC) has been expanded with new positions, and the splitting of the Biodiversity Section into Resource Conservation Section and the National Parks Section was done to further demarcate the separate activities executed by each Section. Two new Divisions within MNRE have now been established and are fully operational, namely (1) Planning and Urban Management Agency (PUMA) has been enacted and (2) the National Water Resources Division. Two other Divisions have been transferred recently from the Ministry of Agriculture and Fisheries (MAF), namely Meteorology and Forestry.

A Legal Unit of the MNRE has been established consisting of a Principal Legal Officer demonstrating the Ministry's willingness to ensure understanding and compliance with current legislation and the need for on-going legal reviews.

The Planning and Urban Management Agency (PUMA) was established in 2002 based on Government's conviction that sustainable development will only occur through institutionalized environmental planning and management supported by appropriate legislation. Government accorded priority to environmental planning and protection from pollution within the overall national development process. Hence the first SDS called for an integrated approach to planning the use of land within the Apia urban area, as well as other parts of the country where it applies.

Samoa has also become party to a number of international conventions and treaties (Multilateral Environmental Agreements [MEAs]) on the environment, particularly all the main Conventions and Protocols for conservation and protection of biodiversity, climate change, Ozone Protection, pollution from hazardous substances and persistent organic pollutants, and land degradation and desertification. Samoa has also been active in non-binding global initiatives and has reported its progress in meeting its Millennium Development Goals (MDGs). Samoa's 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. Samoa has also demonstrated its willingness to implement measures that will minimize the effects of global environmental impacts. However, the lack of resources and technical capacity to support and implement all such activities related to these MEAs has prolonged the immediate implementation of its obligations. Nevertheless, Samoa's active involvement and participation in these Convention processes has enabled the securing of funding towards Samoa's enabling activities, as well as the piloting of conservation and management initiatives under each of the major conventions.

The *Lands Surveys and Environment Act 1989*, although it encompassed the protection of various natural resources, was merely an institutional framework leaving the substantive content to be handled through regulation. The "environment" is also defined as 'the physical features of the surroundings of human beings, including the land, water, atmosphere, climate, sound, odours, tastes, the biological features of animals and plants and the social features of aesthetics'. There is no reference to the social, cultural and economic context in which land and other resources are inevitably utilized, other than the very limited reference to "the social features of aesthetics".

It has been recognized that, in order to achieve the aims of sustainable development and environmental protection (bringing Samoa in line with global trends), adjustments need to be made to the main legislation for environment in the Lands Surveys and Environment Act 1989. The Environmental Legislative Review, which took place in 1993, with its specific recommendations on various aspects of existing legislations, could be a good starting point. A further assessment was commissioned under the Samoa Infrastructure Asset Management (SIAM) I Project as part of the reforms Government was institutionalizing in its Ministries. The MNRE prepared, under that Project, a draft Environment Management Bill (yet to be approved – see below), and its development called for further assessment of legislation relevant to the environment.

This assessment has been further developed under the SIAM II Project where other areas under the mandate of the MNRE, particularly land resources, have also developed appropriate draft legislations. The PUM Act 2004 gave the PUMA of MNRE operational responsibility for development planning and for the regulation of development projects to ensure that environmental, social and related impacts are kept to acceptable levels. Although its approaches are considered by some individuals and organizations to be too complex and more suited to a developed country (many people, including politicians, dislike the role PUMA is playing in the development process as unnecessary government

intervention in private individual matters), others, particularly those disadvantaged by unregulated construction, reclamation and general development, showed their appreciation of having such a service within Government to deal with un-welcomed pollution that would have resulted from the increasing adverse effects of urban drift and non-sustainable land uses.

The Planning and Urban Management ( Environment Impact Assessment – EIA Regulations ), planned to be enacted in 2007, were drafted to prescribe the process for the undertaking of environmental impact assessments (EIAs) with emphasis on the kinds of issues that ought to be considered and evaluated. The decision on whether an EIA is undertaken or not is left with the flexibility of the development consent process under the PUM Act 2004.

The following primary legislation and Regulations have been enacted by Parliament:

- Ozone Layer Protection Regulations 2006
- Plastic Bag Prohibition on Importation Regulations 2006

The following Bills, however, are in the various stages of the legislative approval process of Government and are yet to be submitted to Cabinet for endorsement before tabling in Parliament.

- Biological Diversity Protection Bill
- Biosafety (Genetically Modified Organisms) Regulations
- Waste Management Bill
- Natural Resources Management Bill
- Environment Management Bill
  To protect, conserve and enhance the quality of the environment of Samoa having regard to the need to achieve sustainable development, to establish an effective administrative structure and to make provision for the development, administration and enforcement of effective legislation for environmental matters.
- Forest Management Bill
- Valuation Bill
  To formalize valuation procedures as well as enabling the Ministry as regulator of land valuation.
- Land Survey Bill
  The proposed Land Survey Bill amends the Survey ordinance provisions to enable the implementation of the Land Registration Act.
- Spatial Information Agency Bill
- Also the following issues are being considered, including Planning and Urban Management ( EIA ), Fisheries By Laws ( updated for 27 different locations, PUMA ( Development Consent Application and Fees ), Disaster Emergency Management, and Unit Titles. Drafting of the following Regulations has commenced: Environmental Bio- Prospecting Regulation ( to regulate access to Samoa's genetic resources and the equitable sharing of benefits derived from its users ) and the Beverage Container Deposit Scheme Bill ( to provide for the payment for and refund of deposits in respect of beverage containers to encourage recycling and to protect the environment ).

Information on the environment of Samoa currently exists in a number of separate assessments, reports, strategies and plans. While many of these reports contain basic information of qualitative nature, there have been attempts at quantifying actual numbers and estimates of populations, as well as impacts of contaminants and pollutants in the environment. One of the main goals of Samoa's environment strategy is to encourage the generation of information, particularly baselines for natural resources, so that trends in the environment, as well as impacts of management activities, can be determined. These SEM Indicators will provide critical tools for the MNRE to define Samoa's environmental management progress.

More and more information on the environment has become readily available, with daily and weekly environment columns in the local newspapers as well as radio and television programmes. Information on the designated theme of the annual Environment Weeks, that have been commemorated every year since the inception of DEC, have been archived with publications of the

National Environment Forum papers available both in hard copies and on the MNRE's website (www.mnre.gov.ws). Most of MNRE's public documents and publications can now be accessed on this website, including dedicated meteorological information which contains references to extreme weather phenomena and guidelines for responding to cyclones and other land-based disasters. Despite the generation of all this information, Samoa remains incapacitated and unable to submit timely national communications and reports to the receptor of its international reporting obligations. While a great deal of work has taken place in generating regional information that is also nationally relevant in addition to national data baselines and impacts indicators, there still remain difficulties in their collation. The search for information continues and it is hoped that, with more baseline assessments, and as the basis for determining environmental impacts of development increases with more EIA assessments, then more information will be generated and made available to the public.

Government's financial commitment to the management of natural resources has averaged 3% of total national annual budgetary allocations from 1998-2005. The bulk of environmental management-related work, in the form of projects, is funded through external bilateral and multilateral assistance. External funding has also enabled the involvement of nearly the whole country in environmental management initiatives. At least for the development of CIM Plans, all districts and villages have been engaged at the village level.

National capacity for long-term planning, in its broadest sense, has gained momentum in Samoa, but this SOE Report indicates that the integration of environmental and developmental concerns still needs to be strengthened. 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. Improved systems have been established under policies for natural resources and environmental conservation, as well as protection from polluting activities. Institutions for environmental management have increased in number and have been strengthened with external funding and government reforms. Community contributions to development and conservation activities have also been improved through programmers of NGOs and community-based groups (CBOs). The private sector has also responded by providing services for environmental projects that cannot be effectively undertaken by government Ministries through establishment of new firms and expansion of existing companies. Despite all these improvements, there is still a lack of local individual experts to fill all the technical positions and provide technical advisories to Government. Building this capacity is now possible through project implementation.

**Cross Cutting Issues and Challenges**

The threat of environmental degradation within the constraints of finite resources, most of which are non-renewable, has led to the realization that a sustainable future "requires an effective approach to resource management" (SDS, 2005-2007). This new trend in thinking is in stark contrast to the indifference and lack of appreciation accorded environmental issues over the past years at the national level.

Planning for sustainable development ought to start at the grassroots level and progress upwards into village and district development. Likewise, centralized planning in Government must also filter down to the communities in a transparent and integrated manner. All facets of Samoa's society and economy need to be fully understood, or at least appreciated, so that the critical issues that are causing people to exert undue pressure on the environment can be addressed as well as addressing those global pressures on our vulnerable environment,.

Cross cutting issues and concerns posing challenges to the integrity of the environment, and success of national and community initiatives to ameliorate them, range from poverty to poor land use management, health and sanitation, demographic trends, climate change impacts, and unsustainable design and implementation of economic development activities such as tourism and agriculture.

The Government has demonstrated a strong commitment to social development. This is reflected in particular by the priority given to education, health and basic infrastructure. However, as the formal economy continues to grow, there will continue to be growing social pressures with urban drift,

possibly even leading to higher crime and increased environmental pressures, as well as a weakening of traditional cultural norms that are already being reported (SOE, 1993).

Resolving health issues is one of the sustainable development priorities of Samoa. Existing information, particularly Samoa's National Assessment Reports (NARs), highlight poor waste management practices, poor water quality, free-ranging domestic animals and the excessive use of fertilizers and pesticides as serious health threats in Samoa. Also highlighted was the concern over the continual breakdown of traditional medicine systems. Today, climate-related diseases (and related climate health issues) are further burdening Samoa's health sector.

Modern medicine is expensive and not always available to all sectors of the population. Fundamental environmental health requirements, such as the provision of safe drinking water, food safety and food security, hygiene and sanitation, have been overlooked in national economic planning, with significant gaps in their provision. Nevertheless, access to satisfactory sanitation services has improved from 1990 to 2000 (World Health Organization [WHO], 1998).

Although various components of the overall health of the people has improved, they are faced with threats from HIV/AIDS and a resurgence of infectious and vector borne diseases such as typhoid, dengue fever and leptospirosis. Illnesses related to inadequate water supply and unsanitary conditions are prevalent, especially in informal settlements in marginal locations. Diarrhoeal diseases and acute respiratory infections continue to be a major cause of mortality in young children. In addition, there is an increase in the incidence of lifestyle diseases in Samoa, namely cardiac diseases, diabetes and other non-communicable diseases which are now the leading causes of death in Samoa (Ministry of Health [MOH], 2005).

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

- The reduction, reuse, recycling and recovery of resources,
- The provision of proper treatment and disposal facilities, and
- Promoting more public and private sector participation in waste management strategies.

Comprehensive studies have recently been conducted for a proposed sewerage system for Apia, a system dependent on energy and water resources being available at all times, including times of natural disasters.

Samoa's land cover has undergone tremendous change and modification since the last two decades of the last century, and even far more rapidly as we approach the end of this century's first decade. Traditional land use, apart from settlement areas, was commonly restricted to forest and agricultural use. However, the current speed with which societal technological innovations are being adopted, in tandem with infrastructural development which is largely dictated by macroeconomic ambitions, has resulted in the transition from subsistence living to a more commercialized type of living. Changes in land use have now become far more pronounced fast-tracking rapid changes in Samoa's landscape towards other uses, especially those influenced by commercial interests (e.g. expansion of the livestock industry often at the expense of our remaining rainforests and water catchments).

The issues and concerns of land use planning cut across social structures, community needs and demands, land and land use, services and infrastructure provision, all within an urban area that is the commercial and industrial centre of Samoa. Land use is dominated by subsistence agriculture, apart from indigenous forests. About 77 per cent of land holdings are 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 utilization 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 soil fertility declines. As already seen, uncontrolled land clearance has caused severe soil erosion and flash flooding during the wet season. Also of immediate concern is the effect of increased agricultural activities, especially the use of fertilizers and agricultural chemicals on water resources.

Samoa is exposed to a number of natural and technological hazards. Some of these hazards are seasonal, such as tropical cyclones, floods and droughts. Others are an ever-present threat, such as earthquakes, volcanic eruption, tsunamis, pollutants, epidemics, industrial hazards, and exotic plant or animal diseases.

Since 1985, about twenty tropical cyclones occurred in the Samoa region. Out of that, four had reached hurricane force winds and made actual landfall, with two in the 1990s being the most devastating of all. Other minor tropical cyclones had dumped lots of rainfall over Samoa and caused a lot of damage resulting from flooding and crop damage, such as those events in 1983, 2001, 2002 and 2006.

Also, uncontrolled discharge of waste, especially that which cannot be assimilated into the environment, is cause for great concern. Samoa, Apia in particular, does not have an environment that can sustainably absorb all types of wastes generated. Wastes vary in type, quantity and source from which they originate from, but they can be generally grouped into materials that are liquid, solid or gaseous (e.g. liquid waste from toilets, washing water, oils and chemicals; solid waste from packaging; and gaseous exhaust fumes). These are all discarded as a result of various land use and development activities. Waste can, therefore, be from households, villages, industry and commercial operations. A receiving environment, biophysical or otherwise, such as the receiving environments of Apia Harbour and Vaiusu Bay, receive high volumes of waste water from nearby urban and rural catchments.

While 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:

- 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 (e.g. Samoa's Energy Efficiency in the Transport Sector Project);
- Promotion of alternate sources of energy, including solar energy, hydro, geothermal, bio-gas, fuel-wood, wind and wave power; and other biofuels such as coconut oil (e.g. Samoa's Power Sector Expansion Programme); and
- Development of more efficient wood-burning stoves.

As far as global atmospheric pollution is concerned, Samoa can do little to reduce the impact of global climate change by way of its national development other than to encourage fossil fuel displacement and more sustainable tourism practices. Other countries need to control their emissions of greenhouse gases at source, albeit from industrial sources or from major disruption of carbon sinks (forests, peat marshes, coal deposits, etc.). However, appropriate local policies such as the National Adaptation Programme of Action (NAPA), National Communications and CIMS implemented through CIM Plans that involve contributions from both Government and local communities, can collectively signal that this country is seriously concerned about the threats due to climate change. Specific risks under greenhouse warming include:

- Coastal inundation,
- Tidal effects on estuaries and harbours,
- Shoreline retreat,
- Severe and frequent storm and wave conditions,
- Increased coastal sedimentation,
- Threats of damage to coastal infrastructure,
- Damage to marine resources,
- Acidification of oceans, and

- Pollution of groundwater.

**Way Forward**

This SOE Report would benefit from a complete set of data and information indicating the status of resources, and the extent of impacts that have taken place due to past environmental pressures. However, while there is some information available, there is still the issues and challenges of information scarcity in the areas of, for example, ambient air quality, data on greenhouse gases, ozone-depleting substances, consumption, and indications of the real impacts of climate change and economic valuation of natural resources. Some specific environmental data and information are also available, but they have not really been presented in a convincing format that will make them critical considerations in economic development and financial planning (i.e. as key data in environmental audits). Better monitoring and evaluation of key Sustainable Environmental Management indicators are needed.

Secondly, over recent years, Samoa has seen a great deal of activity and progress made in meeting both international and national obligations to the environment, albeit not hastily enough. While this national commitment has helped create some awareness of all these initiatives with some of the stakeholders throughout the country, it has not been sufficient to alter the general trend in on-going environmental degradation and insufficient mainstreaming of these pertinent environmental challenges into Samoa's own development framework.

The effectiveness of all these environmental and developmental policies, at both the national and community levels, is being retarded by stakeholders not taking this more holistic approach as outlined above. This is where the real benefits of long-term Sustainable Environmental Management Indicator (SEMI) research is translated into sound development planning, improved drafting of legislations, increased capacity building at all levels, along with raised levels of commitment amongst all stakeholders in pursuit of attaining sustainable livelihoods for all in Samoa. Whilst there has been an increase in funding for the environmental and developmental programmes in Samoa over recent years, and whilst their implementation is always challenged by insufficient human resource development and mostly descriptive approaches being taken, the real urgent progress that needs to be made can only come about with increased knowledge of environmental issues and increased application of this knowledge. However, much more remains to be done if standards of living and the quality of life of the current generation are to be maintained, let alone if restoration of degraded environments is also to be undertaken to achieve levels of environmental health and natural resource abundance once enjoyed by former generations.

Samoa's vision for the future should be a nation that is characterised by macroeconomic stability, a thriving and competitive private sector and an efficient highly qualified public sector, adequate employment opportunities, best practices for good governance, quality health and education services, dynamic development of its key agriculture, fisheries and tourism sectors, vibrant socio-cultural values and sustainable management of the environment.

To achieve this vision, there is a need to foster more sound development practices by bringing people into the development process through initiating policies that make development more participatory and equitable, involving all stakeholders in decision making at all levels, particularly in natural resource management, improving incentives for people to manage resources sustainably, enhancing opportunities for low income earners to enter the formal economy, promoting a greater role for NGOs in development and using information technology for faster awareness raising. One such incentive to be proposed may be accessing 'carbon credits', combining this with 'oxygen production' and a vastly improved 'lifestyle public relations campaign'.

In more specific terms, there is a need:

- To consider institutional arrangements for the promotion of sustainable development and the corresponding capacity building activities;
- To give priority to the completion of the two remaining policies under the NEMS (e.g. National Human Population Policy and the Human Resource Development Policy**);**
- To address a growing human population and the impacts of increasing urbanization;

- To create employment opportunities for the ever-increasing youthful population in both the formal wage and non-formal sectors, and ensure parallel productive skills training;
- To reduce inequality and provide assistance to disadvantaged groups by adhering to the sound macroeconomic principles of pro-poor growth;
- To ensure the proper utilization of land resources by promoting land capability guidelines, as well as implementing an integrated system of land information registration that developers can use to guide the best development methods to the most suitable lands;
- To enhance biodiversity conservation by broadening activities through projects that capture the value and security of biodiversity;
- To strengthen and revitalize management regimes for marine resources by including traditional conservation measures to help enhance the awareness of fisheries issues that are supported by scientific evidence and the taking of appropriate precautionary approaches;
- To consider the potential impacts of climate change and weather variability, such as progressive sea level rise, which are already impacting significantly on Samoa's economy, culture and sustainable livelihoods.
- To consider the rapid demand growth in the commercial energy sector which brings with it increasingly urgent requirements for prudent energy efficiency management practices, as well as growth in Samoa's renewable energy sector;
- To address the challenges faced in the water resources sector, such as a fragmented management approach and lack of understanding of related environmental and developmental issues by urgently revising the Water Resources Master Plan; and
- To ensure the review and monitoring of all national actions towards the achievement of international obligations of Samoa, which are also serving their own local environmental needs which are integral to the current and future sustainable development initiatives of Samoa.

In conclusion, the process incepted by the NEMS in 1994 should now be urgently revamped and aligned with the latest GEF Strategic Focal Areas approved for Samoa, namely biodiversity conservation, climate change adaptation and land degradation. However, other areas of great importance that need to be developed further are (i) ensuring an enabling environment for sustainable development (ii) realization of accessible, affordable, sustainable and renewable indigenous energy supplies; (iii) more equitable and sustainable land management practices; (iv) achieving secure and affordable long-term access to nutritious foods (food security); and (v) reducing vulnerability to natural disasters and social and economic pressures through improved disaster management and greater access to micro-financing opportunities. Further cross-cutting priority areas for action have been identified, namely ensuring the capacity for attaining sustainable development through pro-active capacity development, involving sustainable tourism and sustainable waste management in this development initiative (including issues related to ozone depletion and POPs), and combining all the above priorities with an International Waters Programme that encompasses management of freshwater as well as pelagic fish stocks in open waters.

The state of the three main components of the natural environment (e.g. land, air and water) can be monitored through consideration of numerous parameters or indicators (SEMIs) that are indicative of sustainability or otherwise in these natural environments. Measuring and monitoring such SEM indicators will once again be a major challenge for Samoa with its current lack of resources and technical knowledge to also help apply such newfound knowledge. Whilst there may never be sufficient resources on hand to do what is needed, a certain degree of improvisation is urgently required. Hence, Samoa needs to be innovative in approaching funding mechanisms and showing its on-going increasing level of commitment to attaining sustainable livelihoods for all within the foreseeable future. Lastly, the SOE Report 2006 is closely aligned to the Pacific Plan (2006) in recognition of the importance of human rights and gender equality to sustainable development in Samoa.

# 1. Introduction

Samoa became independent in 1962 after a period of administration by New Zealand as a trust territory of the United Nations. All citizens elect its Legislative Assembly through universal Suffrage over 21 years of age. Only holders of traditional chiefly or *matai* titles can stand for elections, with two exceptions. The indigenous population is Polynesian, living mainly along the coast in over 330 villages. The total population recorded in 1991 was 161,298 persons. This has increased to 174,140 in 2001.

The climate is generally hot and humid with only small variations in temperatures (average annual temperature is 26.5ºC). Average humidity for the capital Apia is 83 per cent. The average annual rainfall is about 2,000 mm with about 75 per cent of the precipitation occurring during November-March. Samoa is affected by tropical cyclone patterns with the cyclone season in November – March. Air pressure averages 1,010 mbs.

There are four types of land ownership in Independent Samoa with over 80 per cent of total land under customary ownership. The rest is divided between freehold, government and land vested in STEC and SLC. A growing trend in customary land tenure is the increased individualization 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.

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 residing and 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. Samoa's economy has suffered in the early 1990s from tropical cyclones, Ofa and Val, which struck in 1990 and 1991, respectively, and more recently, Cyclone Heta and Cyclone Olaf in 2002 and 2005, respectively. The destruction of tree crops, forests and infrastructure by cyclones has badly affected economic performance, especially primary production, and these impacts on the environment and the people could be felt for over three years after each cyclone.

The 2006 SOE Report is, therefore, a guideline only, offering readers a clearer understanding of Samoa's environmental vulnerabilities and challenges that must now be addressed.

## 1.1 Social- Political Setting

Samoa is a small South Pacific Island nation that 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, 21 years of age and over, are eligible to vote, only 47 matai (holders of traditional titles and heads of extended families) are entitled to hold office after parliamentary elections, along with 2 seats reserved for non-matai. The Prime Minister is elected by Parliament whilst the other twelve 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.

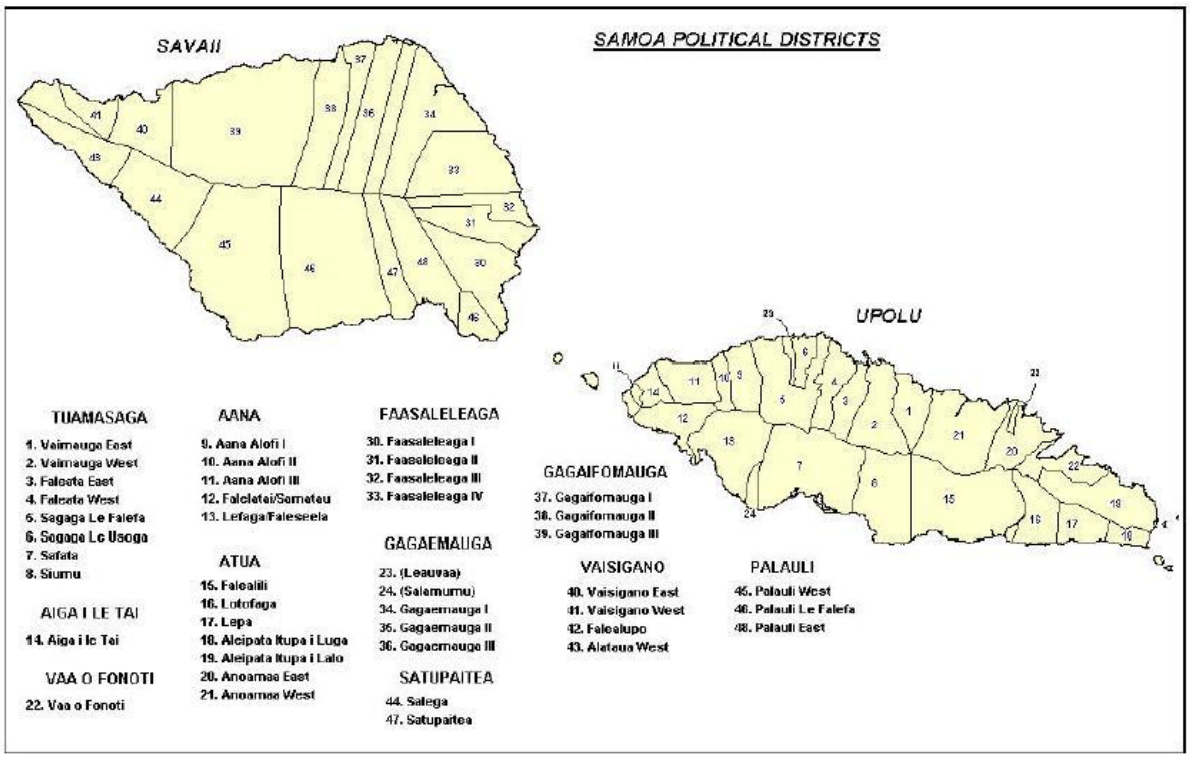
Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of public service institutional strengthening along with good governance programmes as well as Institutional Strengthening Projects (ISPs) within rural villages. To attain optimum environmental management, especially for Samoa's natural resources, society and culture, the MNRE has had to rely fully on obtaining close cooperation from all the village fono (Councils of Chiefs). Certain aspects of societal breakdown are recorded within this 2006 SOE Report, and this issue will be addressed pro-actively in all future programmes designed to help bring about sustainable livelihoods for all.

## 1.2 People

The indigenous population in Samoa is Polynesian, living in over 330 villages mainly along the coast and, more recently, inland with the expansion of inland roads and the establishment of new subdivisions in suburban Apia. Traditional social and cultural institutions are still very strong and the driving force of the fa'aSamoa (Samoan way of life), however, a breakdown in the traditional way of life has been referred to as cultural erosion. 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 *matai*) controls all village affairs, keeps order and provides direction for village development. The 2001 Population and Housing Census shows a national population total of 174,140 persons.

Since the 1993 SOE Report, however, Samoa has taken some steps to curbing further cultural erosion, but the response has been less than expected, less than deserved. On-going refusals to accept pertinent opportunities to strengthen the culture through expanding traditional art forms, building an art centre and cultural centre, expanding the museum, conducting further cultural research, etc. have been either ignored or delayed at a time in Samoa's development path where it is deemed crucial.

Figure 1.1 Political Districts of Samoa




Source: Mapping Division, MNRE.

## 1.3 Environmental Vulnerabilities and Challenges

Extreme levels of cultural, social, economic and environmental vulnerability characterize Samoa's environment. Samoa possesses characteristics that are shared by other Pacific Islands States (PICs). These features are typical of a fragile and vulnerable, but yet an opportunistic, environment that needs the most committed environmental management and sustainable development, including pro-active cultural conservation efforts.

Samoa's small physical size and geographical isolation includes ecological highlights such as endemic species diversity. However, it also presents challenges such as: (i) difficulty in travelling

within and between such Pacific Island Countries, (ii) distributing resources evenly to all, and (iii) efficient environmental networking.

Samoa's unique biodiversity is a result of its geographic isolation which has led to the evolution of unique species and communities of plants and animals, many of which are indigenous to only one island or island group within the Pacific region. These species usually have small population sizes, making them particularly vulnerable to loss from over-exploitation and habitat degradation, and possibly worsened today by the accumulative impacts of global climate change.

In the past century, Samoa has experienced rapid natural human population growth. There is concern that Samoa's population may have exceeded the carrying capacity of its islands. Fortunately though, the high annual emigration rate reduces this natural human population growth to about 1% annually. Human population density is also high in Samoa's capital, Apia, with 569 persons per square kilometre, which is one of the highest in the Pacific (GoS/ADB 2001b).

Samoa's islands are also characterized by extremely limited land resources such as soils, minerals, forests and building materials. This is despite the large areas of land that remain undeveloped due to customary ownership restrictions, access difficulties and a lack of development opportunities.

There is a traditional dependence on the marine environment and its resources for food, tools, transport and waste disposal, despite new technologies and changing lifestyles (SPREP 1993).

The characteristics described above make the environment of Samoa vulnerable to irreversible damage. Limited financial and human resources, including traditional resources, reduce the capacity for effective response and planning to increase resilience. In addition, Samoa, like other Pacific Island economies, is highly vulnerable to external economic fluctuations and changing world trade policies. This stems from a combination of factors such as remoteness from world markets, a high dependency on exports of agricultural commodities that have relatively low value on international markets, geographic dispersion of Pacific Islands, vulnerability to natural disasters, small internal markets and limited natural resource bases (UNDP 1999). In addition, Samoa lacked a foundation of local sustainable economic opportunities, is highly dependent on fossil fuel imports for energy and is losing its traditional sustainable life skills as its natural environments and culture continue to degrade. The combined socio-economic impacts of these above factors have led to non-sustained pro-poor growth with poverty of hardship now being recorded in Samoa (UNDP, 2006). Unless these poverty issues are acknowledged and responded to with urgency, Samoa's social, cultural, economic, environmental and developmental issues can only deteriorate.

This SOE Report is driven by a series of questions, many of them developed through consultations with MNRE and its stakeholders, which address three main themes: what is happening now, why is it continuing to happen, and what are the effects if Samoa fails to respond quickly? For example, in the area of outdoor air, the questions address the quality of the nation's air (*what is happening now?*), the factors contributing to outdoor air pollution (*why is our air quality declining?*), and the human health and ecological effects of outdoor air pollution (*what are the effects on our climate, health, etc. if we choose to ignore this problem?*). Before embarking, however, on the detailed description of the state of Samoa's environment and natural resources, the physical and geographic features of the environment are first presented.

## 1.4 Environment for Sustainable Development

Samoa has been doing its best to participate in international and regional efforts to address key issues related to environmental conservation and sustainable development. Domestically, the Government of Samoa (GOS) has also implemented biodiversity conservation programmes in an integrated manner with its macroeconomic and governance reforms. Samoa, however, continues its participation in regional and international collective efforts to address environmental and sustainable development issues and pursue cooperative arrangements between the Government, private sector, non-governmental organizations and community-based organisations (NGOs and CBOs). All these efforts culminate in advancing environmental integrity and achieving sustainable development for the benefit of future generations. However, Samoa has been slow in adopting some of the more crucial

multi-lateral environmental agreements (MEAs): every effort must be made to incorporate all these MEAs into local national legislation designed to augment Samoa's environmental and developmental capacity.

Samoa has to date learnt some valuable lessons in incorporating environmental issues into decision-making and actions on development, particularly in terms of infrastructure development and resilience building within coastal areas. Despite these efforts, mainstreaming of environmental issues into the development framework remains a challenge, particularly in relation to the most recent Strategy for the Development of Samoa (SDS) 2005-2007 at the national level. While we recognise that no single approach can be adopted universally to achieve sustainable development, selective applications would yield tangible benefits by integrating the three pillars of sustainable development; namely socio-political aspects of the country, economic features and environment aspects and aspirations.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of improving its environmental management. The recent attempts to mainstream environmental issues into the UN Development Assistance Framework (UNDAF) for Samoa (UNDP, 2006) highlights the bold steps already taken by the GoS. The MNRE, in partnership with all other Ministries and 15 UN Agencies, has spearheaded this response thanks to the on-going advices from Samoa's development partners.

## 1.5 Physical and Geographic Features

### 1.5.1 Geography

As the larger and Western part of the Samoan Archipelago, Samoa lies in the South-West Pacific between 13º 25' and 14º 05' South of the equator, and between 171º 23' and 172º 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 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 Samoa is rugged and mountainous with about 40 per cent of Upolu and 50 per cent of Savaii characterized by steep slopes descending from volcanic ridges. The interior of both main islands is still covered with montane forests and, in the case of the highest peaks on Savaii, covered in cloud forest. These areas also contain volcanic peaks with the Upolu crestal ridge rising to 1,100m. Savaii has more and younger volcanic cones with the highest peak reaching 1,848m at Mt. Silisili. Western Savaii and North-West Upolu are almost devoid of surface streams, corresponding to the rainshadow areas as mentioned below.

The two main islands are well served by coastal ring roads and Upolu has 3 cross-island roads. The completion of the current road 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 were once linked by air service between Faleolo near Mulifanua on Upolu and Maota near Salelologa on Savaii, but this air service was discontinued in 2006. Another airport is located in North-West Savaii at Asau, but it has been closed since 2005. The main international airport is Faleolo Airport. The Faleolo Airport terminal received a facelift in the late 1990s, an extended runway and a new automated landing system. Improvements are continuing at the Faleolo Airport with a computerized asset management system. All such infrastructure development projects will be now subject to Planning and Urban Management (Environment Impact Assessment) Regulations, are currently subject to existing PUM Act legislation, and are designed to help modernize Samoa, helping to meet the basic infrastructural needs also of Samoa's tourism sector.

### 1.5.2 Climate

The climate is generally hot and wet, marked by a distinct wet season (November to March) and dry season (May to October). However, due to its equatorial location, Samoa experiences only small

variations in temperature. The average annual temperature is 26.5ºC 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 tradewinds (more than 80 and 50 per cent of the time during the dry and wet season, respectively), the North-West parts of the main islands, as well as the South-East side of Savaii, are rainshadow areas, receiving about half the rainfall of the highland areas. The average 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-April.

Tropical cyclone patterns affecting Samoa originate from three main sources: tropical Easterlies cause winds from the South-East; cold air from
Southern Hemisphere cause cold airflows 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 maximum in August of 1,012 mbs (footnote: milibars per second) and a minimum in January of 1,008 mbs.

However, Samoa is already experiencing change in climate (see Samoa's Climate Risk Profile)that will continue to have a devastating effect on agricultural produce and future food security, on the frequency and severity of cyclones, even on the quality and quantity of potable water supplies, as well as the general health of the population (i.e. climate health issues).

Since the 1993 SOE Report, Samoa has continued to embark on a climate change mitigation and adaptation programme, including climate proofing (the latter is an adaptation initiative). The MNRE is implementing the NAPA Programme as one immediate adaptation measure to help combat global climate change impacts locally. In addition, climate change impacts are one of the 3 main environmental issues being targeted in Samoa under the Global Environment Facility (GEF) Programme of funding for environmental restoration and protection. A Climate Early Warning System (CLEWS) needs to be designed by the MNRE Meteorological Division if climate trend reporting to all key sectors is to eventuate.

### 1.5.3 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 summarized in Appendix A (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 B 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 lavaflows 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 1.1 categorizes the soils of Samoa into ten classes on the basis of parent materials and natural fertility.

Table 1.1 Soil Types of Samoa.

| 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 | Solid 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 fertility | 960 | 2,032 | 2,992 |
| 8 | Peaty soils of low fertility | 32 | 20 | 52 |
| 9 | Coastal land 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 | 11,433 | - | 28,290 |
| | Total | 165.929 | 114,744 | 280,673 |

Source: Kear and Wood 1959.

In addition, earth tremors continue on a frequent basis in Samoa (as measured by the MNRE Meteorology Division at Mulinuu, Apia) and Samoa remains vulnerable to future volcanic activity. The last recorded eruptions were all on Savaii in (find correct year and insert), 1902 and 1905-1911. Some recent submarine volcanic activity has, however, been recorded in American Samoa East of Ta'u Island, with a volcanic cone currently growing from the seabed.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of identifying renewable energy sources including wind, solar, hydro and even geo-thermal possibilities. Further such investigations of the geology of Samoa are warranted as Samoa explores alternative methods to displace the reliance on imported expensive polluting fossil fuels that are a significant source of greenhouse gases that are causing global climate changes.

### 1.5.4 Minerals

There are no known oil deposits or any valuable mineral deposits in Samoa identified as yet. 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 in mining titanium. Natural gas exploration was at one time proposed for the lavafields in Savaii, but never commenced.

### 1.5.5 Construction Material

The Ministry of Works Transport and Infrastructure (MWTI) runs a commercial operation (Samoa Quarry Agency) for rock quarrying at Alafua, near Apia, where fill material for roads and concrete aggregate are produced for government works. The private sector and public also purchase aggregate and sand from the Samoa Quarry Agency. A number of ad hoc sandmining operations have also quarried sites in Savaii and have left scars at locations such as inland Puapua and Vaiaata, the latter being refilled as a rubbish dump. These quarries have 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 was once dredged from the lagoon near Apia, made excellent road and reclamation fill, or was screened to produce coral sand (this sand-dredging operation will soon cease because Vaiusu Bay is to be soon declared as a Marine Protected Area because of its valuable mangrove resources).

While construction in the vicinity of Apia creates a large demand for beach and lagoon materials, these marine resources are widely used by local communities all around the coastline for a variety of purposes. It is now recognised that, collectively, sandmining from most beaches of Samoa has exceeded the rate of supply. Certain beaches which are closest to the largest demand centres have chronic erosion problems resulting from over-mining (e.g. Solosolo). It is also probable that long-term subsidence of the Samoan landmass contributes to a general susceptibility towards coastal erosion. Rising sea levels, estimated to be 36cm within the next 50 years (footnote: report on source of this projection – Climate Risk Profile 2007, SNC), will also be exacerbating further coastal erosion.

Some extraction of coral material once occurred from the floor of the 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 are 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 and terrestrial deposits rather than beaches. Large deposits of sand have been identified at locations in Savaii, which have resulted from black sand being transported and deposited onto inland areas by high waves during cyclones Ofa and Val. For instance large amounts of black sand have been extracted from the deposits at Solomea Beach in Samalaeulu, which has been the main source of black sand for infrastructure construction and brick making in Savaii. Brick making is one of the growing businesses in Samoa with more than five operators in Savaii and four others in Upolu. This growth in brick and other cement product making is cause for concern as some beaches are being mined in huge amounts to meet this demand.

Data is needed on the rate of supply of coral sands. A South Pacific Applied Geoscience Commission (SOPAC) Project to assess the resource at key sites of demand has been completed. Licenses are also being issued stipulating conditions for sandmining that will help reduce coastal erosion. Another study is underway through the SIAM II Project that is hoped to complete the identification of construction material sources, as well as help strengthen a national policy to manage the extraction of these construction materials.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of identifying not only new sources of building materials, but even new building materials such as recycled plastics, etc. In addition, the PUM Act (2004) assists developers to help protect Samoa's vulnerable and limited resources and natural environments.

## 1.6 Environment for Sustainable Development

### 1.6.1. Land Ownership

Land is central to the economic, social and cultural structure of Samoa with excessive cleared land available for future productive purposes. However, in areas of high population density, shortages of customary land for crop production are increasingly evident. Within central Apia, human settlements have been replaced with commercial and other non-residential uses, such as the produce market. This has entailed the conversion of Government leasehold lands to freehold. Other land has required reclamation and informal land-filling.

The three primary types of land tenure in Samoa are also present in the urban town of Apia. Article 101 of Samoa's Constitution 1960 provides this three land tenures in Samoa as freehold land, customary land and public lands. Public lands or land vested in Samoa constitutes 16% of all national lands, and is free from customary title and from any estate in fee simple (freehold). It also includes all land lying below the line of the high water mark which is a line reserved for public purposes. Public lands also include land vested in the Samoa Trust Estates Corporation (STEC) and, more recently, in the Samoa Land Corporation (SLC) which was established in 2000.

Freehold land is held in Samoa for an estate in fee simple, and constitutes only 4% of all national land. About 80% of all remaining land, therefore, is under customary ownership. This is land held in accordance with Samoan custom and usage.

Leased land could be considered the fourth type of land tenure. Land that can be leased includes Government land, freehold and customary land, all of which must be registered upon application under the Land Registration Act 1992/93. When land is registered, it means that it has a unique legal description, its boundaries have been determined or defined, and that the owner(s) is/are known. One of the prerequisites for land development is that title to the land is secured as this enables long-term use of the land and provides the possibility for greater security (GOS/ADB 2001b).

These four types of land ownership in Samoa (see Table 1.2) are illustrated in Figure 1.2. The greater proportion of land is owned by extended families under customary ownership, and Article 102 of the

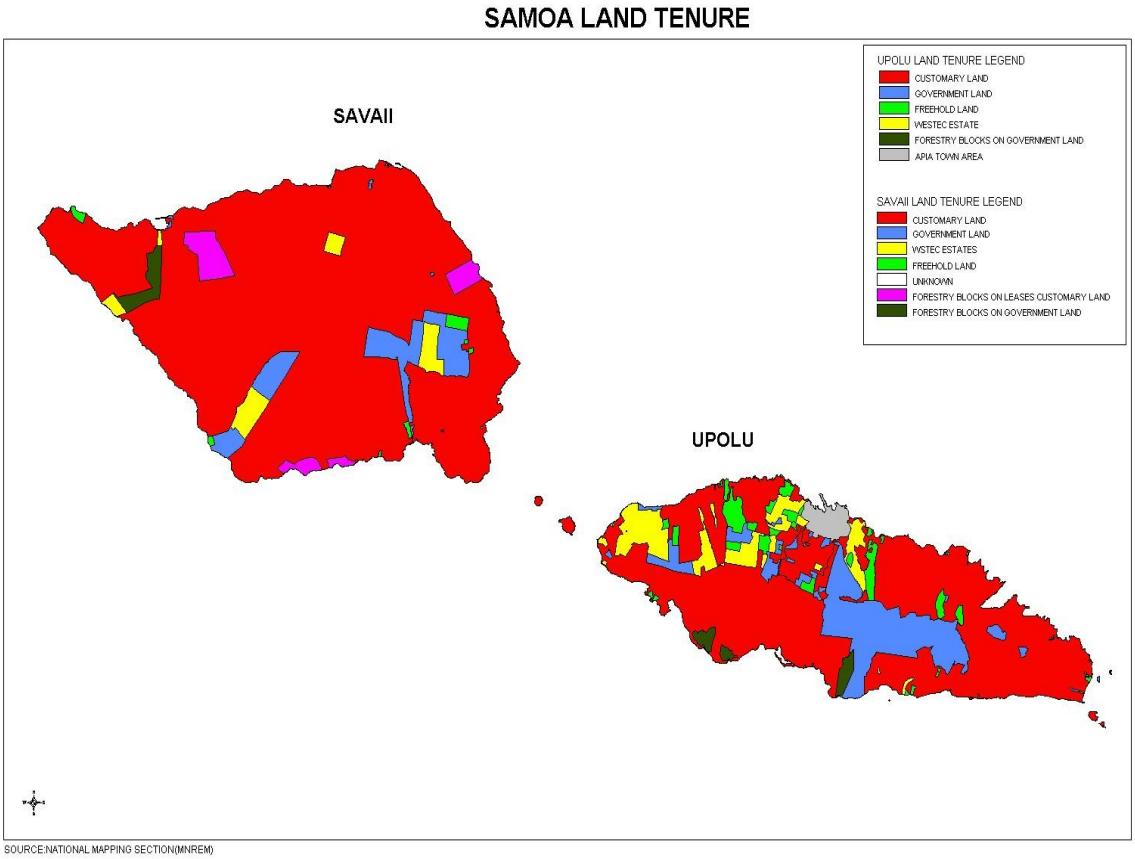
Constitution prohibits the alienation of customary land. Traditionally, the *pule* (customary ownership) of land is determined by consensus among the extended family. This customary land can neither be transferred nor made freehold, although lease arrangements are possible. The *Taking of Lands Act 1964,* however, does allow the Government to take or exchange any type of land for public purposes. With the current privatization of the operations of the STEC, some of the land under its control has been transferred to the Samoa Land Corporation (SLC). The SLC has either sold or leased land to the public. This has increased the amount of freehold land, especially on Upolu. The remaining STEC land is used for commercial plantations. Government land is being utilized for plantation farming, national reserves, public buildings and infrastructure. The recent acquisition of customary land for the township of Salelologa increased government land for public purposes. Hence, the current pattern of land ownership should differ from that presented in Table 1.2 where there would be five types of landowners with the inclusion of SLC. The percentage of Government land would have gained by about 5% with same loss from customary land. Freehold land in Upolu has increased slightly with the SLC sales of previously STEC lands.

Table 1.2 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 |
| STEC & SLAC | 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 |

Note changes in figures on land ownership.

**Figure 1.2 Map of Land Ownership**




Source: National Mapping Section, MNRE

According to O'Meara (1990), a growing trend in customary land tenure is the increased individualization of customary land. 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 *matai* to control family land under threat, it will be interesting how *fa'aSamoa* can cope with this fundamental social change (GOS/ADB 2001b).

The proper utilization of land resources, according to their appropriate capabilities as well as vulnerabilities, holds the key to sustainable land use management. There have been numerous changes in the way land is used in Samoa in the last decade, particularly in Apia as an urban area, and land under agricultural development in rural areas.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of defining land registration in more detail, hopefully in order to encourage increased productivity with commercial leasing of customary lands.

### 1.6. 2 Land Use Patterns

In the rural communities, land remains primarily under customary ownership and a large proportion of it is currently under cultivation.

A study conducted in 1990 (ANZDEC) produced land use capability maps of the whole country. The maps categorized Samoa's land into four main classes:

1) Land with few limitations for agricultural use (39,600 ha);
2) Land with moderate limitations for agricultural use and few limitations for forestry use (121,700 ha);
3) Land with severe limitations for agricultural use and moderate to severe limitations for forestry use (59,400 ha); and
4) Land unsuitable for agricultural or forestry use (69,000 ha).

The predominant land use, apart from indigenous forests, is agriculture. A common land use pattern in most villages consists of a residential area with a village common ground or *malae* on about a kilometre-wide strip of land along the coastline. Immediately inland is a mixed cropping zone of fruit trees, bananas and coconuts, and further inland is a zone of primary food crops of taro, *taamu* and yams.

According to the 1999 Census of Agriculture, 90% of land holdings under agricultural use are on customary land, with the rest divided between freehold, Government leasehold, freehold land and others. About 87% of land is under crops, 4.7% under livestock, which has increased in the last ten years, 4.3% under bush and fallow, while land under non-agricultural use has diminished to just 3.4% from 17% in 1989. This reflects a strong demand for agricultural land and conversion of land previously under non-agricultural use to agricultural use. A notable feature of the agricultural holdings is the higher number of farmers using organic fertilizers (14.8%) than those using inorganic fertilizers (13.7%), while the number of all holdings using agricultural chemicals has slightly risen by 2% since 1989. This is probably due to wide application of chemicals to combat the taro leaf blight.

Of the land under cultivation, the most notable change since the Census of 1989 is land under taro which has decreased dramatically to just 10% from 29%, which is even less than holdings under the giant taro or *taamu*. While this is due to the devastation of the taro blight in the early 1990s, it is certain that this crop is slowly recovering with new varieties of blight-resistant taro proliferating fast. While the supply of taro at the market place has dropped slightly in the last two years, there was a general increase after recovery from 1994 to 2003 from just a thousand taro to over 10,000 per week. Unfortunately, the levels before the taro plight of the early 1990s, which was over 30,000 per week, is an unlikely achievement today. The amount of land under taro cultivation, likewise, could not match the pre-taro blight proportions.

The present land use pattern has developed from a blending of two farming systems where subsistence village cropping has had a plantation cropping system imposed upon it since European contact. More detailed discussions of land use patterns are provided in the Land Use Planning Section.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of attaining better sustainable agricultural practices (e.g. Sustainable Farming Systems Project, etc.) in an endeavour to better preserve land productivity, increase profitability and acquire better food security.

### 1.6.3 Economy

The highest real GDP growth rate (5.1%) was recorded in 2005. Remittances continue to be the largest contributor to the country's economy and are largely responsible for the increase in growth of the commerce industry. Agriculture rebounded in 2005, after a downturn in 2004 due to cyclone Heta. But fish exports, which used to be a major contributor to economic growth, continued to decline primarily as a result of adverse weather conditions and over-fishing by local commercial fishing operators and illegal tuna pirating of nearby Pacific waters. However, *Nonu* exports have climbed over the last three years with *Nonu* Samoa's major agricultural export crop. Public administration, personal services, tourism, manufacturing and construction industries continued a steady growth in 2005, with tourism attracting a 7% growth annually in 2006.

The latest SDS (20085-2008) provides data with regards to employment creation, with those formally employed increasing from 19,879 in 2001 to 20,404 in 2003. This 2.6% increase was accounted for largely by Transport and Communications, Commerce, Hotels and Restaurants and Personal Services. However, employment in the primary and secondary sectors declined, reflecting the poor performance of fishing and rising labour productivity in Other Manufacturing. The private sector thus took a leading role in job creation (see Table 1.3).

Table 1.3 Numbers of People in Formal Employment

| | **2001** | **2002** | **2003** |
|---|---|---|---|
| **Primary Sector** | 473 | 446 | 459 |
| **Secondary Sector** | 5051 | 5439 | 4643 |
| **Tertiary Sector** | 9254 | 9741 | 10166 |
| **Public Administration** | 5101 | 5420 | 5136 |
| **Total** | 19,879 | 21,046 | 20,404 |

(Source: GOS 2005b)

In the financial year 2004/05, domestic fiscal and monetary policies were focused on facilitating an expeditious recovery from Cyclone Heta, which struck the country in January 2004, and to boost real economic growth. Real GDP grew much stronger than expected, led by strong public and private sector construction activities and further growth in tourism earnings, private remittances and grants from abroad. GDP increased 5.6 percent in real terms reflecting strong growth in all major industries. (Refer Table 1.4).

Further, the economy is expected to continue heading upwards for fiscal year 2005/06. Assuming that monetary policies remain relaxed, real GDP will likely grow by 5.0 percent, boosted by a continued upswing in construction activities, tourism and private remittances. Unfortunately, the expected strong growth in the economy would come at a time when large overseas payments are due to be made following the merger between Polynesian Airlines and Virgin Blue, and increased public sector salaries and wages. This will see the balance of payments record a very large overall deficit. A tightening in monetary policy will see real GDP growth slowing down to around 4.0 percent in 2005/06. The slower economic growth rate would help contain the high demand for imports, thus reducing the expected overall balance of payments deficit from $50 million to $30 million. In addition, inflation would also fall from somewhere in excess of 3% to the preferred target rate of 3.0%.

Table 1.4 Real Gross Domestic Product by Industry
(At 2002 Prices. Amounts in Tala Million)

| During the Period | 2002/03 | 2003/04 | 2004/05 | 2005/06 Forecast |
|---|---|---|---|---|
| Agriculture | 64.9 | 61.9 | 69.6 | 73.8 |
| Fishing | 63.3 | 55.3 | 58.6 | 61.4 |
| Food and Beverage manufacturing | 29.4 | 30.0 | 29.9 | 31.3 |
| Other manufacturing | 114.9 | 113.2 | 109.3 | 110.6 |
| Construction | 52.2 | 64.1 | 77.6 | 80.9 |
| Electricity and water | 42.2 | 44.6 | 42.9 | 45.0 |
| Commerce | 179.4 | 181.7 | 186.7 | 196.1 |
| Hotels, restaurants | 21.5 | 24.0 | 25.8 | 26.5 |
| Transport, Communication | 107.6 | 116.2 | 125.9 | 131.2 |
| Public administration | 73.0 | 76.9 | 80.4 | 83.6 |
| Finance and business service | 81.3 | 90.1 | 96.7 | 101.6 |
| Less: Enterprise share of FISIM (1) | -12.6 | -13.6 | -14.2 | -15.1 |
| Ownership pf dwellings | 33.5 | 34.2 | 34.9 | 35.6 |
| Personal and other service | 49.7 | 53.3 | 52.9 | 53.5 |
| Total | 900.3 | 927.2 | 977.1 | 1,016.1 |
| Annual percent change | 1.8 | 3.0 | 5.4 | 4.0 |
| Implicit GDP deflator | 101.5 | 107.1 | 110.4 | 112.8 |
| Annual percent change | 4.6 | 5.5 | 3.1 | 2.2 |

Source: CBS 2005.

Since the 1993 SOE Report, however, Samoa has continued to embark on a programme of macroeconomic reforms that have brought benefits across all sectors of the community.

### 1.6.4 LDC status and SIDS affiliation

Samoa is classified as a Least Developed Country, mainly because of its vulnerability to natural disasters and to external economic and trade developments for which it has no control. Despite these potential constraints, considerable progress has been achieved in the comprehensive macroeconomic reform programmes of the Government. While 'poverty of starvation' may not be evident in Samoa, there is a growing number of vulnerable groups facing 'poverty of hardship' which, together with a paucity of opportunities, can lead to increased vulnerability to poverty; this situation is given emphasis in the current Strategy for the Development of Samoa (SDS, 2005-2007) which has as its theme the creation of opportunities for all.

### 1.6.5 Physical and Built Environment

The Lands and Environment Act 1989 initially defined the environment as constituting only living things and ecosystems that these living things live in, as well as the interactions amongst them. However, when implementing environmental programmes and projects, the MNRE has taken a much broader approach to the environment by considering the environment as a holistic entity and inclusive of every natural resource including air, water, land and all their constituents, as well as the people that live within these ecosystems. The PUM Act 2004 further codified this broad application and defined environment as inclusive also of the built environment and its amenity value.

The state of the physical and built environment, as well as Samoa's natural resources therein, is of great significance to us all in determining the types and extent of action to address environment management needs for sustainable development.

An attempt was made at estimating values of Samoa's natural resources in 2000[1]. Two estimates of the Total Economic Value (TEV) of the goods and environmental services of the forest and marine

[1] Mohd-Shahwahid H.O conducted studies on assessing the economic values of forest and marine resources of Samoa. The economic values of these resources as a producer of fish, timber and materials for handicrafts involve the assessment of the resource rents contributions. The economic valuation technique adopted was the price-based residual valuation method of allocating appropriate opportunity costs to various scarce inputs used in production and assigning a fair profit margin to the

resources were computed. The first estimate of ST$21.0 million per annum, that is about 2.7% of the GDP, refers to the TEV based on the perspective of the citizens of Samoa, by excluding the values generated for the benefit of the rest of the world.

This contribution is significant given that these resources are either the primary input in the production of fishery (ST$15.6 million), timber (ST$0.48 million) and non-timber materials (ST$1.29 million) and the critical attractions to the tourism industry (ST$1.74 million) without which the multiplier from the tourism earnings could not have been generated. The life support ecological function of these resources need not have to be further justified contributing ST$0.6 million. The cultural values of these resources contributed another ST$1.3 million.

Including the value of global benefits or values generated by these resources for the benefit of the rest of the world, particularly on climate regulation services, nutrient cycling and biological control, the TEV was raised to ST$232.5 million per annum which is about 29.9% of the GDP of Samoa using 1999 figures. This large value is mainly contributed by the large area of the marine resources of Samoa relative to its land area. This high value, when including global benefits, is suggestive of the essential role played by Samoa in providing ecological services to mankind. The large global benefits provide evidence for Samoa to seek international support to conserve its terrestrial and marine resources to sustain the global benefits for mankind. There are various economic instruments available for the country to seek such support from, including both internal and international sources.

The MNRE is, therefore, currently preparing to implement large and expensive programmes to restore past land degradations, loss of biodiversity, loss of forestry and agricultural potential, and even the on-going impacts of global climate change. The 2006 SOE Report is, therefore, offering all stakeholders the latest up-to-date account of the state of Samoa's environment as well as the actions being taken by all Ministries and private sector to not only restore past environmental damages, but also ensure future prosperity for all. Without attaining sustainable livelihoods for all in Samoa, poverty issues will continue to escalate in Samoa, impacted further by environmental challenges that are also outside our control (e.g. global climate change, unfair trade relations, terrorism, cultural erosion, social disruption, global economic collapses, etc.).

To also help guide the responses expected from the MNRE, and all other stakeholders, over the next 10 years or more, the MNRE would like to encourage a national monitoring programme of all the different parameters that are relevant to environmental management, sustainable development, as well as monitoring such parameters within individual sectors such as agriculture, education, forestry, health, rural communities, tourism, etc. Unless the awareness of these issues is raised significantly amongst all stakeholders, and unless their relationship with each other is realized and accepted, and unless immediate actions are being holistically taken, then further delays will be indeed costly for all future generations. This 2006 SOE Report endeavours, therefore, to offer this option, guiding the readers, and all the stakeholders, through all the different development scenarios. This 2006 SOE Report is, therefore, a development blueprint and your support is paramount to its success.

## 1.7 Structure of the Report

While this 2006 State of the Environment Report is an update to the 1993 SOE Report, it is also therefore, an attempt to broaden the environment and development scope:
(i) by exploring further the implications of environmental conditions that may alter Samoa's goal of attaining sustainable development,
(ii) by updating all environment and development stakeholders on the various progresses made since the first SOE Report (1993),
(iii) by listing all the newly introduced processes, legislations and MEAs designed solely to spearhead these environmental and developmental initiatives, and also
(iv) by identifying some future options for addressing these environmental, cultural, social and developmental problems.

resource user. Details of the report are contained in *Economic Valuation of Terrestrial and Marine Resources of Samoa*, January 2001, Dept Lands Surveys and Environment, GoS.

Where it is thought that there is limited local understanding of particular issues as a result of lack of current data and available information (for instance the relationship between the levels of POPs in the environment, climate-related diseases and heritage conservation), some background information is provided as well to help illustrate the results of project and management initiatives at both national and community levels.

The 2006 SOE Report, therefore, attempts to review the current status of Samoa's environment and makes the vital links with the principles of sustainable development, with further emphasis on certain features of Samoa's environment that can provide support for this restorative and prophylactic approach. Chapter 2 discusses the state and trends of the environment exploring available indicators to cover climate change and ozone, marine and coastal, water, land, forestry and biodiversity resources. Chapter 3 looks at responses to these trends from the Government and private sectors. It covers government policies and legislation, institutional arrangements and ongoing programmes. The cross-sectoral issues, including population growth and urbanization, health, waste management are covered in Chapter 4, and identify the current major environment and development issues confronting Samoa. Summations and recommendations conclude this 2006 SOE Report with future directions in environment monitoring and reporting as expressed in Chapter 5.

Whilst some *alii* and *faipule* have very successfully managed their limited natural resources within their own village boundaries, they may not, however, be knowingly embracing holistically all the most sustainable practices for all aspects of their own village. To assist the readers and all stakeholders in Samoa's environmental management and sustainable development initiatives, a list of the most sustainable practices possible has been drafted and is also contained in Chapter 5. What is required now is for all stakeholders to continue to add to this list any new developments that directly or indirectly benefit Samoa's environmental management and ability to attain sustainable livelihoods for all within the foreseeable future. This list also makes for a good start for any school students working on environmental projects: they can see very quickly what are some of the obvious issues affecting Samoa's environment and future development.

To help entice villages to participate, and to increase their environmental and developmental capacity within their own villages, an increasing public awareness programme, with specific project outreach programmes, is envisaged, possibly with a yet-to-be designed system of rewards, awards and even short-term economic advantages. The MNRE has launched into a programme of designing the ultimate economic development plan for an archetypal Samoan village, this time developing economically in a more sustainable manner with direct social, cultural and environmental benefits. These benefits may be short-term and/or long-term, with local and/or global benefits. This model economic development plan is also portrayed in Chapter 5 and is indicative of exactly what potential and opportunities may lay ahead for us all. As Samoa's HRD continues to evolve, and as the benefits of long-term monitoring are realized, the 3rd SOE Report should hopefully show some marked improvements across-the-board in all sectors.

# 2. State and trends of the environment

## 2.0 Introduction

The MNRE has been the Governmental agency held increasingly responsible for not only improving Samoa's environmental management, but also meeting the sustainable development goals of the nation. This 2006 SOE Report attempts in Chapter 2 to highlight most of the obvious environmental trends witnessed since the 1993 SOE Report was first compiled. However, closer monitoring of these trends over the past 14 years would have provided a greater wealth of information, possibly even alerting us to some serious challenges at a much earlier stage. For such close monitoring to be most valuable, a long-term approach has to be taken with all the key features and SEM indicators of each environmental theme being clearly identified. Many of these environmental indicators overlap with different sectors, for example the sustainable tourism indicators identified by Twinning-Ward (1999) that either covered waste management and pollution from jets, global climate changes and their impacts on tourism development in Samoa, serious biodiversity losses in the marine and terrestrial ecosystems, declining water quantity and quality, strong reliance on air-transport despite excessive greenhouse gas (GHG) emissions.

Chapter 2 commences, therefore, with an explanation of Sustainable Environmental Management (SEM) Indicators that elucidate the following trends in the more serious environmental challenges facing Samoa, and depict also emerging trends in Samoa's overt attempt to attain sustainable livelihoods within the foreseeable future, simultaneously developing sustainable industries and sectors. Whilst there are numerous examples of various environmental indicators being referred to throughout this 2006 SOE Report, a more concerted effort needs to be made to now monitor all such SEMIs on a dedicated long-term 5-10-20 year basis, recording areas where progress is being made or lost, the rate at which such trends are emerging, the successful achievement of certain tasks and goals, and even helping to identify new environmental challenges and possibly more accurate and more easily monitored indicators, especially those indicators that can be easily monitored by resource-owners, villagers and CBOs themselves.

The GOS and the MNRE have to date, been working with key village decision-makers throughout Samoa to form a collective partnership in sustainable development, and to form a holistic partnership in environmental management in Samoa, that will ensure a sound future sustainable livelihood for the future children of Samoa. The MWCSD could play a major role in catalyzing all the women of Samoa to make this fundamental polakalame atinae (development programme) an immediate success. Samoa needs some more focussed development programmes that will help bring about sustainable development and the women hold the key to sustainable development, hence Samoa's interest in gender equity.

This 2006 SOE Report can also be used to address capacity development. Firstly, it can be used as a management tool promoting a sense of ownership by all stakeholders through the use of effective and immediate outreach programmes. For example, what are the indicators of capacity development for the village fono (Village Council of Chiefs), for the komiti tumama (Womens Committee), for the pulenuu (village major), for the Women Representatives to Government, etc. Some indicators could be non-compliance with MNRE directives, non-sustainable practices continuing within the villages, poor enforcement of village environmental laws, an unwillingness to ban pesticides in all villages, an unwillingness to declare whole villages organically certified, ongoing poor health and dietary practices, etc. If the MNRE was to gauge the level of commitment of women throughout Samoa, there would be grounds for more gender equity, more funding, and more stakeholder participation in the attainment of sustainable livelihoods for all living within rural villages.

Indicator research is just another way of creating cross-cutting awareness of specific environmental and developmental issues. Samoa currently lags behind many other countries in environmental monitoring, however, there may be some indicators in Samoa that are pertinent, for example, in monitoring Samoa's cultural environmental erosion, especially those pertaining to traditional natural resource management. Very little research has been conducted in this field in Samoa and yet it can

be argued that indicator monitoring is an essential environmental management tool that has yet to be fully explored and tested.

However, because indicators are such a valuable environmental management and sustainable developmental tool, and because the communities know so little about them, each possible indicator throughout this 2006 SOE is a reminder to the reader that each such parameter can be used to measure trends, measure success, measure ongoing failures, even measure our rising levels of awareness and commitment to attaining future sustainability within Samoa. These indicators can also be used to help create environmental understanding and awareness amongst stakeholders.

## 2.1 Environmnetal Indicators

Environmental indicators are measures of the state of and pressures on the environment. Their aim is to raise awareness of the environment and show progress towards sustainable development. Indicators tell us about the overall state of the environment.

To date, Samoa has not developed a national system of management targets and performance indicators although interim indicators have been used in measuring economic performance and service delivery under the Performance Budgeting System of government. Externally derived indicators suggested by overseas development and funding agencies have also been used to monitor performance and effectiveness of projects implemented in the environment area. The MNRE has not established agreed indicators to measure environment state although in general terms internationally recognized [number] indicators have been used for this purpose using both our own data and that of others.

The indicators combine data across a range of environmental measures. They do not relate solely to government's Environment Agency responsibilities, although there is an emphasis on data and information collated by the Environment Agency. Indicators have been drawn from a number of sources, including government, non-government organizations, educational institutions and private sector.

Environmental indicators have three basic functions: simplification, quantification and communication. Ideally they should meet the following criteria:

- Scientifically sound
- Easily understood
- Show trends over time
- Sensitive to the change that they are intended to measure
- Measurable and capable of being updated regularly
- The data and information are readily available.

Users are able to select indicators from the set to suit their needs. The set should assist in the selection of indicators for different purposes and promote consistency in their use. Whichever indicators are applicable and appropriate given Samoa's situation has been used in the assessments of the environment reported herein.

## 2.2 Climate Change and Ozone

### 2.2.1 Climate and Weather in Samoa

The South-Easterly trade-winds and the South Pacific Convergence Zone (SPCZ) dominate the climate of Samoa. Two distinctive seasons characterize the country's climate: the dry period from April to September and the rainy/wet period from October to March when the convergence zone is mostly active and uniquely experienced only on the leeward (North-Western) sides of Upolu and Savaii. Tropical cyclones commonly affect Samoa during the wet season, especially during the months of December to February. Rainfall, humidity and temperatures are generally high and uniform

throughout the year. Samoa is also vulnerable to anomalously long dry spells that coincide with the El Nino Southern Oscillation (ENSO) phenomenon (Wulf 2004).

### 2.2.2 Climate Change and Variability

Climate variability, natural or man-made, denotes changes of climate with time describing the differences between long-term statistics of meteorological elements calculated for different periods. Therefore the measure of climate variability is the same as the measure of climate change.[2]

The main impact of current climate variability in PICs indicates long-term weather data trends in relation to droughts. A study by the Meteorology Division in 2003 of Samoa's meteorological data collected over 101 years reported an interesting trend of decreased precipitation levels by 49.28mm. In addition to current climatic variability there is the possibility of climate change and sea level rise due to the enhanced greenhouse effect resulting from worldwide emissions of greenhouse gases. The same study indicated that the mean daily temperature during this period showed a 0.59°C increase. The maximum and minimum temperature also increased by 0.67°C and 0.18°C, respectively (see Table 2.1). It is projected that Samoa will continue to experience increased average daily temperatures as well as droughts (MNRE 2006d).

Table 2.1: Climate Parameters in Apia

| Climate Element | Trend |
|---|---|
| Maximum Daily Temperature | 0.67ºC increase |
| Minimum Daily Temperature | 0.18ºC increase |
| Mean Daily Temperature | 0.59ºC increase |
| Annual Precipitation | 49.28 mm decrease[3] |

Source: MNRE 2006d.

There is already anecdotal evidence on sea level rise with some village communities observing considerable coastal recession of their land due to severe coastal erosion. Samoa's new projection levels, based on analysis of 10-years data, indicate that the local change in sea level rise is higher than the global projections of 0.9 and 0.88mm between the years 1990 and 2100 (IPCC 2001). The South Pacific Sea Level & Climate Monitoring Project estimates a sea level rise of 3.8mm per year for Samoa (MNRE 2005).

### 2.2.3 Rainfall Patterns

Across the country average annual rainfall ranges from 2000 mm in dry areas to 5500 mm in wet areas. The general pattern in rainfall is increasingly influenced by El Nino which brings dryness and below normal rainfall and La Nina event (normal conditions) which favours cyclogenesis around Samoa, producing average to above average rainfall (Crawley 2003). Analyses carried out on local rainfall data and inter-annual variability projections linked firmly to ENSO, and inter-decadal variability, indicated that drier conditions in the near future are likely (MNRE 2006d).

### 2.2.4 Wind Directions

The most striking feature of Samoa's surface winds, according to Saifaleupolu (2000), is the dominance of the South-Easterlies which are directly associated to the meridianal migration of the SPCZ. This Zone is generally located further North of the Samoan group during the dry season (April to September), but moves Southward to Samoa's latitudes during the wet season (October to March). As a result, the South-Easterlies prevail in the dry months while the wind direction becomes more variable during the wet period, normally resulting in the winds being generally stronger and the islands becoming more vulnerable to cyclones.. It is also during this time of the year that Samoa generally experiences heavy rainfall especially in the North and North-Western areas.

2 National Snow and Ice Data Centre. 2006. Glossary [online] Available from http://nsidc.org/arcticmet/glossary/climate_variability.html

3 Trend is from the 1923 – 2000 data collated in the Meteorology Division.

### 2.2.5 Heat Temperature over Time

The global average temperature is projected to increase by 1.4-5.8°C over the period 1990 to 2100 (IPCC 2001). Samoa and other PICs have observed temperature trends and variability in climate derived from qualifying long-term climate data with island near-surface mean air temperature increasing by between 0.3 – 0.8°C during the 20$^{th}$ century. The largest increase was observed in the zones South-West of the SPCZ. Samoa is often located South and or near this zone during the wet and cyclone season (MNRE 2006b). Table 2.1 indicates the mean daily temperature which has increased during this period by 0.59°C. Recent trends are for surface temperature to become more El Nino-like in the tropical Pacific with the Eastern tropical Pacific warming more than the Western part (MNRE 2006d).

### 2.2.6 Impacts of El Nino and La Nina

Two of the most important climatic influences on small islands in the Pacific region are tropical storms and ENSO episodes. ENSO and anti-ENSO (also referred to as La Niña) episodes have a significant impact on the climate of many small islands and can produce extensive wet and dry cycles. Strong El Nino has significant effect on rainfall patterns and duration in Samoa. With sea surface temperatures and pressures higher than the Western part of the Pacific higher convection activity and hence the possibility of tropical cyclogenesis, are likely to occur. To the Eastern part drought and below average rainfall is experienced and enhanced. The El Nino phenomenon which is explained as the difference between pressure between Darwin and Tahiti has a return period of 2–7 years, while La Nina, the normal condition, comes around every 4–7 years. El Nino and La Nina are large-scale climate phenomena that originate from the Pacific with their effects reaching around the global climate (Crawley 2003).

### 2.2.7 Projections of Future Climate

A recent study titled 'Climate Risk Profile for Samoa' (Hay 2006) evaluated the likely components of climate-related risks for Samoa for both present day and future conditions, and suggested that changes over time reflect the influence of global warming. These projections of future climate-related risks and changes in climate are based on the output of global climate models and are for a grid square covering a large portion of Upolu and adjacent areas, reflective on the country as a whole. Further it presented estimates of long-term systemic changes in the average climate for Samoa indicating that by 2050 sea level is likely to have increased by 36 cm, rainfall by 1.2%, extreme wind gusts by 7% and maximum temperatures by 0.7 C.[4] There are already, therefore, numerous climate indicators being monitored over a long-term that are giving environmental management planners some valuable indication of the environmental, social, cultural and economic impacts of global climate change on Samoa. What is needed in Samoa is a concerted effort to further monitor the Sustainable Climate Indicators (SCIs) and relate them to other cross-cutting programmes such as sustainable waste management, sustainable agriculture, sustainable water resources, etc.

### 2.2.8 Status of Ozone in Samoa

The most obvious linkage between ozone depletion and climate change is the fact that ozone itself and the key ozone-depleting substances (ODSs), including chlorine and bromine compounds such as chlorofluorocarbons (CFCs) and halons, are also powerful greenhouse gases (Fergusson, 2001).

The global situation indicates that total atmospheric chlorine (from chlorocarbons) is slowly decreasing at about 0.6% per year. Total bromine (from halons) is still increasing at about 3% per year. Overall, the atmospheric abundance of CFC-11 and CFC-113 is now decreasing and the rate of increase of CFC-12 has slowed. CFC substitutes, such as hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), continue to increase at about 3-7% and 13-17% per year, respectively[5].

4 For more on this report, see Hay, J.E. 2006. Climate Risk Profile for Samoa. John E. Hay & Associates Ltd, New Zealand.
5 Information provided by the National Ozone Unit, Meteorology Division.

CFCs have been banned in Samoa under the Ozone Layer Protection Regulations (OLPR) 2006 which came into force on 1 September 2006 as part of Samoa's obligations as party to the Montreal Protocol. Since then, there has not been any evidence of importation of CFCs into Samoa (National Ozone Unit, 2006).

There is increased use of substitutes in Samoa like HCFCs and HFCs to counteract for the ban of CFC-based products. Although these alternatives still have a smaller ozone-depleting potential, they are allowed in Samoa for transitional purposes until better replacements can be found. A survey conducted in 2004 and 2005 indicated that there has been a 50% reduction of HCFCs being used in Samoa, and there is an increase in the usage in Samoa of non-ODSs such as HFCs.[6] The issue of smuggling banned ODSs into the country may arise which will require strict enforcement of the OLPR regulations by the Customs Department.

### 2.2.9 Effects of Climate Change

The National Adaptation Programme of Action (NAPA) gives a brief summary of the direct and indirect impacts on various sectors identified and considered to be most vulnerable to climate change impacts such as agriculture, biodiversity, culture, energy, forestry, health, tourism, water and even the built environment with all its vital public amenities and public services (MNRE 2005).

*Agriculture and Food Production* – Climate-induced disasters, such as tropical cyclones (with their increased frequency and intensity), flooding in low lying and coastal areas, saline intrusion of underground water, coastal erosion and increased rates of coral bleaching all mean higher demand on food products and unstable levels of agricultural production, all reducing income-generating activities (IGAs) in rural communities, and hence retarding pro-poor growth. Poverty in Samoa can only be exacerbated by such negative environmental, socio-economic and cultural impacts.

*Water Supply and Quality* – Drought has the most obvious impact on water resources especially in relation to quality and quantity. Sea level rise increases the possibilities of seawater intrusion into underground water aquifers as already experienced by many coastal communities.

*Biodiversity and Ecological Conservation* – Tropical cyclones, temperature fluctuation and changes in precipitation patterns all affect the habitats of Samoa's fauna and flora. The intense wave activity of storms recently destroyed much of the coral near shore and severely damaged corals to a depth of up to 10 meters.

*Health* – There is anecdotal evidence of growth in vector-borne and water-borne diseases which can be attributed to the impacts of climate change on the health sector.

*Forestry* – Prolonged periods of drought, usually lasting three months or more, with increased risk of forest fires, have already been recorded in Samoa, mostly in Aopo, Asau and Falealupo, with the first four major forest fires occurring during the drought/dry periods of 1982-83, 1997-98, 2001-02 and 2002-03. However, the non-sustainable removal of the forest canopy through clear-felling for timber extraction, especially in the drier North-West areas of Savaii, exacerbated further this serious impact of droughts, namely increased fire risks. Extensive fires as such further retard forest succession rates, destroy plantation forests, disrupt ecosystems, pollute the air, destroy vital infrastructures, are a risk to human life and undermine attempts to secure sustainable food security regimes. Pristine indigenous rainforests are rarely susceptible to bushfires, however, non-sustainable logging practices in the past have severely increased the environmental, socio-economic and cultural risks of North-West Savaii especially, and this is now where the highest fire risk in Samoa is located.

*Infrastructure* – Lowland and coastal flooding and severe coastal erosion impact on the coastal infrastructure as well as the management of the coastal watershed areas, especially those which service the urban areas.

6 Information on ODS provided by the National Ozone Unit, Meteorology Division, MNRE

*Energy Production* – The droughts in 2002 and 2003 led to the rationing of electricity. Droughts will increase Samoa's reliance on fossil fuel for electricity generation.

*Tourism* – The impacts of climate change on the tourism sector include the loss of beaches through coastal erosion, inundation of scenic sites by sea water, degradation of the coastal ecosystems, saline intrusion of underground water supplies needed for hotels and resorts, disruption to flights by more frequent cyclones and storms of increasing severity, and damage to critical infrastructure by cyclones and storms. The loss of the attractiveness of coral reefs due to bleaching is triggered by increased sea temperatures caused by climate change impacts.

*Urban Settlement* – Climate change will have a significant impact on urban settlement, exacerbated by increasing human population and growing rural to urban migration. Better urban planning is required with improved storm-water drainage systems operational to counteract the increased risks associated with further climate change impacts.

*Village Communities* – The livelihood of the local communities is most threatened by the impacts of climate change, including increased damages to homes and properties by cyclones, unsafe water supplies ; droughts affecting agriculture and causing bushfires, and coastal erosion and flooding of low-lying areas (MNRE, 2005).

## 2.3 Coastal and Marine Resources

### 2.3.1 Change in Reef Cover

Samoa is not well endowed with coral reefs compared with other Pacific islands. Instead, its coral reefs are limited and fringing in nature due to its history of volcanic formation (Taulealo, 1993). In addition, Cyclones Ofa in 1990 and Val in 1991 were reported to have caused severe damage to the coral reef systems throughout Samoa with mass coral destruction, further exacerbated by repeated infestations of crown-of-thorns starfish (MNRE 2004b). However, despite these impacts, Green (1996) reported that the reef front of Upolu Island appeared to be in reasonably good condition following such massive destruction.

A Status of Coral Reef Report (Lovell *et al.,* 2004) presented monitoring data from 2003-2004 of coral cover for Samoa as being reasonably high. The average live coral cover at the permanent monitoring sites within MPAs and selected sites around Samoa was 34.5%. Coral cover for reefs on Savaii Island at 47.5% and on Manono Island at 32.6% exhibited dominant coverage of live coral (Refer Table 2.2). Upolu's substrate was dominated by sand, coral rubble and rock. Significant coral breakage caused by storms led to the high dead coral cover observed. An insignificant number of bleached corals were recorded, probably due to Crown of Thorns Starfish (COTS) or other localized causes, rather than warm water bleaching. Algal cover on coral reefs on Upolu was high with *Sargassum* spp. dominating. Observations during rapid surveys show coral diseases appear to be increasing.[7]

Table 2.2: Summary Data on Corals and Other Life Forms on the Reefs of Samoa

| Location | Live Coral % | Dead Coral % | Algae % | Abiotic % | Other % | Bleached Corals % |
|---|---|---|---|---|---|---|
| Upolu | 23.2 | 9.2 | 21.5 | 41.2 | 0.6 | 3.9 |
| Savaii | 47.5 | 15.6 | 7.1 | 27.4 | 2.0 | 0.4 |
| Manono | 32.6 | 6.0 | 15.1 | 26.9 | 0.0 | 0.0 |
| Mean | 34.5 | 10.3 | 14.6 | 31.8 | 0.9 | 1.4 |

Source: Lovell *et al.*, 2004.

Samoa's reefs and lagoons are amongst the most degraded in the Pacific (Zann 1991 & Taulealo 1993). However, much remains to be documented and understood, for example, the rate of loss and replenishment of marine ecosystems is not well understood (MNRE 2004b). The damage or

[7] Lovell, E., et al. 2004. Status of Coral Reefs in the South West Pacific: Fiji, Nauru, New Caledonia, Samoa, Solomon Islands, Tuvalu and Vanuatu. Status of Coral Reefs of the World 2004.

destruction of productive coastal resources and fisheries is a common problem all around Samoa today where coral reefs have been destroyed by construction, dredging, pollution, siltation, dynamiting or poisoning of fish. These occurrences have had a negative impact on the biodiversity of coastal areas, especially on the Upolu Island, and will mostly likely intensify in the future. The support and participation of Government and local communities are critical to the sustainable management and protection of reefs and lagoons.

### 2.3.2 Diversity of Marine Species over Time

**The Importance of Coastal and Marine Biodiversity**

Samoans once derived most of their protein from fish and other lagoon and reef products. The 1989 Agricultural Census showed that more than 68% of households in rural Upolu and 67% in Savaii were engaged in fishing. 30% of all households derive part of their cash income from fishing. The total annual seafood consumption for Samoa in 2000 was estimated at 9,971 tonnes (valued at over ST62 million). Of this total, 7,169 tonnes or 72% (valued at ST45 million) was attributed to subsistence fishing. Average consumption of seafood *per capita* was estimated to be 75 kg per annum, made up of 44 kg of fish and 13 kg of invertebrates and seaweeds. Consumption *per capita* for canned fish, canned meat, fresh and frozen meat was estimated at 14 kg, 5.7 kg and 92 kg per annum, respectively. Thus local seafood makes up about 34% of the total meat protein consumption in Samoa in terms of weight. However this figure is believed to be much higher in specific communities which rely solely on seafood as their main source of protein. Passfield *et al.* (2001) and Bell (2002) estimated that, combined with fishery exports, the gross value of Samoa's marine resources were around $SAT100 million per year (MNRE, 2004b).

**Marine Flora**

***Mangroves***

Mangroves are unique ecosystems and amazing trees that live halfway between the land and the sea. Plants identified as mangroves represent over 80 species of which three are found in Samoa. The two common mangrove species in Samoa are *Rhizophora samoensis* (red mangrove), *Bruguiera gymnorrhiza* (oriental mangrove) and the rarest of the three, *Xylocarpus moluccensis* high on the coastal cliff-tops of Siutu. Mangroves of Samoa are confined to Upolu, Manono and Savaii Islands, covering about 10 square kilometres.[8] The Vaiusu Bay and Saanapu-Sataoa mangrove stands are the two largest mangrove forests in Samoa (Taulealo 1993).

Despite their high scientific and environmental value, mangrove forests are among the most disregarded and fast-depleting habitats in Samoa. They are being degraded through inappropriate land development, especially around Apia and Vaiusu Bay. For example, in 1978, about 0.65 ha of mangroves were ironically cleared for aquaculture development which subsequently closed in 1983. In addition, alteration of river courses, reclamation in estuaries and lagoons, dumping of rubbish and industrial wastes, and the discharge of raw sewage into mangrove ecosystems further exacerbate the problem. The protection of mangrove ecosystems is controlled under the LSE Act. Samoa is yet to establish a National Mangrove Management Plan (Schuster, 1993).

***Algae***

Recent surveys reveal that a total of 360 species of marine algae are found in Samoa. In the Palolo Deep Marine Reserve (PDMR) alone, 128 species of algae have been recorded, of which 89 are newly recordings for the PDMR. In addition, 4 of the algae recorded in the PDMR are new species of which 1 is endemic to PDMR (found no where else in Samoa) (Skelton *et al*., 2000). There are three species of algae in Samoa that are consumed by people - the seaweeds *Caulerpa racemosa (limu fuafua)*, *Caulerpa* sp. *(limu fuafua)* and *Halymenia durvillei (limu aau)*. Two species of seaweeds have been introduced into Samoa for aquaculture trials – the *Kappaphycus alvarezii* and *K. denticulatum* (see Appendix E). The status of these introduced seaweeds in our marine environment is unknown.[9]

8 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/1%20June%202003%20-%20Marine%20Environments.pdf

9 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/8%20June%202003%20-%20Marine%20Resources%201.pdf

***Seagrasses***
Seagrass distribution in Samoa is limited with the best patches found around Manono Island and the Northern coast of Upolu. Only two species have been reported to occur in Samoa - *Halophila ovalis* and *Syringodium isoetifolium*. Some researchers are of the opinion that *H. ovalis* is probably endemic to Samoa or belongs to another species, *H. minor*. A *Halophila* specimen collected from the PDMR was recently shown to resemble *H. minor* morphologically (Skelton *et al.,* 2000).

Lagoon sand-dredging is sometimes conducted in areas where sea-grasses are located. Thus, either the seagrasses are extracted together with the sand or the high siltation resulting from the dredging activities smothers these seagrass beds. In addition, siltation and freshwater influx, as a result of the poor planning of land-based activities such as land clearance near riverbanks for agriculture, result in soil erosion which can smother seagrasses during heavy rains. When reefs are damaged by either natural causes or destructive fishing methods, waves and strong sea currents are not 'slowed' down. Unhindered waves and currents can cause the built-up of sand on seagrass beds thus killing them.[10]

***Littoral Plants***
Whistler (1992) has documented the littoral (coastal) plants of Samoa recording a total of 76 species which include trees, shrubs, herbs, vines and grasses. The status and role of these littoral plants is not fully understood and research into this area is recommended. This is appended in an updated species list Appendix C: Endangered or Threatened Vascular Plant Species of Samoa (Schuster *et al.,* 1999) and Complete Updated List (GOS/DoS 1998).

**Marine Fauna**

***Marine Mammals***
Several whale species *(tafola)* have been recorded in Samoa's waters. Two Baleen whales – the humpback (*Megaptera novaeangliae*) and minke whale (*Balaenoptera sp.*), and eight toothed cetaceans (whales and dolphins) – the sperm whale (*Physeter macrocephalus*), dwarf sperm whale (*Kogia sima*), short-finned pilot whale (*Globicephala macrorhynchus*), melon-headed whale (*Peponocephala electra*), false killer whale (*Pseudorca crassidens*) spinner dolphin (*Stenella longirostris*), bottlenose dolphin (*Tursiops truncatus*) and the rough-toothed dolphin (*Steno bredanensis*). However, other whales and dolphins such as the Bryde's whale (*Balaenoptera edeni*), killer whale (*Orcinus orca*), cuvier's beaked whale (*Ziphius cavirostris*), blainville's beaked whale (*Mesoplondon densirostris*) risso's dolphin (*Grampus griseus*), pantropical spotted dolphin (*Stenella attenuate*) and fraser's dolphin (*Lagenodelphis hosei*) are most likely to be also found in Samoan waters. Populations of both the humpback and sperm whales throughout the world are considered to be in a vulnerable state (MNRE 2004b).

***Marine Reptiles***
Two species of turtles *(laumei)* are known to be relatively common in Samoan waters, the green turtle (*Chelonia mydas)* and the hawksbill turtle (*Eretimochelys imbricata)*. The latter is believed to be the only species to nest in Samoa, mainly on the small Aleipata islands, Papa Beach and Falealupo/Tufutafoe villages on Savaii Island. Leatherback turtles (*Dermochelys coriacea*) are also known to be present in Samoan waters and there are anecdotal reports of the presence of two other turtle species in the early 1800s when turtle populations were said to be abundant along the coasts of Upolu and Savaii. Turtles are considered as important tokens or taboo animals to many coastal communities. However, a marked decline in population was evident from the early 1970s mainly due to human exploitation of nesting females and eggs (MNRE, 2004b), but more recently from the export of turtle shells to Japan that has since been banned. There are two sea snake species reported, the banded sea snake (*Laticauda* sp.) and *Pelamis ploturus,* although little is known of their status. However, it is likely that there are more than two sea snake species found in Samoa.[11]

10 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/8%20June%202003%20-%20Marine%20Resources%201.pdf
11 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/8%20June%202003%20-%20Marine%20Resources%201.pdf

### *Fish*

The latest compilation by Wass in 1984 summarised most of the fish species of Samoa where most were from Tutuila Island, American Samoa, with few from Upolu. Wass listed 991 species, representing 113 families, with 284 new records for the Samoan Archipelago. Of the total, 890 are considered shallow-water or reef-inhabiting species (generally found at depths <60 m); 56 are considered deeper bottom fish species (associated with the bottom at depths of 60-500 m), and 45 are considered pelagic surface species (frequenting offshore waters above the thermocline at depths < 200 m). About 40 fish species are endemic to the Samoan Archipelago (found only in Samoan waters) and (possibly many fish species are yet to be identified), but it is likely that these will be found once extensive collections are carried out in neighbouring archipelagos. The number of endemic fish species will definitely change and be constantly revised to include smaller fish species (e.g. gobies and blennies), and this figure of 40 endemic species may well increase to 200-300 (Skelton *et al.* 2000). FISH BASE™, a software programme developed by the International Centre for Living Aquatic Resource Management (ICLARM), provides a comprehensive database for the fish species of Samoa (GoS 2002c).

A status report of reef fishes, undertaken by Samoilys & Carlos in 1991, highlighted a reduction in biomass and size of fish in shallower and more heavily fished areas, while higher biomass was found in less fished and deeper reef slopes (Skelton *et al.,* 2000). This was confirmed by Green (1996) after surveying seven sites on Upolu where the richness of fish species increased with depth (i.e.deeper habitats having more species than shallower sites). The continuing practice of spearfishing with SCUBA tanks continues until today, although illegal, and this practice has been deemed overseas to be highly non-sustainable especially for what may also be considered ecologically-important fish species that are responsible for maintaining the coastal ecosystems in balance.

Declines in various fish stocks are attributed to over-fishing and destructive fishing practices which include the use of destructive fishing methods and fishing practices that target juveniles or spawning migration. Natural factors and phenomenon also contribute to loss or declines of fish stocks. The once traditional role of the *tautai* (master fisherman) in each village ensured that traditional fish conservation practices were strongly adhered to, simply for sustainability purposes. Without re-introducing these traditional roles, attaining sustainable development in Samoa will be further thwarted.

### *Finfish*

FISH BASE™ lists 26,710 finfish species known worldwide. Of this total, 12,848 are listed as primarily marine, 11,311 primarily freshwater and 2,553 brackish or diadromous. No detailed study has been conducted on fresh-water fish species occurring in Samoa. However, FISH BASE™ lists 31 fresh-water fish species recorded in Samoa of which 26 are native species, while 5 are introduced. There are now actually 6 introduced fresh water fish species with the recent introduction of another species of tilapia. Of the 26 native fresh water species listed, at least 3 are also listed as marine/brackish-water fish species (Skelton *et al.,* 2000).

### *Corals*

Little is known of the diversity and the number of coral species found in Samoa and their status needs to be confirmed by further research. Krämer (1995) and Gosliner *et al.* (1996) listed about 50 hard coral species in Samoa (whilst a survey in 2005 listed 123 hard coral species), supporting over 900 fish species and numerous other reef-dependent organisms. Samoa has a low number of coral species compared to other islands such as Fiji which has 163 species of hard corals (Skelton *et al.,* 2000).

### *Seabirds*

As oceanic islands, it is perhaps not surprising that a large number of shore and seabirds either live or come to nest and feed in Samoa. In all, 20 species of shore and seabirds are known to nest in Samoa and many more migratory species can be seen passing through. But other than their nesting not much more is known about these birds (MNRE 2004b). Birdlife International received a Report on the 5 Important Bird Areas (IBAs) in Samoa, prepared by OLSSI in 1998, including bird counts from Fanuatapu Island.

***Marine Molluscs***

Recent update of the compilation of marine mollusc data indicated a preliminary count of about 788 species of marine molluscs recorded in Samoa. These species fall under 4Classes (Bivalvia, Cephalopoda, Gastropoda, Polyplacophora), 6 Subclasses, 16 Orders and 99 Families. [12]

Table 2.3: Marine Molluscs Common in Samoa

| Class | Scientific, common and Samoan name | Status |
|---|---|---|
| Bivalvia | Giant clams *(faisua)*, oysters, thorny oyster (fatuaua) and rock oyster (tio), venus shell (tugane), ark shell (pae), coconut scraper cockle (matatuai/asi), hardshell clam (pae), pen shell (fole), surf clam (li), sand cockle (pipi). | C |
| | *Tridacna squamosa* and *T. maxima,* exist in Samoa.(Reef Clams) | FE |
| | *Hippopus hippopus* (Giant Clam) | LE, RI |
| | *T. derasa* and *T. gigas*. | I |
| Cephalopoda | Octopus (fee), squids, cuttlefish (gufee), nautilus. | C |
| Gastropoda | Topshell*(Tectic pyramis)* (aliao) and the turban shell, *(Turbo chrysostoma)* (alili), spider conch (*Lambis lambus)* (palaau), various cowries including the tiger cowry (*Cypraea tigris)* (pule uli), the giant triton or Pacific trumpet shell (*Charonia tritonis*) (foafoa), stromb (*Strombus gibberulus)* (panea) and the trumpet shell (*Cassis cornuta)* (pu), green seahare (*Dolabella auricularia(* (gau). | C |
| | *Trochus niloticus* and the green snail, *Turbo marmoratus*. | I |
| Polyplacophora | Ten species of chitons of the Polyplacophora class, with 2 Samoan types 1 new species and 2 endemic species. | |

C – common, FE – functionally extinct, LE – locally extinct, RI- re-introduced, I – introduced

- ***Crustaceans***

Some crustaceans are important sources of food and income in Samoa in the subsistence and artisanal fisheries, particularly the mangrove crabs, spiny lobsters and the freshwater prawns. [13]

12 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/8%20June%202003%20-%20Marine%20Resources%201.pdf
13 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/15%20June%202003%20Marine%20Resources%202.pdf

Table 2.4 Crustaceans common in Samoa

| Species | Scientific, common and Samoan name | Status |
|---|---|---|
| Crab | Coconut crab, *Birgus latro* (uu); mangrove crab, *Scylla serrata* (paalimago); several coastal crab species including the land crabs, *Cardisoma carnifex* (tupa), *Cardisoma* sp. (mali'o) and the red-claw mangrove crab, *Sesarma erythrodactyla* (u'a); hermit crab, *Pagurus* sp. (uga); ghost crab, *Ocypode ceratophthalmus* (aviivii); rock crab, *Grapsus* sp. (amaama); and the Fiddler crab, *Uca* sp.; reef crabs such as, *Carpilius maculatus* (kuku), *Leptodius* sp (vaevaeuli) and *Zosymus aeneus*; coastal lagoon crabs such as the swimmer crab, *Thalamita* sp. (paatala) and the burrowing crab, *Calappa* sp. (tapola). | C |
| Lobster | Spiny lobsters (ula sami): *Panulirus penicilatus*, *P. versicolor* and *P. longipes femoristriga* | R, VR |
| | Slipper lobster (papata) *(Parribacus antarcticus* and *P. caledonicus)* | C |
| | Musical furry lobster (*Palibythus magnificus*). | OES |
| | Two species of freshwater crayfish, *Cherax quadricarinatus* (redclaw) and *C. destructor* (yabby) | I |
| Prawns/Marine Shrimps | Freshwater Prawns, *Macrobrachium lar* (fa'ivae/ula vai) and *Palaemon* sp. | C |
| | Giant Malaysian freshwater prawn, *Macrobrachium rosenbergii*, | I |
| | Coastal shrimps: mantis shrimp or banded prawn-killer, *Lysiosquilla maculata* (valo); clam shrimp, *Pontonia* sp.; the cleaner shrimp, *Lysmata* sp.; and the banded coral shrimp, *Stenopus* sp. | C |
| | Stars and stripes shrimp (*Plesionika edwardsii* (=*longirostris*), stripes gladiator shrimp (*P. ensis*), golden shrimp (*P. martia*), mino nylon shrimp (*Heterocarpus sibogae*), smooth nylon shrimp (*H. laevigatus*), Madagascar nylon shrimp (*H. dorsali*), and *Penaeid* sp. | C, N |
| | Giant tiger prawn, *Penaeus monodon* (marine shrimp species) | I |

C=common, N=native, FE=functionally extinct, LE=locally extinct, RI=re-introduced, I=introduced, R=rare, VR=very rare, OES=only existing specimen(s) in the world ENDEMIC???

### *Polychaetes*

The palolo worm, *Eunice viridis*, is harvested in Samoa when its epitokous segment (hind reproductive segment) swarm to the sea surface during spawning in October and/or November, correlating with the third quarter of the moon. The name "palolo" originally referred to the Samoan species, *E. viridis*, but is now applied to a number of other polychaetes all of which exhibit a similar swarming behaviour. The Palolo epitokes that contain eggs during spawning are blue-green in colour, while those containing sperm are tan (brownish/creamy). Other marine polychaetes found in Samoa include unidentified bristle worm species known locally as *atualoa-sami*. [14]

### *Scyphozoa (the True Jellyfish)*

The most common jellyfish species found in Samoa is the upside-down jellyfish, *Cassiopea* sp. It is often found lying at the sea bottom upside down, exposing its green algal symbionts to the sun. This species is consumed locally and is sometimes sold wrapped in leaves. [15]

### *Echinoderms*

The echinoderms are diverse animals all of which are marine animals. The phylum name "echinoderm" is derived from the spiny skin these animals have. Several species of sea-urchins and sea cucumbers are utilized locally for food and are sold either at market outlets or along the roadside.[16]

14 MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/15%20June%202003%20Marine%20Resources%202.pdf

15 MNRE. 2006. Public Awareness. [online]. Apia, MNRE. Available from: htttp://www.mnre.gov.ws/documents/newspaper/15%20June%202003%20Marine%20Resources%202.pdf

16 Ibid.

Table 2.5: Echinoderms Common in Samoa

| Class | Scientific, common and Samoan name | Status |
|---|---|---|
| Holothuroidea [sea cucumbers or holothurians] | Holothuria [Halodeima] atra [lollyfish - loli], Stichopus horrens [pricklyfish - *sea*], Bohadschia argus [leopardfish - ulutunu/fugafuga gatae], B. marmorata [tigerfish - fugafuga ai], Actinopyga mauritiana [surf redfish - mama'o], A. echinites [redfish - mama'o], Holothuria (Microthele) nobilis [black teatfish - susu valu uliuli], H. fuscogilva [white teatfish - susu valu pa'epa'e], H. eiulis [pinkfish - sea amu'u], H. fuscopuncatata [elephant's trunkfish], Stichopus variegatus [curryfish - neti], Thelenota ananus [prickly redfish - fa'atafa, sauai], T. ananx [giant bech-de-mer], Microthele axiologa [elephant's trunkfish – sauai] and S. chloronatus [greenfish - maisu]. Some other sea cucumber species not utilized include, Holothuria hilla [amu'u] and the two species of peva, Synapta maculata and Euapta godeffroyi. | C |
| Echinoidea [sea urchins, heart urchins and sanddollars] | Echinometra matthaei [boring sea urchin - tuitui]; Tripneustes gratilla [short spine sea urchin - sava'e]; Diadema sp. [long spine sea urchin - vaga]; Toxopneustes pileolus [tapumiti]; Heterocentrotus mammillatus [pencil urchin - vatu'e]; Diadema savignyi [long spine black urchin - vaga]; Echinothrix calamaris [banded urchin - vaga]; Echinothrix diadema [black sea urchin], and Mespilia globules [globular sea urchin]; Brissus latecarinatus [sand dollar - ofaofa]. | C |
| Asteroidea [sea star or starfish] | Acanthaster planci [Crown of thorns - alamea], Culcita novaeguineae [cushion star], Linckia laevigata [blue starfish - 'aveau], and Linckia multiflora [spotted sea star - 'aveau]. | C |
| Ophiuroidea [brittle stars, serpent stars and basket stars] | Ophiolepis superba [banded brittle star], Ophiomyxa sp. [serpent brittle star], Ophiomastix sp. [Zubi brittle star] and Ophiarachnella gorgonian]. | C |
| Crinoidea [feather stars and sea lilies] | Two species of feather stars have been reported to occur in Samoa. One of the species is Comanthus wahlbergii. | C |

C=common, FE=functionally extinct, LE=locally extinct, RI=re-introduced, I=introduced

### 2.3.3 Marine Conservation Areas Established

The Palolo Deep Marine Reserve (PDMR) was established in 1974 and proclaimed on 5th December 1979. The PDMR encompasses an area of 137.5 ha (1.38 sq. km) comprising the 'deep' hole ideal for snorkelling, a small land area, a fringing reef and shallow inshore flats extending seaward to 500 metres. The PDMR is administered by the MNRE (Division of Environment and Conservation) and is managed by a family which resides on-site (MNRE, 2004).

The Aleipata MPA is about 19.44sq miles in total area, 0.331 sq miles of which is declared as a No-Take-Zone. The MPA extends from Utuele headland at Tiavea in the North to Nonoa at Lalomanu on the South-Eastern coast. It also includes the area from the high water mark to about half a mile seaward from the reef drop-off, and includes the islands of Nuulua, Nuutele (Vini Beach), Fanuatapu and Namua. All 11 villages of the Aleipata District are included namely Tiavea, Samusu, Amaile, Utufaalalafa, Saleaaumua, Malaela-Mutiatele, Lotopue, Satitoa, Ulutogia, Vailoa and Lalomanu.[17]

The Safata MPA is about 24.6 sq miles in total area, 0.085 sq milesof which is declared as No-Take-Zone. The MPA extends from Le Niu at Saanapu in the West to Ava o le Fua at Mulivai in the East. It extends from the high water mark to one mile seawards from the reef drop-off and includes the Aau Gasese submerged reef. The MPA includes nine villages, namely Mulivai, Tafitoala, Fausaga, Fusi, Vaiee, Nuusuatia, Lotofaga, Sataoa and Saanapu. There are 10 No-Take-Zones in the MPA which have been designated according to results of scientific survey and local knowledge. [18]

[17] MNRE. 2006. Public Awareness. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/fact_sheets/MPA%20info%20sheet%20Aleipata.pdf

[18] MNRE. 2006. Public Awareness. [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/fact_sheets/MPA%20info%20sheet%20Safata.pdf

Under the Fisheries Division of MAF, community-based fish reserves have been established in 72 villages with 43 in Upolu, 25 in Savaii and 4 in Manono.[19]

### 2.3.4 Endemic, Extinct and Endangered Species

Endemic marine species in Samoa are relatively rare and not well documented. A survey by Wass in 1984 documented some endemic marine animals and plants such as the 40 endemic fish species reported only from Samoa, and a red algae (*Ceramium rintelsianum)* found at the PDMR (Skelton *et al.,* 2000), but may well be present in neighbouring PICs. Research into many of the neighbouring PICs' fauna and flora is lacking and should be encouraged. The lack of knowledge of the biodiversity of the coral reef and related ecosystems will hinder conservation efforts and may result in more and more species becoming extinct.

Zann & Mulipola (1995) reported the reef clam *Tridacna squamosa* as being functionally extinct in Samoa. Extinct species may include the giant clam *(Hippopus hippopus)* where only shell remains were found, although very little information is known of this species in Samoa. It has, however, been re-introduced by the Fisheries Division which currently holds some mature specimens at its lagoon nursery.

The grey mullet (*Mugil cephalus)* and milkfish (*Chanos chanos*) seem to have seriously declined. The populations of the giant triton (*Charonia tritonis*), a predator of the crown-of-thorns starfish, have reduced dramatically due to over-fishing for the ornamental trade. The mangrove crab (*Scylla serrata*) is facing localized threats from being over-harvested (e.g. within the Safata Bay). The boom in the bêche-de-mer industry in the early 1990s caused a decline in the numbers of target species and the industry collapsed a few years after (Skelton *et al.,* 2000).

Cetaceans (whales and dolphins) are experiencing serious threats to their survival and are considered internationally as being species of high conservation concern. They are a priority for conservation under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as well as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Commercial whaling by countries outside the South Pacific region during the nineteenth and twentieth centuries has resulted in the severe depletion in the populations of the great whales in the region. Some of the major threats to the survival of these marine mammals include marine pollution caused by oil spills, plastic debris and noise, direct take, by-catch and ship-strikes.[20]

To help replenish stocks of the endangered hawksbills, a turtle hatchery was established by the Fisheries Division of MAFFM at Aleipata in 1971. The hatchlings grew to 30-40% in length and 100-120% in weight after one month and were then released 3-7 km outside the reef. There have been no studies of turtle populations in Samoa since the hatchery was closed in 1983, but since the nesting grounds remained unprotected, it was inevitable that populations would have further declined. Management strategies promoting turtle conservation have been instituted through regulations prohibiting turtle harvesting for commercial purposes, while allowing for traditional use of turtles with carapace lengths above 72 cm. A tagging programme initiated by SPREP is ongoing with fishermen reporting stranded turtles and sometimes bringing caught turtles in to be tagged. A tagged turtle from Samoa is reported to be breeding in the French Polynesia area in the East and Papua New Guinea in the West, and turtles tagged in Tahiti have been caught in Samoa. Joint efforts among PICs are vital to the survival of these marine animals (MNRE 2004b).

### 2.3.5 Introduced Species

The introduction of aquatic species to Samoa began in the early 1900s when mollies (*Poecilia mexicana*) were introduced to control mosquitoes. Numerous further projects and undertakings involving the introduction of marine organisms are outlined in Appendix D: Chronology of mariculture and resource enhancement activities/projects in Samoa and Appendix E: Marine organism

19 Information provided by DEC Division, MNRE.
20 Information provided from the Samoa Marine Biodiversity Protection and Management Project, administered by MNRE through DEC Division.

introductions into Samoa (Bell & Ropeti 1995; Bell & Mulipola 1998). In 1999, 300 green snails (*Turbo mamoratus*) were introduced from Tonga for reef stocking purposes while over 10,000 giant clams were introduced from American Samoa and Fiji in the 1998/1999 period. The impact of these introductions on the marine environment is still not known (Skelton et al., 2000).

### 2.3.6 Climate Change and Cyclone Damage

The 1992 Chase and Veitayaki study looked at the implications of climate change and sea level rise for Samoa, particularly for marine and coastal resources. Sea level rise is likely to be associated with many climate-related factors such as the rise in sea surface temperatures (SSTs), the increase in frequency and severity of cyclones and high levels of carbon dioxide in the atmosphere and in the marine environment. The response of coral reefs of Samoa to sea level rise is, therefore, difficult to ascertain. However, sea level rise may further impact Samoa's already threatened coral reefs. The lowlands and inter-tidal areas along the coast will also be affected by climate change whereby, ports, landings, harbours, breakwaters and buildings located on reclaimed lands will all need to be relocated or raised. Apia, which is largely built on encroached coastal land and marshes, could be inundated by a significant rise in sea level, expected at 300mm by 2050. The Faleolo International Airport, which is located at about 1m above sea level, could also be at risk. Some village areas may become uninhabitable and need to be relocated.

The effect of increased air temperature is perceived to be minimal. The inshore and offshore fisheries are, however, expected to be severely impacted, and coral bleaching will become more prevalent. Samoa has a relatively high annual rainfall and this is predicted to increase if global temperatures rise. The poor water retention of the Samoan soil due to its volcanic history will likely result in increased water run-off resulting in soil erosion and high sedimentation in freshwater and in lagoon waters.

The continuing stresses imposed by various climatic factors and man-made activities on coral reefs will lead to these reefs becoming non-resilient to strong wave action. Some parts of Upolu Island along Luatuanu`u and Solosolo are constantly affected by strong wave action due to the lack of protection from coral reefs. The back-to-back severe cyclones *Ofa* and *Val* in 1990-91 caused widespread damage to the marine environment. Live corals were uprooted from the front reef slope and dumped along the leeward side of the reef crest, mainly only along the Northern parts of Savaii and Upolu islands, creating emerged 'coral islets'. The frequency and severity of cyclones will no doubt accelerate destruction in low-lying areas affected by sea level rise. Strong winds may assist in water circulation, however, they are most likely to create havoc for coastal inhabitants.

A study of the status of the world's coral reefs by Wilkinson reports that the 1997-1998 period revealed a high incidence of coral bleaching due to elevated sea surface temperatures (SSTs) in the Indian Ocean and some parts of the Pacific Ocean (cited Skelton *et al.,* 2000). The central part of the South Pacific escaped the brunt of the bleaching, although some localized bleaching was seen in inshore areas as a result of prolonged exposure to extremely low tides. This was seen at PDMR which has suffered bleaching on the Eastern side of the main 'Deep Hole' from early 1998. The front reef slope was surveyed in July and September 1998 with no bleaching event seen. It is interesting to note a recent report from Australia by Jompa & McCook (1999) highlighting the importance of *Sargassum* (seagrass) canopy in lessening the impact of coral bleaching on inshore reefs. Samoa has in the past experienced coral bleaching due to high SSTs, although this has not been documented. The recent coral bleaching event in the South-Central Pacific had insignificant effect to Samoan coral reefs, as compared to Fiji which recorded its worst coral bleach episodes within this past decade. There are reports of coral bleaching in both the inter-tidal and sub-tidal zones around the Apia vicinity and in some rural areas (Skelton et al., 2000).

## 2.4 Water Resources

### 2.4.1 Water Sources

Historically, the community water supplies from groundwater have been derived from coastal springs commonly found around the coastal villages of Samoa. Groundwater is most readily available from freshwater lenses (in the younger less weathered basalts), but aquifer yields are constrained by the risk of inducing saline intrusion. With the high rainfall and virtually no drought period, the flows of such springs are sustained throughout the year. There are minor perched aquifers, held up by less permeable strata, which may be of local significance for inland springs, some of which are developed as supplies (Roffe, *et al.,* 1995).

Despite the high rainfall) occurring between October and March, many parts of Samoa are devoid from perennial streams and rivers due to the high permeability of the underlying volcanics. The driest areas are found in North-West Upolu and North-West Savaii. Rainwater is harvested and widely practiced in dryer areas of the country such as in Western Savaii.

Surface water is abstracted from catchment areas of the central highlands of Upolu and south-east of Savaii. There are 28 surface water intakes on Upolu producing an average of 42.5 million cubic meters of water per year and 2 on Savaii (Patamea and Sili).[21]

### 2.4.2 Water Quality

The issue of water quality is important for determining that the capacity of freshwater resources is able to sustain the health and social wellbeing of communities (rural and urban) and to provide sufficient water to meet environmental needs (particularly needs of animals and birds).

Dorsch Consult (2001) reported on behalf of Samoa Water Authority (SWA) that, prior to the implementation of the Apia Water Supply Consolidation Project in 1999, water quality was not according to any standard. Very high turbidities were experienced, particularly during the rainy seasons, causing frequent blockages of pipes due to the solid content of the water distributed. The water contained high counts of bacteria causing a considerable risk to public health. At the time, water supply had to be considered sufficient with regards to quantity, whereby an overall amount of about 43,000 m³/day was supplied for a population of about 50,000.[22]

Table 2.6: Treated and Raw Water Supply Development

| Data | Treated water supply | | | Raw water supply | | Total | | Total |
|---|---|---|---|---|---|---|---|---|
| | ATP m³/day | FTP m³/day | MTP m³/day | Alaoa m³/day | Vailima m³/day | Treated m³/day | Raw m³/day | m³/day |
| IWACO, 1993 | 8,760 | 11,410 | 2,370 | 15,980 | 860 | 22,540 | 16,840 | 39,380 |
| AWSCP April 1999 | 11,285 | 11,126 | 3,063 | 15,984 | 1,560 | 25,474 | 17,544 | 43,018 |
| AWSCP May 2001 | 10,456 | 11,756 | 3,032 | 7,344 | 1,200 | 25,243 | 8,544 | 33,787 |

Source: Dorsch Consult 2001

Presently, the current quality of water from treatment plants is very good as it is filtered and chlorinated. There are 4 treatment plants in Samoa, namely Malololelei, Alaoa and Fuluasou on Upolu and one on Savaii at Palauli (Assets Division, SWA).

Kingston (2004), in his country report of Samoa to the World Health Organization on 'Surveillance of Drinking Water Quality in the Pacific Islands', noted some of these improvements. SWA utilizes a process where water passes through three treatment phases; sedimentation, where raw water from intakes feeds into sedimentation tanks with retention time of 4 hours to reduce turbidity and TSS. It is then filtered through a roughing filter and slow sand filters to remove microbial contamination. The

21 Information and Figures provided by Assets Division, SWA, Upolu and Savaii Sections.
22 For detailed figures and data, see Dorsch Consult. 2001. Apia Water Supply Consolidation Project. FINAL REPORT. Apia, Samoa.

filtered material has to be removed by hand from the slow sand filters and dumped under uncontrolled conditions due to lack of funds. Water is finally disinfected by chlorination and Kingston reports how the bacteria counts, including *E. coli* counts, have been zero since SWA in July 2001 added chlorination with calcium hypochlorite as a final treatment phase before water distribution. Dorsch Consult (2001) further confirms this, stating that areas with treated water supply are considered to receive clean drinking water according to WHO standards on a reliable basis.

Water from boreholes is untreated and is of very good quality. Water from springs, of which there are only two at Tiavea and Faleseela (Lefaga), is also untreated, but is of very good quality. Untreated surface water does not meet WHO standards and is generally not suitable for potable water supplies (Assets Division, SWA).

A survey to identify and quantify the volume of unwanted Persistent Organic Pollutants (POPs) and associated environmental contamination in Samoa identified that the level of chemical contamination is comparatively low, and that chemical pollutants in drinking water are of less concern than microbial contamination associated with unsafe sanitation practices (Kingston 2004).

Water quality issues inevitably stem from the clearing of forests (deforestation) for both timber and agricultural practices, resulting in reduced water quality due also to the increased use of pesticides and fertilisers within the catchment areas. This is determined by the nitrate contamination of drinking water and its increased turbidity (TSS) caused by soil erosion and the increased surface run-off, particularly during the rainy season. The forest clearance of watershed areas has, therefore, affected the supply and deteriorated the quality of water in the urban area of Apia, mainly because of the greater velocity of water flowing downhill to the lower slopes. This change in aesthetic quality of drinking water can cause communities to drink from polluted sources, and impacts on the ability to treat water quickly and inexpensively (ibid).

However, current developments with servicing clean water to both urban and rural areas have markedly improved water quality around the country. Water metering is playing a crucial part in this positive development, not only enhancing quality supply, but also acts as a means of controlling the sustainable use of water supplied. Unfortunately, information on water resource quality is sparse, yet threats from potent pesticides and disposal of wastes are still evident (SWA 2006).

### 2.4.3 Population Access to Water Supply

Samoa Water Authority (2006) reports that access to safe water supply is a key performance indicator yet it is neither routinely assessed nor publicly reported at present. The 2001 Population and Housing Census for sources of water supply presents only a partial and perhaps misleading picture of water supply provision in Samoa as it does not reflect access to 'safe' water supply (see Table 2.7).

Table 2.7: Source of Water Supply per Household

| Location | Piped | Piped shared | Well/spring | River/lake | Rain | Total |
|---|---|---|---|---|---|---|
| AUA | 4.960<br>93.5% | 206<br>3.9% | 44<br>0.8% | 26<br>0.5% | 67<br>1.3% | 5,303<br>100% |
| NWU | 5.682<br>81.5% | 771<br>11.1% | 92<br>1.3% | 43<br>0.6% | 381<br>5.5% | 6,969<br>100% |
| ROU | 4,306<br>79.7% | 422<br>7.8% | 246<br>4.6% | 102<br>1.9% | 330<br>6.1% | 5,406<br>100% |
| Savaii | 4,295<br>78.1% | 447<br>8.1 | 34<br>0.6% | 14<br>0.3% | 711<br>12.9% | 5,501<br>100% |
| Total | 19,243<br>83% | 1,846<br>8% | 416<br>1.8% | 185<br>0.8% | 1,489<br>6.4% | 23,179<br>100% |

Notes: HH=household; AUA=Apia urban area; NWU=Northwest Upolu; ROU=Rest of Upolu Notes: Source: SWA 2006.

The above statistics have been used to state that 91% of the population has access to a piped water supply (columns 1 & 2), yet many piped supplies are intermittent and may be prone to contamination. However, overall service coverage by the SWA (July 2004) was 68% of the population, comprising 16,752 active customers (13,616 customers on Upolu and 3,136 customers on Savaii). Only one third

of this total population currently receive treated water and some 15% of samples from these treated supplies fail quality tests either through ineffective treatment or intermediate contamination. The potential for delivering treated metered water was significantly increased following the recent implementation of projects in NW Upolu and SE Savaii, and the consolidation phase to these projects will ensure that full benefits are realized. The remaining 32% of the population either receive water from independent village schemes or their own small sources.

About 50% of SWA customers in both Upolu and Savaii are metered. In the Apia urban area, many customers have been transferred to metered treated supplies for a number of years and excessively high consumption figures have fallen significantly as a result. In rural areas, except in NW Upolu and SE Savaii, borehole and surface water sources are untreated and many fall below the (draft) national drinking water standards based on WHO guidelines. In non-metered areas, water consumption and wastage remains high and is exacerbated by high levels of leakage.[23]

The Apia urban area is supplied from gravity sources that have reliable yields, higher than the current demand. However, the current demand is greater than the design capacity of the treatment works and this has become a controlling factor on the size of the area served. In the rural areas of Upolu and Savaii, boreholes that supply the villages only operate for between 11 and 17 hours per day. Electricity is the major operational cost for SWA and these hours have been arrived at by balancing economy in electricity costs and demand. However, unaccounted for water (UFW) in the Apia urban area is more than 40% of production and is estimated to be similar or even higher in rural areas. Villages like Letogo and Vailele-tai and Vailele-uta still rely on river water and can experience periods of severe water shortage from July to November. In addition, these villages also suffer from piped water with high turbidity, so excessive that as soon as it rains for any period of time in the dry season, the mains are again turned-off.

Savaii also experiences periods of severe water shortage throughout the year. The parts of West Savaii and North-West Upolu, which are in the rain shadow are almost devoid of surface streams, suffer chronic water deficiencies. Some rainwater is collected in tanks or alternatively trucked-in.

Around 15% of the population relies on services from independent or village/community managed water supply schemes, there being 18 such schemes in Upolu and 4 in Savaii. The quality of water supplied by small independent schemes is variable and none are treated. Most of the schemes were developed by the former Public Works Department, but most are coming to the end of their useful life. The village committees that operate these schemes do not collect sufficient income to rehabilitate the schemes and most do not have the technical knowledge of how to do so. Despite this, there are still strong desires to remain independent. This desire is driven by a mistrust of the Government to provide reliable supplies, a desire to remain free of Government water charges, and reluctance for treated metered supplies. However, this situation is also not helped by a lack of knowledge and advice being offered within such communities on the health aspects of untreated water supplies (SWA, 2006).

### 2.4.4 Flowing Streams and River Systems

Fresh water is a fundamental resource for any small island nation and Samoa is no exception. All of Samoa's forty river systems originate in the uplands and drain into the sea creating watersheds. The rivers are fairly evenly distributed throughout Samoa with the exception of Savaii where the land is considered to be dry. The rivers are partly perennial and partly seasonal in character. These rivers are Samoa's main source of fresh water, comprising 75% of Samoa's water sources (GoS 2003b). The major surface water sources on Upolu are the Fuluasou, Vaisigano, Namo, Mulivai, Salani, Tafitoala, Nuusuatia, Leafe or Lotofaga and Faleseela Rivers. The only major perennial watercourses on Savaii are the Sili (or Vaiola), Palauli (or Faleata) and the upper reaches of the Maliolio River in Patamea (RKL/GMA Ltd 1995).

The volcanic origin of Samoa has resulted in terrains that have abundant streams and waterfalls. Despite this, the Western part of Upolu and the larger parts of Savaii lack any surface water because

23 Information provided by Samoa Water Authority.

of the highly permeable nature of soils and the Mulifanua volcanic rocks. Thus, groundwater and rainwater catchments are the common sources of water in these areas (GoS 2003b).

### 2.4.5 Catchment Areas and Changes Over Time

Water in Samoa's main watersheds is being used for drinking, domestic and industrial uses and hydropower. In 1981, 80% of the country's electric power was generated by diesel plants, whereas today close to 40% of the electric power is generated by hydro-power.

Close to 58% of these areas were in natural undisturbed condition, 34% were disturbed and 7% were disturbed and in extremely degraded conditions. After the two cyclones, Ofa and Val in 1990 and 1991, the condition of these watersheds deteriorated drastically. A Forestry Division assessment of cyclone damage in the Vaisigano watershed indicated a 40% level of uprooted trees and 50% of badly damaged standing trees. Constant forest clearance of lands by villagers, the opening of new village roads within the watersheds and other development activities has continued with the ongoing deterioration of the country's most important watersheds. The protection of mountain watersheds has a direct or indirect impact on soil fertility, essentially influencing agricultural developments positively. Watershed degradation has a direct impact on water quantity and quality. Low quality is unacceptable for human and livestock consumption and a reduction in water quantity severely impacts consumption, hydro-power generation, irrigation and industrial uses. [24]

Five watersheds were identified in 1983 for serious management within the Vaisigano, Fuluasou, Faleaseela, Falefa and Palauli Faleata river catchment systems. The Watershed Management Section (WMS), under the Forestry Division (FD) of the MAFFM, rehabilitated the first two watersheds after the 1990 and 1991 cyclones. A total of 424.6 hectares were planted in the Vaisigano watershed and 383.0 hectares in the Fuluasou watershed. Community planting is on-going in Falefa and Faleaseela watersheds. Recently, this functioning arm has been transferred to the MNRE. Community-based watershed management approaches are being initiated on the island of Apolima and the village of Lepa. These various watershed management developments will provide some lessons and models for promoting nationwide effective community-based management of the country's watershed areas which are largely in lands under customary land ownership or owned by village landowners.[25]

### 2.4.6 Water Resource Issues and Concerns

It has been identified that the major threats to an adequate water supply are continuing forest clearance in water catchment areas either for agricultural plantations or being caused by severe cyclones. Further, discharges of untreated wastewater with associated pathogenic organisms into streams, rivers and coastal estuaries is causing water pollution and degrading the quality of water. These discharges occur from outfalls (point source pollution) and from more diffuse flows from on-site sanitation systems within urban areas or surface water catchments. Rapid urbanization is putting greater pressure on both surface water (and groundwater) supply catchments used for urban and nearby peri-urban and rural water supplies. In the water catchments supplying water to Apia, uncontrolled urban expansion and agricultural activities are noticeable, and this will impact heavily on water quality and water quantity supplied in the future.

Impacts on physical quality of water supplies make water unusable from days to months. It is not uncommon for consumers to experience high turbidity and suspended solids after periods of heavy rainfall. The water becomes unusable for a day or more. The effectiveness of water supply intakes and treatment systems is compromised by high-suspended sediment loads, leading to higher costs of providing clean, safe water supplies. Apia's water supply, which is fed from a number of catchments above the town, requires filtration (roughing filter and slow sand filter) and disinfection (chlorination) to achieve adequate water quality for the consumers. It is reported by the Samoa Water Authority that

[24] MNRE. 2006. *Public Awarenesss.* [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/13%20July%202003%20%20Watershed%20Management%20In%20Samoa.pdf

[25] Ibid.

the treatment plant filters requires more frequent cleaning in recent years. This is most likely a result of ongoing clearing within the water supply catchments by landowners for the purpose of grazing cattle and planting crops.[26] Cattle grazing in water catchments also pose serious health threats, including leptospirosis and gastro-intestinal infections caused by *E. coli* of bovine (cattle) origin. However, more needs to be done to remove this source of watershed degradation.

After very heavy downpours, treatment plants have been overtopped by floods and covered in sediment from heavily-disturbed catchment areas, causing disruption to water supplies for months (e.g. water supply for Apia was severely disrupted after a major flood in April 2001). This sort of event is more likely unavoidable, but the severity of such major floodings is increased by catchment forest clearing, leading to higher and more rapidly rising flows than under prime conditions (Kingston 2004).

### 2.4.7 Salinization

In Samoa, like any volcanic island with varying ages of landscapes, groundwater is more easily available from younger, less weathered and permeable formations such as those found in Mulifanua, Lefaga, Puapua and Aopo. Groundwater occurs as either perched (high level) or basal (low level) aquifers. Basal aquifers tend to be more important than perched aquifers because they are more common and generally have larger storage volumes. Basal aquifers consist of unconfined, partially confined or confined freshwater bodies which form at or below sea level. They are usually in the form of a 'freshwater lens' (or 'groundwater lens') which underlies the whole island as witnessed by the many coastal springs found all around the coastal villages of Samoa. Basal aquifers are, however, vulnerable to saline intrusion owing to the freshwater-seawater interaction, and must be carefully managed to avoid over-exploitation and consequent seawater intrusion. The yield of the basal aquifers is constrained by the risk of inducing horizontal and vertical intrusion of saltwater into the freshwater aquifer by over abstraction (RKL/GMA Ltd., 1995).

According to an Assessment Report on Community Vulnerability and Adaptation to Climate Change (Wulf, 2004), salinization is a major vulnerability experienced by many low-lying coastal villages around Samoa. In the case of the village of Saoluafata, the three coastal springs that the villagers use to drink from in times of water shortages and for cooking purposes have suffered salt-water intrusion due to storm surges making it unsafe for consumption. The villages believe that the possible cause of the salinization problem is due to changes in river flow, which has become weak while the sea flow has become noticeably stronger. Another possible cause is due to the very thin spring water lens which seawater can easily penetrate and thus make it salty in quality.

The villagers depended on these coastal springs during times of drought as experienced in 1997 and 1998. It was recorded that during the last drought, the villagers had to buy water from water trucks and some who could not afford this still used the salinated springs for consumption. After the village was hit by cyclones and their water supply destroyed, most people resorted to these springs. Even though it was not safe for consumption, the alternatives were limited. Today, the villagers still use these springs for consumption and other purposes, especially as they are still experiencing water shortages from tap water, their water supply being limited to only certain hours of the day.

### 2.4.8 Boreholes

Rural areas of Samoa are primarily dependent on groundwater resources, abstracted from boreholes at below 80m by electric submersible pumps. In the West of Upolu, these groundwater resources are scarce and to supplement supply, the European Union is currently funding a program to divert surface water from the central catchment area to rural villages. Savaii relies on groundwater abstracted from boreholes, pumped into a reticulation system by submersible electric pumps and distributed by gravity through in-house connections (Kingston, 2004).

[26] MNRE. 2006. *Public Awarenesss.* [online]. Apia, MNRE. Available from: http://www.mnre.gov.ws/documents/newspaper/13%20July%202003%20%20Watershed%20Management%20In%20Samoa.pdf

Borehole locations are normally sought between 40 m and 60 m above sea level and about 1 mile (1.6 km) inland from the coast. Drilling depths are generally not more than about 50 m, resulting in the base of the boreholes at 10 m above sea level or less. Principally the Apia Observatory set this rule, in order to minimize the risk of saline intrusion.[27] Most boreholes are drilled in rocks of the Mulifanua formation. This formation is highly permeable and the most important aquifer in Samoa.

Upolu has a total of 31 boreholes and Savaii has 23. The SWA has proposed developing surface water resources on the island to supplement the groundwater supply. With some exceptions, borehole waters are of good quality chemically and bacteriologically and are generally untreated (Assets Division, SWA). Some have been abandoned because of salinity problems whilst others indicate possible problems with salinity, which could be controlled to satisfactory levels if pumped at rates consistent with their 'safe' yield. Boreholes, which have been in use for long periods of time and have become old, are most likely to be affected by salinization as water extraction rates begin to exceed supply of groundwater within the spring water lens (RKL/GMA Ltd 1995).

## 2.5 Land Resources

### 2.5.1 Area of Total Land under Cultivation

Agricultural plantation areas comprise the largest portion of non-forest categories, forestry areas being the dominant feature of total land utilization in Samoa. Cultivation of agricultural plantations amounted to more than 63,000 ha covering and contributing to 22.3% of the total land area of Samoa. Based on 1999 aerial photos, land under cultivation or agricultural lands in the form of plantations and mixed cropping was estimated to be 28,621 ha in Savaii and 34,476 ha in Upolu (MNRE 2006b).

Plantations are made up of permanent agricultural installations, mostly tree crops or continued/repeated planting of coconuts or bananas for agro-industrial purposes. Plantations covered 26,158 ha on Savaii and 26,770 on Upolu. Mixed cropping is usually land currently and recently cultivated with a mixture of herbaceous and tree crops such as root crops, taro, yam, cassava, breadfruit, etc. This includes areas of current cropping and adjacent areas recently abandoned and now overgrown with secondary shrub and tree species. The practice of mixed cropping covered 2,463 ha on Savaii and 7,706 ha on Upolu.

The 1999 Agricultural Census found the average household controlled 9 acres compared to 15 acres in the 1989 Census. Potential fertile lands still exist. Populated areas under village tenure are under severe pressure to develop land of trivial economic worth. About 70% (481,591.5 acres or 200,021 ha) of Samoa's land area is suitable for cultivation and cattle grazing (ibid). These include areas of marginal land requiring heavy fertilization for crop production and areas for cattle grazing of questionable viability above 600m elevations. Land that used to be under forest cover has been extensively altered to allow for all other uses, in particular agricultural expansion. In the rural communities, land remains primarily under customary ownership and a large proportion of it is currently under cultivation at the expense of native forests recovering (GOS 2003b).

Mono-cropping, rather than the more traditional systems such as mixed cropping and integrated farming, is more likely to result in land degradation via soil erosion due to excessive rainwater run-off. Degradation of land and its resource base is believed to be almost non-reversible, especially in view of severe repercussions on the soil and productivity of the land (MNRE 2006c).

### 2.5.2 Residential Land Coverage

Samoan families are experiencing more of the modern lifestyle as they increasingly build their homes closer to main roads to enjoy better access to transport, electricity and water, such infrastructures being focused along the main island transport corridors that network Upolu and Savaii. This continuous pattern is facilitating land use changes while impacting upon traditional social systems and

27 Refer Section 2.3 - RKL/GMA Ltd. 1995. National Water Resources Master Plan Study (Stage 1). DRAFT FINAL REPORT. RKL, Surrey, England.

values. Such systems traditionally encouraged houses to be built around the central *malae* or meeting place so that the socio cultural norms and practices could be readily applied, observed and regulated. This contrasts to newer urban-related 'quality of life' concerns based on infrastructural needs that are now driving different patterns of housing and land use, such as those fronting the main road from Apia to Faleolo. As such, there is a breakdown of the traditional system of village layout and society in general (GoS/ADB, 2001a).

Furthermore, the expansion of settlements around the fringes of Apia has been driven by a process of conversion of primarily Government-owned plantation lands into low-density fringe residential development, as well as infill development on freehold lands and customary lands in the established inner urban villages. The residential areas of Vaitele, Vaiusu, Fuluasou West, Fuluasou East, Mt Vaea, Vaisigano East, Maugafiafia (South-East of Vailele) and Vaivase-uta, but mainly West coast villages such as those near Faleula and adjoining catchment villages such as those in Fuluasou to the South, have all experienced recent major residential growth (ibid). Figure 2.1 shows population settlements in the main islands of Samoa mainly on coastal low-lying areas, and residential coverage represented by yellow blocks and bright red for roading (Hay and Suaesi, 2006).

**Figure 2.1: Population settlements in the main islands of Samoa**

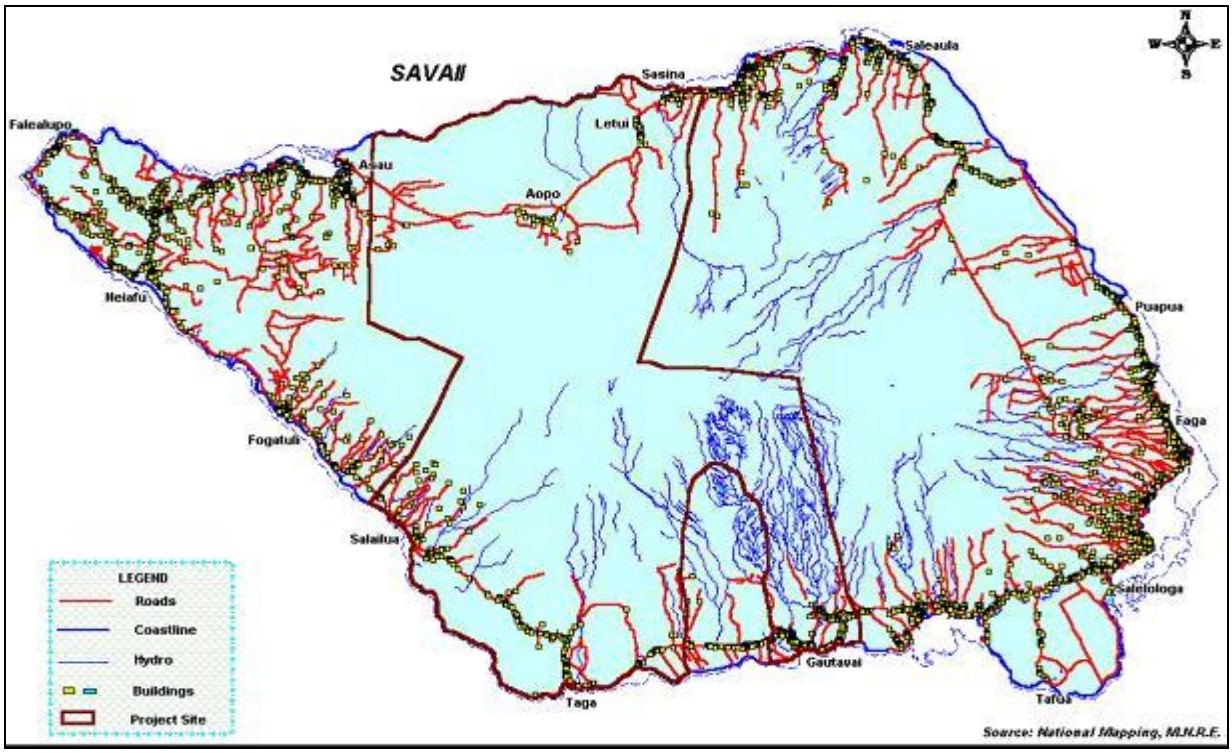
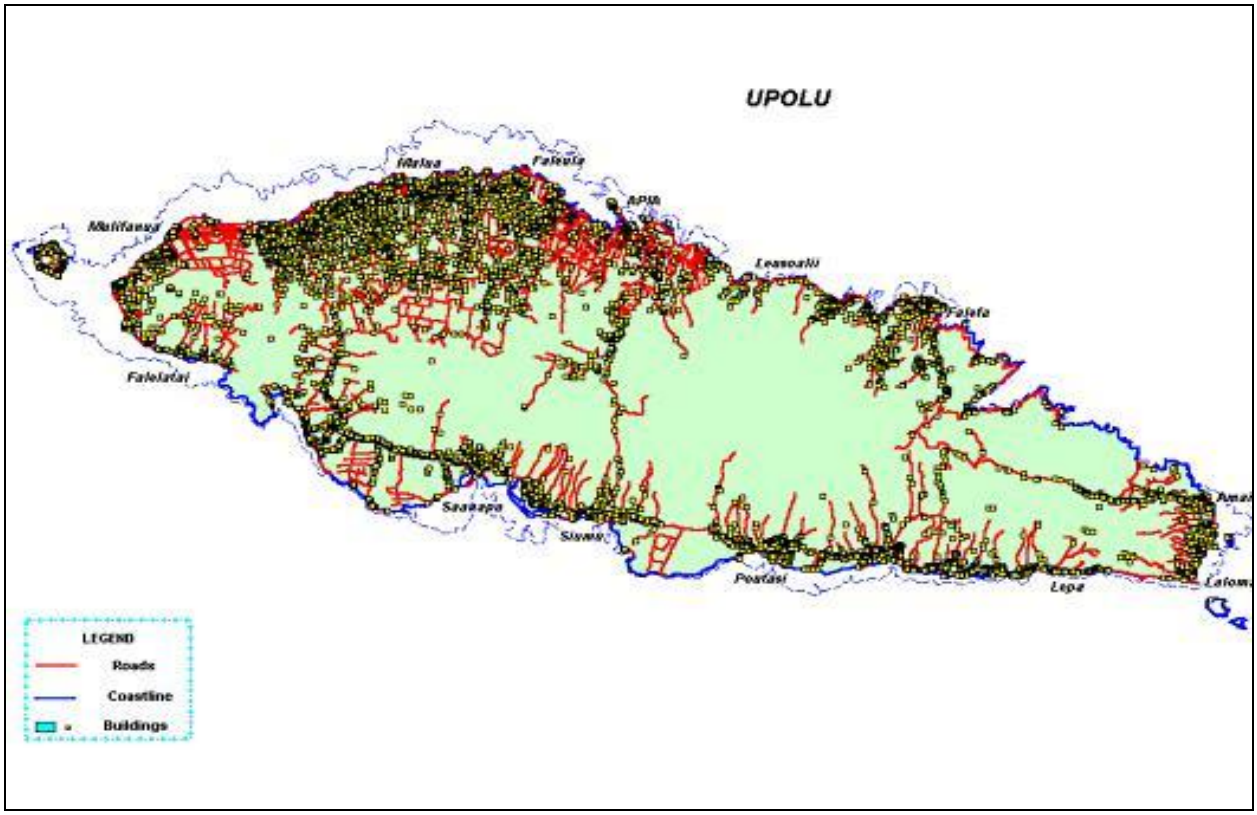


**Figure 2.1: Population settlements in the main islands of Samoa**




Source: National mapping, MNRE

Based on analysis of 1999 aerial photography maps of Samoa, attempts at quantifying land cover categorized as built-up areas, which includes all settlement areas encompassing continuous developments, industrial or commercial built-up areas, and scattered isolated houses including gardens and inner city parks, estimated that it covered 2.5% of the total land area of Samoa, 1,772 ha in Savaii and 5,292 ha in Upolu (MNRE 2006c).

The main concern for residential land especially in the urban areas is that there is not enough land to house the influx of people and, more importantly, to provide adequate village plantations and garden space. While no detailed land capability analysis has been undertaken for Apia, the stream edges and steep slopes that define the middle and upper parts of the drainage catchments are the principal constraints to further inland housing development (GoS/ADB 2001a). Increasing economic pressure, rapidly changing attitudes and rising poverty will eventually impact on the quality of land resources important for high residential areas. In terms of impacts affecting people, most are marginalized to the extent of landlessness, and sustained food supplies are limited, requiring intensive labour, and income is generally decreased (MNRE, 2006c).

Adverse effects of urbanization on the environment are often visible with soils becoming compacted and less fertile, increasing the use of agrochemicals (ibid).

### 2.5.3 Urban and Rural Land Coverage

A rapidly growing Apia clearly dominates the settlement pattern in Samoa supported by over 350 smaller rural villages. This includes the Government designated town growth area focused on Salelologa in South-Eastern Savaii. This strong development pattern that is emerging is one where both rural and urban villages are generally located close to the coast along the fringing plain, with produce gardens and agricultural lands located inland.

Traditional housing and plantation lands are being supplemented by modern housing and smaller gardens especially on customary lands, where open walled *fale* housing and large areas for gardening characterize households that support their livelihood based on a contribution from the 'subsistence sector' (GoS/ADB, 2001b).

Villages are growing rapidly in the urban hinterland, with many having expanded to the extent that their village boundaries blur the 'urban rural' divide. As a result, villages now form one linear strip of urban development between Apia and the International Airport at Faleolo. The pattern is also prominent in Salelologa, but on a smaller scale.

Development within Apia is occurring along the undulating and extensive coastal plain to the West whilst penetrating South along the Fuluasou and Vaisigano river valleys, as well as the foothills of the dominant Mt. Vaea. Urban development to the East is constrained by the absence of a contiguous coastal plain, with small traditional villages such as Laulii, Leusoalii, Luatuanuu and Solosolo occupying the available coastal strip. The most significant developments in the last twenty years that have resulted in the existing urban rural patterns are:

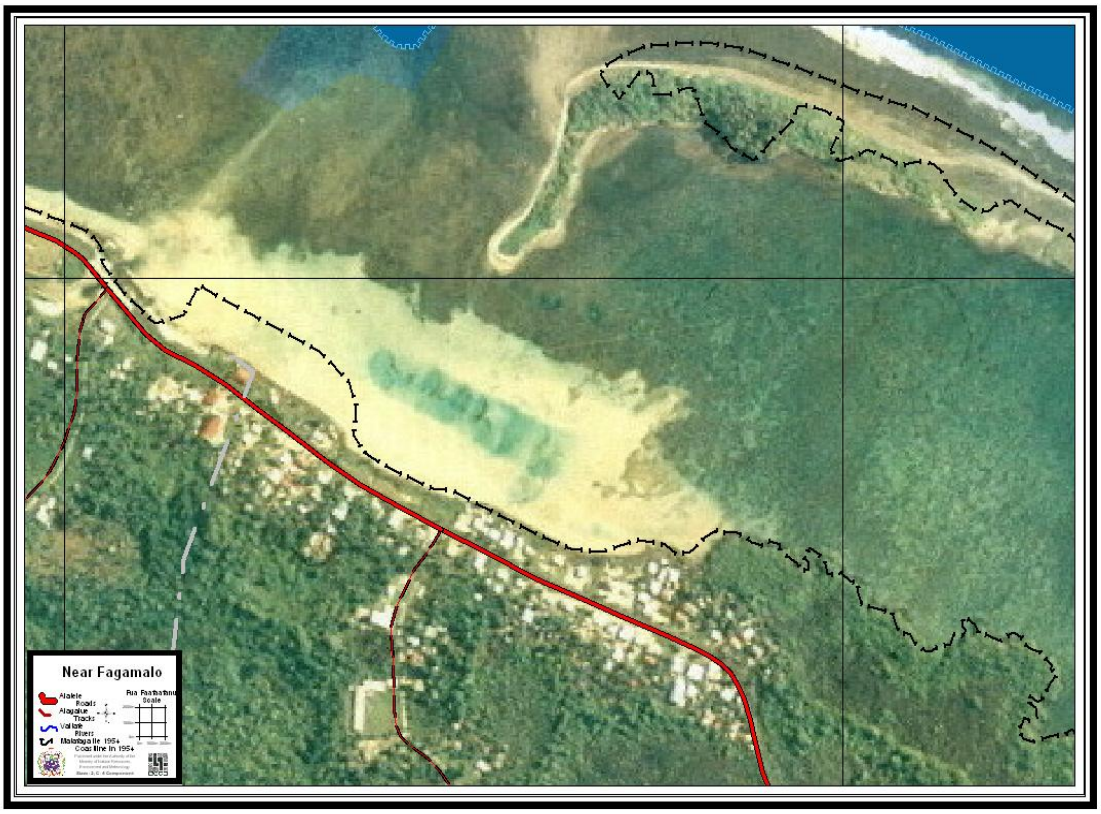
- The change and intensity of use in the central business area and the inner villages of Apia,
- The infill and fringe development adjoining urban areas in the valleys in the South such as Tiapapata and Afiamalu, and
- Continued outward expansion of Apia to the North-West of Upolu (the North-West Upolu corridor) including the conversion of fringe urban lands at low residential densities (ibid).[28]

### 2.5.4 Land Lost to Sea Level Intrusion and Erosion

Loss of land to coastal erosion is a major vulnerability to coastal communities in Samoa according to an Assessment Report undertaken for Community Vulnerability and Adaptation to Climate Change (Wulf 2004), as evident in the case of Lano village along the North-Eastern coast of Savaii as the majority of villagers settle close to the shoreline. It was noted that most families have not moved inland after the cyclones, and most have rebuilt on the coastline. This is due to absence of roads, electricity and infrastructure needed for resettlement inland. Rising seas and high storm surges and sand mining activities have eroded coastal lands at a fast rate of about 5 meters per year. The destructive action of storm surges, coupled with sea level rise, and further exacerbated by sand mining, has resulted in a significant loss of land along the coast. Increasing deforestation along the coast has further worsened the situation. Coastal settlements remain vulnerable to sea level rise and coastal erosion. Shifting boundaries along the coast have led to disputes among landowners. The residents are very concerned for their security in the event of increased sea level rise and tropical cyclones. The road, and rock seawalls built to date, may help protect most family lands near the coast, but a great deal of land has been lost already (ibid). Figures 2.2 and 2.3 shows coastal villages of Fagamalo (Savaii) and Solosolo (Upolu), respectively, which have experienced shifting coastlines with 1954 coastline represented by black dotted line over-laid with 1999 aerial photography mapping showing present state.

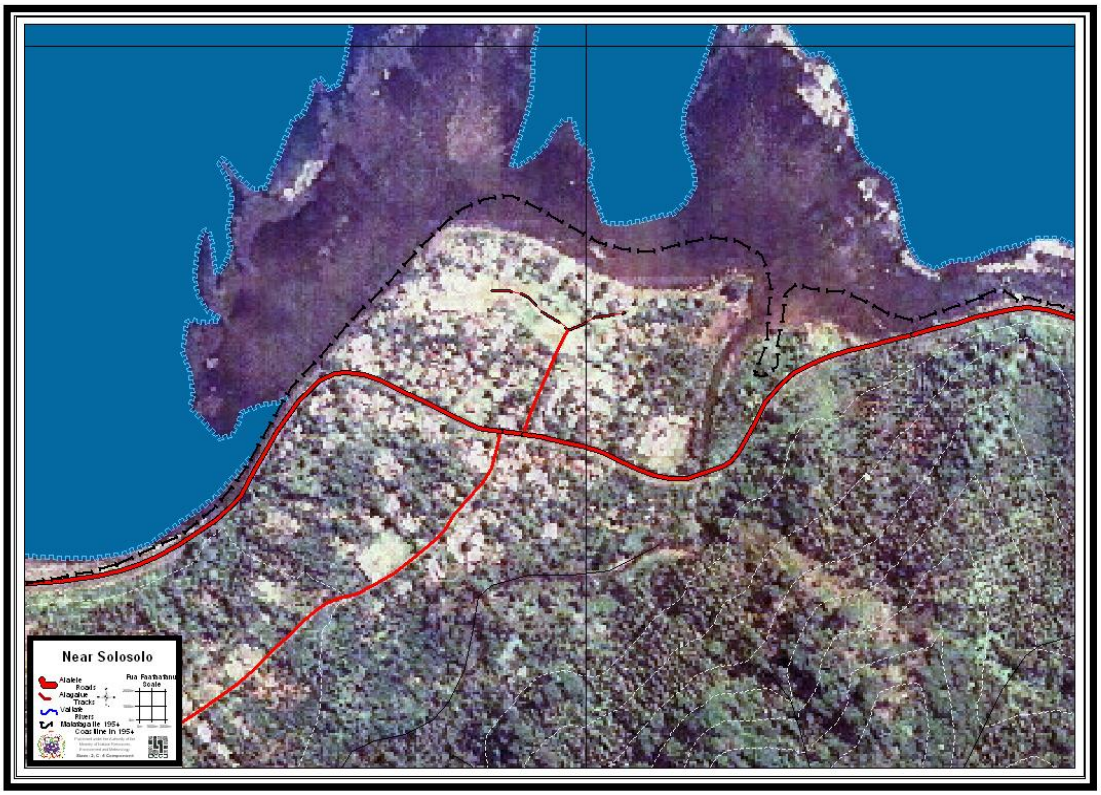
[28] See Section 4.4 Land Use for Sustanaible Development.

**Figure 2.2: Shifting coastlines – Saleaula village (Savaii)**




Source: National mapping, MNRE

**Figure 2.3: Shifting coastlines – Solosolo village (Upolu)**




Source: National mapping, MNRE

### 2.5.5 Land Gained from Reclamation

The boundaries between sea and land are perennially changing. In many sheltered bays and estuaries, the sea is receding, while in other portions of the sea-coast, it is continuously encroaching.

The process of reclamation includes maintaining water and air quality, minimizing flooding, erosion and damage to land properties, wildlife and aquatic habitats caused by surface mining. The final step in this process is often topsoil replacement and re-vegetation with suitable plant species. Reclamation can occur both on land and on sea. Land may either be reclaimed for reasons of raising the level of existing physical ground or for fill purposes of land being mined for resource extractions.

The most common form of reclamation practices is reclamation occurring in the sea or, most simply put, reclamation is the forming of land by filling the sea. The main object of reclaiming land from the sea in Samoa is to increase the area of ground available for establishing various physical purposes. These may range from residential and cultivation purposes to major development projects such as tourism, individual/commercial business ventures, wharf construction and other infrastructural improvements.

Reclamation can incur both positive and negative impacts on the coastal environment. On the one hand, it helps add resilience to vulnerability of the sea-and-coast's physical coexistence, while on the other it can incur heavy losses to ecosystems of the immediate coastal environment. Placing fill in a reclamation area may affect the water quality of the adjacent sea as well as threatening the thriving existence of fish stocks and habitats found in nearby coastal seas and connecting lagoons. The potential impacts must be fully assessed by comprehensive environmental studies and minimized by implementing mitigation measures. [29]

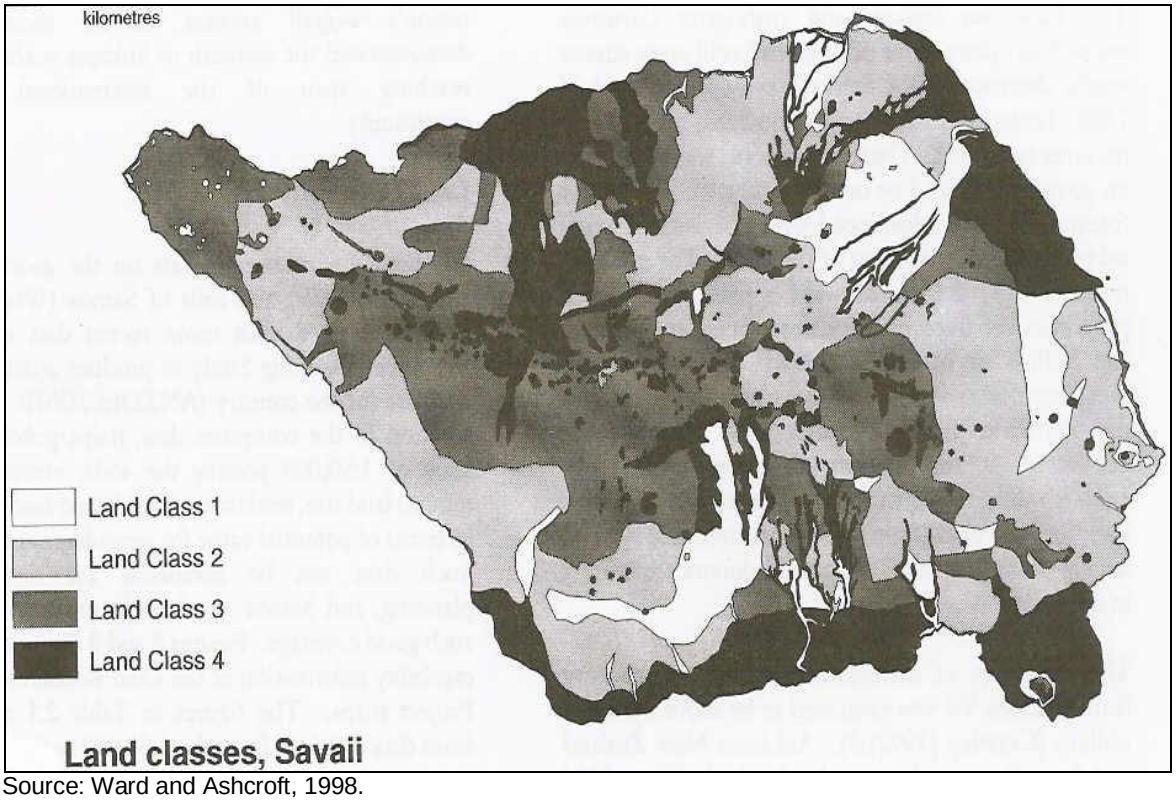
### 2.5.6 Land Capability Allocation

Excellent environmental data on the geology produced by Kear and Wood in 1959 and soils of Samoa by Wright in 1963 have been used with more recent data in a Land Resources Planning Study to produce a detailed GIS database for the country (ANZDEC/DSIR 1990). Figures 2.4 and 2.5, taken from Ward and Ashcroft (1998), draw on the land capability information of the Land Resource Planning Project maps for Savaii and Upolu, respectively. The figures in Table 2.8 are drawn from data digitized from the 1:50,000 series maps.

Land Class 1 is generally flat or gently sloping, but such land makes up only 14.2% of the country's total area. Soil nutrient levels vary considerably, but the relative absence of periods of moisture deficit in most areas mean that these areas are relatively easy to cultivate and manage.

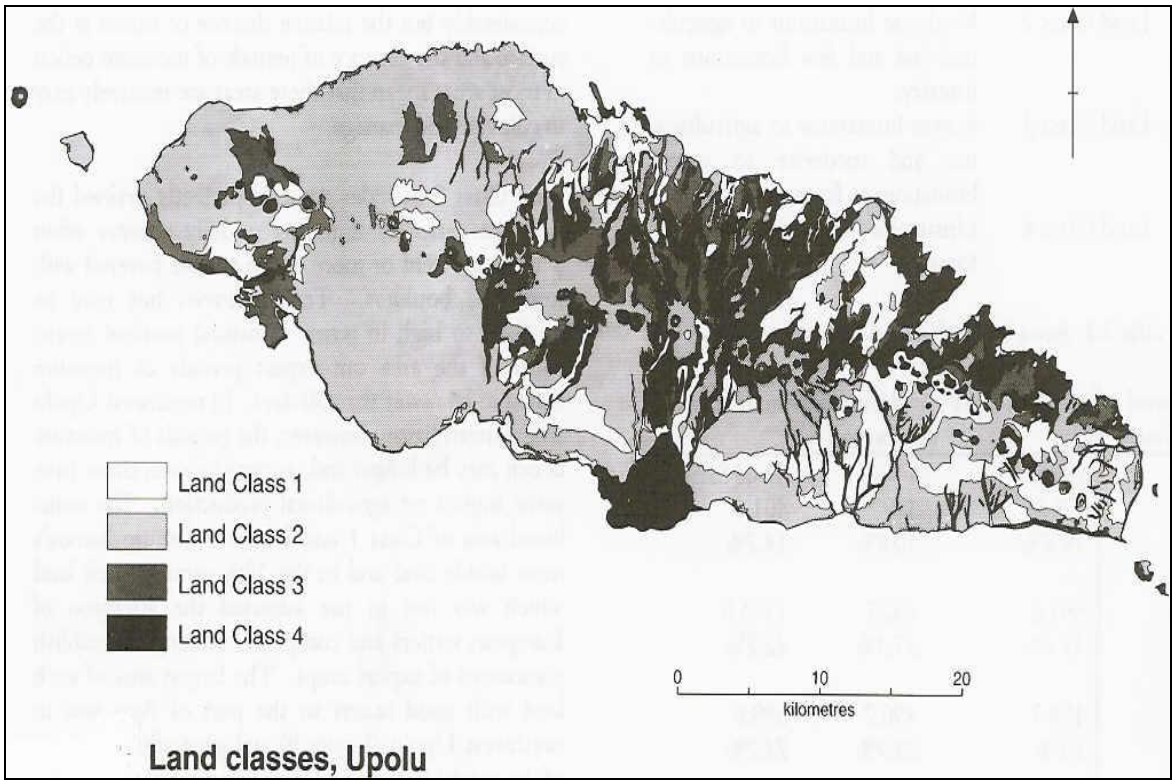
29MNRE. 2006. Public Awarenesss. [online]. Apia, MNRE.. Available from: http://www.mnre.gov.ws/documents/newspaper/environment/11th%20April%20-%20Reclamation.pdf

**Figure 2.4 Land Classes Savaii**




Source: Ward and Ashcroft, 1998.

**Figure 2.5: Land Classes Upolu**




Source: Ward and Ashcroft, 1998.

Land Class 2 includes some imperfectly drained flat land, but generally is rolling or hilly country often with 50 percent or more of the surface covered with stones or boulders. Fertility varies, but may be medium to high in terms of natural nutrient levels. Most of the area can expect periods of moisture deficit to be fewer than 30 days. In North-West Upolu and Western Savaii, however, the periods of moisture deficit may be longer and, as noted above, this have some impact on agricultural productivity. The combined area of Class 1 and 2 makes up Samoa's most usable land.

The severe limitations, which restrict the uses of Land Class 3, include soils, which often contain more than 50 per cent of stones and boulders, or sheets of lava close to the surface, which may create bogs. Erosion potential on the steeper slopes is moderate or severe. At higher altitudes, where rainfall is very high, the soils may be very strongly leached. Land of this class is unlikely to be useful for any intensive purpose and much is included in areas which have been designated as having important catchment or conservation value.

Areas in Land Class 4 include both upland bogs and coastal swamps, some of the latter being saline. Other areas are very steep land with severe actual or potential erosion risk. This class also includes land covered by pahoehoe lava sheets with little soil. In general, its use is limited to watershed protection or other conservation purposes.

Table 2.8: Areas in each Land Class

| Land Class | Area (km²) and proportion of land area (%) | | |
|---|---|---|---|
| | Upolu | Savaii | Total Samoa |
| 1 | 221.9<br>19.6% | 179.8<br>10.6% | 401.6<br>14.2% |
| 2 | 561.5<br>49.6% | 632.7<br>37.3% | 1193.6<br>42.2% |
| 3 | 108.7<br>9.6% | 490.2<br>28.9% | 599.6<br>21.2% |
| 4 | 238.9<br>21.1% | 393.5<br>23.2% | 633.6<br>22.4% |

Source: Ward and Ashcroft, 1998

As indicated in Table 2.8, a little more than half of Samoa's land does not have severe limitations for agricultural use, and most of this land has already been cleared of forest and has at some time been put under agricultural or forestry use. Even if such land is currently underused in terms of its potential, because it has once been cleared and used, most of it is now held in the ownership of specific *aiga* or individuals. Therefore, it is not available for general development. Most customary land which is still forested lies at higher elevations and is either less suited climatically for agriculture, or has other severe limitations to its use for anything other than conservation forest and watershed protection (ibid).

## 2.6 Forestry Resources

### 2.6.1 Total Forest Area in Samoa

Samoa's total land area is about 285,000 ha, and more than 171,000 ha is total forest area, consisting of major forest types (mangrove and forested wetlands). These figures, estimated from the recent forest survey, SamFRIS [30] are a little more than 60 per cent of the total land area, which is more than earlier mappings assumed or predicted.

[30] The Samoa Forestry Division / FAO project "Strengthening the Institutional Capacity of the Samoa Forestry Division (SFD) to Effectively Plan and Manage Forest Resources" in 2004 – 2005 established the 'Samoa Forest Resources Information System'. This was a necessary planning data to manage Samoa's natural forest resources and plantation forests in a sustainable way. And essentially, providing the SFD with the necessary equipment and training to upgrade its capacity to assess, manage and monitor the remaining forest resources of Samoa. The SamFRIS project began in mid 2003 and has now completely re-mapped the country's forest resources based on 1999 aerial photographs into a MapInfo based GIS. In addition, a comprehensive forest survey involving more than 400 survey plots has been conducted to gather data about the structure and quality of Samoa's forests.

Medium forest covers the biggest area size with 72,563 ha. There is virtually no more closed forest left, except for a small area found on Nuutele Island (0.05%). Open forest makes up for a sizeable portion, covering some 20% of the total land area. Pure stands of secondary forest already cover 13% of the total land area, not including large swaths of abandoned coconut plantations encroached by secondary scrub or forest.

Agricultural plantation area (non-forest) makes up the largest portion with more than 53,000 ha covering almost 19% of the country. While plantation area is almost evenly distributed between Savaii and Upolu, there are clear discrepancies for mixed crops, grassland and built-up area, which all dominate on Upolu. Barren land almost exclusively occurs on Savaii on recent lava flows and landslides on the slopes of the main volcano (Mt Silisili).

The mapping results provide area size figures for all eight islands covered by the aerial photos. Table 2.9 recapitulates area sizes for the 16 main forest and land cover categories.

Upolu still has a forest cover of approximately 47%, while 69% of the total area of Savaii is still under forest. However, discrepancies become evident when looking at the distribution of forest types where there is little to no medium forest left on Upolu except for 402 ha situated in Northern Upolu. Medium forest on Savaii still covers an area of 72,150 ha. Upolu has the largest forest category of open forest with more than 33,000 ha.

Some difficulty has been encountered with the various sources of total forest plantation area. The aerial photo interpretation rendered a total area of 5,102 ha, which comes relatively close to the existing Forestry Division records of 5,653 ha. Available forest compartment maps, however, showed an area of only 3,551 ha. An explanation given by FD was that inconsistencies may have been caused by writing-off cyclone damaged plantations, which still figure in some of the records.

Table 2.9: Area Sizes of Forest Types and Land Cover Categories (ha)

| Main Category | Savaii | Upolu | Samoa* | % of Samoa land area |
|---|---|---|---|---|
| Closed forest | 0 | 0 | 82** | 0.0 |
| Medium forest | 72151 | 403 | 72563 | 25.5 |
| Open forest | 22272 | 33049 | 55348 | 19.5 |
| Secondary forest | 19800 | 17296 | 37173 | 13.1 |
| Scrub | 15065 | 7000 | 22115 | 7.8 |
| Forest plantation | 3798 | 1305 | 5103 | 1.8 |
| Mangrove | 16 | 353 | 370 | 0.1 |
| Wetland | 148 | 597 | 745 | 0.2 |
| Plantations | 26158 | 26770 | 53114 | 18.7 |
| Mixed crops | 2463 | 7706 | 10228 | 3.6 |
| Grassland | 5193 | 12299 | 17494 | 6.2 |
| Barren land | 1973 | 30 | 2005 | 0.7 |
| Built-up | 1772 | 5292 | 7098 | 2.5 |
| Infrastructure | 32 | 432 | 463 | 0.2 |
| Lakes | 16 | 203 | 219 | 0.1 |
| Rivers | 22 | 42 | 64 | 0.0 |
| Total | 170879 | 112777 | 284184 | 100 |

*includes all 8 islands **sizeable areas of closed forest occur only on Nuutele Island. Source: FAO, 2005

The biggest proportion of Upolu's forest area is made up of open forest (62%). The total remaining forest area of Upolu (95%) consists of open forest and secondary forest, proving clearly the high degree of forest depletion. Savaii's medium forest makes up for the largest portion (61%) of the total forest area, more than open forest and secondary forest combined. Forest plantations make up only for a very small portion if compared to the total remaining forest area of Upolu (2%) and Savaii (3%) as illustrated in Table 2.10.

Table 2.10: Area Proportions of Forest Types on Upolu and Savaii

| Category | % Upolu total forest area | % Savaii total forest area | % Samoa total forest area |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| Closed forest | 0 | 0 | 0 |
| Medium forest | 1 | 61 | 42 |
| Open forest | 62 | 19 | 32 |
| Secondary forest | 33 | 17 | 22 |
| Forest plantation | 2 | 3 | 3 |
| Mangrove | 1 | 0 | 0 |
| Wetland | 1 | 0 | 1 |

Source: FAO, 2005.

### 2.6.2 Types of Forests and Coverage of Samoa

SamFRIS forestry survey could not identify presence of closed forests from the 1999 aerial photos (except for a few small patches on Nuutele Island).

The only medium forest left in Upolu is at the Southern side of Upolu at Tafatafa, Falealili.

The upland of Upolu is covered with a large area of open forest that stretches along the central ridge from NW to SE. It reaches the coast only in a few, isolated locations, such as south of the O Le Pupu-Pue National Park (Togitogiga) and along the North-Eastern shore. On Savaii, the open forest is rather situated in the lowland coastal areas, especially on the North-Eastern and the Southern coastal strip. Two more patches of open forest exist on the South-Eastern tip of Savaii (Tafua Rainforest Preserve) and on its Northern shore near Fagamalo.

Secondary forest category is especially concentrated on the Northern flanks of Upolu where it covers large areas of formerly cleared land, now covered with secondary growth forests dominated by *Albizzia spp.* Other isolated patches do occur in the coastal areas practically all around Upolu. On Savaii, the secondary forest covers predominantly the Northern and North-Western lowlands intersected by volcanic scrubs on recent volcanic lava flows.

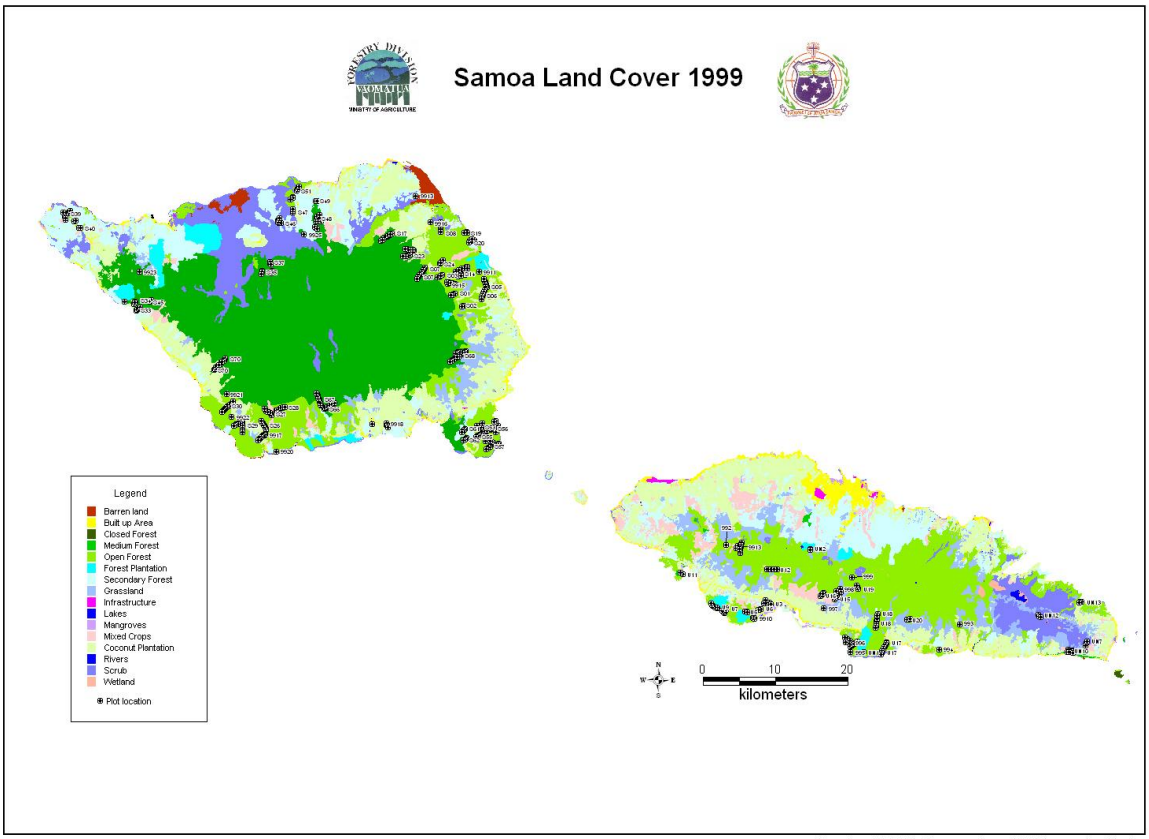
Coast-bound mangrove forest almost exclusively occurs on Upolu where it is confined to small pockets on the Northern shore near Apia and on the South coast near Saanapu/Sataoa.

Forested wetlands of forested marshes and swamps are confined to small and isolated areas (e.g. depressions on the eastern tip of Upolu below Afulilo Dam and in a few inland craters on Upolu and Savaii.

Forest plantations usually occur as either large scale, compact plantations or small-scale village owned woodlots. Due to the scale of the forest mapping, only compact plantations have been mapped where identifiable from the aerial photos and completed by existing forest compartment maps. There are three main forest plantations on the Southern coast of Upolu and two more on the northern flanks of Mt. Vaea. Forest plantation area is almost three times larger on Savaii where large tracts have been planted in the North-West of the island. Other plantations are situated in the South (Gatavai area) and in the East of Savaii (Puapua area).

Although not counted as forest area, the scrub vegetation represents, at least in some parts, recovering vegetation that develops towards a secondary forest. It constitutes natural vegetation in other areas as seen on recent volcanic lava flows. Large swaths of scrub are, therefore, found on the Northern slopes of Savaii where 20$^{th}$ century eruptions left one major and widespread lava flow (Mt. Matavanu to Saleaula). Other areas in the South-East of Savaii are caused by degradation. On Upolu, a large coherent block of scrub vegetation is found on the South-Eastern end of the central mountain ridge, where it is supposed to be edaphic (of or relating to soil type) in the first place and further degraded by cyclone-induced damage (FAO, 2005). Figure 2.6 illustrates vegetation and land cover for Samoa.

**Figure 2.6: Distribution of Land Cover Categories on Savaii and Upolu**




Source: Forestry Division, MNRE.

### 2.6.3 Merchantable Forest Area and Resource

SamFRIS provides available data on merchantable production forest that are presently indicative, but should not be considered final.

Table 2.11 presents preliminary merchantable timber volumes of main forest types for the two main islands. The values reflect the generally higher degree of degradation and depletion of Upolu's forests. All forest types on Savaii, including secondary forests, are on average merchantable, while preliminary values for Upolu range all below the current volume threshold of 29 m³/ha. Based on the average volume values, the potential area of 28,847 ha of production forest on Upolu (see Table 2.12) could not be considered merchantable. However, the average volume values are expected to change once additional survey and future sampling data is integrated.

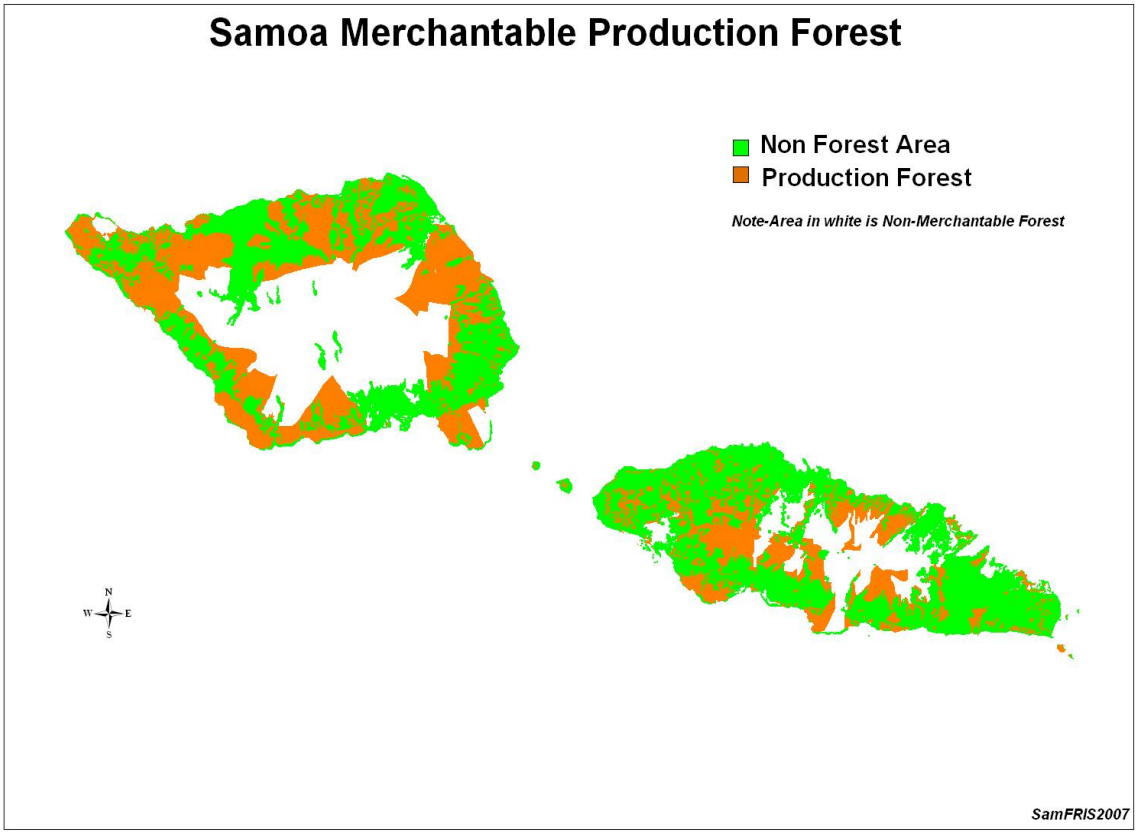
Table 2.11: Preliminary Merchantable Timber Volumes (m³/ha) of Main Forest Types

| Forest type | Upolu | Savaii | Samoa average |
|---|---|---|---|
| Medium forest | 27.7 | 44.5 | **42.6** |
| Open forest | 24.3 | 31.3 | **29.1** |
| Secondary forest | 7.7 | 33.7 | **31.0** |

Source: FAO, 2005.

The merchantable forest area of Upolu makes up less than 1% of the total production forest area, emphasizing the depleted condition of the remaining forest resources. Savaii has more than 40,000 ha of theoretically merchantable forest, almost 70% of the total production forest area. The rate of merchantable forest of Samoa is currently at 46% of the total production forest area. Figure 2.7 shows the location of Samoa's merchantable forests.

**Figure 2.7: Merchantable Production Forest in Samoa**




Source: Forestry Division, MNRE

These results presented in Table 2.12 are only indicative and are prone to change with the continuation and extension of the SamFRIS forest survey.

Table 2.12: Preliminary Merchantable Forest Analysis for Upolu and Savaii

| Category | Upolu | Savaii | Samoa total |
|---|---|---|---|
| Total production forest | 28847 ha | 58345 ha | 87269 ha |
| Total merchantable forest | 118 ha | 40333ha | 40451 ha |
| % of production forest | < 1% | 69% | 46% |

Source: FAO, 2005

### 2.6.4 Conservation Forest Area

Conservation or Protected Forest Areas have only recently begun to be put into practice in the South Pacific region. In 1978, with the establishment of the O Le Pupu-Pue National Park in Togitogiga, Samoa became the first Pacific Island nation to create a National Park. Since 2000, two new national parks have been established, including Mauga o Salafai, the first to be located on Savaii, and Lake Lanoto'o towards the summit of Upolu.

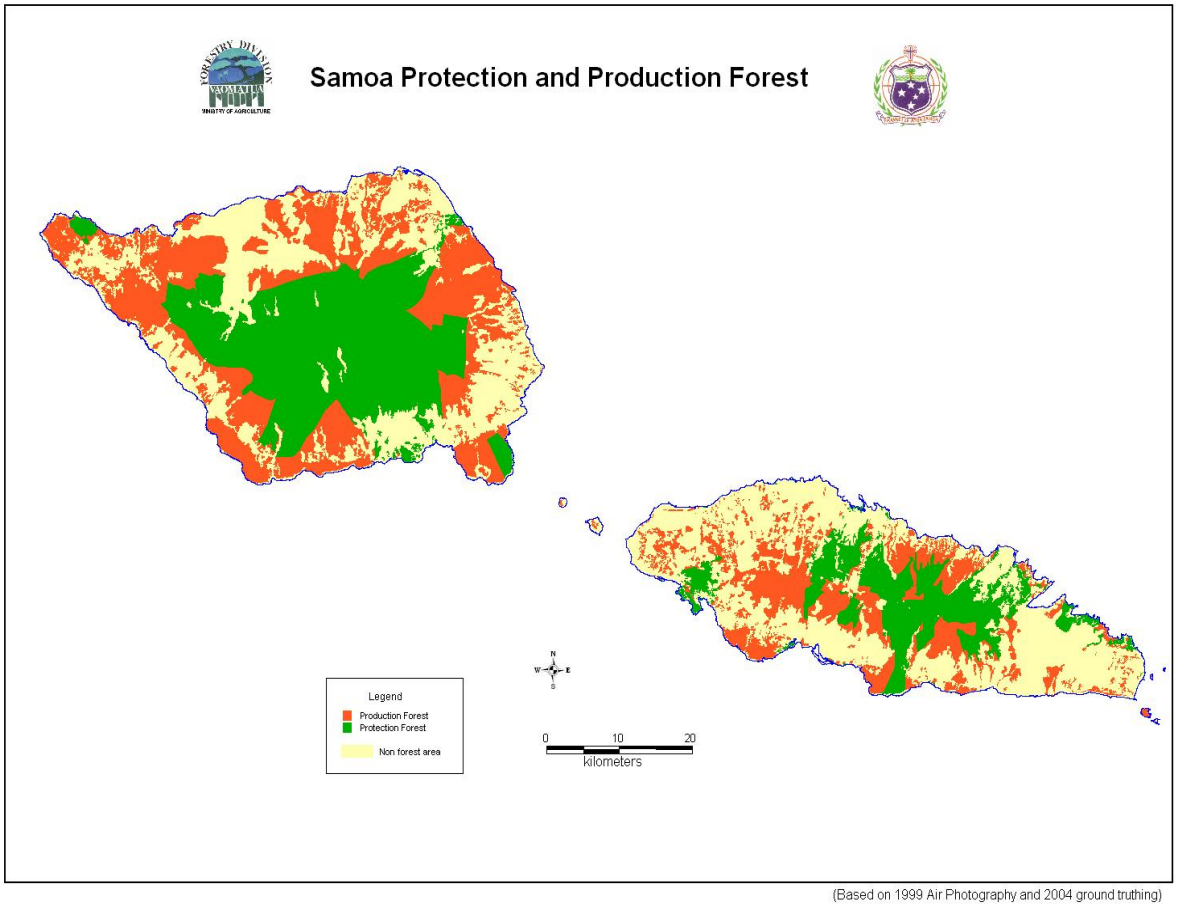
The total protected forest area consists of existing and proposed national parks and nature reserves, community conservation areas, areas of more than 30% slope[31] and water catchment areas defined as critical. All forest area outside protected forest is by definition considered production forest. This

[31] The criterion of >30% terrain slope angle for the definition of protected forest areas is not yet official for Samoa. However, there is a wide consensus between MAF/SFD, MNRE and conservation NGOs that this value should be applied. FAO equally defines this value as a general rule (see: FAO Guidelines or the management of tropical forests No. 135, p. 108, ch. 2.2)

does not imply that production is possible and will effectively be carried out, as other criteria still apply to define the merchantability of a production forest area.

Almost half of the total remaining forest area of Samoa has been determined as protected forest indicative of the pro-active steps being taken to conserve Samoa's remaining biodiversity. Altogether 83,805 ha of forest correspond to the protected forest criteria, with more than 70% of it situated on Savaii. The total area of potential production forest covers some 87,269 ha, two thirds of it is again found on Savaii. The distribution of the protected and production forest areas on Upolu and Savaii is shown on Figure 2.8, Protection and Production Forest in Samoa, as well as Table 2.13, Protected and Production Forest Area on Upolu and Savaii (FAO, 2005). With about 30% of total land area in Samoa classified as protected forest, this puts Samoa in an excellent position to conserve much of its biodiversity.

**Figure 2.8: Protected and Production Forest in Samoa**




Source: Forestry Division, MNRE

Table 2.13: Protected and Production Forest Area on Upolu and Savaii

| Category | Upolu | Savaii | Samoa total | % Samoa land area |
|---|---|---|---|---|
| Protected forest | 23977 ha | 59709 ha | 83804 ha | 29.5% |
| Production forest | 28847 ha | 58345 ha | 87269 ha | 30.7% |
| Total | 52824 ha | 118054 ha | 171073 ha | 60.2% |

Source: FAO, 2005.

### 2.6.5 Diversity of Tree Species

The diversity of tree species in the forest composition and the relative dominance in forests are of high importance in economic as well as ecological terms. SamFRIS provides information that

analyzes the relative dominance of tree species on Upolu and Savaii and in totality of Samoa. Table 2.14 lists the most frequent tree species with tree diameters of >10cm and >40cm DBH (Diameter at Breast Height). *Pometia pinnata* ranks first for both tree diameters as do two invasive tree species. *Funtumia elastica* already ranks second and *Castilla elastica* ranks eighth among the top 10 most frequent species. Seven commercial tree species rank among the top 10 of trees >40cm DBH.

Table 2.14 Dominant tree species on Samoa (by frequency)

| DBH >10cm | | | | DBH >40cm | | |
|---|---|---|---|---|---|---|
| No. | Scientific Name | Commercial Species | Count | Scientific Name | Commercial Species | Count |
| 1 | *Pometia pinnata* | Yes | **2275** | *Pometia pinnata* | Yes | 394 |
| 2 | *Funtumia elastica* | | 2034 | *Dysoxylum samoense* | Yes | 174 |
| 3 | *Canaga odorata* | | 1481 | *Dendrochride harveyi* | | 160 |
| 4 | *Macaranga stipulosa* | | 1334 | *Garuga floribunda* | Yes | 123 |
| 5 | *Dysoxylum samoense* | Yes | 1296 | *Elaeocarpus grandis* | | 101 |
| 6 | *Macaranga harveyana* | | 999 | *Planchonella torricellensis* | Yes | 86 |
| 7 | *Rhus taitensis* | | 827 | *Syzygium inophylloides* | Yes | 81 |
| 8 | *Castilla elastica* | | 738 | *Syzygium clusiifolium* | Yes | 78 |
| 9 | *Myristica fatua* | *Yes* | 723 | *Rhus taitensis* | | 68 |
| 10 | *Adenanthera pavonina* | | 570 | *Canarium viiense* | Yes | 65 |

Source: FAO, 2005.

The most frequently encountered tree species on Upolu (see Table 2.15) is already an invasive one, *Funtumia elastica. Pometia pinnata* only ranks 6$^{th}$ and a second invasive species, *Castilla elastica* ranks 3$^{rd}$. However, there are still four commercial species among the top 10 frequent tree species. Commercial species take the first three ranks for trees with >40cm DBH and one invasive species ranks 5$^{th}$.

Table 2.15: Dominant Tree Species on Upolu (by frequency)

| DBH >10cm | | | | DBH >40cm | | |
|---|---|---|---|---|---|---|
| No. | Scientific name | Commercial species | Count | Scientific name | Commercial species | Count |
| 1 | *Funtumia elastica* | | **1857** | *Dysoxylum samoense a* | yes | **98** |
| 2 | *Dysoxylum samoense* | *Yes* | 692 | *Pometia pinnata* | yes | 74 |
| 3 | *Castilla elastica* | | 595 | *Planchonella torricellensis* | yes | 57 |
| 4 | *Canaga odorata* | | 560 | *Dendrochride harveyi* | | 56 |
| 5 | *Macaranga stipulosa* | | 549 | *Castilla elastica* | | 30 |
| 6 | *Pometia pinnata* | *Yes* | 492 | *Rhus taitensis* | | 30 |
| 7 | *Planchonella torricellensis* | *Yes* | 353 | *Syzygium clusiifolium* | Yes | 25 |
| 8 | *Kleinhovia hospital* | | 346 | *Palaquim stehlinii* | Yes | 17 |
| 9 | *Myristica fatua* | *Yes* | 336 | *Kleinhovia hospita* | | 12 |
| 10 | *Rhus taitensis* | | 259 | *Macaranga stipulosa* | | 12 |

Source: FAO, 2005.

*Pometia pinnata* is the dominant tree species on Savaii (see Table 2.16) for both tree diameters. Significantly, there are two invasive species among the top 10 most frequent tree species. These are Funtumia elastica and Castilla elastica. Commercial species show the same proportions as on Upolu. However, species are differing whereby *Planchonella torricellensis* only figures among the top 10 species on Upolu, but not on Savaii.

Table 2.16 Dominant Tree Species on Savaii (by frequency)

| | DBH >10cm | | | DBH >40cm | | |
|---|---|---|---|---|---|---|
| # | Scientific Name | Commercial Species | Count | Scientific Name | Commercial Species | Count |
| 1 | *Pometia pinnata* | *Yes* | 1783 | *Pometia pinnata* | yes | 320 |
| 2 | *Canaga odorata* | | 921 | *Garuga floribunda* | yes | 122 |
| 3 | *Macaranga harveyana* | | 873 | *Dendrochride harveyi* | | 104 |
| 4 | *Macaranga stipulosa* | | 785 | *Elaeocarpus grandis* | | 101 |
| 5 | *Dysoxylum samoense* | *Yes* | 604 | *Dysoxylum samoense* | yes | 76 |
| 6 | *Rhus taitensis* | | 569 | *Syzygium inophylloides* | yes | 75 |
| 7 | *Elaeocarpus grandis* | | 476 | *Dysoxylum maota* | Yes | 62 |
| 8 | *Adenanthera pavonina* | | 469 | *Canarium vitiense* | Yes | 58 |
| 9 | *Myristica fatua* | *Yes* | 387 | *Syzygium clusiifolium* | yes | 53 |
| 10 | *Diospyros samoensis* | *Yes* | 352 | *Rhus taitensis* | | 38 |

Source: FAO, 2005.

Table 2.17 indicates general diversity of the main forest types by presenting the number of different tree species, commercial and non-commercial, encountered per forest type. When assessing trees with DBH of 10cm and above, open and secondary forests show higher numbers of different tree species. Less than half of these are commercial species.

Open and medium forests show significantly more tree species of >40cm diameters than the secondary forests. That is 42 and 43 species, respectively, 22 of which are commercial. Only 29 different tree species occur in secondary forests at diameters of more than 40cm, with 18 of these species considered commercial.

Tree species diversity is markedly different between medium forests on Upolu and Savaii. Medium forest on Savaii contains a maximum number of 41 species, while the same forest type on Upolu is composed of only 16 different species.

Table 2.17: Number of Different Tree Species per Forest Type

| Forest Type | DBH >10cm | | DBH >40cm | |
|---|---|---|---|---|
| | All | Commercial | All | Commercial |
| Medium Forest | 60 | 27 | 42 | 22 |
| Open Forest | 66 | 28 | 43 | 22 |
| Secondary Forest | 65 | 26 | 29 | 18 |

Source: FAO, 2005.

### 2.6.6 Natural Forest Regeneration

Natural tree regeneration has been recorded by simple tallying of trees below 10 cm DBH on 50% of the survey plot area. Out of a total of 100 different tree species recorded during the survey, 73 species have also been identified in natural regeneration, 30 of which are commercial species. The dominant tree species in natural regeneration are listed in Table 2.18. A complete list with botanical names and ranking is attached in Appendix F: Tree Species List. Out of the top-10 ranking regenerating species, the first four are commercial species with a total of seven commercial species in the top-10 making it the majority of the list.

Forest survey results seem to indicate that natural regeneration is less diverse on Upolu, where only 50 different tree species have been found to regenerate compared with 69 species on Savaii (see Table 2.19). Only 70-80% of all tree species surveyed for both islands is indicated as undergoing the tree regeneration process. Interestingly, as data seem to suggest, the general proportion of commercial species is higher for regenerating trees. With one-third proportion of regeneration consisting of mature trees, this also shows that more than 40% of all species counted are commercial.

Table 2.18: Dominant Tree Species in Natural Regeneration

| No. | Scientific Name | Commercial |
|---|---|---|
| 1 | *Dysoxylum samoense* | Yes |
| 2 | *Planchonella torricellensis* | Yes |
| 3 | *Myristica fatua* | Yes |
| 4 | *Pometia pinnata* | Yes |
| 5 | *Cananga odorata* | |
| 6 | *Syzygium inophylloides* | Yes |
| 7 | *Syzygium clusiifolium* | Yes |
| 8 | *Diospyros samoensis* | Yes |
| 9 | *Macaranga stipulosa* | |
| 10 | *Macaranga harveyana* | |

Source: FAO, 2005.

Table 2.19: Number of Species in Natural Regeneration on Upolu and Savaii

| Location | DBH >10cm | | | Regeneration | | |
|---|---|---|---|---|---|---|
| | Total Species | Total Commercial | % Commercial | Total Species | Total Commercial | % Commercial |
| Upolu | 77 | 27 | 35.1 | 50 | 23 | 46.0 |
| Savaii | 87 | 28 | 32.2 | 69 | 30 | 43.5 |
| Total Samoa | 100 | 35 | 35.0 | 73 | 30 | 41.1 |

Source: FAO, 2005.

Table 2.20 shows figures that include all tree species, disregarding their ecological or commercial value. It appears that on average regeneration is comparable for medium and open forest with around 3,000 plants per hectare. Figures for secondary forest are more than 50% higher taking into consideration the higher number of stems recorded for low diameter classes in secondary forest.

Table 2.20: Average Number of Regenerating Trees/ha per Forest Type

| Forest Type | Total no. of Plots | Total no. of Trees | Average no. of Trees/ha |
|---|---|---|---|
| Medium Forest | 121 | 36307 | 3000 |
| Open Forest | 296 | 86601 | 2920 |
| Secondary Forest | 35 | 16162 | 4620 |

Source: FAO, 2005.

### 2.6.7 Change in Total Forest Cover Over Time

SamFRIS has greatly enabled the comparison of forest maps with results of earlier assessments and mapping in analyzing effective forest cover change over the last decades. Area size data are available for the years 1954, 1977, 1987, 1990 and 1999. However, it was difficult to attain direct comparison of the forest area figures due to different definitions and methods used. Effective quantification of forest cover change, therefore, has to be interpreted with some caution. Table 2.21 presents information on the proportionate area under forest for the whole of Samoa, as well as for Savaii and Upolu.

Table 2.21: Historic Forest Cover in Samoa (% Total Land Area)

| Year | Upolu | Savaii | Total Samoa | Data Sources |
|---|---|---|---|---|
| 1954 | 65 | 79 | 74 | Fox and Cumberland, 1962 |
| 1977 | 44 | 61 | 54 | Olsen & Co., 1978 |
| 1987 | 43 | 63 | 55 | ANZDEC, 1990 |
| *1990** | *25* | *50* | *40* | *SFD, 1994* |
| 1999 | 46 | 69 | 60 | SFD/SamFRIS, 2004 |

The 1990 figures are not directly comparable with the other figures. Source: FAO, 2005.

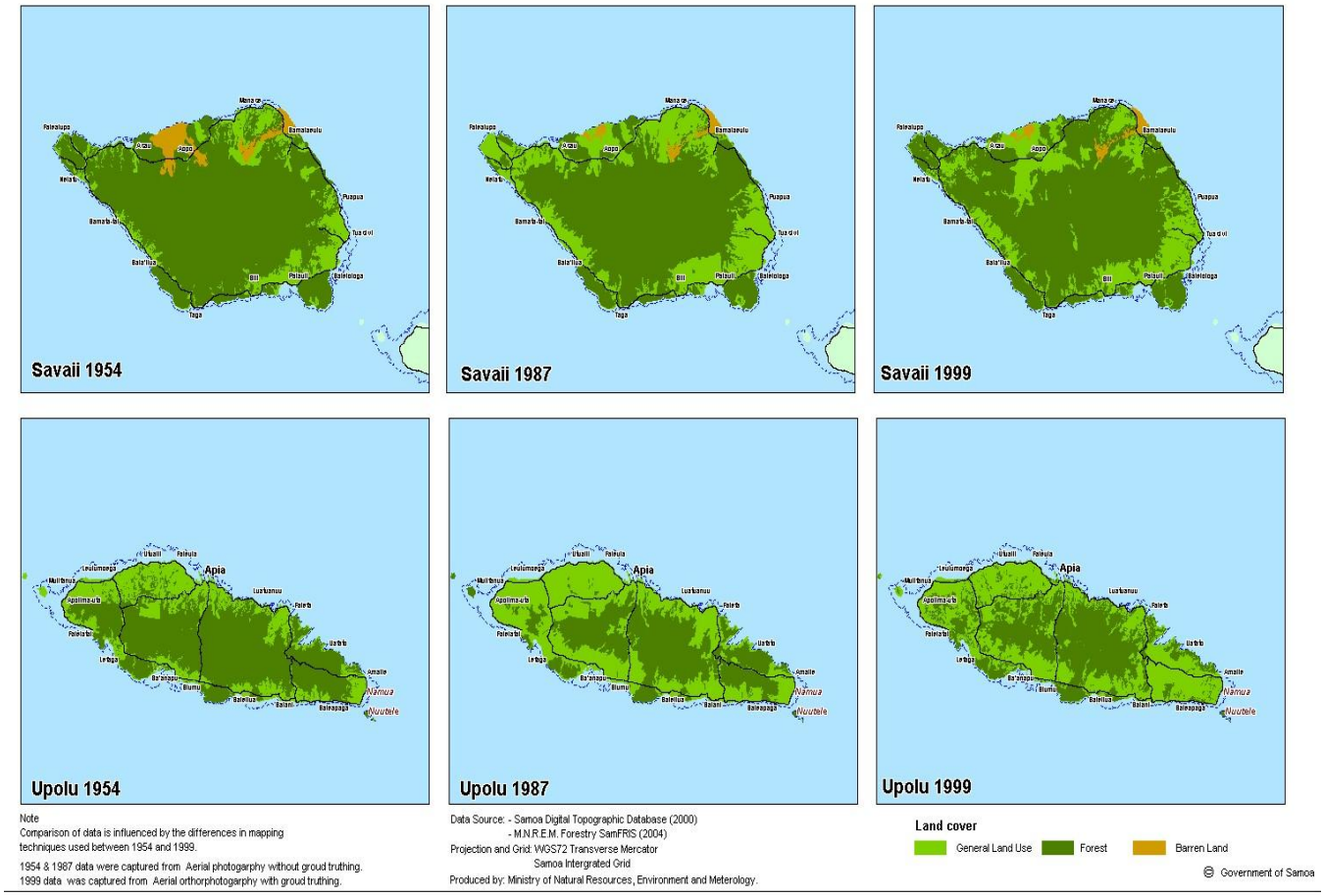
According to the findings of the SamFRIS project (2005), only the 1954 and 1987 data are directly comparable as both used a similar definition of forest. The 1977 data was derived from forest type maps produced by the national forest inventory using aerial photo interpretation. The exact definition

of forests and the mapping criteria applied to delineate the total forest area are not known. Overall forest area figures for Samoa (1987) are slightly lower than those estimated 10 years before. This is an implication that the 1977 inventory may have used a rather conservative forest definition. The 1990 SFD forest assessment only mapped the remaining area of primary mature forest, which resulted in very low figures for total forest cover. The present SFD/SamFRIS assessment, based on 1999 aerial photographs, used a higher mapping scale (1:5,000), mapped smaller forest units (down to 1ha) and more forest types than any other previous forest cover mapping. This was reinforced with a more complete and thorough ground truthing than had been done for most of the historic forest cover maps.

Significantly and considering the overall context of forest change for Samoa, figures from 1954 to 1987 seem to support the general notion of a serious decline in forest area, from a national forest cover of 74% down to 55%. Although figures derived from the 1977 forest inventory are slightly lower than the 1987 data, they do indeed confirm the general trend of a serious decline in total forest area. Recent figures seem to imply that there has been an increase in national forest cover from 55% to 60% over the period of 1987 to 1999, which is probably an artefact and open to future sampling, as earlier assessments did not map with same level of detail. It is more likely that forest cover has been slightly reduced since 1987. The fact that 32% of the total forest cover in 1999 was classified as open forest (less than 40% tree cover) and less than 0.05% was classified as closed forest, indicates that the Samoan forest is now extremely open and patchy. Another 24% of the forest cover is classified as secondary re-growth forest.

Although available data do not allow for a historic comparison of forest quality, historic descriptions and observations point out that Samoan forest used to be mostly closed canopy with a smaller element of secondary forest. Substantial damage to the forest structure seems to have been caused by recent cyclones (Ofa in 1990 and Val in 1991), which locally had devastating effects on the vegetation. Even though total forest area has not decreased substantially, contrary to earlier predictions, the overall quality of the remaining forest is supposed to have declined seriously. The analysis of the forest survey data reveals a high degree of invasive species in open forest category, especially on Upolu. This suggests a high vulnerability of the natural forest once the forest structure becomes disturbed and the canopy is opened up, be it by natural causes (cyclones) or man-made (logging). Open forest and secondary forest account today for already 60% of the total forest area of Samoa, emphasizing the need to prevent the remaining medium dense forest from a further qualitative degradation (FAO, 2005). Figure 2.9 shows Samoa's forest cover.

**Figure 2.9: Samoa Forest Cover Change**




Data Source: Samoa Digital Topographic Database (2000)/ MNRE, Forestry SamFRIS (2004)

## 2.7 Biodiversity Resources

### 2.7.1 Number and Types of Species

The first comprehensive ecological survey of the Samoan islands was the Terrestrial Ecosystem Mapping exercise, which started in 1987 and was concluded in March 1991. With the establishment of the Government's Division of Environment and Conservation (DEC), two major national ecological surveys took place in 1991 and 1997, identifying major sites rich in the native flora and fauna of Samoa (MNRE, 2004a).

**Flora**

A 1992 survey classified Samoa's vegetation into 19 plant communities within five broad categories, as follows:[32]

Littoral vegetation: Four communities of vegetation situated on the seashore were recognised, herbaceous strand or beach, littoral shrub-land; *Pandanus* scrub; and littoral forest whereby much of these types have been lost or degraded. The best remaining examples are at Aleipata Islands, O Le Pupu-Pue National Park and sites on the South (central) coast of Savaii.

Wetland vegetation: Four communities are recognised: coastal marsh, montane marsh, mangrove scrub/forest and swamp forest. There has been a very serious loss of wetlands, particularly in the lowlands, and only a few intact areas of each type remain.

[32] Whistler, 1992.

Rainforest: Four communities are recognised on an altitudinal gradient: coastal, lowland, montane and cloud forest (the latter is restricted to Savaii with the summit reaching over 1800 m). The few remaining significant areas of coastal forest are at the Aleipata Islands, Apolima and possibly Tafua Crater. Lowland forest sites were surveyed by Park *et al.* (1992) who identified 14 sites as the minimum needing protection to achieve adequate representation of this habitat. Montane and cloud forest (above c. 1000m) areas were mapped by Pearsall & Whistler (1991) and surveyed by Schuster *et al.* (1999). The montane habitat is considered to have the richest flora of any forest community in the country. On Upolu, no montane sites were found that either had good forest or were clearly recovering (from cyclone damage) and there was substantial impact from several weeds. On Savaii, the forests are recovering faster at higher elevations where there is little human activity, whereas the process is much slower at lower areas where forest cutting has added to the problem. The upland survey visited 13 sites all considered in need of some conservation and identified two large ones (linked to lowland forests) as priorities.
Volcanic vegetation: Two communities, lowland volcanic scrub and upland volcanic scrub, are recognised and these occur only on recent lava flows on Savaii.
Disturbed vegetation: Four communities derived from a combination of human activities and weather are recognized – managed land, secondary scrub, secondary forest and fernlands.

The native flora of Samoa comprises 96 families, 298 genera, and nearly 550 vascular plant species (Whistler 1992, 2005), 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 Archipelago. 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 *Bulbobphyllum* (*Orchidaceae*: 11).

The native ferns comprise 21 families, 71 genera, and about 220 species (Whistler 1992). The fern allies (*Psilotum, Selaginella, Lycopodium and Tmesipteris*) comprise 14 species. The most diverse and interesting groups of plants are the orchids and ferns (MNRE, 2004a).

About 25% of the plants are endemic to Samoa (i.e. found nowhere else) and 32% endemic to the Samoan archipelago. A further 500 or so species of plants have been introduced to the islands since the first Samoans brought the coconut, taro and other species for cultivation about 3,000 years ago. Today, about half the plants in the country are exotic (i.e. have been introduced by human beings). While some of these plants are beneficial for agriculture, others have become destructive weeds. 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. *Merremia* 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 (GOS 1998).

**Endangered Plant Species**

There are no officially endangered or threatened plant species in Samoa. Whistler (1992) provided a list of "potentially endangered or threatened vascular plant species of Samoa" (Taulealo, 1993). In the ecological survey of mid-slope and upland forests of Samoa undertaken in 1996 (Schuster *et al*. 1999), an updated species list was documented. Some of these species were collected or found, but the vast majority were not recorded or collected. Those, which were found, are either still to be considered "endangered or threatened" in Samoa or, based on new evidence from the 1996 survey or any other recent work by Whistler, should be removed from the list. This is annexed in Appendix C Endangered or Threatened Vascular Plant Species of Samoa[33], and the Complete Updated List[34]

[33] Schuster, C., Whistler, .A., Tuailemafua, T.S.,1999. The Conservation of Biological Diversity in Upland Ecosystems of Samoa. (Compiled and edited by D. Butler). Division of Environment and Conservation of the Department of Lands, Surveys & Environment. Apia, Samoa. Pp xxiv – xxv

[34] GOS/DoS, 1998.

Appendix G lists New Plant Species[35] recorded and Appendix H presents a list of Invasive Alien Plant Species[36].

**Fauna**

A complete list of Samoa's fauna is annexed as **Appendix K.**

**Terrestrial Mammals**
There are 13 species of terrestrial mammal now present in Samoa and, of these, only three are native, two flying foxes (or fruit bats), the Samoan Flying-fox *(Pteropus s. samoensis)* and the Tongan or White-necked Flying-fox *(P. tonganus)*, and a small insectivorous bat, the Sheath-tailed Cave Bat *(Emballonura semicaudata), which is* now believed to be extinct in Samoa. The flying foxes are important for the long-term survival of the forests for they pollinate the flowers of many species and also disperse the seeds of the fruits that they eat throughout the forest. It has been estimated that almost one in three Samoan forest trees depend on flying foxes in some way. Exactly why populations of tagiti (Cave Bat) plummeted immediately after the Cyclones Ofa and Val are still not known. Attempts to locate breeding colonies of the Cave Bat in Samoa recently have failed.

Of the introduced species, the early Polynesian voyagers brought 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)* arrived with the Europeans (GOS 1998).

**Birds**
Thirty-five species of land birds and 20 sea and shore birds have been recorded in Samoa. Eight of the land birds are endemic to Samoa (there are an additional six endemic sub-species), while four avian 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, ***puna'e*** or Samoan Wood Rail (*Pareudiastes pacificus*) is probably extinct on Savaii, though a population may persist on upland Savaii. The 'taio', the endemic 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 avian species listed as "rare or endangered" prior to the two devastating cyclones in 1990 and 1991 (which would have reduced their numbers even further), the following are apparently of most concern: Tooth-billed Pigeon *(Didunculus strigirostris),* Mao or Giant Honeyeater (*Gynnomyza samoensis*); 'tuaimeo', Samoan Ground Dove (*Galliclumba stairii*); 'tutu malili', Island Thrush (*Turdus poliocephalus samoensis*); 'matapaepae', Samoan White-eye (*Zosterops samoensis*); 'vai', White-browed Crake (*Poliolimnas cinereus*); and the Sooty Rail (*Porzana tabuensis*). However, the upland survey (Schuster *et al*., 1999) and recent monitoring counts done by the DEC, showed all species to still be present and most to be increasing in number, albeit slowly. Samoa's most famous species, the Tooth-billed Pigeon or *manumea,* is a species of ancient origin with no clear lineage amongst existing pigeons anywhere in the world; Mayr (1945) regarded it as a possible relative of the extinct dodo of Mauritius. The species is still encountered in reasonable numbers in some upland forest areas, recorded at 10 of the 13 upland survey sites. Other pigeon and dove species declined dramatically as a result of the cyclones in the early 1990s, and their recovery appears threatened by hunting, particularly in the case of the Pacific Pigeon or *lupe (Ducula pacifica).*

The breeding sea bird fauna is poorly known with only 9 species confirmed breeding compared to over 20 in American Samoa. The difference is largely made up of terns and burrowing shearwaters and petrels, and work was planned in 1995 to determine which seabird species nest in Samoa (MNRE 2006b).

The importance of the country's birdlife, particularly the number of endemic species and the threats to them, have been recognized by the International Council for Bird Preservation and Birdlife

[35] Schuster, C, et al. (1999), page xxv
[36] ibid, page xxvi

International. Savaii Island has been identified as one of the world's 'Endemic Bird Areas' in need of urgent conservation attention. The island supports all 15 of Samoa's endemic bird species. Refer to Appendix I: Global Status of Samoa's Bird Species.

**Reptiles**
Fourteen species of lizards (all geckos and skinks) and one terrestrial snake (Pacific Boa, *Candola bibroni*) have been recorded in Samoa. Most of the lizards appear fairly abundant and only one (Samoan Skink *Emoia samoensis*) is endemic to the Samoan Archipelago (GOS 1998).

**Fresh Water Fish**
There has not been a detailed study of the native fresh water fish fauna. Brief surveys conducted as part of the Environmental Impact Assessment of the Afulilo Hydroelectric Power Project noted a relatively sparse fish and insect fauna with some very common crustacea. A study of fresh water wetlands in American Samoa identified 17 species of finfish and eight species of crustacean and most of these may occur in Samoa (ibid).

In recent years, 6 species of fresh water fish have been introduced to Samoa: the Mosquito Fish (*Gambusia* spp.) and Topminnows (*Poecilia mexicana*) were introduced early in the twentieth century for mosquito control purposes. Goldfish (*Carassivs auratus*) have an established population in the crater lake, Lake Lanotoo. The African Tilapia (*Oreochromis mombassica*) was originally introduced for aquaculture as a tuna bait fish and have now established populations in most bodies of fresh water.
Note: It is proposed to eradicate these populations where possible and replace them with the Israel Tilapia *(Oreochromis niloticus),* a more acceptable species for aquaculture (Zann 1991).

**Invertebrates**
***Terrestrial***
Little is known of the terrestrial invertebrate fauna of Samoa, but it is likely to be much more diverse than the vertebrate fauna and will contain large number of endemic species. There is some information on three groups in particular:
Butterflies – Samoa has 21 species of butterflies, all of which are shared with other islands, but two are endemic to the Samoan Archipelago. These are the Swallowtail *(Papilio godeffroyl)*, which is thought to be threatened, and the more common *Hypolimnas thompsoni.*

Land Snails – Land snails have undergone an extensive radiation throughout the islands of the Pacific as observed by Cowrie in 1992. While the land snail fauna of Samoa is still poorly studied in comparison to that of American Samoa, there are more than 20 species known here, including four post-European introductions. Recent collecting work by the Division of Environment and Conservation in the lowland and upland forests is currently being analyzed. The Samoan archipelago holds 19 endemic species, two endodontids, nine charopids and eight partulids. One endodontid species, *Thaunatodon hystrellicoides,* is listed as threatened and five of the eight partulids are known to occur here *(e.g. Eua expansa, E. Montana, Samoana stevensonia, S. canalis and S. conica)* though their present status is uncertain. The most significant threat to the land snails comes from the recent establishment in the country of the vegetarian Giant African Snail *(Achatina fulica)* (current outbreak began in 1990 and three areas on Upolu now infested with a recent outbreak recorded on Savaii Island). Many islands (including American Samoa) have reacted to the arrival of this agricultural pest by introducing two carnivorous snails *(Euglandina rosea* and *Gonaxis kibweziensis).* These have had little impact on the target species, but decimated native land-snail populations, causing mass extinctions. The South Pacific Commission argues strongly against this approach in a recent pest leaflet. Eradication efforts are continuing, but with very limited success due to the shortage of staff and financial resources.

Ants – ants of this region have been of interest to ecologists and evolutionists because the native species on each island have been joined by as many new species introduced by human activity. There is thus likely to be considerable competition between the different species. In their report on ants of Polynesia, Wilson and Taylor in 1967 listed 59 species for Samoa, of which 12 are endemic. Seventy-eight species are listed for the Samoan Archipelago by Kami & Miller, 1998. Introduced ants as noted by Pearsall in 1992 are implicated in local extinctions of land snails and several snail species

are now considered to be restricted to higher altitudes as a result (cited by Schuster, 2001). Table 2.22 summarizes Samoa's biodiversity with number of species by life form.

Table 2.22: Samoa's Biodiversity – Number of Species by Life Form

| Life Form | Endemic Species | %Endemics | Native Species | Introduced Species | Threatened Species | Total Species | Relative Regional Ranking Endemism |
|---|---|---|---|---|---|---|---|
| Flowering Plants | 174 | 30 | 540 | 500 | 136 | 770 | 5th |
| Ferns/Fern Allies | 40 | 18 | 228 | ? | ? | 228 | ? |
| Land Birds | 8 | 23 | 33 | 3 | 14 | 36 | 5th |
| Sea Birds | NA | NA | NA | NA | NA | 21 | ? |
| Reptiles | 1 | 7 | 4 | 11 | 4 | 14 | ? |
| Ants | 12 | 18 | 30 | 7 | ? | 68 | ? |
| Land Snails | 35-38 | 49-53 | 64 | 14[5] | 12? | 72 | 2nd |
| Butterflies | 2 | NA | 19 | NA | 1 | 21 | ? |
| Aquatic Fauna | NA | NA | 25 | 4 | NA | 29 | ? |
| Marine mammals | | | | | 1 | 10 | |
| Marine Vertebrates | NA | NA | NA | NA | 4 | 8 | ? |
| Marine Invertebrates | NA | NA | NA | NA | 14 | 95 | ? |
| Fisheries | NA | NA | 890 | 2 | NA | 991 | ? |

Table adapted from Samoa's Biodiversity Strategy and Action Plan: Keep the Remainder of the Basket. GaOS, 2001. 95pp.

***Other Groups***

During a pilot survey in 1995 of the uplands of O Le Pupu-Pu'e National Park, Clarkson and others observed a combination of hand-collecting, malaise trapping and light trapping sample beetles *(Coleoptera),* bugs *(Hemiptera)* and moths *(Lepidoptera)*. A high degree of endemism was observed among the moths with 57% of the 109 species collected endemic (ibid).

***Fresh Water Environment***

No comprehensive survey has been carried out. During the Afulilo EIA reporting in 1991 by Waugh and others, one short-clawed crayfish was collected from a site below the falls had not been found elsewhere in Upolu and its taxonomy is unknown, indicating the need for more work on this group. A consultant interested in bio-monitoring (August 1995) collected freshwater invertebrates from catchments near Apia and his results may be available soon (GOS 1998).

### 2.7.2 Invasive Species in Samoa

Invasive species may be brought into Samoa intentionally for a reason or accidentally. Invasive species are one of the biggest threats to Samoa's environment biodiversity particularly the native plants and animals. This includes the Myna Birds (Jungle and Common), the Red-vented Bulbul, Rock Pigeon *(Lupe Palagi),* the African Snail, the Mint Weed, the Rubber trees, the African tulip tree, the Eucheuma seaweed, and the Taro Blight, all of which have had considerable impact on the economy of Samoa. In 2006, a rattan plant was discovered in the Apaula streambed within the Vailima Forest Reserve area. The plants were identified as a Rattan Palm *(Calamus sp.)* and were reported to the Samoan National Invasives Task Team lead by MNRE/DEC. Since then a small group of members have been trying to eradicate and remove this plant from Samoa.[37] Recently, a live Cane Toad was collected in Apia, most likely introduced from American Samoa where they are very common.

[37] MNRE. 2006. *Public Awarenesss.* [online]. Apia, MNRE.. Available from: http://www.mnre.gov.ws/documents/newspaper/article%2010%20Sep%202006.pdf

The continuing spread of existing invasive species is due to the lack of human and financial resources to manage them. It is also due to native species becoming invasive once their natural controls are absent, such as is the case of the Pacific ship rat's increase in the islands of Nu'utele and Nu'ulua, where it has escaped its natural predators on mainland Upolu. Appendix J provides a comprehensive list of invasive species in Samoa classified by taxonomic species and life form.

### 2.7.3 Conservation/Protection Areas

A review of the conservation value of a total of 226 South Pacific Islands, as reported by Dahl in 1983, ranked three of the islands of Samoa highly, Savai'i at number 23, the Aleipata islands at 30 and Upolu at 46 (GOS 2002c).

A range of ecosystem types were described for Samoa from the results of studies undertaken by Pearsall and Whistler (1987-1991), Park *et al.* (1992-1993) and Clarkson *et al*., (1994) and Schuster *et al.* (1996) and a number of sites were recommended for a system of reserves, national parks, protected and or conservation areas which can best represent the ecosystems of Samoa's biodiversity (MNRE, 2004a).

In the earlier studies, a list of 14 ecosystem sites were identified as being of highest priority areas for conservation in Samoa due to their being rare and threatened by expanding developments. Furthermore, they consider 12 of these sites as being highly significant to global biodiversity. This is mainly due to their world rarity and endangered status or the concentration therein of endemic species. These 12 ecosystems ranged from marshes, swamps and rainforests in and close to lowland areas of the coasts to rainforests and mixed species swamps, as well as high altitude cloud forests on Savaii Island along the island's mountain ridges.

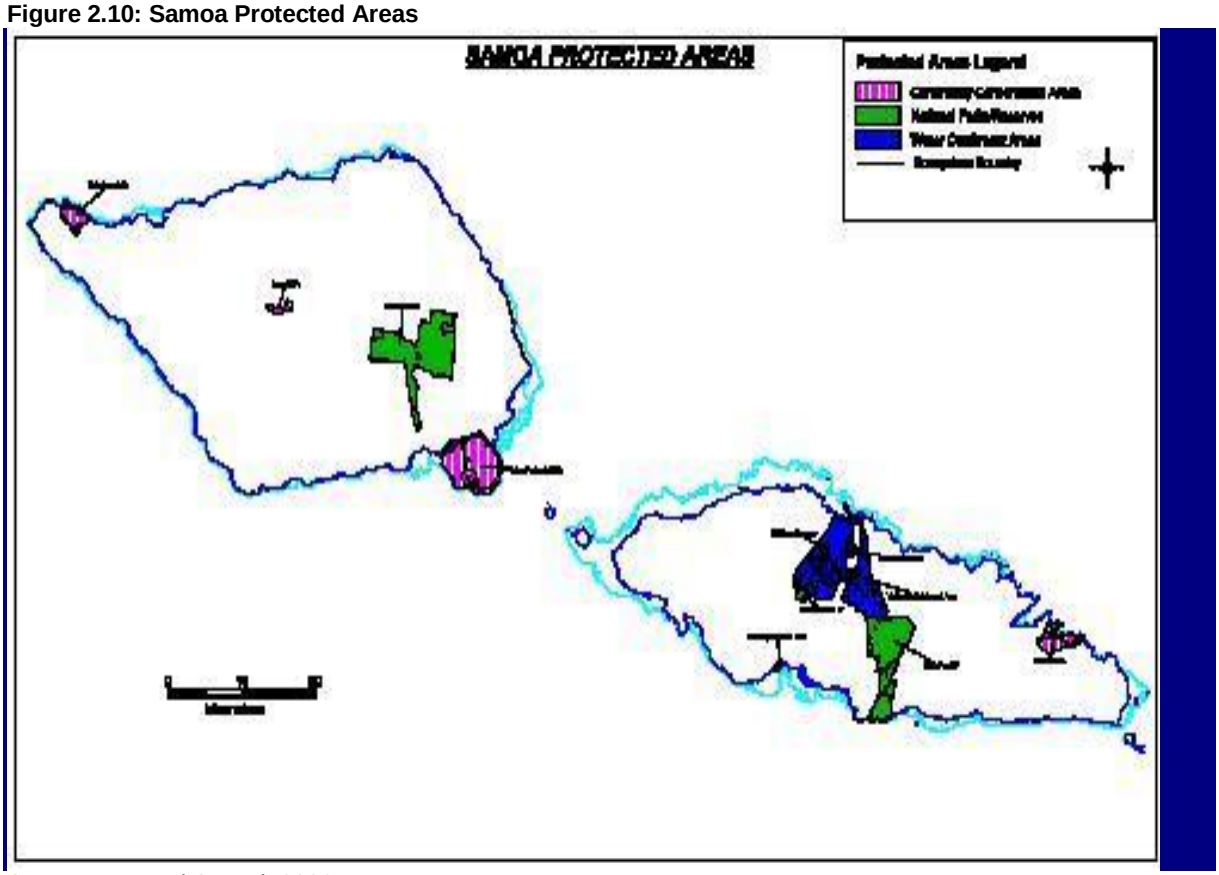
The purpose of the upland studies by Clarkson and Schuster and others was to determine the ecological status of mid-slope and upland forests, with a view to identifying key sites of significant biodiversity value for conservation and protection. The survey showed a slow recovery of the forests at higher elevations of Savaii and at lower elevations of Salega, Gagaifomauga and Asau. The damage to the montane forests is much more extensive in Upolu than Savaii. This is largely due to human induced activities. The vegetation in most areas is dominated by introduced species. Plans were then envisioned to deal with the preservation and management of potential upland sites of significant biodiversity value identified in the survey.

To protect and preserve sites of significant biodiversity potential, especially those identified as the minimum required which best represent the types of ecosystems found in Samoa, is now the most important priority in ecosystem management. These include the lowland or coastal forests of: Uafato-Tiavea, Aopo-Letui-Sasina, Vaoto, Saleapaga-Lalomanu, Taga-Lata-Salailua, Siuvao Point (Falelima) and Cape Mulinuu-Tufutafoe, Aleipata Islands and the coastal wetlands of: Sataoa-Saanapu, Apolima-uta, Vaiee-Tafitoala Peninsula and Vaipu (MNRE, 2004a).

The second priority is the creation and management of sites to protect rare and endangered species. Important initiatives for this purpose include the creation of a seabird sanctuary in the islands of Aleipata and the upland forests of Savaii.

A third priority is the protection of ecological systems from invasive species of plants and animals. Other general priorities which require the commitment of individual developers and village communities, such as the protection of ecological systems which are sources of food and materials for daily sustenance (such as lagoon and reef systems, wetlands) and the rest of the terrestrial systems which support agriculture, fisheries and other grassroots social and economic developments (ibid). Figure 2.10 illustrates location of some of Samoa's Protected Areas.

**Figure 2.10: Samoa Protected Areas**




Source: Hay and Suaesi, 2006

### 2.7.4 Living and Genetically Modified Organisms

Samoan farmers have used biotechnology for many years to crossbreed plants and animals. However, modern biotechnology, where genes are transferred between species, is a relatively new concept in Samoa. The products of modern biotechnology are often referred to as Genetically Modified Organisms (GMOs) and Living Modified Organisms (LMOs).

As a small island developing state that is heavily dependent on agriculture and fisheries, Samoa is particularly vulnerable to the potential adverse affects of LMOs and GMOs. At the same time, Samoa also recognises the potential development gains from the use of modern biotechnology. However, it is important to strike a careful balance to ensure that our environment, health and culture are not damaged in the process.

Biosafety is a way of reducing the potential risks that may result from modern biotechnology and its products. It is a way of protecting a country's biodiversity, or its environment and human health from any possible adverse effects of GMOs and LMOs.

The Government of Samoa has approved in 2005 a National Framework on Biosafety which is a combination of policy, legal, administrative and technical instruments that ensure an adequate level of protection for the safe transfer, handling and use of LMOs and GMOs resulting from modern biotechnology. In particular, it aims to safely manage LMOs and GMOs that may have adverse effects on conservation and the sustainable use of biological diversity, also taking into account possible risks to human health.

This work was a collaborative effort amongst the Government Ministries, corporations and statute bodies, and as well as NGOs and the business community in 2003-2005, and has gained a lot of

support and recognition in Samoa and abroad through education, media and awareness raising activities and especially through stakeholder consultations at all levels.

The second phase of this programme, which is the implementation phase of the existing National Framework on Biosafety, will help to achieve the strategy by the Convention on Biological Diversity (CBD) (GOS 2004).

### 2.7.5 Rejuvenation Project Outcomes – *Manumea* and *Ma'oma'o*

Two of Samoa's endemic bird species, the Samoan tooth-billed pigeon *(manumea)* and the Samoan giant forest honeyeater *(ma'oma'o)*, are rare and classified as endangered by the IUCN or World Conservation Union. The Government of Samoa's efforts in rejuvenation projects culminated in its 2006 endorsement of Recovery Planning for their conservation.

The *manumea* and *ma'oma'o* have great significant cultural and heritage value to Samoans. The *manumea* was a traditional and highly esteemed source of food, especially for the high chiefs, and fine mats were often made with its feathers sown into them. Both birds also play a vital ecological role in the Samoan rainforests by distributing the seeds of our native Samoan forest trees.

The two birds' natural habitats are the mature native forests of Samoa. Their numbers have declined dramatically, mostly through loss of forest habitat, and they are now only found in a few areas largely at higher altitudes or in the upper parts of major river catchments.

***Manumea* Recovery Planning**
An 11-month programme of surveys of the *manumea* recorded birds at only 10 locations, but some of these represented large areas of forest. Village consultations conducted at the same time showed strong interest and commitment to conserve the species. Two national workshops were held to present a draft of this plan which expressed a need to gain support for its implementation and a need for capacity building for village communities to help play a key role in this.

A Recovery Plan was produced in October 2006 identifying a goal of making sure that the *manumea* is no longer in danger of extinction, with secure populations on Upolu and Savaii, and the bird returned to many different forest areas. It aims for most Samoans to recognise the *manumea* as a key part of their natural heritage and to play their part in its long-term conservation.

It has eight objectives and one is to manage key forest areas on Upolu and Savaii, which are the key sites where significant populations of *manumea* remain. There are five sites on Upolu including the two national parks and forests owned by Tiavea and Uafato and Matafaa and Falelatai villages, and three sites on Savaii including much of the upland forests there. The second objective is to eliminate shooting of the bird, which still occurs even though it is fully protected. Two other objectives are to establish new populations on rat-free islands, in new mainland sites and even in captivity.

There are also still many aspects of the ecology of the *manumea* that are not known, so research is proposed to enable conservationists to learn more. One objective focuses on developing public awareness and education programmes, and the second on developing the partnerships and funding required, and establishing a recovery group to carry out a plan of action over the next ten years (GOS/MNRE 2006b). A PhD thesis on the Biology of the Samoan Tooth-Billed Pigeon was written some 25 years prior by Dr. Ulf Beichle, but very little research has been carried out since.

***Ma'oma'o* Recovery Planning**
Village consultations carried out during recent surveys showed that many people were not familiar with the *ma'oma'o*, however, there was strong interest in its conservation among those who knew of it.

The main goal is securing the *ma'oma'o* so it is no longer at risk of extinction, maintaining its existing populations on Upolu and Savaii, and re-establishing populations at former sites.

It follows eight objectives and one of which is to manage key forest areas on Upolu and Savaii which are the sites where significant populations of *ma'oma'o* remain. There are five sites on Upolu

including the upper Vaisigano River valley, two national parks and forests owned by Tiavea and Uafato and Matafaa and Falelatai villages, and one on Savaii, its upland forests. Detailed surveys are planned at some of these sites to identify changes in numbers. Research is proposed to find out more about the *ma'oma'o* and the threats to its survival. Two other objectives are to establish new populations on rat-free islands, new mainland sites and even establish a captive breeding colony. The final three objectives focus on developing public awareness and education programmes, developing the partnerships and funding required, and establishing a recovery group to carry out a plan of action over the next ten years (GOS/MNRE 2006a).

# 3. Responses to Environmental and DevelopmentalTrends

## 3.0 Introduction

Samoa has developed a national policy framework for the sustainable development and management of its environment and natural resources. While it started much earlier as part of its biodiversity conservation programmes under the Agriculture Department in the 1970s, major changes started in 1993 with the inception of the National Environment and Development Management Strategy (NEMS) which resulted in the formulation of national policies for addressing 13 Target Environment Components (TECs). Policies addressing issues such as national population and sustainable development, water resource management, land use, biodiversity conservation, forest development, waste management, climate change and ozone protection have been approved and are currently operational.

## 3.1 Policy Development and Environment Management Programmes

Since the formulation of the above policies, detailed strategies and action plans have also been developed and implemented to address key environmental concerns including the National Biodiversity Strategy and Action Plan (NBSAP), National Adaptation Plan on Action (NAPA) for Climate Change, National Waste Management Strategy 2000-2010, Water Resources Strategy 2006-2016, National Implementation Plan (NIP) for Persistent Organic Pollutants (POPs) and the National Biosafety Framework. Since the establishment of PUMA and the coming into force of the Planning and Urban Management Act 2004 (PUM Act), planning polices have been developed including the National Parking Policy, Environmental Code of Practice and National Building Guidelines. More over, a National Coastal Infrastructure Management Strategy is in place as well as the completion of 41 Coastal Infrastructure Management (CIM) Plans (involving 283 villages). Table 3.1 summarizes the national environment policy framework and key issues involved.

Table 3.1 National Environment Policy Frameworks

| Year | Policy Framework Component | Key Environment Issues |
|---|---|---|
| 1991-1997 | National Watershed Management Policy<br>National Forest Development Policy | Degradation of watershed areas,<br><br>Deforestation and demands for water and forest resources |
| 1994 -2000 | National Population and Human Development Policy<br>National Land Use Policy<br>National Waste Management Policy<br>National Water Resources Policy | Population needs, land use management, waste management, and conservation and sustainable development of biological resources |
| 2000 | MNRE Institutional Reform Policy | Capacity building and capability development for government |
| 2000 | Coastal Infrastructure Management Strategy | Coastal erosion, landslides and flooding hazards |
| 2001 | National Biodiversity Strategy and Action Plan | National priorities for conservation and sustainable use of Samoa's marine, freshwater and terrestrial biodiversity resources |
| 2004 2005 | National Adaptation Programme of Action for climate change<br>National Heritage Conservation Policy | Vulnerabilities to and resilience against impacts of climate change |
| 2005 | National Implementation Plan for POPs | Impacts and management of persistent organic pollutants and hazardous substances |
| 2005 | Development Consents Policy | Provides information on the process for development consents and criteria and requirements for evaluations |
| 2005 | National Biosafety Framework | Handling and use of biotechnologies and biotechnological products |
| 2005 | National Buidling Guidelines | Provides guidelines for amenity requirements for buildings and pollution control measures for |

| | | |
|---|---|---|
| | | protection of environment |
| 2006 | National Parking Policy | Encourages the availing parking spaces in public areas and commercial buildings in town to include provisions for parking spaces |
| 2006 | National Action Plan on Land Degradation | Land degradation and land use management |
| 2006 | Ban on Commercial Logging Policy | Prohibition of commercial logging of indigenous forests |
| 2006 | National Forest Policy | Update of the National Forest Policy |

These policies provide the basis for programme implementation with MNRE continuing to play the lead role in the following:

- Conduct research on ecological values of ecosystems in order to continuously update information on the status of ecosystems and impacts on species biodiversity,
- Re-design programmes to be in line with the national strategies and take on a participatory approach to gauge community involvement,
- Seek more financial assistance and expertise to assist in further development and sustainable management of Samoa's natural resources,
- Have an integrated approach in implementing current programmes, such as POP's, Climate Change, Montreal Protocol on ODSs, Marine Protected Areas and International Waters, to include all relevant stakeholders,
- Promote programme sustainability in the long-term through government providing local budgetary allocations to conduct some activities such as public awareness and policy formulation,
- Develop specialized skills, particularly the capabilities to compile and store data on various environmental concerns such as biodiversity, climatic patterns, monitoring of waste generation, and a geographic information system (GIS) that can all help monitor the changes in Samoa's natural resource integrity,
- Consolidate the collation and collection of data on traditional practices and knowledge which must be an integral part of future assessments, and
- Encourage technology transfer from places similar to Samoa where best practices have been proven.

## 3.2 Institutional Frameworks

There have been major changes undertaken by the Government of Samoa through its Public Sector Reform Programme and the strengthening of partnerships with the private sector in terms of outsourcing some Government activities to be implemented by private operators.

Although MNRE is the focal-point spearheading overall management of all activities concerning the environment, there is growing involvement of other Government agencies, non-governmental organisations (NGO's) and the private sector to address environmental issues. The establishment of the National Beautification Committee (NBC) in 1997 within the former Samoa Visitors Bureau (now the Samoa Tourism Authority) is one indicator of inter-departmental networking with the private sector in monitoring and regulating a clean environment in work places and village areas. The NBC conducts regular visits to business areas and villages for clean-up purposes and beautification of villages, encouraging more community participation to develop a cleaner environment. Like the NBC, each of the policy and strategic development projects housed within the MNRE~~M~~ has its own advisory committee or working group with representation from all sectors relevant to each particular thematic area. For instance there is the National Ozone Task Team, National Climate Change Task Team, the National Biodiversity Team, National Disaster Advisory Committee to name a few. The CEO of the MNRE chairs each Committee or Task Team, a responsibility that is often delegated to the Assistant CEO of the responsible Division of MNRE.

Since the inception of its first Corporate Plan in 2000, the MNRE has maintained its vision through a mission aimed at achieving sustainable management of Samoa's environmental resources through a closer partnership with the private sector. The Corporate Plans (2000-02 and 2003-05) continue to outline the approved structure (effective in 1999) and changes that have resulted from Government reforms for the MNRE. The latest MNRE Corporate Plan (2006-07) shows an expanded institutional structure as contained in Appendix L. In the previous SOE (1993), there was only the Division of

Environment and Conservation (DEC) that was involved with issues of environmental concerns. The current Corporate Plan, on the other hand, sets out strategies to achieve its stated objectives for the three year plan period in line with its stated vision and mission, the latter being "to further develop and implement best practices in the sustainable development of the country's environmental resources, in partnership with all relevant stakeholders" (MNRE, 2006a), with an institutional structure to implement.

The establishment of PUMA in 2002 was based on Government's conviction that sustainable development will only occur through institutionalized environmental planning and management supported by appropriate legislation. The Government accorded priority to environmental planning and protection from pollution within the overall national development process. Hence the first SDS called for an integrated approach to planning and to the use of land within the Apia urban area as well as other parts of the country where it applies.

PUMA, DEC, Land Management and Corporate Services currently house the various environment projects with designated project officers to coordinate these programmes at the national level and provide collaboration with international counterparts on the progress of implementation of such project activities. These projects include Climate Change, Montreal Protocol, International Waters, POPs, (IUCN) Marine Biodivesity Conservation Project and World Bank-funded Samoa Infrastructure Asset Management II (SIAM II) Project and Cyclone Emergency Recovery Project (CERP).

A MNRE Legal Unit has been established consisting of a Principal Legal Officer, with the recruitment of legal and research officer assisting this function. The establishment of this unit demonstrates the Miinistry's willingness to improve understanding and compliance with current legislation and the need for on-going review. A contributing factor is the increased training of the authorities/professionals charged with the implementation and enforcement of the relevant environmental legislations. The desire and commitment to protect the environment has seen a conscious attempt by other line Ministries to consult with environmental agencies more frequently on important environmental issues. This consultative approach differs greatly from the commonly ill-informed or ill-advised arbitrary decisions made in the past, with little or no regard to the environment and often based on insufficient research and/or monitoring.

MNRE attempts now to focus more on a holistic approach for the sustainable management of Samoa's environmental resources. Natural resources and environment management frameworks that exist within Government have been developed, but they need further strengthening if Samoa's efforts to promote environmentally sustainable development are to be highlighted and showcased for the Pacific region.

The DEC has been expanded with new technical positions, with the splitting of the Biodiversity Section into separate Terrestrial and Marine Resources Conservation Sections to further distinguish the specific focal areas being executed by each Section.

Two new divisions: the PUMA and Water Resources Division have also been established. However, two other Divisions have been transferred from the original Ministry of Agriculture, Forests, Fisheries and Meteorology (MAFFM), namely Meteorology and Forestry with the latter taking in the National Parks function that was previously under DEC.

A Renewable Energy Division and the Global Encironment Facility (GEF) Services Division also have been included within MNRE to help address these increasing responsibilities to attain sustainable development.

Since 1993, institutions relevant to environmental management have remained the same. However, the refinement of responsibilities and mandates within Government has given birth to new agencies and more human resources working on environmental programmes. Table 3.2 presents new agencies and sections that existed after 1993.

Table 3.2 Current and possible future agencies with lead and support roles for key environmental components

| Key environmental components | Agency of MNRE | Agencies with potential lead roles | Agencies with potential supporting roles |
|---|---|---|---|
| Water Resources | Water Resources Division | SWA | MWTI, MAF |
| Population needs, environmental health, waste management | DEC, PUMA | MOH & NHS | MWCSD, MESC, VC |
| Built-environment, coastal erosion control, landslides and flood hazard | PUMA | MWTI | SWA, MWTI, MAF, DMO |
| Management of agro-biodiversity, sustainable use of marine and terrestrial biodiversity | DEC, Forestry | MAF | MCIL, NUS, METI, OLSSI, FSA, VC |
| Handling and use of biotechnologies and biotechnological products | DEC, PUMA | MOH | MAF, MCIL, NUS, USP |
| Land use and land degradation | Land Management, Capacity Building | MAF 7 MWTI | MAF, NUS, USPA?? |
| Climate Change | Meteorology, PUMA, DEC | MWTI | SWA, MWTI, MAF, MOH |
| Management of POPs and toxic chemicals | DEC | MOH | MAF, SWA, NUS, USP |

NGOs which have an environment focus continue to be involved in the implementation of government-led environment activities. Their role lies in advocacy for environmental management in areas of education and public awareness, and also highlighting local environmental issues. The roles and functions of environmental NGOs are not clear-cut. Some have been delegated the implementation of projects at community level, while others are involved in the review of activities undertaken by the MNRE. There are currently three existing environmental NGOs, namely O le Siosiomaga Society Inc. (OLSSI), Faasao Savaii, and Matuaileoo Environment Trust Inc. (METI) which promote sustainable environmental management and sustainable development. Other NGOs in the agricultural sector, that have also shown their interest in the protection of the environment, include the Beekeepers Association, Samoan Organic Farmers Association (SOFA) and the various microfinancing organisations that promote sustainable development projects at the grassroots level (e.g South Pacific Business Development [SPBD]).

A wide collection of policy objectives-have been achieved to date as a combined result of efforts being made by all the above agencies. The systemic capacity of Samoa, however, to respond to recent trends in development and environmental managenment is reflected in the considerable advancements to date that have been made which are detailed separately in the following thematic areas.

## 3.3 Global and Regional MEAs

### 3.3.1 MEA Membership

Samoa is party to a number of international environmental agreements and treaties. Each of the main thematic MEAs that Samoa has become party to has its own corresponding project unit that was set up for its overall coordination. Namely, UNFCC, CBD, Vienna Convention and Montreal Protocol, UNCCD, Stockholm Convention (POPs) to name a few. Table 3.3 illustrates the various MEAs that Samoa is a member.

Table 3.3 Multilateral Environment Agreements Samoa is a Party

| Country Name | Global Agreements / Conventions | | | | | | | | | | | | | | | | Regional Agreements / Conventions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ramsar Convention | World Heritage Convention | MARPOL | CITES | Convention of Migratory Species | **UNCLOS** | Ozone Layer (Vienna) Convention | Montreal Protocol | Basel Convention | Rotterdam Convention | Framework Convention on Climate Change | Kyoto Protocol | Convention on Biological Diversity | Cartagena Biosafety Protocol | Convention to Combat Desertification | POPs Convention | Waigani Convention | SPREP Convention | Regulation of Whaling Treaty | Apia Convention | Pacific Tuna Convention |
| Samoa | ® | ® | | ® | ® | ® | A | A | A | A | ® | ® | ® | ® | A | ® | ® | ® | | ® | S |

Legend: ® - Ratified S- Signed A - Acceded

### 3.3.2 MEA Programmes and Policy Responses

Prior to UNCED, a number of projects had begun. These included the UNDP funded Watershed Management project which highlighted public awareness of the benefits of integrated watershed management. Its outcomes contributed to the endorsement of legislation to set up the Samoa Water Authority separate from the Public Works Department in 1993. A number of conservation agreements were signed between some villages and private donors in order to protect their indigenous forest as conservation sites, while donor organizations assisted with some village developments such as Falealupo and Tafua villages in Savaii.

From 1988 to 1994 three ecosystem surveys were conducted; the first one was carried out with support from SPREP and The Nature Conservancy (TNC) which, systematically collected information for the conservation of biodiversity while the New Zealand Government and the World Wildlife Fund for Nature funded the second survey of the lowland ecological ecosystems which also covered marine resources such as mangroves. The third assessment looked at the Upland ecosystem, which was also supported by the New Zealand government. Another UNDP funded project supported an inshore assessment of marine resources. Initial preparations of the draft EIA legislation and pollution controls regulations also took place. More recently, assessments of other key environmental issues have been anabled for biological Diversity of Samoa under its NBSAP, Hazardous Chemicals and POPS inventory, Ozone Depleting Substances, Green House Gases Inventory of Sources and Sinks as well as Vulnerabilities of Samoa to climate change, Solid Waste Audits, and Land Degradation situations through Samoa's membership and active involvement in the above MEAs.

The following specific actions elaborate on the various actions and programmes that were enabled and supported by Samoa's affiliation with MEAs.

*Adoption of the National Environment Strategy in 1993.* The main focus of NEMS was on a cross-sectoral policy development targeting the 12 priority environment issues or Target Environment Components. The NEMS set the framework for policy development and capacity building at the same time. Policy committees were appointed which consisted of local personnel from relevant Ministries and organisations who worked on conducting awareness programmes, collation of information, evaluation and actual drafting of the policies. Local personnel benefited greatly from this exercise of hands on policy formulation.

A number of protected area systems were established in the post UNCED period. Six new nature reserves and botanical garden in addition to the existing four were established, 4 watershed management areas were identified and 2 major community conservation areas fully managed by the village communities were declared. About 59 community-owned and managed fish reserves have been established on Upolu (38), Savai'i (17) and Manono (4) (Environment Forum, 2000) under an AusAID funded Fisheries Extension project to address the problem of fast depleting inshore marine resources. The success of this programme has lead to some villages setting up by-laws under this system of protection to provide the legal mandate for management of their fishery resources effectively.

*Samoa Marine Biodiversity Protection and Management project (1999-2004).* MNREM in partnership with the IUCN (World Conservation Union) has worked with the Districts of Safata (9 villages) and Aleipata (11 villages) to establish two multi-use, community-based marine protected areas. The project aims at empowering the local communities of these districts to effectively protect and manage coastal marine biodiversity and help them achieve sustainable use of their marine resources.

*Species Protection Programme*: The South Pacific Regional Initiative on Forest Genetics projects started in 1996 with its overall objective to better conserve and sustainably develop the region's forest genetic resources. This project is currently coordinated by the Forestry Division and the project arose out of concern for the rapid rate at which forest genetic resources are depleting due to direct result of logging and agricultural activities.

The Pacific-German Sustainable Indigenous Forest Project has established a pilot site at Samalaeulu Lowland Forest in Savaii. The aim is to develop community-base sustainable systems for harvesting and maintaining forest resources viability in Samoa. Established in 1998, the project is awaiting the settlement of land disputes between members of the Samalaeulu village council before it undertakes the first trial harvesting of forest resources at the pilot site.

*A New Zealand funded National Inventory of Terrestrial Resources* project was completed in 1994 through an ecological survey of mid-slope and upland forests with a view to identifying key sites of significant size, so that their subsequent conservation would cover the full range of habitats to ensure the long-term survival of species and genetic biodiversity. There were three grading for the sites being surveyed; grade-1 referred to the most important sites of significant size with links to lowland forests such as Gagaifomauga III and Palauli West, and Anoamaa. Grade-2 site was ranked important because of the opportunities available for immediate action and the uniqueness of its biodiversity and covered all of Eastern Upolu Uplands and the rest of other areas were grade-3 sites. The survey also recommended for its findings the need to undertake wetland survey, and carry out more detailed entomological studies.

*Strategic Action Programme for International Waters 2000-2005*. This project focussed on fresh water resources and was started under the DEC but now transferred to the Water resources Division. The identification of fresh water as the main focus for Samoa emerged as a priority component given the number of development projects and major competing users of fresh water resources; such as the Samoa Water Authority for piped supplies, the Electric Power Corporation for hydropower and agriculture demands at sites without piped water. As well the continuous logging of indigenous forests and agricultural development will have a perilous impact on the environment, with loss of biodiversity, land degradation and over exploitation of fresh water resources. The prioritising of fresh-water in this project posed a need to regulate the extraction of underground water, as increase consumption and excessive use of natural resources may deplete this valuable resource.

*Solid Waste Management Programme.* DLSE through on-going project continues to address the issue of waste management by focusing on activities such as; waste separation, waste assessment and evaluation, public awareness campaigns with a specific national day on Waste Awareness in Samoa and development of strategic and planning policies in order to minimize the generation of any type of waste. As well the SPREP funded Solid Waste Awareness and Waste Minimisation project focuses on public education through stakeholder consultations, community and school workshops.

Other relevant programmes currently operated by DLSE includes; the contracted municipal waste collection in Apia which started 1994; the rural waste collection for the rest of Upolu and Savaii and this started early 2001; the development of the Vaiaata landfill 1999 and its daily operation in Savaii; development of a sanitary engineered landfill at Tafaigata, and its daily operation.

*Persistent Organic Pollutants programme:* The objective of this programme is to create sustainable capacity and ownership in Samoa to meet obligations under the Stockholm Convention, including initial preparation of a POP's Implementation Plan, and broader issues of chemical safety and management as articulated in Chapter-19 of Agenda 21. Samoa does not produce any of the substances listed as controlled Persistent Organic Pollutants in the Convention however it relies on imports to supply all of its agricultural, medical, and industrial chemicals. (POP's Project Proposal: 2001).

*The Climate Change programme started in 1997- 2001 under the PICCAP (Pacific Island Change Assistance Programme*) project and Samoa is one of the participating Pacific Islands. The government has submitted its first National Communication Report to the Conference of the Parties (COP) in 1999. Samoa's national communication report covers both issues of climate change and sea level rise in the country as well as action plans to address them. The National Implementation Strategies have been completed, and Cabinet has approved a National Adaptation Programme of Action (NAPA) in 2005. An extensive public awareness campaign has been run since the inception of the various climate change projects.

*Montreal Protocol Country Programme: Protection of the Ozone Layer*. Samoa is among the first island states of the Pacific to have established a National Ozone Unit in 1999 as part of its Institutional Strengthening Project, funded by the Multilateral Fund. Samoa has completed its national phase-out strategy, which runs parallel with the Country Programme and Refrigerant Management Plan 2000. At the national level, awareness programmes through media publicity, presentations in schools and communities, and considerable activities take place during September the month of World Ozone Day every year. A national policy with an action plan on the Protection of the Atmosphere targeting programmes to eliminate ozone-depleting substances has been completed and approved by the Minister of MNRE. The action plan adopted an accelerated timetable of ODS phase-out by the 31 December 2001. Key aspects of the Action Plan are legislative bans, and restriction on imported ODS as well as on ODS-based equipment and products. The Customs arm of the Ministry of Revenue is enforcing these.

### 3.3.3 Effects of MEA Programmes and Policy Reponses

Samoa has sustained the momentum of updating existing programmes that were highlighted in the NEMS (1993) such as; protected area systems, species conservation programmes, hazardous substances, climate change, and Ozone protection and waste management. There has been an increase in new programmes as a result of Samoa being a contracting party to international/regional agreements and protocols. These projects have run smoothly during their implementation, with sufficient resources to cover operations and reporting. Government has also successfully taken on board some of the institutions initially set up through MEA sourced funds such as the Ozone Unit and Terrestrial Biodiversity and POPs Sections. Unfortunately other institutional mechanisms set up under the MEA programmes have been restricted to short term or at least for only the duration of external MEA funding availability.

Finally MEA projects have been mostly enabling activities and their impacts have been felt mainly at the policy and systemic levels of government. The real improvements to the livelihoods of people and the environment as a result of implementation of policies and action plans are yet to be realised and this may depend greatly on the commitment of government to mainstreaming environmental considerations spelled out by these policies in its development. Equally critical to such improvement is closer involvement of Samoa's people and their commitment to conserving the environment.

## 3.4 Non-binding Agreements and Instruments

### 3.4.1 General

The four key non-binding agreements that are of particular importance to Samoa for sustainable development of its environment are (i) the UN Conference on Environment and Development (UNCED) and Agenda 21 in 1992, (ii) the Barbados Programme of Action for Small Island Developing States (BPOA) in 1994, (iii) the Millennium Development Declaration and Goals (MDGs) in 2000 and the World Summit on Sustainable Development (WSSD) and Johannesburg Plan of Implementation (JPOI) in 2002. At the global level, a number of high-level conferences and summits of relevance to environmental protection and sustainable development have been conducted over the last six years, each one to some extent building on internationally agreed commitments and providing blueprints for action. These include the annual Commission for Sustainable Development (CSD) Sessions, GEF Council Meetings, the Monterrey Consensus on Finance for Development in 2001, and the Asia-Pacific Ministerial Convention for Environment and Development held in Kitakyushu, Japan, in 2000. Samoa has actively participated in these forums. Delegations have at times also included representatives from the national NGO community.

### 3.4.2 UNCED's Agenda 21 and BPOA

Samoa has actively adopted the principles of UNCED's Agenda 21 and specifically responded to implementation of the Blueprint for the Sustainable Development of Small Island Developing States (SIDS) in the Barbados Programme of Action (BPOA) through its NEMS process. Despite limited funding received directly towards BPOA activities or for recognition in certain development arenas, as well as lack of a specific funding mechanism under the UN to support these programmes, some resources have been leveraged for specific actions from GEF (ADB 2003). Implementation to date has been mostly funded by Government through soft loans or internal budget. Efforts have been in certain sectors concentrating on building technical skill capacity, developing policy and plans, coordinating national and regional actions, undertaking sub-national environmental assessments and capacity building in international negotiations. The level of progress made locally was evaluated in 2004 when Samoa submitted its National Capacity Self-Assessment (NCSA) Report that indicated the many achievement it had made. These were in policy development under NEMS, institutional strengthening projects and enabling activities all of which were completed under GEF funding, as well as integrated infrastructure and planning initiatives that have now been put in place.

### 3.4.3 Millennium Development Goals

A recent evaluation of MDGs by the O le Siosiomaga Society concluded that all eight MDGs were relevant to the situations of Samoa (SNHDR 2006; p175). It was also indicated that Government has been quite advanced in its progress towards the achievement of MDGs. For the MDGs on extreme poverty, universal primary education, gender equality, reduction of child mortality and mental health improvement, there is a strong enabling environment with positive policies and comprehensive programmes in place to support them. MDGs for combating HIV and AIDS, and other major diseases, and promoting global partnerships have made fair progress, but need more on-going involvement of civil society. The MDG on environmental sustainability is perhaps the most critical in national development. Some progress has been made in preparatory phases of EIA with the recent passing of the PUM Act.

### 3.4.4 Johannesburg Declaration on Sustainable Development

The Johannesburg Declaration on Sustainable Development is the most recent statement of global sustainable development priorities. Samoa envisaged wider benefits by broadening the scope of the special case of SIDS from an oceans' perspective. Because of this apparent wide range of challenges from vulnerability to climate change to the need for a specific programme of work on island biodiversity conservation, special mconsideration was given to SIDS (JPOI and SBSTA 8, 2002). The thematic and cross-sectoral issues covered in the JPOI have been restated in Samoa's statements and participation at the BPOA +10.

Government's support for the UNCED and BPOA processes was extended at the highest level from its inception. The late Prime Minister, Hon. Tofilau Eti Alesana, in his address to the UNCED (1992), referred to the NEMS as a comprehensive approach to addressing environmental issues in Samoa. Later in the 1998 National Statements of Economic Strategy, emphasis placed on policies that have been formulated under NEMS showed Government's clear recognition of the need to indicate its commitment to sustainable development for the future livelihood of its people.

At the international and regional levels, Samoa has actively participated in most international negotiations, often taking on the leadership for SIDS. Overall, Samoa has made considerable progress in addressing the major environmental concerns that it currently faces and continues to face in recent years. These efforts need to be linked to those efforts of other nations, both bilaterally or multilaterally.

## 3.5 Network and Partnership Mechanisms

### 3.5.1 National Partnerships

Since 1996, the biannual Statement of Economic Strategy (SES) and, more recently, the SDS which defines the national policy framework and the strategic directions and development priorities of Government towards a sustained quality of life for the Samoan people, replaced the long-term earlier Development Plans. Significant progress has, therefore, been achieved since 1996 with each SES and SDS improving on previous development milestones.

In the SES 2000-2001, the Government pledged to ensure that all stakeholders must contribute positively to the partnership between Government and the private sector for long-term sustained benefits. Priority was given to sustainable management and development of the environment in areas of environmental planning and policy, climate change, oceanic/coastal resources, waste management, biodiversity conservation and capacity building.

In the years since UNCED (1992), several important international and regional environmental agreements have been negotiated and concluded. Samoa, since UNCED, has shown its interest and commitment by already adopting a number of international and regional environmental agreements (see Table 3.3).

At the national level, the private sector and communities were enticed to become part of the whole process of environmental management in spite of the scarce resources to facilitate biodiversity conservation and environment management projects. The private sector partnerships were most effective in the area of waste management as a large quantity of waste is being generated from manufacturing and processing industries, as well as from the construction sector. Success in villages at the grassroots level could also be secured only with the involvement of the broarder communities. Hence, public/private partnerships were instrumental in the development of strategies, policies and plans at the national, district or village levels.

One of the aims of networking and partnership mechanisms is the generation of interest and keeping momentum espoused by NGOs and CBOs in progressing their relevant mandates. NGOs, and more so CBOs, have been increasingly involved with the implementation of Government projects, either as partners in national committees or as consultants.

### 3.5.2 Linking with Regional Networks

Samoa saw many benefits for its environment by becoming party to MEAs and also being active as part of the network of Pacific islands within SPREP and other CROP agencies. However, Samoa still does not have all the capacity it needs to sustainably manage its natural resources and environment. Skills and expertise available elsewhere within the Pacific region, especially SPREP, was an avenue to substitute for the lack of capacity in-country. Samoa took advantage of the various regional capacity building programmes to enhance its local institutions and strengthen individual competencies of its technical staff.

## 3.6 Environmental Legislation

### 3.6.1 Principal Legislation for Environmental Management

Government recognised that current national laws are inadequate in providing comprehensive protection for the environment. Previous legislations were more focused on resource exploitation with little to no value placed on the protection of the environment. Much of the old legislation is scattered in various Acts which are administered by different Ministries and Departments. The Lands, Surveys and Environment Act 1989 (LSE Act), although it encompassed the protection of various natural resources, was merely an institutional framework leaving the substantive content to be handled through regulation. The "environment", however, is defined as "the physical features of the surrounding of human beings, including the land, water, atmosphere, climate, sound, odours, tastes, the biological features of animals and plants and the social features of aesthetics". There was no reference to the social, cultural and economic context in which land and other resources are inevitably utilized other than the very limited reference to "the social features of aesthetics". Sustainable development, which requires the integration of environmental factors with socio-economic considerations in decision-making processes, is not referred to at all.

Part VIII of the LSE Act deals with the "environment and conservation" and focuses on natural resources and the environment - its application extending to the territorial waters of Samoa. The principal functions of the DLSE in relation to the environment and conservation are described very broadly under this Part, and includes the provisions on "all aspects of environmental management and conservation" ensuring and promoting "the conservation and protection of natural resources and the environment". It also includes the provisions for national parks and reserves, dealing with pollution, carrying out research and promoting public awareness of the environment and conservation. Other specific aspects include "ensuring the effective public participation in environmental planning…. processes" and the potential environmental impact of development proposals, both public and private.

An Environment Board is also to be established under this Part with its principal objective being "the protection and conservation of the natural resources and the environment". Its membership is broad based and includes representatives from other Government departments, namely Agriculture and Fisheries, Education, Health, Trade and Commerce, Transport, as well as industry and community representatives, and a representative from the Pulenu'u Committee. The DLSE Director was advisor and secretary to the Board. The Board has been non-functional since 2000.

Table 3.4 presents the various legislation for environment, as well as those that play a relevant role in environmental protection or management.

Table 3.4 Relevant environmental legislation

| Main Legislation | Supporting Legislation |
|---|---|
| Agriculture, Forest and Fisheries Ordinance 1959. | Pesticide Regulations 1990. |
| Alienation of Customary Land Act 1965 | |
| Alienation of Freehold Land Act 1972 | |
| Animals Ordinance 1960 | Animal Diseases Prevention Regulations 1968<br>Animals (Protection of Wild Birds) Regulation 1981<br>Protection and conservation of Wild Animals Amendment Regulation 1993 |
| Building Alignment Ordinance 1932 | |
| Burials Ordinance 1961 | |
| Business Licenses Ordinance 1960 | |
| Civil Aviation Act 1963 | |
| Commerce Act 1978 | |
| The constitution of the Independent State of Western Samoa 1960 | |
| Consumer Information Act 1988 | |
| Customs Act 1977 | Customs Amendment Regulation 1986<br>Order Prohibiting Export of Logs 1990 |
| The Customs Tariff Act 1975 | |
| Development Bank Act 1974 | |

| | |
|---|---|
| Dog registration and Control Ordinance 1955 | |
| Electric Power Corporation Act 1980 | |
| Enterprise Incentives and Export Promotion Act 1992 | Enterprise Incentives and Export Promotion Act Regulations 1992 |
| Excise Tax (Domestics Administration) Act 1984 | Excise Tax (Import Administration) Act 1984<br>Excise Tax Rate Act 1984 |
| Exclusive Economic Zone Act 1977 | |
| Fisheries Act 1988 | |
| Food and Drugs Act 1967 | |
| Forest Act 1967 | Forests Regulation 1969, 1983 & 1991<br>Watershed Protection and Management Regulation 1992 |
| The Fuluasou Land for Public Purposes Ordinance 1949 | |
| Handicrafts Industry Act 1965 (Repealed) | |
| The Health Ordinance 1959 | Board of Health (Vermin) Regulation No.2<br>Board of Health (Rubbish) Regulation No.4<br>Board of Health (Mosquitoes) Regulation No.5<br>Board of Health (Buildings, Drainage & Privies) Regulation No.6<br>Board of Health (Building, Drainage & Sanitation) Regulation No.8<br>Board of Health (Concrete Buildings) Regulation No.16<br>The Samoan Village Regulations 1938 |
| Internal Affairs and Rural Development Act 1983 | |
| Komesina o Sulufaiga (Ombudsman) Act 1988 | |
| Labour and Employment Act 1972 | The Labour & Employment Regulations 1973 |
| Land for Foreign Purposes Act 1992/1993 | |
| Land Registration Act 1992/1993 | |
| Land Survey and Environment Act 1989 | Watershed Protection and Management Regulations 1992 |
| Land and Titles Act 1981 | |
| Ministry of Transport Act 1978 | |
| National Biosafety Act 2005 | National Biosafety Act 2005 |
| National Cultural Center Trust Act1978 | |
| National Investment Corporation Act 1981 | |
| National Parks and Reserves Act 1974 | |
| Noxious Weeds Ordinance 1961 | |
| Omnibus Fees and Charges Amendment Act 1988,1991 | Omnibus Rates and Exemptions Amendment Act 1986 |
| Petroleum Act 1984 | Petroleum Regulations 1960 |
| Plants Act 1984 | Plants and Soil Import (Disease Control) Regs 1951 |
| Poisons Act 1968 | Poisons Licenses Regulation 1969<br>Selenium Control Regulations 1969<br>Deadly Poisons Regulations 1969<br>Poisons Regulations 1969 |
| Police Offences Ordinance 1961 | |
| Produce Export Ordinance 1961 | |
| Public Service Act 1977 | Public Services Regulations 1953 |
| Public Works Ordinance 1959 | |
| Pulenuu and Sui o le Malo Act 1978 | |
| Planning & Urban Management Act 2004 | |
| Road Traffic Ordinance 1960 | Road Traffic Regulations 1961<br>Road Traffic Orders 1971 |
| Road Transport and Traffic Control Act 1990 | |
| Robert Louis Stevenson Foundation Act 1991 | |
| Samoan Antiquities Ordinance 1954 | |
| Shipping Act 1972 | Port Control Regulations 1939 |
| Special Projects Development Corporation Act 1972 | |
| Statistics Act 1971 | |
| Stevenson Memorial Reserve and Mount Vaea Scenic Reserve Ordinance 1958 | |

| | |
|---|---|
| Survey Ordinance 1961 | Land Survey Regulations 1939 |
| Taking of Land Act 1964 | |
| The Territorial Sea Act 1971 | |
| Trade, Commerce and Industry Act 1990 | |
| Village Fono Act 1990 | |
| Water Act 1965 | |
| Water Authority Act 1992/1993; (not yet assented to) | |
| Western Samoa Trust Estates Corporation Act 1977 | |
| Western Samoa Trust Estates Corporation Reconstruction Act 1990 | Western Samoa Trust Estates Corporation Reconstruction Act 1990, Order as to Vesting of Lands |
| Western Samoa Visitors Bureau Act 1984 | |
| Youth, Sports and Cultural Affairs Act 1976 | |
| Samoa Tourism Authority Act | (to be updated ) |

Samoa is aware of the urgent need for further changes or adjustments in the existing legislation concerning the protection and conservation of the environment: the development of the required regulations to make the Act an effective planning tool is being seen as a good starting point. Regulations should also be made to allow Samoa to fulfil its obligations as required under International Conventions that Samoa is already a party to.

A significant limitation in the current LSE Act is that some of its provisions like the requirement for EIAs, do not apply retrospectively to land use and pollution already in existence before the commencement of this legislation. Previously, there were no provisions in the LSE Act dealing with air and noise pollution. The Health Ordinance 1959 covered these, but in a very generic way.

Under the LSE Act where litter or wastes are dangerous/hazardous or toxic, individuals can be imprisoned for up to a month. However, there is no corresponding set of fines or perhaps more severe and harsher punishment for corporations and companies in the private sector. The LSE Act does little to effectively protect the environment. Penalties consisting of small fines and short imprisonment terms do little to rectify the problem, let alone act as a strong deterrent for people not to offend. The Government should send out a strong message that it is serious about protecting and conserving the environment. Fines for environment-related offences should be increased with higher fines imposed on corporations and private businesses. Community groups have also expressed that enforcement is weak when it comes to environmental protection laws, and many indivudials, while well aware of the law, are turning a blind eye when pursuing their economic goals.

The Environment Board should be re-activated in order to fulfil its role as envisaged under the LSE Act. With the Planning and Urban Management Board already instituted, the formation of the Environment Board may need to reconsider the overlapping roles in relation to the EIA process, amenity insistence and pollution control.

Provisions should also be made to promote the sustainable use of marine resources and to control marine pollution as regulations can be made under the Exclusive Economic Zone Act 1977, although no such regulations have been drafted and Samoa's marine resources remain unprotected. The Marine Pollution Prevention Bill, developed by the Ministry of Transport, is still awaiting final comments from the stakeholders. This draft legislation should compliment a parallel Act aimed at regulating pollution from land-based activities. This will draw distinction between the legal frameworks for marine operation (shipping) sources from the land-based sources of pollution.

There is a real need for a better and more coordinated approach between all departments, agencies CBOs and NGOs which have a stake in the protection and conservation of the environment so that accountabilities and responsibilities are more clearly defined. There is also a need to avoid unnecessary duplication of effort and wastage of scarce resources. L egislation should, therefore, become more streamlined and sensitized to the mandates of others.

### 3.6.2 The PUMA Act 2004

The PUMA Act 2004 gave the PUMA of MNREM operational responsibility for development planning and for the regulation of development projects, to ensure that environmental, social and related impacts are kept to acceptable levels. Although its approaches are considered by some individuals and organizations to be too complex and more suited to a developed country – many people, including politicians, dislike the role PUMA is playing in the development process as unnecessary government intervention in private individual matters. Others particularly those disadvantaged by unregulated construction, reclamation and general development showed their appreciation of having such a refuge in government to deal with unwelcome pollution that would have resulted from the increasing adverse effects of urban drift, and unsustainable land uses.

The inclusion of amenity values within the environment defined in the PUM Act is another area appreciated by the public. Influences of peaceful living benefits and the willingness to reside considerately among small plots in new residential areas at Vaitele, Vailele and the central urban area places importance on exercising the powers for maintaining acceptable amenity levels. MNRE is able to assist the public in cases of amenity infringement under the PUMA Act as well as through application of the Nuisance provisions of Health Ordinance.

Advocacy for change in PUMA's mandate and procedures would have to ensure that the planning and regulatory processes fully reflect Samoan cultural and social systems. This will require extensive consultations at community and other levels if the desired improvements in consistency, certainty, transparency, equity and timeliness are to be achieved while also ensuring that good environmental outcomes are not compromised. A comprehensive framework will be needed to guide any changes in the legislation and associated regulations.

The PUMA Act provides for a clearer process for invoking the EIA process. The requirement for an EIA or whichever form it needs to be carried out pursuant to the requirements of the PUM Board and Act could result in its mandatory undertaking or admission depending on the seriousness and complexity of the development. The key consideration being the significance of the likely environment impacts. A draft EIA Regulations under the PUMA Act is now ready for submission to parliament. It prescribes the process for undertaking of environmental assessments with emphasis on the kinds of issues that ought to be considered and evaluated. The decision on whether an EIA is undertaken or not is left with the flexibility of the development consent process under the PUMA Act 2004.

### 3.6.3 Future Legislation for Environment Management

It has been recognized that in order to achieve the aims of sustainable development and environmental protection (bringing Samoa in line with global trends), adjustments need to be made to existing legislation. The Environmental Legislative Review, which took place in 1993, with its specific recommendations on various aspects of existing legislations, could be a good starting point. A further assessment was commissioned under the SIAM I project, as part of the reforms government was institutionalising in its Ministries. The MNRE prepared under that project a draft Environment Bill, and its development called for further assessment of legislation relevant to the environment.

This has been further developed under the SIAM II project where other areas under the mandate of the Natural Resources and Environment, particularly land resources have also developed appropriate legislation drafts.

The following Bills are in the various stages of the legislative approval process of government;

- ***Environment Bill 2001***
  (To protect, conserve and enhance the quality of the environment of Samoa having regard to the need to achieve sustainable development, to establish and effective administrative structure and to make provision for the development, administration and enforcement of effective legislation for environmental matters) This Bill is yet to be submitted to Cabinet for endorsement before tabling in Parliament.
- ***Land Registration Bill 2006***

(To translate the land registration system to a Torrens system where land registration information database becomes computerized).

- ***Valuation Act 2006***
  (To formalize valuation procedures as well as enabling the Ministry as regulator of land valuation)
- ***Survey Bill 2006***
  The proposed Survey Bill 2006 amends the Survey ordinance provisions to enable the implementati0on of the Land Registration Act.
- ***National Disaster Management Bill 2006***
  (To bring into effect the National Disaster Management Plan and formalize institutional set up for preparation, response and recovery from national disasters)
- ***Environmental Bio-Prospecting Regulation1999***
  (To regulate access to Samoa's genetic resources and the equitable sharing of benefits derived from its users)
- ***Ozone Layer Protection Bill 2001***
  (To provide for the protection of human health and environment against adverse effect resulting or likely to result from human activities which modify or are likely to modify the ozone layer and to implement in Samoa the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that deplete the Ozone Layer)
- ***Beverage Container Deposit Scheme Bill 1999***
  (To provide for the payment for and refund of deposits in respect of beverage containers to encourage recycling and to protect the environment)
- ***Environmental Impact Assessment Regulations 2006***
  (To formally establish the EIA process to be followed under the Development Consent process of the PUMA Act 2004)

## 3.7 Environmental Information

### 3.7.1 Environmental Information since first SOE Report

Information on the environment of Samoa currently exists in a number of separate assessment reports, strategies and plans. In the 1993 SOE Report, quantitative and qualitative information on the environment was scarce mainly due to the lack of previous research and assessments having been undertaken. Information gathering was piecemeal until the development of the NEMS and formulation of policies that called for more baseline information gathering and assessments to provide basis for the development of programmes and projects that followed.

These baseline information gatherings and assessments have resulted in the availability of current information on flora and fauna of Samoa, as well as updates on counts for specific species of fauna that are considered of high priority for conservation actions**.** A great deal of information also exists among specific agencies and at all levels from national to community and grassroots. They are largely sectorally-based. The baseline data on flora and fauna have been mostly presented on the basis of existence and, only recently, on the level of populations in various key habitats.

Despite this increased availability of data, there is still a lack of information and particular tools ~~to~~ for decision-making at both national and community levels where they matter the most. For example, there is little baseline data available to support environmental impact assessments. The effectiveness, or otherwise, of environmental policy and management initiatives is difficult to determine~~d~~ if there is inadequate information on the state of the environment. If environmental and related considerations are to be integrated successfully into sector plans and operations, then there needs to be a mechanism for determining the extent to which specific environmental outcomes are being achieved. This can be done through the use of Sustainable Environmental Management Indicators (SEMI). The same indicators can also be used to ensure that environmental considerations are an integral part of performance-based budgeting.

The Ministry of Finance monitors the effectiveness of Government programmes, including the implementation of environmental projects by the MNRE, though, currently, the process is somewhat ad-hoc. Plans are in place to develop appropriate indicators to improve the robustness of the project

performance monitoring. These can be used to assess the extent to which all Government agencies are ensuring that their activities are making productive and sustainable use of natural resource assets and related environmental services.

Nevertheless, more and more information on the environment has become available and commonplace, with daily and weekly environmental columns in the local newspapers, as well as radio and television programmes. Information on the designated theme of the Environment Weeks that are commemorated every year has been archived, with publications of the Samoan Environment Forum on the MNRE's website (www.MNRE.gov.ws). Most of MNRE's public documents and publications can be accessed on this website.

The Environment Information Centre is one particular initiative of MNRE that has continuously evolved with the growing need for environment information. It started off as a Reference Information Centre for the staff of the DEC and now it has expanded to be the Resource Information Centre for the MNRE, being the repository and clearing house for all information that comes into the divisions of MNRE (Corporate Services, Technical Services, Land Management, PUMA, Renewable Energy, Legal Services, GEF Services, Water Resource Management, Meteorology, Forestry and DEC) that deal with environmental issues. The Environment Information Centre is the main place for researchers, students and academics to use when they come in to look for information and do their studies.

The use of a Geographic Information System (GIS) to store and present environmental data has progressed well in Samoa with the strengthening of the National Mapping Section of the Technical Services Division. Trainings on GIS and relevant spatial information technologies and methodologies is continuing for the relevant MNRE staff. A GIS user group has also been established.

All the reports and deliverables from the MNRE projects are available in English, but some have also been translated into Samoan. Legislation, policies, guidelines and codes of practice have also been prepared for key thematic areas such as EIAs, coastal management, biodiversity and climate change. They, however, need to be packaged in ways that makes them more accessible to the public, particularly those at the grassroots level. Information on the economy of Samoa is provided the Report of the Census of Population and Housing 2001, the 2002 Agricultural Census, SES and SDS.

### 3.7.2 Information Storage

The generation of information, particularly baseline data for natural resources, is very important so that trends in the environment, as well as impacts of management activities, can be determined. More over, Samoa is a party to a number of MEAs where reporting of national situations that reflect the state of the thematic area of concern is a national obligation. Inevitably, Samoa increasingly becomes absorbed into the global economy and world conservation initiatives. Samoa's commitment to the relevant international and regional initiatives for the sustainable development of the environment and natural resources needs to be ascertained at times. Evaluation of its performance against the goals and objectives of international actions, therefore, need to be carried out.

In all of Samoa's national policies which were developed under NEMS, dissemination of information is promoted as the basis for effective implementation of such national environmental management priorities. This is premised on the notion that easy accessibility to information will promote awareness and create interest in environmental issues and solutions, particularly at the community level, thus allowing more informed decision-making processes to prevail.

### 3.7.3 Benefits of Information Availability

Samoa has been able to report on the progress it has made in the area of environmental management. The first formal 1993 SOE Report recorded the state of environment of Samoa. Samoa's reporting obligations under the UNFCCC, CBD, Montreal Protocol, UNCCD, Stockholm Convention, etc. have all been enabled through the availability of information from such national assessments.

Policies have also been developed based on priorities identified in such national assessment. Evaluation of progress made under the WSSD, BPOA and the meeting of Millennium Development Goals (MDGs) was also possible based on available information. In the thematic areas, greenhouse gas sources and sinks have been estimated, consumption of Ozone Depletion Substances (ODSs) determined, national waste generation rates identified, POP levels assessed, and species counts for flora and fauna, as well as their habitat locations researched. The generation of such data and information over time has also enabled the assessment of change in forest cover, on-going status of endangered species (e.g. *ma'oma'o* and *manumea*) and the risks in hazard areas being more carefully evaluated.

Assessment of environmental impacts of development is supported by the availability of data and geographic information. Changes experienced at particular locations can also be documented and photographically presented to assist future predictions of changes and possible impacts.

## 3.8 Science and Technology

Samoa has limited capacity in science and technology. Specific areas of priority include biodiversity assessment, land capability, water quality analysis, waste management and pollution prevention, coastal and marine science, energy, climate change, land use planning, transport and sustainable development. In the energy sector, there has been greater adoption of technology for improved market-based energy management than in other sectors. However, efforts to develop or adopt renewable energy technologies are at the early stages.

The main objective of the recently established Research and Development Institute of Samoa (RDIS) is to conduct research in niche areas where Samoa has competitive advanges in products or services. The institute's initial priority areas of development are sustainable energy and food technology. While local science fairs are conducted for students to demonstrate their knowledge of science and technology, the status of science teaching at schools is weak. As a result, there are very few students that graduate from university in science.

New technology in the area of solid waste management has been introduced with the Fukuoka landfilling technology. The Tafaigata Fukuoka Landfill is the first of its kind in the South Pacific. It is an example of the type of technology that can be adapted to suit local conditions and operated within the level of local staff and plant capacity. Technology for wastewater treatment have been tested and implemented at specific sites and locations in Samoa. The use of on-site sewage treatment systems has been adopted within the central business district of Apia whilst awaiting the final designs and implementation of ADB-funded reticulated waste-water public system.

Samoa also needs to ensure that it is not the recipient of obsolete technology or new technologies that require large maintenance costs. New technologies should be well-tested through cost–benefit analyses and sustainability assessments prior to local application.

## 3.9 Financing the Environment

### 3.9.1 National Performance-Budgeting

The Economic and Development Planning Division of the Ministry of Finance has a planning and performance-budgeting function (Hay & Suaesi 2006). This function provides a framework for the allocation of financial support for human and other resources to the environmental management functions of Government and across the board. This framework is applied annually for the whole of Government and its individual Ministries and corporations in order to help formulate and approve annual budgets. An agency's budget is closely guided by the planned outcomes in its corporate and management plans.

Table 3.6 illustrates the trend in national budgetary allocations to the key sectors of the economy that are underpinned by the utilization of environmental and natural resources, namely agriculture, public

works and infrastructure and environment. Government's financial commitment to the management of natural resources has averaged 3% of total national annual budgetary allocations over the last seven fiscal years (1998-2005). There has been little variation from this average in the last seven years, although the MNRE has grown in size and its activities expanded[38]. The same trend is also evident in the Government's commitment to agriculture which is a highly relevant sector to environment in terms of biological diversity and conservation. Two major divisions of MAF have been recently moved to MNRE, hence the budget allocation for 2005/06 would reflect the loss and gain by the two Ministries, respectively.

Table 3.6: Percentage of annual budgetary allocations for key environmental areas

| Fiscal year | 1998/99 | 1999/00 | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 |
|---|---|---|---|---|---|---|---|
| Agriculture | 5.8 | 5.9 | 5.8 | 5.9 | 5.6 | 5.2 | 4.7 |
| MWTI | 14.5 | 12.2 | 13.4 | 12.5 | 13.6 | 14.1 | 15.6 |
| MNRE | 3.1 | 2.8 | 3.1 | 3.6 | 2.9 | 2.8 | 3.6 |

In the last seven years, only small allocations in terms of national budget and external aid have been provided to address natural resources and environmental management needs. The bulk of environmental management-related work in the form of projects is funded through bilateral and multilateral assistance. The latest information on the current and planned public sector investment projects, relevant to natural resources and environmental[39] management, was estimated by Hay and Suaesi (2006) at approximately 37% of the total value of Government's public sector investment projects. These are either through loans or grants.

### 3.9.2 External Support

Table 3.7 shows the trends in percentage of total foreign aid allocation for key sectors of the economy that are underpinned by environment and natural resources, namely agriculture, public works and infrastructure, water supplies and environment.

Table 3.7: Percentage of Foreign Aid Allocations

| Fiscal year | 1998/99 | 1999/00 | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 |
|---|---|---|---|---|---|---|---|
| Agriculture | 12.4 | 9.1 | 6.6 | 5.9 | 3.1 | 3.2 | 4.1 |
| Works | 1.6 | 9.3 | | | | | |
| Environment | 0.5 | 0 | 1.0 | 3.2 | 2.1 | 1.9 | 1.5 |
| Water | 5.1 | 21.9 | 21.8 | 35.7 | 6.7 | 2.1 | 2.2 |

There has been a general increase in environmental areas funded under enabling activity projects in the last four years. A considerable increase in the external funding for the water sector has enabled the formation of the newest division for water resources in MNRE.

Government reforms have resulted in the reshuffling of Ministries such as transfer of Forestry and Meteorology from MAF to MNRE. PUMA has also been returned to MNRE after 18 months with MWTI. Government has also made known its commitment to sustainable development through supporting a number of national awareness events and the annual Environment Week for over ten years. Samoa has actively participated in international negotiations for MEAs, further reflecting the government's support for the environment at the highest level.

As mentioned above, Samoa has an enabling project under each of the MEAs that it is a party to. Regional programmes under SPREP also allocate funding for Samoa. With all these projects progressing smoothly and meeting their objectives and timeframes, there is a concern that, once the funding for enabling activities is exhausted, Government may not be in a position to keep those projects funded and operational. While there is at present a large dependence on external funding for capacity building and pilot projects, MNRE should explore all bilateral and multilateral partnerships,

[38] MNRE Corporate Plan 2000-2003 and 2004-2006

[39] MOF. 2006. Public Sector Investment Programmes 2005/06-2007/08. GOS, Apia. pp 16-20.

nationally and globally, for continuing this strong support for its on-going environmental programmes. The latest initiative to establish a GEF unit within the MNRE is just one further example of such international partnerships flourishing with the commitment from GEF of further on-going funding.

External funding has also enabled the involvement of communities in environmental planning and management initiatives through the development of 41 CIM plans. Funds have also been made available through the GEF's Small Grants Programme for the implementation of community-based environmental projects.

## 3.10 Capacity Building to Support Environmental Programmes

### 3.10.1 What is happening?

The sustainable development of environment and natural resources is dependent on the capacity and resources of the agencies responsible for its planning and management. The responsible agencies should also have the necessary capacity and knowledge to carry out its mandate, and have a broad range of skills to be able to deal with the diversity of multi-sectoral issues that often characterize environmental and resource management initiatives.

### 3.10.2 The NCSA Initiative

Capacity building in Samoa is increasingly taking a more integrated approach to development planning. This includes building capacity within the Government to help prepare and secure approval of national policies and legislation. While many activities are currently project-driven, recent moves to a more programmatic approach are encouraging. The implications of core funding by the Government still need to be addressed. The partnership between the Faculty of Education (FOE) of the National University of Samoa and the Curriculum Development Unit of MESC is helping to ensure that the teacher training provided by the FOE is addressing the growing and changing technological and development needs of the community, and reflecting these promptly within the education system curricula.

While the Government is now outsourcing some development projects, there has not been a concomitant increase in the capacity of the private sector and civil society to provide such project services. For example, there is a need to improve the capacity of the private sector with respect to environmental planning, management and monitoring. Capacity is also required in line Ministries to ensure effective engagement with the private sector, CBOs and NGOs, and also to ensure that outsourced work is adequately assessed to comply with Government policies and plans and monitored for effective implementation. Importantly, many Ministries are still implementing project activities instead of providing an enabling environment for sustainable sector operations.

### 3.10.3 Strengthening the Role of Women and NGOs

In 1992, Samoa ratified the Convention on the Elimination of all Forms of Discrimination Against Women, and in 1994, the Convention on the Rights of the Child was also ratified. These are administered by the Ministry of Women, Community and Social Development (MWSCD) which provides policy and strategic advice and, to a lesser extent, vital welfare programmes. In 1999, a National Policy on Women was approved by Cabinet.

Gender awareness training workshops are an integral part of capacity building efforts by the MWCSD, as well as other Government departments and civil society bodies such as CBOs and NGOs. While the Government has yet to develop a policy on NGOs, it has adopted a collaborative arrangement with NGOs in terms of policy development and project administration. NGOs have been assisted to ensure that they become more effective in service delivery.

### 3.10.4 People with Disabilities

An important aspect of social integration is the goal of full and equal participation in national development by people with disabilities, as well as the removal of any barriers to the achievement of that goal. Forms of discrimination to be removed include lack of access to education, health services and employment, and difficulties in entering buildings and public space. There is a need to collect appropriate data on people with disabilities as they also play an important part in Samoa's national development. Emphasis should also be placed on the accessibility of infrastructure, particularly in key industries such as tourism.

### 3.10.5 Capacity for Project Management and Implementation

A number of training activities have been conducted for each of the Target Environment Components that Government has prioritized for action and where financial assistance was available. For instance, the Ozone Unit within the Metorology Division has completed the first phase of capacity building in good service practice for the phase-out of chlorofluorocarbons (CFCs), including the licensing system for their importation. Work on the second phase, for a complete phase-out of Ozone Depleting Substances (ODSs), is in progress Public awareness workshops and annual National Ozone Awareness events highlight the threats of ozone depletion and hence the need to reduce the use of ODSs. Consumption of CFCs in Samoa has been reduced since its phase out was implemented.

The MNRE's Meteorology Division needs strengthening with more resources required for disaster management operations. The Climate Change Unit, also within the Meteorology Division, is responsible for the coordination of climate change programmes and the implementation of national obligations under the UNFCCC, including the Integrating Climate Change Risks in the Agriculture and Health Secors in Samoa Project.

The most recent notable change in capacity building and awareness is the strengthening of the environment agency of Government, the MNRE. In 1992, there was only ten staff in the DEC, seven of which were local technical staff. At present, there are twenty two, all of whom are locals. As well, other Divisions dealing with land management, forestry and water resources have been added, as well as support services in planning and urban management, meteorology and spatial information have also been added or expanded along with a Renewable Energy Division and GEF Services Division. In all, the MNRE has 181 permanent staff and 254 casual employees.

In addition, numerous public awareness programmes for waste management, using various media including radio and television, are targeting community groups at community, village and district levels. School Information Kits have been prepared to go hand in hand with specific waste presentations, and both CBOs and NGOs have been involved in expanding the public's awareness of waste management issues. One way of disseminating information and technology that deals with waste management is through demonstration projects. One of the objectives of the National Policy on Waste Management is to promote environmentally-friendly technologies like composting trials at the village level, and also waste-to-energy pilot projects at the national level. In addition, Samoa's waste management system for Upolu and Savaii Islands is receiving regional recognition for its piloting successes, with abundant opportunities emerging to transfer this technology to other PICs (e.g. Fiji has already expressed an interest).

The Village Fisheries Extension Programme is a community-focused fisheries project which encourages villages to define key problems, discuss causes, propose solutions and take appropriate actions. Information at each of these stages is provided by various village groups, including women's groups and untitled men's groups, and is recorded by trained facilitators. The Fisheries Division provides technical advice mainly on fisheries-related matters including the development of alternative sources of seafoods. The Research Unit within the Fisheries Division undertakes surveys of fish reserves in participating villages. A general baseline survey normally takes into account the physical characteristics of the proposed reserve and this is carried out by the staff of the Fisheries Division who has been trained in scientific monitoring methodologies at marine institutions abroad. An opportunity exists here for long-term Sustainable Fisheries Indicator (SFiI) research, many of these

indicators over-lapping with other sectoral indicators (illustrating the harmonizing potential of many of these environmental management and sustainable development programmes).

Under the DEC marine biodiversity village level monitoring programme, several communities have members that are now equipped with the monitoring techniques and, in collaboration with staff of the Fisheries Division, they implement the monitoring of coral reefs in the established community-owned fish reserves.

The IUCN-funded Marine Biodiversity Conservation Project provides the village communities at Aleipata and Safata districts with the opportunities to plan and manage their own marine resources, implement alternative income generating activities, as well as build capacity and enhance environmental awareness.

### 3.10.6 Community Capacity Trends, Number of Workshops and Awareness Programmes

Success in the protection and sustainability of natural resources is achieved through community support and cooperation. The MNRE and its partner organizations must promote environmental education and awareness throughout the whole of Samoa. Collaboration and partnerships can add to the overall success of programmes and in achieving environmental goals.

During 2005, numerous workshops were conducted by the various Divisions and Units of MNRE. According to the MNRE's Annual Reports for the past six years, an average of 15 national workshops, 50 district and village workshops, and 10 consultative meetings were held annually. The high number of village consultations was a result of the SIAM II CIM Plan preparations in 2000 and again during 2005/2006. In the SIAM II Project, all 41 district CIM Plans have now been completed. These CIM Plans provide guidance in coastal protection and management in order to strengthen community resilience against the risks of natural hazards within the coastal areas.

### 3.10.7 NGO Capacity

NGOs play a very important part in complementing the capacity within the Government for addressing environmental and developmental issues. The number of environmental NGOs in Samoa has increased from one to four, and their contribution to the work of Government and communities has also expanded immensely.

At the local level, village councils have had numerous meetings and workshops with Government agencies responsible for natural resource and environmental management. Consultations have taken place with MWTI in relation to improving services and expanding infrastructure into villages, particularly the more remote villages. MAF has extensive programmes working with *pulenuu* and village councils in fisheries and forest conservation. MNRE regularly invites villagers andrepresentatives of village councils to district gatherings to solicit their views, as well as consult with them on systems and principles of natural resource management. While the actual impacts of these capacity building initiatives are yet to be fully evaluated, some villages have already agreed to ban deforestation, prohibit sandmining, ban pesticides, etc. Also, the upkeep of village hygiene and cleanliness is also a daily responsibility for other Community-Based Organizations (CBOs) such as the women's committees, *aualuma, aumaga*, etc.

### 3.10.8 Systemic Capacity

The response by Government in the form of policies, strategies, standards, codes of practice and procedures to guide the management of natural resources determines the systems for environmental management and sustainable development. Strategies and action plans are now in place for most of the Target Environmental Components (TECs) and these have been developed from their respective policies. These systems are either prescribed by law or through policy statements. The challenge now is to provide suitable and competent personnel and resources to enable implementation and enforcement. MNRE is also endeavouring to draft new environmental management and sustainable development legislation that is prefaced by the mandates included in all relevant MEAs and other relevant regional and global protocols and conventions.

### 3.10.9 Spatial Information

One of the tools that can assist Samoa in the management of its natural resources and environment is the use of spatial information. The available data date back to the early 1950s. Historic series of aerial photographs, which have been upgraded to orthophoto maps, provide a basis for generating images for monitoring many of the environmental parameters as well as determining the condition of land areas over time.

A standard topographical map series at 1:20,000 scale covers the islands of Samoa in 28 map sheets. This map series was revised in 1999 at 1:50,000 as Samoa's national base map, superceding the older series. Rectified orthophoto maps at 1:50,000 were also produced to visualize the entire island. Aerial photographs were taken in 1954, 1970, 1980, 1981, 1990 and 1999 are also available. The most recent aerial photographs were completed in 1999 with 100% coverage at 1:50,000 and 100% coverage of coastal areas at 1:15,000, measuring 3kms inland from the coast. Ikonos satellite images which were captured in 2004 are also available and can be used as a dataset to revise the existing topographical map series. Land resource maps of Samoa are also available and are classified under land capability, soil and land use/tenure.

### 3.10.10 Planning Services

The capacity for planning for environmental management and protection has grown substantially since the late 1990s. For the MNRE itself, two new Divisions were established, namely the Land Management Division and PUMA, both with their own planning and policy sections. PUMA now provides spatial planning and environmental protection advisory services to Government and the public sector.

The Planning and Urban Management Board has provided a national system for ordely land use planning by offering a development consent process as well as monitoring of public amenity issues.

# 4. Cross Cutting Issues and Challenges

## 4.0 Introduction

Growing concerns by both the Government and the public about protecting the fragile local natural, physical, cultural, social and economic environments, and the need to increase the awareness of how best to conserve and restore Samoa's limited and highly vulnerable natural resources, have become more evident in recent years[40]. The on-going threat of cumulative environmental degradation, most of which are non-renewable, has led to the realization that attaining a sustainable future will require a more effective approach to resource management than what we have experienced to date. This implies a certain indifference and/or lack of appreciation of environmental issues over the past few decades in Samoa, both at the national and community levels.

However, the establishment of the Division of Environment and Conservation (DEC) in 1989, within the Department of Lands, Survey and Environment (DLSE), was indicative of the real commitment that Government was placing on addressing some key environmental issues, especially biodiversity conservation. The Lands, Survey and Environment Act 1989 (LSE Act) stated that DEC's primary role was to:

- influence the management of natural and physical resources and ecosystems
- enact effective environmental legislation
- ensure and promote the conservation and protection of the natural resources, and
- advocate conservation of the environment.

As mentioned above, protection of the environment, or *siosiomaga* (our 'surroundings' in Samoan), implies protecting our physical, natural/biological, cultural, economic, man-made/built and social environments simultaneously. If Samoa takes this holistic approach, then the cross-cutting issues and challenges become far more evident. MNRE has, therefore, accepted this challenge by designing appropriate national policies, strategies, plans, appropriate legislation, etc. in order take a more programmatic approach to the major issues confronting, often, more than just one sector.

However, as both the public and private sectors increased their respective environmental and developmental commitments over time, and as the appropriate financial and human resources were slowly acquired, the overall progress was still seen to be piecemeal. Therefore, the real challenge facing MNRE now is reducing this 'response time'. Therefore, with all the best resources in place, the GOS, MNRE and all other stakeholders, could be assured of a very different outcome, hopefully with an increasing standard of living, the MDGs being exceeded, and the integrity of Samoa's future sustainable development pathway being assured.

Samoa is in the process of formulating a long-term partnership with GEF, not only in terms of funding many of the key development programmes in Samoa, but also by offering the best possible technical assistance as well. Samoa has, therefore, accepted a reciprocal obligation to GEF to not only accept and implement this technical assistance, but also to help disseminate these environmental and developmental achievements throughout other PICs. However, raising the environmental awareness in all villages in Samoa is in itself a monumental task. Creating the most enabling development environment is another task with formidable challenges ahead for us all.

And this highlights yet another challenge, and that is the difficulty in mobilizing primarily an informally-educated population that cannot measure CFCs, ODSs, POPs, GHGs and creating the most enabling development environments, especially at the Governmental level. Without good governance and sound accountability of our national leaders, and without the best possible human ethics being deployed, attaining sustainable livelihoods for all will only continue to be a dream or an ambition and not a reality. Achieving this holistic and enabling environment has been the single-most challenging issue faced in the past decade or more by the MNRE. However, without all the ongoing and increasing commitments from all relevant Ministries, the progress reported to date in the 2006 SOE Report would never have been possible. Chapter 5 identifies the slowly-emerging way forward,

[40] GOS. 2002. Strategy for the Development of Samoa 2002-2004. MOF, Apia, Samoa.

identifies the existing gaps in our approaches to date, and concludes by emphasizing the need to establish real-life examples of sustainability within Samoa. One of the largest oversights to-date has been the failure to recognize the important role to be played by the *fa'aSamoa*, possibly more effective than any other single measure taken to-date. Our Elders entrenched sustainability

In 1993, the Government commissioned the first State of the Environment (SOE) Report and developed its National Environment and Development Management Strategies (NEMS) as a result. NEMS sets out the procedures and structure for environmental management and sustainable development and outlines activities to guide effective environmental management in a bid to conserve the country's limited resources. This was another attempt to strengthen the integration of environmental issues into development planning and implementation.

The formulation of NEMS was seen as a positive step in the right direction. However there is still a need for a greater credibility through the allocation of adequate financial and human resources and integration into the Government's planning process. Planning for sustainable development ought to start at the grassroots level and progress towards the village and district levels. Likewise, centralized planning in Government must also filter down to the communities in a transparent and integrated manner.

All facets of Samoa's society, culture and economy need to be fully understood, or at least appreciated, in order to understand why people exert undue pressure on their natural environment, social environment, cultural environment and even their economic environment. These issues and concerns cut across numerous sectors and present challenges to attaining sustainable management of the environment and success of national and community initiatives to strive for sustainable livelihoods for all within Samoa. Cross cutting issues and concerns posing challenges to the integrity of the environment and success of national and community initiatives to ameliorate them range from poverty to poor land use management, health and sanitation, demographic trends and unsustainable design and implementation of economic development activities.

This Chapter 4, therefore, presents many of these issues in a sequence that allows the reader to gain a simple cumulative impression of not only the severity of the issues before us all, but the urgency with which Government and the private sector need to respond in order to reverse the environmental and developmental trends as outlined in Chapter 2.

## 4.1 Poverty

### 4.1.1 Is there Poverty in Samoa?

One of the primary targets of the Millennium Development Goals (MDG's) that Samoa has adopted is to eliminate poverty at the national and community levels. Its goals specifically target "halving the proportion of those whose income was less than one (US) Dollar a day in 1990 by 2015", and "halving the proportion of people who suffered from hunger in 1990 by 2015". Samoa has an average daily income on a per capita basis that is above the minimum threshold set by the UN at $USD1 per day. The second target may also be disputed as being insignificant for Samoa. However, consultations and documentation indicate that there is weight in expressing that poverty actually exists in Samoa in the form described in the UNDP Pacific Human Development Report (1999); being not so much just a poverty of income, but rather poverty of opportunity, as poverty of income is often caused by poverty of opportunity.

The Government has responded to this poverty of hardship and poverty of opportunity through providing better education as a priority. The current SDS (2005-2007) encourages the emphasis on education in families where there is greater involvement of parents in their children's education. Much improvement has also been made to school facilities and equipment through bilateral reactions with developing partners. The Ministry of Education, Sports and Culture (MESC) has gone through institutional strengthening programmes, including the establishment of the Samoa Qualifications Authority (SQA) in 2005 whereby systems and processes for improved quality control of plans and

outputs are developed. Opportunities to escape the impacts of poverty are availed locally through the National University of Samoa (NUS) and the University of the South Pacific, Alafua Campus (USPA).
On a macro scale per capita GDP, which has been traditionally used as the measure of the standard of living, has increased from $USD760 in 1993 to around $USD1,200 according to current estimates. On a global scale, the human development achievements based on the Vulnerability Index continued to place Samoa under the United Nations category of Least Developed Countries (LDC). The shortcomings of the GDP per capita has led to the increasing use of the Human Development Index (HDI) which is constructed from a number of economic, health and education achievement indicators including life expectancy, real per capita GDP, adult literacy rate and combined enrolment ratio. In 1994, Samoa ranked 88 out of 174 countries in the HDI which was slightly less than Fiji, but well above Papua New Guinea. The strong social indicators such as life expectancy, literacy and access to water, health and education services have lifted the global ranking of Samoa in contrast to the GDP per capita measure.

Existing literature and consultations indicate that the main characteristics of poverty as they apply to Samoa on the basis of available statistics are discussed as: (i) poverty of income; (ii) food poverty line; (iii) basic needs poverty line and (iv) poverty of opportunities.

These poverty concepts are often analyzed based on national household income surveys which attempt to measure household or individual income or the extent of income inequality. The effectiveness of these income-based measures is limited on account of the special characteristics that are also important for livelihood. In the case of Samoa, such characteristics include the role of subsistence production, remittances, operations in the cash and non-cash economy and an understanding of the Samoan traditions and culture.

### 4.1.2 Poverty of Income

Income poverty is defined as the lack of sufficient income to meet minimum consumption needs. Relative poverty means living in a considerably worse way relative to other people in the same society.

As part of the UNDP Poverty Strategy Initiatives 2004, the latest empirical study to measure poverty in Samoa was conducted through the Department of Statistics using the results of the 1997 Household Income Survey. The study examined absolute poverty using food and basic need poverty line estimates as well as relative poverty assessed in terms of the characteristics of the poorest 20 percent of sample households. There has been some controversy with the findings of the study on sampling methods such that Government has yet to decide on an acceptable benchmark for poverty measurement. As a result Government undertook a poverty-focused survey in 2002 to develop a comprehensive poverty strategy.

### 4.1.3 Food Poverty Line

The Food Poverty Line (FPL) identifies households which cannot afford a basic minimum nutritionally adequate and palatable diet. Using the data from the 1997 Samoa Household Income and Expenditure Survey, the FPL was estimated through the UNDP funded study at $SAT152.43 representing a weekly diet for a family of four adults and three children developed by the Nutrition Centre of the Health Department. The results showed that around 50% of households do not have sufficient daily food expenditure to meet the dietary requirements.

### 4.1.4 Basic Need Poverty Line

Basic Need Poverty Line (BNPL) identifies households which cannot afford the basic minimum nutritionally adequate and palatable diet as well as essentials for life such as transport, energy (electricity, kerosene and wood), health, education, water, and housing. Using data from the 1997 Samoa Household Income and Expenditure Survey the BNPL was estimated at $SAT189.27 representing a weekly minimum expenditure for a diet for a family of four adults and three children as well as the minimum costs for transport, energy, health, education, water and housing. The results

found that one in three households could not properly meet their basic needs and were poor according to the estimated BNPL.

The UNDP (2004) analysed characteristics of the poorest households using standardized household expenditure data. This analysis assumed that household expenditure was for the equal benefit of all household members which may not necessarily be so in reality. The results show a median total daily expenditure per adult equivalent from standardized data of $SAT6.12. The lowest 20% of households spent around ST3.39 per day for each adult male equivalent.

### 4.1.5 Poverty of Opportunity

Poverty of opportunity is defined as the inability of people to lead the kinds of lives they aspire to. It is also based on the principle that more people are denied basic human opportunities than are denied a minimum income. Poverty of opportunity can be assessed in terms of education, health and employment, however, it can also involve the denial of opportunities in material well-being, access to markets, job security, political and social freedoms and other dimensions.

On account of the peculiar Samoan culture and social practices, the broader concept of poverty of opportunity includes the level of access to and standards of education and health services, lack of economic assets, social exclusion and political marginalization, is considered a more appropriate description of poverty for Samoa[41].

The possible potential areas, which aggravate vulnerability to poverty in Samoa, are linked to the following economic, political, cultural and vulnerability factors:

(i) A narrow economic base and geographic isolation from markets,
(ii) Customary land tenure system with no clear registration system in place hinders development of customary lands, particularly in rural areas. However, it also ensures that there is access to land for every member of the extended family,
(iii) Customary owned land cannot yet be used as collateral for financing,
(iv) Vulnerability of agricultural crops to pests and diseases as shown by the taro blight could aggravate poverty in the agro-based villages in the rural areas,
(v) Vulnerability to cyclones and other natural disasters like flooding is significant given the concentration of settlements and traditional villages that are located in exposed coastal areas,
(vi) Urban drift,
(vii) Lack of paid employment opportunities,
(viii) Lack of access to credit,
(ix) Geographical isolation from the mainly centralized services, and
(x) Impinging global environmental impacts of unknown severity.

The growth of the formal economy has been reflected in a growing concentration of income since the early 1970s. However, where growth is achieved on a sustained basis, it has been argued that generally poverty will be reduced and most people will benefit from a higher standard of living. Seen in these terms, the growing income concentration from 1972 to 1997 is related to the growth of the formal and urban sector in Samoa and is an important condition for a higher general standard of living.

The wage-earning sector makes up less than half of those who are classified as economically active. In 1996, the national average wage in the formal sector was about $SAT5,000, with 60% of wage earners earning less than the average and around 86% earning less than $SAT10,000 (UNDP 1998). Urban villages are much more likely to have a waged worker compared with peri-urban and rural villages. Village studies have shown that 78% of families in an urban village had at least one waged worker compared with 37% in a peri-urban village and 33 percent in rural villages (Fairbairn-Dunlop 1991). Within the traditional domain, both pastors and local entrepreneurs have higher economic standing. However, entrepreneurs must redistribute considerable income to traditional causes to maintain their ability to operate effectively as an entrepreneur.

41 Government of Samoa. 2003. National Assessment Report for Barbados Programme of Action, Apia.

The Government has demonstrated a strong commitment to social development. This is reflected in particular in the priority given to education, health and basic infrastructure. However, as the formal economy continues to grow, there will continue to be growing social pressures with urban drift, possibly leading to higher crime and increasing environmental pressures and a weakening of traditional cultural norms.

## 4.2 Health

### 4.2.1 Health Services

Samoa at present has health indicators equivalent to those of some developed countries. These include demographic features of the young and older population as described in the section on Population such as fertility rate, life expectancy, cases of communicable and non- communicable diseases, nutrition-related conditions, water-borne and food-borne diseases, and iron deficiency (anaemia) prevalence.

Indicators for health service delivery includes the number of doctors, facilities and equipment as well as programmes and capacity building initiatives undertaken by the health service providers, both private and Government. One example is the new health care waste management system currently in operation after many years of poor disposal techniques due to a deteriorated incinerator at the National Hospital at Motootua. The operation of the new waste management system includes the collection and separation of combustible waste and all pathogenic wastes that can either be incinerated at the central incinerator or at the Tafaigata Landfill.

Due to recent reforms, the Ministry of Health (MOH) has been segregated into 2 entities: the MOH and the National Health Services (NHS). The MOH maintains the regulatory, policy development and monitoring role. The NHS, on the other hand, provides health service delivery, including all public hospitals and facilities. The facilities include the Tupua Tamasese Meaole (TTM) Hospital which is referred to as the National Hospital in Apia, the Malietoa Tanumafili II (MTII) Hospital referred to as the Regional Hospital for Savaii, six District Hospitals (3 on Upolu Island at Lalomanu, Poutasi and Leulumoega, and 3 on Savaii Island at Foalalo, Sataua and Safotu), and 19 Community Health Centres. The number of doctors as of 2006 is about 50 which are employed by Government, and as many as 20 are private practitioners on call.

Community Health Centers on both Upolu and Savaii are located at the following villages. (Table 4.1).

Table 4.1 Community Health Centres in Samoa

| **Upolu** | **Savaii** |
|---|---|
| Lufilufi | Patamea |
| Sauano | Samalaeulu |
| Salimu & Musumusu | Fagamalo |
| Maasina | Aopo |
| Siumu | Taga |
| Fusi | Sili |
| Afega | Tafua |
| Siufaga | Faala |
| Savaia | Satufia |
| Mulifanua | |

Health promotion and health prevention remains a key strategic focus. The Government will continue to develop and intensify health promotion and health education policies and programmes. Primary healthcare services will be improved through strengthening primary and secondary prevention and treatment programmes for non-communicable diseases (NCD).

An integrated community health service will be established at the community level. This will ensure effective planning, management and resource utilization for primary and secondary health service delivery. A mobile clinic is currently in operation to improve rural community health services.

Health facilities will continue to be upgraded to enable an efficient and effective delivery of health services. Existing facilities have been renovated to improve operational efficiency. Strengthening collaboration with the private sector will be further pursued, one example being the Sleep Clinic operated by METI in Apia with over 400 patients being treated for obstructive sleep apnoea within a 7-year period.

### 4.2.2 Non-Communicable Diseases

Lifestyle diseases or Non-Communicable Diseases (NCDs), that are associated with diet, lack of exercise and excessive use of alcohol and tobacco, can be exacerbated by the condition of the environment within which the person is exposed to. Air pollution, caused by smoking and fumes from vehicles and factories, is a known cause of respiratory diseases. Table 4.2 illustrates that the leading causes of in-patient deaths in Samoa are associated with the circulatory system, pre-natal conditions, respiratory conditions and infectious and parasitic diseases.

Table 4.2 Leading Causes of Mortality in Samoa (1999 and 2002)

| Rank | Disease (Cause Groups) | 1999 | | 2002 | |
|---|---|---|---|---|---|
| | | Number | % Total Illnesses | Number | % Total Illnesses |
| 1 | Circulatory Diseases | 65 | 25.4 | 70 | 38 |
| 2 | Respiratory Diseases | 35 | 13.7 | 19 | 10.3 |
| 3 | Infectious & Parasitic Diseases | 22 | 8.6 | 29 | 15.8 |
| 4 | Certain Conditions originating in the pre-natal period | 22 | 8.6 | 8 | 4.3 |
| 5 | Diseases of the digestive system | 19 | 7.4 | 7 | 3.8 |
| 6 | Injury, poisoning and other consequences of external causes | 19 | 7.4 | 9 | 4.9 |
| 7 | Endocrine, nutritional and metabolic disease | 15 | 5.8 | 6 | 3.3 |
| 8 | Neoplasms (cancers) | 14 | 5.4 | 14 | 7.6 |
| 9 | Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified | 12 | 4.7 | 13 | 7.1 |
| 10 | Diseases of the skin and subcutaneous tissue | 11 | 4.3 | 9 | 4.9 |

Source: Ministry of Health Annual Report s - 1999, 2002 & 2003.

### 4.2.3 Diseases Associated with Natural Disasters and Pollution

Serious concerns are placed on unhealthy conditions. These concerns are directed at diseases, either caused by natural disasters or pollution, which are not properly treated. Diseases as such in Samoa include vector-, water-, air- and food-borne diseases, including the following:

- Typhoid
- Dengue fever
- Filariasis
- Lung cancer
- Respiratory diseases and
- Food poisoning

One further concern is the issue of poor sanitation. This is due to poor water management and water treatment which has caused the contamination of drinking supplies. Some diseases, in particular

typhoid, gastroenteritis and diarrhoea, are frequently diagnosed due to the consumption of polluted drinking water. Emphasis should be placed on these diseases as highlighted in Table 4.3 below.

Table 4.3 Water-borne Diseases in Samoa

| | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|
| Typhoid | 72 | 129 | 141 | 144 |
| Gastroenteritis | 314 | 355 | 332 | 140 |
| Diarrhoea* | 17 | 18 | 15 | 16 |

*NB diarrhoea is classed as an Indicator and not a disease in itself.
Source: Rural Water Supply and Sanitation Study (2005)

It is, however, difficult to trace the source of the outbreaks for these waterborne diseases due to lack of resources. It is estimated, however, that many more people suffer from the effects of water-borne diseases than the incidence recorded in the statistics. Multi-pronged public health interventions which are designed to tackle these problems are, therefore, essential as it will be difficult to attribute any observed improvement to a particular intervention.

### 4.2.4 Preventive Healthcare

Resolving health issues is one of the sustainable development priorities of Samoa. Existing information particularly Samoa's National Assessment Report (NAR) highlighted poor waste management practices, poor water quality, free-ranging domestic animals and the excessive use of fertilizers and pesticides as serious health threats in Samoa. Also highlighted was the concern over the continual breakdown of traditional medicine systems.

Modern medicine is expensive and not always available to all sectors of the population. Fundamental environmental health requirements, such as the provision of safe drinking water, food safety, hygiene and sanitation, have been overlooked in national economic planning, with significant gaps in their provision. Nevertheless, access to satisfactory sanitation services has improved from 1990 to 1998 (WHO, 1998).

Although the overall health of the people has improved, they are faced with threats from HIV/AIDS and a resurgence of infectious and vector-borne diseases such as dengue fever and leptospirosis. Illnesses related to inadequate water supply and unsanitary conditions are prevalent, especially in informal settlements in marginal locations. Diarrhoeal diseases and acute respiratory infections continue to be a major cause of mortality in young children. Cardiac diseases, diabetes and other non-communicable diseases are the leading causes of death in Samoa (MOH, 2005).

There are an increasing number of deaths from suicide, accidents and a growing incidence of substance abuse and crime (SPC 1998). The increasing problems associated with excessive alcohol consumption and corresponding services, the demand for which continues to grow (PIFS 2002), are straining Samoa's limited health resources. Medical and dental services are limited and hospitals are understaffed and under-equipped. There is an unequivocal link between the change in diets from traditional indigenous foods to less nutritious diets (with increasing proportions of imported foods) and the increase in obesity.

## 4.3 Land Use for Sustainable Development

### 4.3.1 Types of Land Use

About 15% of land in Samoa is publicly-owned and is generally known and recognized as Government land. Under statutory law, access to Government land is through lease or exchange of either freehold land or customary land. Freehold land takes up 4% of the total land area. Landowners independently manage their own lands. These can be alienated in any manner desired by the owner, be it through sale, gifting, leasing, licensing or exchange. However, alienation to non-citizens or overseas residents is prohibited under the Alienation of Freehold Land Act 1972 unless granted consent by the Head of State.

Customary land comprises 81% of land in Samoa. These lands, which are vested in Samoans in accordance with Samoan custom and usage, are primarily managed by the *matai* who is the head of an extended family. As trustee for his/her family, the *matai* is responsible for the management and allocation of the land for various uses by family members. These lands are protected from alienation by sale by the Constitution of the Independent State of Samoa 1960, except by way of lease or license in accordance with the Alienation of Customary Land Act 1965.

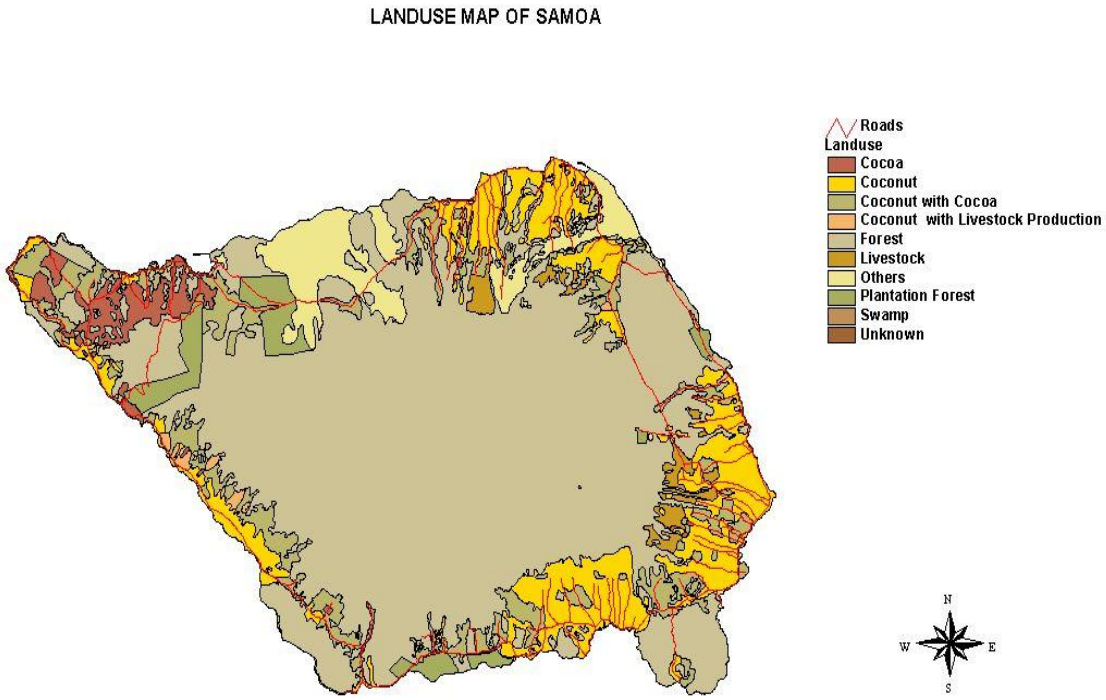
An emerging form of land tenure is leased land which is land under lease arrangements between the leasor (landowner) and the leasee (applicant). All types of land, whether Government, freehold or customary, can be leased out to individuals, corporations and community or to private investors. In this regard, leasing can provide a viable option to access the land necessary for private sector growth. It also allows for upgrading the socio-economic statuses of individual family with large-scale farming intentions and for residential purposes. Ideally, leasing allows the use of land without alienating it from traditional landowners.

The Government closely controls the leasing of customary land. The Minister of MNRE, as the trustee of customary lands, is vested with the power to manage and administer lease arrangements between the leasor and the leasee. The Minister's involvement in land leasing is designed to ensure that landowners are protected from entering into inappropriate land deals or making unwise decisions, and to prevent alienation of customary land or ownership from the landowner.

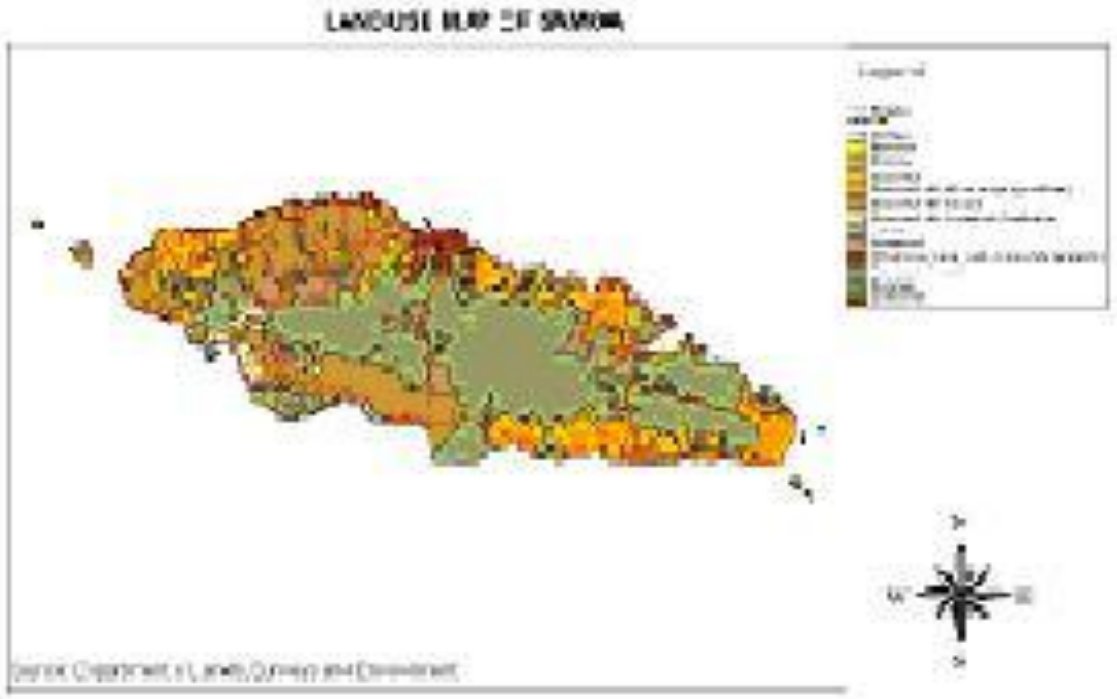
### 4.3.2 Changes in Land Use

Samoa's land cover has undergone tremendous change and modification since the last two decades and far more rapidly as we approach the end of this century's first decade. Traditional land use, apart from settlement areas, was commonly restricted to forest and agricultural use. However, the current speed of societal technological innovations, in tandem with infrastructure development which is largely dictated by macroeconomic ambitions, land use change has become far more pronounced because of the influence of commercial interests. Additional alterations to the landscape are made worse by by-products of natural disasters. The old land use maps of Upolu and Savaii represent land areas that are under current use, and the most typical land use reflected, apart from forest, is land under agricultural use.

**Figure 4.1 Land Use of Samoa**




Source : Department of Lands, Surveys and Environment



It is difficult to estimate accurate change to the land cover without using forest survey data which may reflect the transformation of Samoa's land cover to various other uses. Periodically, Samoa's forest resources have been inventoried and studied at various times since 1954, and most recently in 2004 using the 1999 aerial photos (SamFRIS, 2004). The resulting estimates from these various reports are at times inconsistent and do not allow for significant comparisons, but they remain the only data on which to base planning and management decisions on.

Earlier in the 1980s, it was recorded that of the total land area of 2, 935 sq. km or equivalent to about 285, 000 ha, about half was in forest. And of the 150, 000 ha of forests, about 55, 000 ha fell under protection forests as National Parks and Reserves, with 95, 000 ha regarded as commercial forests, with a small area as re-afforested land (Samoa, Dept. of Economic Development, 1985). The ADB report (1985) estimated in the same period the total area under tree crops, mainly coconut and cocoa, at 77, 211 ha.

The trend with land use patterns in the 1990s records is slightly different with additional land uses and variations observed in the land use type. The following land use Tables 4.4 and 4.5 reflect this variation and the situation with land use change to Samoa's land cover.

Table 4.4 Estimates of Landuse in Samoa, 1991

| Landuse Type | Area (ha) '000 | % |
|---|---|---|
| Plantation forests | 10.7 | 3.8 |
| Indigenous forests | 104.0 | 36.8 |
| Agricultural Use (Crops & Pastures) | 139.2 | 49.4 |
| Other (lava flows, towns, etc) | 28.1 | 10 |

**Source**: NEMS, 1994 p. 34

NEMS (1994) estimated land use in 1991, as Table 4.4 shows, under four categories with land under forest cover at 36.8% followed by land under agricultural use at 49.4%. Other land use types comprising the remaining land cover are plantation forests and other which includes some other type of land uses.

Table 4.5 presents further approximate figures for early 1990s of which 34.7% of total hectares are predominantly under agricultural use with merchantable forest and protected forest under village conservation areas at 4.6% and 1.1% respectively. Other land uses, which are more or less forest-based, comprise the remaining percentages with unproductive forest areas standing at 39.4%. This implicates an unfavourable situation with the land terrain soils predominantly porous and and/or rock-strewn.

Table 4.5 Estimates of Land Uses in Samoa 1993

| LAND USE TYPE | AREA (ha) | (%) |
|---|---|---|
| Merchantable Forest | 13, 574 | 4.6 |
| Forest Protected / Village Conservation Areas | 3,089 | 1.1 |
| Watershed Areas | 31,992 | 11.3 |
| National Parks/Reserves | 2,880 | 1.0 |
| Land Available for Reforestation | 10,000 | 3.6 |
| Agriculture / Cropland | 98,000 | 34.7 |
| Recent Lava Fields | 11,433 | 4.1 |
| Unproductive Forest Areas | 111,112 | 39.4 |
| **Totals** | **282,000** | **100.0** |

**Source: Extracted from Climate Change Synthesis Report 2004**

Based on 1999 aerial photos, land use estimates in Table 4.6 shows a clearer and more detailed breakdown of land use types with additional categories, apart from forest and agriculture, to include 'Built up area' and 'Infrastructure' areas under which encompasses a number of other significant uses.

Table 4.6 Land-cover categories of Samoa (based on 1999 aerial photos)

| Main Category | Description | Area (ha) | | %age of Samoa land area |
|---|---|---|---|---|
| | | Savaii | Upolu | |
| Forest | Land with a tree crown cover of more that 10% and a minimum size of 1 hectare. Includes man made plantation forests, mangrove forests and other natural forests | 118,037 | 52, 406 | 60.0 |
| Agricultural Land | Plantations – permanent agricultural installations, mostly tree crops or continued/repeated planting of e.g. coconuts or bananas (agro-industrial) Mixed Crops – land currently and recently cultivated with a mixture of herbaceous and tree crops such as root crops, taro, yam, cassava, breadfruit, etc. This includes areas of current cropping and adjacent areas recently abandoned and now overgrown with secondary shrub and tree species | 28,621 (Plantations - - 26, 158) (Mixed Crops - 2, 463) | 34,476 (Plantation - 26, 770) (Mixed Crop - 7, 706) | 22.3 |
| Wooded Land (Scrub) | Areas with dominance of woody perennial shrubs of less than 5-7m height and without a definite crown | 15, 065 | 7, 000 | 7.8 |
| Built-up Area | All settlement areas, encompasses continuous developments, industrial or commercial built-up areas and scattered isolated houses including gardens and inner-city parks | 1,772 | 5,292 | 2.5 |
| Barren Land | All land lacking any vegetation cover except for infrastructure and built up areas | 1, 973 | 30 | 0.7 |
| Infrastructure | All roads (hard surfaced or loose) and infrastructure related facilities (e.g. airports/airstrips, ports, wharves, sports compounds etc.) | 32 | 432 | 0.2 |
| Other | Includes grassland, lakes, rivers and wetlands | 5,379 | 13,141 | 6.5 |
| **Total** | | **170, 879** | **112, 777** | **100** |

**Source**: SamFRIS (2004) p. 13

Moreover, Table 4.6 indicates the remaining forest resources of Samoa. The total forest area ~~c~~consisted of all major forest types, including mangrove and forested wetlands, and amounting to more than 171,000 ha which makes up more than 60% of the total land area: this is, therefore, larger than earlier mappings indicated Of the non-forest categories, agricultural plantation area makes up the largest portion with more than 53, 000 ha covering almost 19% of the country. While plantation area is almost evenly distributed between Savaii and Upolu, there are clear discrepancies for mixed crops, grassland and built-up area–which are dominant on Upolu. Barren land is common on Savaii Island, particularly on recent lava flows and landslides on the slopes of the main volcano, Mt. Silisili. The island of Upolu still has a forest cover of approximately 47% while 69% of the total area of Savaii is still under forest. However, discrepancies become evident when looking at the distribution of forest types. There is virtually no medium forest left on Upolu with only 402ha situated in northern Upolu. Medium forest on Savaii still covers an area of 72,150 ha. On Upolu, on the other hand, the largest forest category is open forest with more than 33, 000ha.

Consequently, considering the magnitude of the current conversion of the landscape from forest to various other uses, there has been numerous changes in the way land is used in Samoa in the last decade which continues to this century particularly in Apia for an urban area and land under agricultural development or use in rural areas. Land that used to be under forest cover has been extensively altered to allow for all other uses, in particular agricultural expansion. In the rural communities, land remains primarily under customary ownership and a large proportion of it is currently under cultivation more so at the expense of native forests.

### 4.3.3 Planning for Land Use

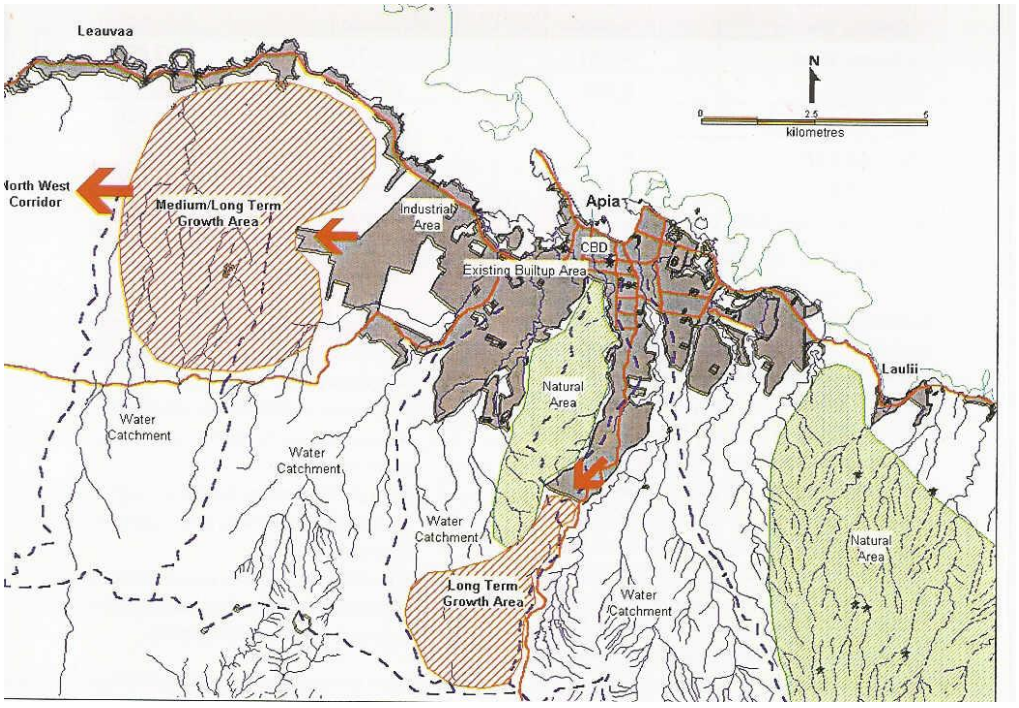
Government initiatives began in the 1920s on land use planning. It was later revamped in the 1980s, and recently under an ADB-funded project for development of an integrated Urban Planning Strategy for Samoa which encountered difficulties in defining the urban area of Apia. Such difficulties include:

- The coverage of 'urban' type services - water, electricity, transport and waste disposal - is widespread in the Census-defined Apia urban area, North West Upolu and Upolu.
- Population is growing both within and outside the narrow Census-defined Apia urban area; and
- The coastal road corridor between the small Census-defined Apia urban area and Faleolo Airport in North West Upolu contains contiguous village development where one village abuts the other, thus complicating defining a precise urban boundary for Apia.

The 2001 Census of Population and Housing indicated an increase of 7% in the population share for Apia and North West Upolu from 46% in 1991 to 52% in 2001. The Apia urban area, as defined by the 2001 Census, had marginally increased from 35,489 in 1991 to 38,836 persons in 2002. However, if the two districts to the east and west of the core Apia urban area are added to reflect the neighbouring Apia urban area, then the population of the existing built up urban area of Apia is 60, 872 persons or approximately 35% of the 2001 national population.

This implies that the population of the Apia urban area and its neighbouring areas is rising. Its growth will be concentrated on the coastal plains of North West Upolu. (see Figure 4.2)

**Figure 4.2 Urban Growth Directions**




Source: PUMA, MNRE.

Estimates of Apia's urban share of national growth for planning purposes should be seen in the context of exactly what extent the growing North West Upolu corridor is effectively defined as 'urban' in character. The clear trend is that population growth will lead to continued pressure on the resources of Apia and peri-urban areas, as well as continued economic, social and environmental change within the wider regions of Upolu and Savaii. These changes will continue to lead to increasing demands for land, infrastructure and services, housing, with changes in village size and home ownership, along

with change in village and family social organizations and patterns as are currently being experienced.

The villages are growing rapidly in the urban hinterland with many having expanded to the extent that their village boundaries blur the 'urban rural' divide. As a result, villages now form a one linear strip of urban development between Apia and the International Airport at Faleolo, some 30 kilometres to the North -West of Apia. Traditional housing with open walls *(fale)* and plantation lands are being supplemented by modern *palagi* housing. Smaller gardens, especially on freehold lands, and larger areas for family plantations on customary lands, characterize households that support their livelihood based on subsistence farming..

There is generally a high coverage of service levels in the provision of water supply, whereby 94% of households in the Apia urban area had piped reticulated water (2001 Census), as well as main roads in urban Apia, despite increasing concerns of road maintenance. There is also a solid waste household collection service for not only Apia, but for both main islands. Significantly, sanitation in Apia is by septic tank, pit latrine or a handful of package treatment plants for commercial buildings. There is no reticulated sewerage system for the urban area of Apia or elsewhere in Samoa. This is despite the Apia central business area and adjoining customary villages being built on a floodplain with a high water-table and often subjected to annual wet season flooding.

### 4.3.4 Land Tenure Impacts on Land Use Planning

Land tenure is the most dominant factor in shaping the form and distribution of settlement and land use in the Apia urban area specifically and Samoa generally. Understanding the pattern and history of land tenure in the wider Apia area goes along way to explaining the current fragmented patterns of development and difficulties faced in implementing a more formal planning and urban management system. Introducing and legislating these land tenure and ownership systems from the mid 19th century and onwards rather than an integrated planning system have been the primary influences in Apia's urban development.

In Apia, alienation of customary lands from traditional owners to freehold and Government lands began in the 1850's as European settlers, including missionaries and traders, sought land for housing, churches and warehouses around Apia Harbour, as well as for agriculture. The largest areas of alienated lands were on the gentle plains and foot slopes on lands above Apia Harbour, as well as in North-West Upolu where it was suitable for development of coconut plantations. In 1893, Britain, Germany and the United States established a Land Commission under the Berlin Act of 1889 to assess land claims by non-Samoans (Ward and Ashcroft 1998). As a result, freeholds as well as Government lands were registered as being alienated. However, the taking of customary lands for government purposes was finally prohibited by law under the Samoa Constitution in 1962.

There are significant differences between customary and freehold lands that contribute to the determining factor in where and how development has occurred in Apia and its hinterland. Customary land can be developed by its customary owners in accordance with the authority of the family *matai* or chief, and any conditions set by the village council. Customary land cannot be subdivided or sold for freehold development: its development potential is severely limited to leasing only. Conversely, freehold land, representing approximately 70% of the land tenure pattern in Apia and the wider urban fringe, can be sold, subdivided and leased.

Given the above, the urban morphology of Apia constitutes a loose assembly of areas of freehold properties interspersed with villages on customary lands, and with no independent local government administration. As a result of this, the emerging urban growth trend in Apia is clearly one where:

- The dispersed nature of development means high servicing costs and a major lag in service provision, as is prevalent in the Government's own freehold subdivisions;
- There is an absence of an effective sewerage system for highly populated areas within Apia especially the flood-prone Apia central business area where septic tanks empty into storm water drains or directly into the harbour;
- There is a fragmented distribution of freehold land for 'private' development;

- Environmental degradation, including waste discharge, is increasing as development encroaches into lands suitable for development in the lower catchment areas;
- An extensive network of water and electricity services in the rural areas which blur a clear division between the Apia urban and rural areas;
- There is minimum cost recovery and user pay charges for services. User pays is still a foreign concept for many, especially those living on customary lands (e.g. water rates have only been introduced since 2001).

### 4.3.5 Land Use Management Framework

Issues and concerns of land use planning cut across social structures, community needs and demands, land and land use, services and infrastructure provision within the commercial and industrial centre of Samoa. In this context, the importance of urban Apia to the economy cannot be understated with the urban area generating 70% of the national income (UMPT 2001). Increasing environmental degradation, combined with population growth, economic development, increasing stress on environmental resources, declining infrastructure levels and concern over community and village wellbeing, are all overlapping themes in the development of Apia. All these factors contributed to Government establishing the Planning and Urban Management Agency (PUMA) in 2002 with its empowering legislation (PUM ACT 2004) which was enforced in 2004.

The functions of PUMA are threefold and are as follows:
*Function 1:* Generating Urban Policies and Plans
- Setting goals for urban improvement
- Developing plans and policies
*Function 2:* Regulating
- Regulating development
*Function 3:* Managing Urban Services
- Mobilizing resources for urban improvement
- Implementing improvements through annual operating plans
- Achieving desired urban outcomes, monitor and review plans, guidelines and systems, and efficient delivery of urban services.

The Planning and Urban Management Strategy (2002) and its Implementation Plan 2003 set the framework for better management of sewage and drainage systems in Samoa. The Plan took an incremental approach to lessen the burden of high costs associated with large-scale conventional sewage treatment systems with ocean outfalls. An ADB facilitated integrated sanitation and drainage project has been approved by Government in November 2003 and is being implemented by SWA in partnership with other local and international consultant agencies.

The utilization of Government land that is not vested with either the SLC or STEC remains under the mandate of the Land Board. Leasing customary land under the Land Board legalizes the register of business ventures such as hotel developments, etc. In ensuring there is consistency with environmental management requirements, decisions of the Land Board have been subject to environmental impact assessments (EIAs) and this is a positive move in the direction of integrating environmental concerns into the land use planning of Government and leased customary land.

## 4.4 Trade and Investment

### 4.4.1 Accessing World Trade Organization

The trade and investment situation of Samoa is changing rapidly with the signing of regional trade agreements such as the Pacific Island Countries Trade Agreement (PICTA), Pacific Area Closer Economic Relations Agreement (PACER) and its membership and accession to the World Trade Organization (WTO) and the interest shown by large economies such as Japan, the EU and the United States of America. Trade and investment in Samoa needs to be steered by the following:

- The capture, maximization and retention of benefits presented by trade and investment opportunities, and protection of Samoan culture through environmental planning methods,

- The effective management of environmental risks associated with increased liberalization of trade and investment regimes at global and regional level, and
- Building recognition and appreciation of the multidimensional nature of trade, investment and environmental linkages.

For Samoa, the actual implications of trade liberalization on the environment are not yet known ~~but~~ because the new trade regimes are not yet fully in place. Therefore, timely action is required to ensure that trade and the environment are mutually supportive. Integrated environmental and developmental assessment processes can be used to introduce simple 'user pays' systems to capture financial multipliers in-country. Better policing of development can also ensure that investment incentive instruments adequately capture benefits in time to cover 'deferred community costs', and/or maintain obligations for social and environmental rehabilitation beyond an investor's presence. Integrated Government policy on environment and development should also enable Samoa to contend with pressures expected from the greater mobility of international capital, the increasing power of trans-national corporations and international agencies. Limited human resources and skills, however, are a constraint to effective participation in regional and multilateral trade policy issues and trade negotiations.

Samoa will require contemporary legislative structures and provisions in order to take full advantage of trade liberalization opportunities, and also to guard against the potential negative consequences of investments. Lack of laws or ineffective links between land, environmental and investment laws and trading regimes will place Samoa in conflict with sound trade and investment practices. Appropriate legislative frameworks need to be supported by national objectives, data/information, consistent standards of practices and due process, implementation mechanisms (including good incentives), equitable regimes of penalties and means for enforcement. Ineffective and compromising or competing laws and policies will need to be curbed and perverse subsidies (e.g. for logging and fisheries) eliminated. In addition to these key elements, Samoa also needs to update associated domestic laws that cover, for example, employment, land use and allocation and consumer protection. Arrangements establishing certainty in tenure over land and marine resources are paramount in establishing a confident basis for investment, whether local or foreign, and for determining responsibilities for environmental management.

Foreign investments into Samoa have been encouraged during the preparation of Samoa's accession to WTO. Although further negotiations are still to be conducted, especially where enquiring countries who are already members of WTO insist on a complete opening-up of the Samoan market, full disclosure of Samoa's policies and procedures for business operation, as well as requirements for environmental protection, was necessary. International obligations of Samoa under the various MEAs, as well as local regulatory frameworks like the Development Consents administered by PUMA, would inform future investors of the sustainability of their investments when all impacts of related development are assessed and valued.

### 4.4.2 Construction Impacts on Environment

All major constructions in Samoa, whether being implemented under local, international or joint venture companies, are subject to requirements of a Development Consent which includes undertaking of environmental assessments. The demand for qualified personnel to undertake environmental assessments has attracted international consultancies to take up the challenges in provisions of design and management services in Samoa.

Samoa does not have environmental standards for technology and pollution sources emitting contaminants into the environment. However, international standards of the World Health Organisation (WHO), relevant standards and procedures of New Zealand and Australia National Environment Agencies and the USEPA have been selectively applied where appropriate. Codes have been developed and operationalized to address waste management needs such as the National Codes of Environmental Practices 2002 and the National Building Code 2002.

The Planning and Urban Management (Environment Impact Assessment) Regulations (2007) give effect to the manner and approach to be taken when conducting an EIA under the Development

Consent process of the PUM Act. Some examples of projects (completed prior to the implementation of EIA Regulations) which were subjected to EIAs include:

- Upgrading of the Tafaigata Disposal Landfill in 2003
- Healthcare Waste Incinerator Plant at Tafaigata Landfill which was designed to operate at the international emission control standards
- Landfill established at Vaiaata on Savaii in 1999

The sustainable development of infrastructure assets by Government, under its major investment projects of the World Bank and ADB, have also seriously accounted for environmental impacts of each project activity. As a result, Government has agreed that all project activities will be subject to the environmental standards and procedures of the international financial institutions as well as adopting local draft EIA requirements. While all WB and ADB projects have undergone environmental assessment of impacts either as a Preliminary Environmental Assessment Report (PEAR) or full EIA, other investment projects that are fully funded by Government have attempted to simplify the procedures even to the extent of requesting exemptions from the Development Consent process and environmental considerations. Occasionally, the urgency of construction by Government and or its corporations have led to Cabinet exercising its powers under the PUM Act to make a determination on whether an EIA is called for or not.

The marine environment has been most affected by construction development. Consultations conducted in Savaii indicated that the new extension to the Salelologa Wharf have resulted in increased turbidity in the surrounding seas and reduction of marine organisms such as sea cucumbers and crustaceans. Reclamations for a hotel in Taumeasina, Upolu, ended up with the developer extracting sand and rubble from the nearby reef leading to habitat destruction and reduction in reef molluscs and crustaceans.

## 4.5 Disaster Management

### 4.5.1 Risks and Types of Disasters

Samoa is exposed to a number of natural and technological hazards. Some of these hazards are seasonal such as tropical cyclones, floods and droughts. Others are an ever-present threat such as earthquakes, volcanic eruption, tsunamis, epidemics, industrial hazards, and exotic plant or animal diseases.

Since 1985, about twenty tropical cyclones occurred in the Samoan region. Out of that, four had reached hurricane force winds and made actual landfall with two in the 1990s being the most devastating. Other minor tropical cyclones had produced abundant rainfall over Samoa and caused extensive damage from flooding such as those events in 1983, 2001, 2002 and 2006.

The worse cyclones ever to seriously hit Samoa in recent time were tropical cyclones Ofa in 1990 and Val in 1991. Cyclone Heta struck Samoa in February 2004. During the same season in 2005, there were 5 tropical cyclones that developed around the Samoa region and moved in the general Southerly direction. It included Lola, Mena, Nancy, Olaf and Percy, with the two latter tropical cyclones classified as Category 5 being the closest near misses for Samoa.

According to the approved National Tropical Cyclone Response Plan (2005), the probability analysis of historic records indicates a tropical cyclone with hurricane force winds above 75mph is most likely to impact Samoa once every five to six years. The probability of a tropical cyclone with storm force winds of 55 to 74 mph to impact Samoa is most likely to increase to two in every four years. It is also most likely that the number of tropical cyclone with gale force winds of 38 to 54 mph will increase to two in every wet or cyclone season.

BECA International[42] assessed the risks of all hazards that Samoa is exposed to and tabulated the levels as follows in Table 4.7. The risk assessment was based on both the likelihood of a significant disaster being caused by the hazard and the consequences of the hazard if it did occur.

Table 4.7 Highest Risk Hazards for Samoa

| **Hazard** | **Level of Risk** |
|---|---|
| Cyclone | **Extreme** |
| Volcanic Eruption | **Extreme** |
| Tsunami | **Extreme** |
| Urban Fire | **Extreme** |
| Public Health Crisis | **Extreme** |
| Environmental Crisis – invasive Species | **Extreme** |
| Flood | **High** |
| Earthquake | **High** |
| Landslide | **High** |
| Forest fires | **High** |
| Aircraft Emergency (airport) | **High** |
| HazaChem incident – marine | **High** |
| Lifeline Utility Failure – Water | **Moderate** |
| Agricultural crisis – animal or plant disease | **Moderate** |
| Civil Emergency – external | **Moderate** |
| Lifeline Utility – telecommunications | **Low** |
| Lifeline Utility – electricity | **Low** |
| Single asset infrastructure failure – building collapse | **Low** |
| Single asset infrastructure failure - dam | **Low** |
| Drought | **Low** |
| Maritime vessel emergency | **Low** |
| Terrorism | **Low** |

Tsunami risk in Samoa is rated as “extreme”. This is because Samoa lies only about 150km northwest of the Tonga shear fault zone where the Pacific Plate sub-ducts beneath the Australian Plate. The main areas at risk of a tsunami are all low-lying coastal areas of the inhabited islands of Samoa, which is areas less than 10 metres above sea level. Anecdotal accounts indicate a total of 60 tsunami events have been recorded between the years 1837 to 1980.

Based on probability analysis of historic records, a tsunami with a mean run-up of between 7 and 9 metres, has a return period of between 50 and 100years (NDAC, 2005).

### 4.5.2 Impacts of Disasters

As indicated in Table 4.7, tropical cyclone, volcanic eruption and tsunami are the most serious concerns for Samoa’s human, socio-economic, natural and built environments. This is because about 70% of Samoa’s population and infrastructure, including key lifeline services, are located on low-lying coastal areas.

These disasters, in particular tropical cyclones, can cause a lot of deaths and injuries, substantial damages to property and severe disruption to lifeline services commensurate with the strength and duration of the cyclone, as well as the level of preparedness a country or community had undertaken. Diseases such as dengue fever, typhoid fever and diarrhoea will emerge as a result of water and food contamination or unhygienic conditions brought about by tropical cyclones and other associated hazards. More people will most likely die as a result of being infected by these diseases.

People will also become traumatized due to the loss of life or property, as well as the financial implications of reconstruction or rehabilitation. In addition, the horrific experience from a devastating tropical cyclone will continue to impose psychological stress on people affected, hence counselling will be needed during the relief and recovery periods.

[42] BECA International. 2005. National Disaster Management Plan. Produced as part of the SIAM II Project under the World Bank.

In the worst-case scenario, village social structures can also be affected (functionality) as individuals and families will primarily focus on their own recovery from a tropical cyclone event; it may take some time to reorganize social structures within the village communities. Therefore, there will be a need to encourage and strengthen collaboration and collectiveness.

**(i.) Impacts on the Economy and Built Environments**

Samoa's economy largely depends on its natural resources which must rely on favourable climatic conditions for growth and sustenance. Devastation caused by tropical cyclones and other associated hazards will cause major disruption to Samoa's economic development. It will also mean limited financial resources will be diverted into reconstruction and rehabilitation of damages caused by tropical cyclones.

The extreme events of tropical cyclones Ofa and Val caused damage with cost estimates of about four times the GDP of Samoa, and severely impacted Samoa's economic growth. The high winds, storm surges and heavy rains of these 2 severe cyclones severely damaged agricultural plantations, infrastructure and the country's socio-economic base.

**(ii.) Impacts on the Natural Environment**

Samoa's natural environment is also affected by tropical cyclones and associated flooding. Tropical cyclones and associated hazards such as storm surge, strong wave, damaging wind activities and heavy rainfall can cause long-term destruction to the natural terrestrial and marine eco-systems which will take years to recover.

### 4.5.3 Institutional Needs

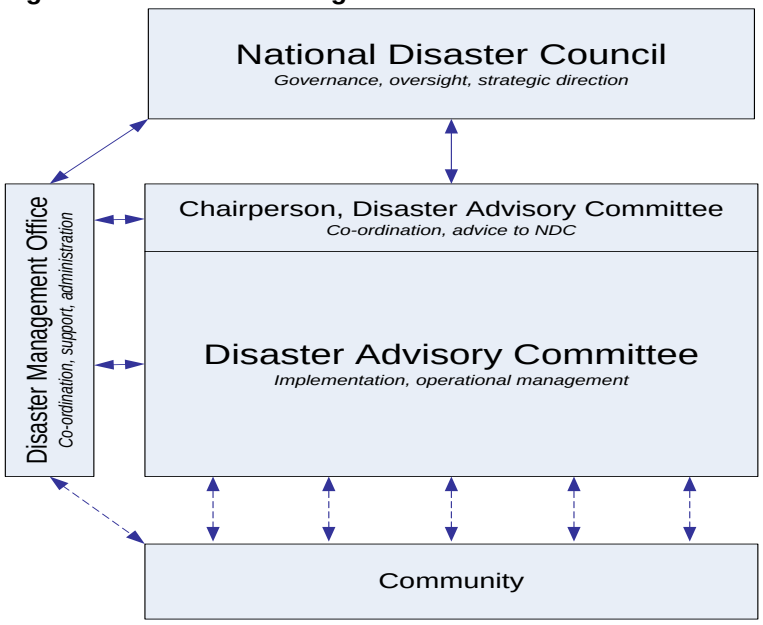
An important aspect in the development of the National Disaster Management Plan (NDMP) was determining the most appropriate institutional arrangement to implement the Plan. Management of actions to prepare and respond to disasters is a critical area for the sustainable management of natural resources and environment as experience indicates huge impacts and destruction by disaster on the broader environment[43]. Relevant Government Ministries and corporations, private sector and NGOs are all involved in one way or another with either mitigation of, preparedness for, response to or recovery from disasters. What is needed, however, is a coordination mechanism that can drive the whole process of preparation, response and recovery or rehabilitation.

The following diagramme (Fig. 4.3), adopted from the NDMP, presents the organisational structure for disaster management in Samoa.

The structure is based on the Disaster Management Office (DMO) and Disaster Advisory Committee (DAC) forming the focal point for co-ordination and implementation of all disaster mitigation, preparedness, response and recovery programmes and activities. The National Disaster Council (NDC) is responsible for oversight and approval of all disaster management activities, as advised by the DAC. Working groups and projects may be established as required to support the NDC or DAC. During disaster response, DAC co-ordinates and manages response activities from the National Emergency Operations Centre and reports to the NDC for direction and decision-making as required.

43 MAF. 2004. Cyclone Heta Impacts on Agriculture. A summary of survey conducted after cyclone Heta indicated a drop in incomes of rural families due to their dependence on agriculture. The majority of families surveyed experienced food shortages which was more severe in rural areas.

**Fig. 4.3 Institutional Arrangements for National Disaster Management**




## 4.6 Population Growth and Urbanisation

### 4.6.1 National Population Trends

Samoa's population in 1991 was 161,296. The preliminary results of the 2001 population census recorded a population of 174,140. This indicated that after a period of ten years, the population increased by 8%. Table 4.8 presents the preliminary results of the 2001 Population and Housing Census.

Table 4.8 Population of Samoa (1991/2001)

| | 1991 | | | 2001 | | |
|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** |
| APIA URBAN AREA (AUA) | 18,396 | 17.093 | **35,489** | 19,724 | 18,833 | **38,557** |
| NORTH WEST UPOLU (NWU) | 20,498 | 18,548 | **39,046** | 27,374 | 25,038 | **52,412** |
| REST OF UPOLU (ROU) | 21,991 | 19,722 | **41,713** | 21,652 | 19,693 | **41,345** |
| SAVAII | 23,714 | 21,334 | **45,048** | 21,863 | 19,963 | **41,826** |
| **Samoa** | **84,599** | **76,697** | **161,296** | **90,613** | **83,527** | **174,140** |

The preliminary results show a male: female ratio of 100:92 in 2001 compared to 100:90 in 1991. A notable feature of the 2001 census is the shift in the population of the four major districts. In 1991 the population of North-West Upolu was 39,046, but increased to 52,412 in 2001, representing an increase of 34%. For the same period, the population of Savaii dropped by 7%. The Apia Urban Area population increased by 8% with the rest of Upolu declining slightly. The dramatic increase in the population of North-West Upolu is explained by the significant occupation of newly settled areas such as Vaitele, located just outside the boundary of Apia Urban Area. The drop in the population of Savaii suggests that there has been a significant resettlement of Savaii people in search of improved education and health facilities and better employment opportunities on Upolu Island. This resettlement is reflected in the rising number of people in North-West Upolu and the Apia Urban Area.

The official 2001 Census of Population and Housing confirmed the trends in population totals of the main enumeration areas, and Samoa's population reached a total of 176,848 persons by November 2001. This is an increase of about 10% when compared to the last census in 1991 with only 161, 298 persons. Of the total population, 38,336 persons living in the Apia Urban Area with the remaining total of persons living in the rural areas of North-West Upolu, rest of Upolu and Savaii Islands.

Based on the Age Groups recorded, 41% of the total population were below the age of 15 years, 55% aged between 15-64 years and 4% of the total population were aged 65 years and over. The same proportions were also identified in the 1991 census. Given the large proportion of young persons, 63 % of the total population are single or never married, 33% married while 1% and 3% are divorced and widowed, respectively.

Births and migration numbers largely influence population growth in Samoa. Births are estimated at about 5,000 in a year (29.1/1000), deaths at 1,000 in a year (6/1000) and more than 1,500 persons migrated overseas (-10/1000) every year. While births increase the population, migration on the other hand reduces this growth, keeping population growth at a minimum level. This pattern of growth has always been in existence since Samoa became independent in 1962.

### 4.6.2 Human Resources ( Education and Training )

Education plays a very important role in human resource development. The 2002-2004 SDS targeted improvements in the areas of teacher training standards and quality, curriculum and teaching materials, education facilities, coordination between private and public stakeholders and strengthening the MESC. The Government has also approved compulsory free education for primary schools.

The education budget has been increased from 10% of the national budget since 1981 to between 22 and 23% in 2000 to 2003. Capital spending in education was made possible through external grants and concessional loans that ranged between 10 to 12% of total capital spending.[44]

The Government in recent years has promoted programmes for the training of teachers, nurses, laboratory technicians and trades people. Vocational skills training are also offered by a number of private organizations. To improve the teaching of vocational skills, the Samoa Polytechnic has been merged with the National University of Samoa (NUS). This has upgraded courses now offered as university programmes for secondary school graduates, including degree and diploma courses in arts, science, accounting, management, education, sports science and all apprentice courses previously offered at the old Samoa Polytechnic. The local Alafua Campus for the USP also provides a range of extension study courses. Enhanced coordination among all education stakeholders was evident in the development of the new MESC and Compulsory Education Amendment Act 1992/93.

Much of the advanced and professional training for Samoan students is provided through overseas scholarships. 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’ countries. In response, the Government in 1991 reintroduced the scholarship bond to oblige those who had undertaken overseas’ training to work in 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 Samoa. In general, the concept of human capital needs to be considered in order to arrive at a comprehensive and integrated policy on local education investment.

Institutional and process strengthening should go hand in hand with the enhancement of the available human resource capacity. Key activities that affected this progress made in institutional restructuring focused on strengthening the existing human resource development in the public sector. The SDS identified education and health as the two national priorities in the enhancement of human resource to support its strategic development goals. Training needs analyses have been completed in most of Government Ministries. Notable is the progress made in the strengthening of capacity within the

[44] GOS, SDS 2005-2007

MNRE which has been mandated with the protection of the environment and natural resources. Personnel have been trained and appointed to senior positions for all MEAs that Samoa has become a party to, as well as senior positions traditionally within MNRE.

### 4.6.3 National Population Policy

The development of the National Population Policy (NPP) is a response to the growing concerns of the increasing population and its socio-economic impacts. Its objective is to highlight population issues and concerns, and raise awareness so that these issues and concerns are considered in national planning initiatives. Achieving sound and sustainable population growth indicators that are consistent with available resources, is the ultimate goal of the policy. The policy, therefore, provides a process for discussing and monitoring population issues.

The formulation of the NPP was mainly based on historic data prior to the 2001 Census. The policy, therefore, has not benefited from the updated results of the 2001 Census as well as the latest in 2006. Notwithstanding that, it is expected that Samoa's population structure and associated issues would remain largely the same between 1991, 2001 and now.

### 4.6.4 Pressures of Urbanization

The natural increase (difference between births and deaths) of Samoa's population is always very high with migration playing a significant role in narrowing this natural increase. Overseas migration is generally accepted as a good population control for Samoa. However,, it may become a real threat in the long run when overseas countries eventually reduce the number of migrants from Samoa. The continuous high birth rate, contributing to the large proportion of young persons in Samoa, indicates the potential of high population growth in the future.

The increasing population growth puts pressure on all resources making it difficult for sustainable development to be effective. While many have argued that reducing population growth is the solution for sustainable development, it has often been strongly argued that meeting the requirements for basic needs first has more impacts on lowering population growth and not vice versa (UNDP, Samoa National Human Development Report, 2006).

There is no simple answer to facilitate sustainable development. It is a complex issue that needs all levels to play their roles starting from the national level, community level, and down to the grassroots level to contribute in one way or another. Maintaining quality education, healthy living and subsistence living will help lower population growth in order to meet the needs of present generations without compromising the needs of future generations.

The effects of an uncontrolled population growth will lead to:

(i.) rural-urban drift,
(ii.) a predominantly youthful population, and
(iii.) an increasingly elderly population.

This would further impact on demands for utilities and services, their development often underpinned by the non-sustainable utilization of limited and vulnerable natural resources.

#### *(i.)* Rural-urban Drift

It is evident from the 2001 Census that there has been a massive movement away from rural areas to the urban areas. Table 2 indicates that over 52% of the total population resides in urban Apia and North-West Upolu. The high concentration in these areas places undue pressure for the provision of education and health services, as well as infrastructural services such as electricity, water and telephone.

#### *(ii.)* Youthful Population

Prior to 2001, Samoa's population structure was such that over 40% of the population was under 15 years of age. This was largely due to improved infant mortality rates and migration. The young population draws very heavily on the national budget for the provision of education and health services.

The Census of Population and Housing 2001 also showed that of those aged 15 years and over, the rate of unemployment has risen from 2.1% (1,175) in 1991 to 4.7 percent (2,618) in 2001. Out of those being categorised as being employed, 47% was reported working in unpaid employment, meaning those people who are working in activities such as planting, fishing and assisting with the family economic welfare without any form of income. Lack of income is another major source of environmental degradation and exploitation of natural resources. Like lack of knowledge, people turn to abuse natural resources such as polluting fishing resources and cutting down trees, and even turn to criminal behaviour due to lack of money.

Promoting small and informal businesses in the community and making access to financial assistance easier are good alternatives for promoting more employment opportunities for many. With secured income, people will have the capacity to participate consciously in sustainable development initiatives.

***(iii.)*** **Increasing Elderly Population**

With improved health care, a greater percentage of the population is likely to live longer and, therefore, the elderly population rises. With the Government providing free medical treatment and transportation, as well as social security benefits under the Senior Citizens' Pension Scheme, a continued increase in the elderly population will become a real budget burden.

### 4.6.5 Migration

Samoa loses much of its investment in human resource development through emigration, particularly as migration becomes more selective and targeted in favour of the professional and skilled. A quota of up to 1100 new Samoan migrants enter New Zealand each year, although migration for humanitarian reasons usually raises this number to around 2,000 per year. Migration directly affects the nation's workforce, with the largest group of migrants being in the 15-24 age group, with male/female ratio roughly even. The high dependency ratios and the atypical family composition (i.e. families of elderly and very young) place an economic and social burden on those `left behind' in Samoa. Women, children and youth may have to work longer hours to supplement the family budgets and fulfil the familiy's community obligations.

### 4.6.6 Population Increase vs. Selected Household Services

The increase in population also leads to increasing demands for household basic services. The more demands on household services the more pressure on available services. Table 4.9 shows the total number of households in Samoa and the proportions of households using selected services in 1991 and 2001.

Table 4.9 Selected Household Information

| | 1991 Proportion of households using service | 2001 Proportion of households using service | In 1991 (%) | In 2001 (%) |
|---|---|---|---|---|
| Total Number of Households | 22,195 | 23,079 | | |
| Tap water supply | 19,895 | 20989 | 89.6 | 90.9 |
| Toilets using water | 19,684 | 20439 | 88.7 | 88.6 |
| Lighting-electricity | 17,497 | 21447 | 78.8 | 92.9 |
| Cooking fuel-firewood | 15,935 | 14321 | 71.8 | 62.1 |
| Waste disposal-Truck | - | 13,487 | - | 58.4 |
| Fixed phone | - | 5,189 | - | 22.5 |
| Cellular phone | - | 1,946 | - | 8.4 |

Sources: Population and Housing Census Report 1991, and 2001.

In the total number of households, an extra 880 households had been added to total households in 1991, reaching a total of 23,079 in 2001. Additional households lead to increasing demands for household services like water, electricity, sanitation, waste disposals, telephones and related-services. Generally, Samoan households have a high standard of accessibility to water and electricity

for household amenities. About 90% of total households in 2001 have access to tap water for domestic usage and almost 90% of households also use water for toilet facilities. Household electricity has increased from 79% in 1991 to 93% in 2001 to almost 97% in 2007.

Greater accessibility to these services indicates better quality of living. It also shows an increasing pressure and strain on limited resources, particularly water. Quality water management is consistently needed to sustain this natural resource. These statistics highlight a strong relationship between the increasing population and the demand on housing materials and household services. The question is: how can we approach the issue of sustainable development in view of the demographic characteristics of Samoa?

In other household amenities, cooking fuel shows that firewood is the most used fuel by Samoan households. While there is a noticeable decline of firewood usage (72 to 62%), more than half of total households still depend on firewood for cooking. This also calls for effective forest management to monitor the exploitation of local forest for firewood. Burning of fossil fuel contributes to the greenhouse gas emissions as well as persistent organic pollutants (POPs) such as Dioxins and Furans.

Creating a healthy environment, particularly in the urban area where most of Samoa's population is concentrated, must make planners realize the need for change in attitudes and perceptions of natural resources and amenity values. This means community awareness of environmental issues needs to be strengthened. Introducing or strengthening (where they exist) systems that include rules and standards will result in improvements that are affordable. Government and stakeholders should involve institutions, private enterprises and individuals in building the systems that will bring about change. The systems and the environment must be monitored, continually reassessed and further developed so that they remain effective in creating a healthy urban environment for all to enjoy and prosper in.

## 4.7 Traditional Systems

### 4.7.1 Cultural Heritage

The SDS recognises that the *fa'aSamoa* or Samoan culture as the key factor in achieving and maintaining social harmony within the Samoan society. It is a valuable social security system that provides cohesion in the community.

The village council or *Pulega a Alii ma Faipule* is the paramount hierarchy in the Samoan structure with membership consisting of *matai* or titled persons, and includes both men and women. It is the decision making body and effectively maintains law and order within the community. The *Aumaga* or untitled men implement the decisions of the council. Similarly the Women's Committees or *Faletua ma Tausi* plays a vital role in the implementation of decision making in key areas of their domain namely health, education, village beautification and family welfare.

Religion is deeply rooted in the Samoan culture as reflected in the Constitution. The position of the church in the community can be quite influential as evident on a number of occasions when the church has reversed decisions of the village council as a result of consultative intervention. Unfortunately, there have also been cases where culture and religion clash. Nevertheless the potential influential standing, and the extensive outreach of the church within the community, makes it a valuable vehicle to drive pro-harmony strategies where communities can apply the same to environmental management projects and activities that they implement on a daily basis.

The family nucleus is a key resource for promoting social stability. It is the fundamental platform for social cohesion and is regarded as the initial learning environment for any Samoan child. The role of the parents in taking care of the welfare of the family and providing support to the children is critical. A stable family is more likely to uphold cultural, religious and family values which are prerequisites for social harmony, hence it is important to ensure that family values are reinforced and strengthened.

### 4.7.2 Heritage Sites

There are not many well known and highly developed historic sites in Samoa, despite references to the existence of a high number of them. Historically, the failure to recognize these sites as important and hence conserve them, may have led to their ongoing destruction over time. The pressure of development may have led to some sites being converted into investment instead of conserving them. With the exception of a few, the historic sites that are now developed have emerged as a result of environment-related conservation efforts and tourist promotion initiatives. Perhaps the establishment of an agency directly responsible for cultural discovery could trigger renewed interest in discovering further historic sites.

Therefore, the development of historic sites for environmental conservation and tourist promotion purposes has to a large extent been the basis for continued maintenance of these sites. With the rise in the number of tourists visiting Samoa, the development of existing and new historic sites should be a sound marketing strategy.

On the cultural side, maintaining the strengths of the Samoan culture is considered critical for continued social cohesion and stability. Inevitably, the Samoan traditions and cultural values will go through a process of change partly as a result of social and economic pressures. But Samoa cannot afford to lose its culture because the social and economic cost of a disintegrating system is enormous, as seen in other Pacific Island Countries. Measures should be put in place to enhance the role of the village council as stipulated in the Village Fono Act 1990. There must be a platform where the judiciary system works hand in hand with the operation of the village council because there are mutual benefits in the two working together. The NUS has a Centre for Samoan Studies (CSS) which provides the opportunity for anyone to study and appreciate the Samoan culture more. The recent appointment (2007) of a fulltime lecturer in Archaeology at the CSS is indicative of the importance of cultural preservation being shown by Government.

The further discovery of new archaeological sites, and upgrading of existing sites, have establishment and maintenance cost implications. However, the rightful villages can see the benefit in terms of the cultural significance as well as the possibility of raising rural incomes through tourism (e.g. Pulemelei Mound on Savaii has 3000 ancient monuments, most in a neglected state).

Prior to Samoa being a state party to the World Heritage Convention in 2001 a number of activities were already implemented mainly related to natural sites and cultural heritage. For instance, a national inventory for Samoa's fauna and flora for both marine and terrestrial species was conducted under the CBD (Schuster, 2001) and a documented series of traditional folklores and cultural activities established under the Ministry of Education, Sports and Culture ( Legends of Samoa Vol 1 to 5: Samoa Ne'i Galo ). The inventory of cultural sites identified in this series also covered those sites considered priority areas for conservation. The numbers of sites suggested were mostly identified in previous studies of Samoan ecosystem as priority areas for conservation due to their biological diversity significance in terms of species and ecosystems. A study commissioned by UNESCO in 2002 for the Samoan Archipelago indicated the potential for the islands to be nominated as a serial site for the conservation of biological diversity for outstanding universal value under natural heritage (Thorburn, 2002). An inventory of cultural and natural sites was also established as part of Samoa's priority activities under the Convention.

The development of the Cultural and Natural Heritage Conservation Policy (2004) recognised the preservation of heritage resources and provided a framework for the sustainable management of Samoa's natural and cultural heritage in recognition of their significance to the lives of Samoan people. The policy also sought to improve approaches to heritage planning by ensuring that the preservation of our natural and cultural heritage are fully recognized and taken into account in the formulation and implementation of development programmes.

The National Heritage Coordinating Committee, chaired by MNRE, had already started to prioritize activities at the national level for the conservation and preservation of its natural and cultural heritage sites, including the completion of Samoa's Tentative List of priority areas with high potential to be

included under the World Heritage List for both its cultural and natural importance. Two sites have been considered based on certain criteria of "Outstanding Universal Values and Form of Integrity" (World Heritage Convention Operational Guideline, 2005) and a series of consultations with communities from these areas were conducted to help finalize the information for the Tentative List. The 2 sites considered; namely, Fagaloa Bay (Uafato/Tiavea Conservation Area considered for nomination as a 'Mixed Site') and Manono, Apolima and Nuulopa Islands to be considered for possible nomination as a "cultural landscape".

## 4.8 Integrated Water Catchment and Coastal Area Management

### 4.8.1 Water Catchment Management

Implementing integrated water catchments and coastal area management would help Samoa to address a range of issues including disaster management, land degradation, water resource conservation, biodiversity loss, climate change, pollution and coastal area degradation. This approach is particularly important to Samoa since its generally small landmass means that entire islands could be considered as the coastal zone.

Impacts on human health due to microbiological contamination and elevated nitrate levels in water supplies, as a result of watershed or water catchments disturbance from clearing and agriculture, is an issue of concern for water catchment management. For example, Baisyet (1994), stated, "the pollution of drinking water and the resulting health hazard may be one of the biggest watershed issues in island countries of the South Pacific." Also, this major issue of water pollution in the Pacific region (and other regions) and the linkages with water-borne diseases has been raised in the past (e.g. Detay *et al.* (1989), Miller *et al*. (1991) and UNESCO [1991]), and reiterated in more recent reports including ADB (1999), SOPAC (2001), Falkland (2002) and Crennan and Berry (2002). The high incidence of diarrhoeal diseases and other infectious diseases (e.g. hepatitis, typhoid and sometimes cholera) on some small islands is often caused by poor quality groundwater used as a source of drinking water. The incidence of diarrheal diseases in some Pacific islands has been found to vary with water availability and climate. High incidences tend to be associated with low water availability and higher temperatures (Singh *et al*, 2001).

Flooding of the major watersheds and catchment areas is a real concern for Samoa's infrastructure development and planning. Of particular interest are the Vaisigano catchment in central Apia and the Fuluasou catchment in Faleata. With the changing climate, flooding will become a major problem for those living in low lying areas as well as those living by rivers. Between rainfall periods, dry periods will become drier, facilitating greater evapo-transpiration rates. Water catchment areas will rapidly dry up and hydroelectric stations will become ineffective. A recent assessment of historic flooding data by KBR (2006) proved that knowledge of the frequency and extent of flooding in Samoa is limited. SOPAC recorded severe floods in 1939, 1975, 2001 and 2003. The most recent severe flooding in Apia was recorded in February 2006, although it would appear that this was the result of surface water ponding and poor drainage rather than fluvial flooding from the major river basins of Vaisigano and Fuluasou. Less severe floods occur more frequently with moderately severe flooding reported in 1982, 1991 and 2000. Minor localized flooding is also more frequent as land use and development increases blocking natural channels which in some areas intensify the problems associated with flooding.

A watershed condition inventory, conducted in 1983 and revisited in the SAMFRIS survey of 2005, has clearly indicated the status, problems and the immediate actions needed for highly degraded watershed areas in Samoa. However, the constant forest clearance of lands by villagers, the opening of new village roads and other development activities has continued the ongoing deterioration of the country's watersheds. The protection of mountain watersheds has a direct impact on soil fertility which essentially influences agricultural developments downstream. The degradation of watersheds has a direct impact on water quantity and quality. Low quality water is unacceptable for human and livestock consumption, at the same time a reduction in quantity has a severe effect on water consumption, hydropower generation, irrigation and industrial uses.

Furthermore, the siltation of hydropower and the water supply schemes constitute a major problem mainly in the Vaisigano and Fuluasou Rivers, respectively. The siltation of the Moamoa water intake, and the contamination of water by a livestock farm upstream, forced the intake to close. The Fuluasou river hydropower reservoir, built in the early 1950s, is completely silted up. Weedicides used upstream in the cultivated area are another major source of pollution that deteriorates the water quality and makes it unpalatable and tocic. Also, such toxic contaminants are transported via riverflows to the coasts where they further pollute marinelife in the lagoons.[45]

An ADB-funded project for the improvement of drainage and sanitation in Samoa, with emphasis on Apia catchments, has developed modelling techniques to assist planning for land use and building guidelines. The models developed are used to map the likely extent of a flood for 20 and 100-year return period for the five priority river basins of Apia. Data and output maps would then provide guidance on where mitigating measures should concentrate, as well as the types of solutions for each particular location of the catchment.

The same project also recommended a Drainage Management Plan with key components assigned to responsible stakeholders which are expected to cooperate integratively in its implementation. The components include (i) staged works within the priority drainage area, (ii) implementation of operations and maintenance, (iii) conducting of community education programmes, (iv) development of design criteria and identification and (v) application of opportunities costs and benefits. This new Drainage Management Plan is expected to be complimentary to the current Apia Master Drainage Plan.

### 4.8.2 Coastal Area Management

The coastal area and its marine environment has always been a vital component of our way of life. It provides a major source of our protein. In the past, travelling by sea within Samoa was common. In 1722, Roggewein, the first European to sight Samoa gave it the name “the Isles of the Navigators” when he noticed how much the Samoans used canoes then. It has been estimated that approximately 70% of Samoa’s population is situated in low-lying areas along the coast.[46]

A Coastal Infrastructure Asset Management Strategy (CIMS) has been developed. The whole islands of Samoa have also been mapped to illustrate their levels of vulnerabilities in relation to natural hazards of erosion, flooding and landslides, as well as combined impacts of strong wind and extreme events. All 41 districts have had their Coastal Infrastructure Management (CIM) Plans completed and agreed to.

## 4.9 Environmental Awareness

### 4.9.1 MNRE Awareness Programmes

Environmental awareness has been significantly improved over the last decade with the number of programmes and awareness activities already effectively implemented. All projects implemented by the MNRE contain an awareness component. The development of plans and strategies that are expected deliverables for these projects have all gone through a consultative process where the stakeholders are informed of the principles and themes promoted by each project. For instance, the level of awareness has been determined for ozone issues and waste management. The outcomes indicate that there is improved awareness of waste management issues, particularly the role of DEC. Awareness of ozone issues is above average. There is also much interest shown from the private sector in investing in alternate technology that addresses waste management problems or reduces greenhouse gases. Demonstration projects, starting from basic composting trials, are becoming common with the recent trial of composting toilets.

[45] ibid

[46] Available at MNRE. 2006. *Public Awarenesss.* [online]. Apia, MNRE.. Available from: http://www.mnre.gov.ws/documents/newspaper/15%20June%202003%20Marine%20Resources%202.pdf

In addition, ongoing public education programmes include newspaper articles with a designated environment column, radio programmes and national events for commemoration of national awareness days for priority environmental thematic areas. NGOs have also played an important role in complementing Government initiatives in area of environmental awareness. NGOs, and others promoting various Environment-Friendly Technologies (EFTs), implement programmes of Government through partnership arrangements or as consultants.

Awareness programmes, however, are becoming expensive and dependent on externally-sourced resources. Choices for modes of airing of environment programmes have nevertheless improved with new TV and radio stations. The popularity of national awareness days is also limited to those closely involved with environmental working teams and committees, and specially invited community representatives that participate mainly because of their role as CBOs.

### 4.9.2 Awareness Surveys

Awareness of the 1993 State of the Environment (SOE) Report is, however, negligent. Most of awareness is in town and tertiary institutions, as well as those closely involved with environmental programmes. In fact, more than 50% of all those consulted during the collation of information had neither seen nor heard of the existing 1993 SOE Report. Limited printed copies of the 1993 SOE were made available to key stakeholders. The Report is not available on the Internet and very little outreaching of this Report was conducted since its publication.

### 4.9.3 CIMS Plans Effectiveness Survey

An effectiveness survey was conducted by Government under the SIAM II Project which concluded that there is strong desire by the Women Representatives to Government to participate in the planning processes of Government. They are also very interested in being informed of similar activities. This indicates the high interest of women in environmental management through spatial planning. It was also noted by the survey that those involved in the Project were the only ones who held any detailed knowledge about the CIMP preparations. The main findings showed that 40% of the surveyed population was aware of the CIMS, and that only 23% of all those surveyed had some knowledge of the CIMS process, even after 5 years of actual implementation.

It is important for public awareness conducted at the community level to ensure there are follow-up activities, and that all focus groups of the community are involved. There is a natural tendency for consultations to involve mostly men which is a reflection of the male-*matai*-dominated nature of community decision-making in traditional Samoan villages.

## 4.10 Waste Management and Pollution Control

### 4.10.1 Waste Management

It should be noted at the outset that despite the many efforts by Government and NGOs to clean-up Samoa, the problems of waste management keep coming up. Uncontrolled discharge of waste especially that, which cannot be assimilated into the environment, is an ongoing cause of great concern. Samoa and Apia in particular, do not have an environment that can sustainably absorb all types of wastes generated. Waste varies in type, quantity and sources that they originate from, but can be generally grouped into materials that are liquid, solid or gas. For example, waste from toilets, washing water, oils and chemicals, solid waste from packaging and exhaust fumes that are discarded as a result of various land use and development activities. Waste can, therefore, be from households, villages, industry and commercial operations. A receiving environment, biophysical or otherwise receives waste. In Apia, the receiving environments of Apia Harbour and Vaiusu Bay receive water from catchments, much of it severely polluted.

Under the framework of the 1993 SOE Report and 1994 NEMS, the MNRE (previously DLSE) was mandated the responsibility for waste management. The MNRE started work in the area of waste

assessment and evaluation of public awareness of waste management issues and problems to enable its strategic planning and policy development unit to address waste problems.

### 4.10.2 Waste Types and Generation Rates

Three waste characterisations have taken place. The findings pointed to a waste generation rate that was similar to the larger countries of the Pacific such as Fiji, Solomons and Vanuatu, but the rate for Samoa has increased over the years from 0.52 kg/person/day in 1994 (Gangaya) to 0.99kg/person/day in 1999 (Malua, 2000). The latter generation rate was applied to the total population of Apia to estimate the total amount of waste generated in Apia, and remains relevant today. A similar survey was conducted in Savaii at Faasaleleaga as an example of rural area waste generation. A lower generation rate of 0.45 kg/person/day was recorded (Malua, 1998). A recent survey was conducted by the MNRE using a sample of households in Apia and Vaitele. Its preliminary results came up with a lower generation rate of 0.45kg/person/day. Table 4.10 presents the generation rates and their bulk density, as well as sewage sludge.

Table. 4.10 Amount and Composition of Solid Waste from 1994 to 1999

| **Parameter** | **Apia** | | | **Faasaleleaga** |
|---|---|---|---|---|
| | ***1994*** | ***1999*** | ***2006***[!] | ***1998*** |
| **Generation Rate (kg/person/day)** | 0.52 | 0.99 | 0.45 | 0.45 |
| **Total waste generated in 1 year** | 6,643,000 kg or 6,000 tonnes | 13,051,962 kg or 13,000 tonnes | 17,476.27kg or 17,000 tonnes | 1,500 kg or 1.5 tonnes |
| **Total volume of waste to be disposed each year** | 46,454.5 cubic meters | 91,272.5 cubic meters | | - |
| **Waste Composition** | % | % | % | % |
| **Paper** | 13 | 7 | 7.99 | 2 |
| **Plastic** | 8 | 8 | 9 | 18 |
| **Metals** | 14 | 7 | 7.7 | 40 |
| **Biodegradable or organic** | 59 | 68 | 64.3 | 20 |
| **Glass** | 2 | 2 | 1.8 | 13 |
| **Textiles** | 3 | 5 | 5.5 | 3 |
| **Potentially Hazardous Wastes** | <1 | 1 | <1 | <1 |
| **Others** | <1 | 2 | 3.4 | 4 |

[!] **Sourced from MNRE Waste Survey 2006**

In considering these recent generation rates, one could say that the rate at which solid waste is generated within Apia may have dropped (refer to Table 4.11). This is due to the lack of any old waste being piled up which can be cleared using the survey as recognized in the surveys of 1999. The reduction in the generation rate could also mean that urban area residents are actually generating less waste as a result of waste awareness campaigns, or due to an efficient waste collection service. However, when extrapolated to the increased population of Apia from the 2001 Census (38,836 people) the total amount of waste generated on an annual basis increases by another 4,000 tonnes. The composition of solid waste remains the same with most being organic and food waste with slight increases in paper and plastic components.

Table 4.11 Solid Waste Generations Rates

| Year | **Generation Rate** | **Bulk Density** | **Sewage Sludge** |
|---|---|---|---|
| 1994 | 0.52 kg /person/day | 350kg/l | - |
| 1998 | 0.45kg/person/day | - | - |
| 1999 | 0.99/kg/person/day | 144kg/l | 17.9kg/day |
| 2006 | 0.48kg/person.day | 140kg/l | - |

An evaluation survey was conducted in 1999 to gauge the level of awareness and understanding of waste management issues and solutions in the country. The conclusions pointed to high general awareness of MNRE's waste programme, but the detailed understanding of types and environmental

impacts of waste is only at an average level. It is apparent that more awareness programmes need to be implemented.

The National Waste Management Policy, which was approved by Government in September 2001, has now been successfully implemented, absorbing all the development initiatives that have been instigated by both the private and public sectors.

Factors that are significant to MNRE's understanding of uncontrolled waste discharges in urban development and their effects are:

- The urban environment compared to a rural environment,
- The types of waste generated and the effects on the environment, and
- Our knowledge of plants and animals that live naturally in soils and water and how to keep these environments healthy.

### 4.10.3 Sanitation

According to Samoa's 2001 Population and Housing Census, over 60 % of Samoa's population has access to a flush toilet inside the property. Table 4.12 presents the different types of sanitation facilities used by households. What is evident is that there are still a large proportion of families using pit latrines (11.4%), while some households share their toilet facilities.

Table 4.12 Sanitation Facilities Available in Households

| | Flush with Septic | Flush Shared | Pour and flush (Pisikoa) | Pisikoa Shared | Pit latrine | Total |
|---|---|---|---|---|---|---|
| Household | 13,487 | 849 | 5,439 | 664 | 2,640 | 23,079 |
| % | 58.2 | 3.7 | 23.5 | 2.9 | 11.4 | 99.6 |

In the central business area of Apia, approximately 90% of households and 93 % of businesses have septic tanks for on site treatment (GHD, 2006). Previous studies of the state of septic tanks indicated around 40% of households and 10% of businesses experienced ongoing operational problems with their toilet systems.
Despite having a flush toilet, some of the families are located in areas where there is unreliable water supply due either to location in leeward areas of the islands or low capacity of the water supply to meet the high population demand. Many of the sanitation facilities also do not have proper septic tanks, hence wastewater tends to seep out and into the groundwater. When water pressure drops in the underground water pipes, contaminated groundwater seeps inside these water pipes with serious health repercussions. This leads to contamination of household water supplies, resulting in exposure of people to water-borne diseases. At present, 1 person in 60 each year is affected by water-borne diseases to the extent that they require a hospital visit. The Environment Health Office of the MOH has investigated outbreaks of water-borne diseases, but their data storage is inadequate. MOH and National Health Service (NHS) plan to implement a new Patient Information System (PATIS) to improve data storage capabilities.

Larger commercial offices and manufacturers within Apia operate wastewater package plants, most of which treat standard domestic sewage generated by individual premises. The Vailima Breweries at Vaitele and the Samoa National Hospital at Motootua operate the largest plants. Overall, the quality of the effluent discharged by these plants is variable in nature. The owners of the plants are responsible for the operation and maintenance of their systems. Frequent breakdowns are recorded, including the plants being operated inadequately.

Government, through SWA, is expected to address the sanitation problems in urban Apia by developing a new sewage treatment system. The European Union (EU) is addressing the same issue for rural communities in Samoa.

### 4.10.4 Hazardous Waste and Persistent Organic Pollutants

Samoa does not manufacture any of the intentionally released substances such as pesticides and industrial chemicals, thus the main sources of entry are through transportation and handling, storage,

use and disposal. As for unintentional releases, the main sources are through uncontrolled combustion of different fires, controlled combustion processes such as incineration, and incomplete combustion of motor engines. Table 4.13 summarizes available information on a wide range of imported pollutants

Table 4.13 POPs and Persistent Toxic Substances (PTS) in Samoa

| Chemicals | Use | Amounts | Current status | Levels | Trends |
|---|---|---|---|---|---|
| Aldrin | Banana plantations | Moderate | Non-consent for import since 1998 | • Widely used in banana plantation up to the 1970s<br>• No known contamination or stockpile | • No new releases into the environment<br>• Soil erosion could result in bio-accumulation in aquatic and marine organisms |
| Chlordane | Termite control | Low | Non-consent for import since 1993 | • Contamination in only two storage sites (ASC Vaitele and ISC Vaivase) | • No new releases into the environment<br>• Possible contamination at homes sprayed with chlordane<br>• Localized contamination can be eliminated with clean-up |
| DDT | Banana plantations | Widely used in banana plantations | Non-consent for agricultural use since 1993 | • Contamination at ASC Vaitele facility, and some old plantations<br>• low level detection in pig fat, marine organisms tested<br>• Very low levels of DDT in humans possibly from past use or imported food and other products | • Possible increase in food chain bio-accumulation from existing low levels in marine organisms from Vaiusu Bay and domesticated pigs<br>• Decreasing levels of presences in humans due to the absence of any new releases |
| Dieldrin | Banana plantations | Widely used in banana plantations | Non-consent for import since 1998 | • widely used for banana plantations<br>• Confined contamination in two confirmed sites<br>• Presence in marine organisms | • No new releases into the environment<br>• Decrease of bio-accumulation in food chain |
| Heptachlor | Termite control | Low | Non-consent for import since 1994 | • very low and confined use for termite control<br>• contamination only at ASC Vaitele compound and ISC Vaivase | • no new releases into the environment<br>• Possible contamination at homes sprayed with chlordane |
| PCB | Electrical transformers | Low | Exporting countries do not produce PCB transformers anymore | • unknown number of imported transformers with PCB<br>• three contaminated sites (EPC Vaitele, Salelologa and TVC Asau) | • no new imported transformers containing PCBs<br>• contaminated sites are sealed and planned for disposal, therefore pose limited risk to the environment and human health |

| | | | | | |
|---|---|---|---|---|---|
| PCDD/ PCDF | Produced from combustion processes and burning | Moderate | Produced from combustion processes and burning with low levels from other processes | • emissions are low compared to other countries<br>• highest releases from biomass burning and incinerators | • considerable decrease in future when new incinerators with good APC are installed<br>• implementation of waste management strategy |
| **PTS:** | | | | | |
| TPH/PAH | Oil waste | Low | | • presence at the main bulk storage oil facility | • will be reduced when good oil management plans are installed for waste oil disposal |
| TBT | Anti-fouling for boats | Low | No anti-fouling done in the country | • presence in marine sediments from main Matautu Wharf | • Could continue to be present in the area due to high traffic use of the area, although no anti-fouling is done in country (water blasting hulls?) |
| CCA/PCP | Timber treatment | Moderate | not used anymore | • the TVC site in Asau is the only area that has significant presence which should be a priority contaminated site for clean-up | • clean-up of SFC site will eliminate future contamination |
| Lindane (g-BHC/ HCH) | For scabies | Low | Non-consent for import for livestock use since 2000 when alternative was identified | • found as degradation product beta-HCH in breast milk samples | • used for medical purposes only |

### 4.10.5 Information Gaps in POPs

Important data and numerous documentations are unavailable or unobtainable to help facilitate the compilation of a full inventory on POPs and PTS in Samoa. These include:

- Historic inventory records on the quantities of chemicals imported into the country each year. The only information obtained were the chemical inventories for 2003 chemicals from ASC, Farm Supplies Ltd., Scientific Pest Management and Arco Chemicals,
- Full amounts on production and use of dioxin and furan releasing activities,
- Absence of records on PCB containing transformers imported into the country,
- Air sampling for POPs concentration in the air, and
- Historic records of plantations which used POPs pesticides.

Due to the absence of any toxicology or eco-toxicology studies in Samoa regarding the possible impacts on the environment and human health from POP releases, it is difficult to clearly show any linkages between the current increase in the amount of cancer patients in the country or any wildlife population decreases with POPs existence. Furthermore, the lack of an institution or agency that approves and regulates the importation, use and disposal of industrial chemicals denotes that accurate numbers could not be identified.

As reported in the Agriculture Survey 2005, although there has been a reduction in the percent of agriculturally active households that used chemicals for agricultural purposes, 38% compared to 44% recorded in 2004, the chemicals used are the kinds that are mostly directly applied to the ground cover. The most predominant type of chemical use is weed control, as reported by 86% of households.

### 4.10.6 Water Contaminants

The drains and streams in and around Apia receive discharges from septic tanks, laundries, contaminated run-off from markets, roads and vehicle servicing yards, and litter. The contaminants in these wastes, as described above, cause water to become congested with unnatural plant growth due to an increasingly anaerobic (i.e. without oxygen) environment, the soil often becoming black and odorous. The contaminants also result in the soils becoming covered and clogged with materials that alter the soil ecology, killing plants and animals that live there. Similarly, the open areas in Apia that are covered with litter, oils and grease from machines and other waste materials, suffer equally. .

The plants and animals that live in water and soils naturally have an ability to assimilate small quantities of waste, thus keeping the environment healthy. When they die, the environment loses essential life-generating systems and the results can include bad smells, unsightliness, public health risks and loss of food sources.

A number of studies have been undertaken to determine the extent of water quality contamination and their origins as land based sources of pollutants. The water sources that were targeted by the SWA Master Plan Study (1997) were primarily from boreholes, hence the absence of major pollutants such as disease pathogens, sediments and pesticides. Table 4.14, however, presents relative amounts of contaminants as suspended solids, etc. which points to the overarching threats from land-based sources of pollution, and domestic wastewater loadings being the most evident pollutant in areas of high population density.

Table 4.14 Pollutants in Water

| Pollutants | Suspended solids | Biological Oxygen Demand | Nitrogen | Phosphorus |
|---|---|---|---|---|
| River sediments | 7,100 – 8,700 | - | 67 | 21 |
| Domestic wastewater loading | 584 | 1,170 | 740 | 83 |
| Solid waste generation | 59 | - | - | - |
| Industrial pollutants | 10 | 64 | - | - |

Source: Cable W (2000)

Further, discharges of untreated wastewater, with associated pathogenic organisms, into streams, rivers and coastal estuaries is causing water pollution and thus degrading the quality of water. These discharges occur from outfalls (point source pollution) and from more diffuse flows from on-site sanitation systems within urban areas or surface water catchments. Rapid urbanization is putting great pressure on surface water, groundwater and supply catchments used for urban and nearby rural water supplies. In the catchments supplying water to Apia, urban expansion and agricultural activities, especially cattle grazing, are noticeable and these are already impacting heavily on water quality and water quantity.

### 4.10.7 Waste Destinations and Pollution by Residues

Typically a traditional, rural environment has a low population density, much open space generally enriched by foliage, and few machines and modern appliances. In contrast, a modern, urban environment has a medium to high population density, little open space with foliage, much land cover with buildings and artificial pavements, and many machines and modern appliances. The consequences of this urban environment are twofold: discharges from people and machines are more concentrated and the natural environment available to assimilate these discharges is limited. For example, a wastewater discharge in a rural environment can be readily absorbed and renovated by the soils and the micro-organisms within them and the plants. A wastewater discharge in an urban environment, if it is uncontrolled, is likely not to have open, natural soils and plants for absorption and renovation.

Waste is composed of materials that can be assimilated by a natural environment where the concentration of the waste is not too high. However, where the concentration is high, the waste load puts stress on the natural systems in the environment and this stress can damage or destroy the

natural systems of plants and animals. Examples of waste material and their effects on the natural environment in urban Apia are;

- Oils and grease that float on water, for example, in parts of the Mulivai or Fugalei Streams, prevent oxygen diffusing into the water to keep the plants and animals that live there healthy,
- Food scraps, human excrement and litter that settle, covering soil and the base of drains and streams, prevents sunlight reaching the plants and animals that live there naturally,
- Nutrients such as nitrogen and phosphorus, that are essential for the growth of plants and animals, but which, in high concentrations, can cause excessive growth and dominance by some species causing an upset to the natural balance,
- Pathogens (micro-organisms that cause disease in humans) from human excrement and washing water pose serious health concerns, and
- Toxins, such as mineral oils from cars and other machines, chemicals from paints, cleaners and herbicides which kill plants and animals. Tests indicate hydrocarbons are high in parts of Vaiusu Bay, including in close proximity to the oil storage tanks on Mulinu'u Peninsula.

Companies involved in trade of hazardous substances are expected to meet chemical safety standards for operations as well as disposal of waste from their premises.

The Government has expanded its municipal solid waste collection service to cover the rest of the two main islands of Upolu and Savaii. A new landfill is also developed on the island of Savaii which is mainly rural. The landfill at Tafaigata on Upolu island is in the early stages of being upgraded to an engineered sanitary landfill. A special area has been designated for sewage disposal, as well as a special area for hazardous wastes. The landfill at Vaiaata is a response to a long overdue disposal site for the whole island of Savaii. As an initial response to the need for urgent upgrade to the landfill and lack of funding earmarked for its daily operation, Government introduced a disposal fee for all incoming wastes to the Tafaigata Landfill in January 2001.

### 4.10.8 Air Quality in Polluted Areas

Air pollution or contamination of the atmosphere by gaseous, liquid, solid wastes or industrial by-products can endanger human health and the welfare of plants and animals. Consequently, it attacks materials, reduces visibility and produces undesirable odours, as well as resulting in noise pollution emissions. Among air pollutants emitted by natural sources, only radioactive gas is recognized as a major health threat. However, sources of major air pollutants are of human-induced activities. These include driving cars, industrial activities such as manufacturing products,, generating electricity and the most prevalent and widely dispersed air pollutants come directly from identifiable sources such as sulphur dioxide from electric power plants, carbon monoxide from motor-vehicle exhaust and some from industrial processes, CO2 from all combustion sources and lead (Pb) pollutant from motor vehicle exhaust, lead smelters and battery plants.

In Samoa, the Government has been alerted to the continued concerns of residents in one of the villages near Apia where one of the main diesel generators for electricity is located. Fume reduction measures and soundproofing measures have been applied by the EPC staff, but these tend to fail after a few weeks of adherence. An old bitumen plant, used by one of the contractors at Vaitele, has also come under scrutiny due to smog and particulate emissions from its chimney. Investigations confirmed that there is indeed emission of pollutants from the bitumen plant which would have been improved by a higher emission stack to allow for better dispersion of the plume.

Ozone (O3) gas is also a very dangerous pollutant in smog and could cause serious crop damage and visibility reduction. The effects of long-term exposure to low concentrations of airborne pollutants and particulate matters can cause related diseases such as lung cancer, fever, migraines, bronchitis, heart and lung diseases, or it can create an overall uncomfortable and hazardous environment for human survival. Other adverse effects of air pollution are potential injury to plants (e.g. crops) and animals (e.g. livestock).

### 4.10.9 Waste Management Systems at Individual, Community, Institutional and National Level

An interesting question was asked on means of waste disposal in the Population Census 2001. Out of the 23,079 households in the country, 58% of total households reported that they depend on public trucks to dispose of their rubbish, 4% reported burning their own rubbish while 24% and 14% dispose their rubbish in the sea or the bush, respectively. Such factual evidences demonstrate a worrying health and environmental issue. In short, health issues are significant for sustainable development. Samoa will never achieve full sustainable development if health issues are ignored from the process. The reason for such prevalent practices rest on lack of awareness and people's feeling of convenience and disregard for their traditional way of life. Sometimes the Government garbage service becomes inconsistent and the easiest way to get rid of rubbish is to dispose of it on vacant land, riverbeds or the sea.

At present, the public solid waste collection that used to cover only the Apia urban area has been extended to the rural areas, as well as on the island of Savaii. Despite this available service, many households still dispose of their wastes either by burning them or discarding them on the riverbanks, streams, mangroves, beaches and the sea. The increase in demand for imported products, which are mostly packaged in non-biodegradable material, and subsequent burning or dumping them in the current manner will contribute to the demise of the marine environment. Direct pollution as a result of sewage out-falls, oil spills and industrial wastes will further exacerbate the problem. This can be highlighted by a solvent spill from a leaked fuel tanker docked at the Apia Wharf in August 1999. Efforts to control the spill were limited to basic material (cloths), but the extent of the impact on the marine environment is unknown due to the lack of equipment and expertise to monitor such an impact.

### 4.10.10 Trade in Waste

Trade in waste occurs in Samoa, both formally and informally. Four companies are currently exporting recyclable waste, particularly scrap metal and plastics. Shipments of containers leave Samoa once full. A specific area has been allocated at the Tafaigata landfill for the operation of scrap metal recyclers which would be assisted by the contraction of aluminium can sorter and crusher. Two companies now operate from the Tafaigata landfill, exporting on average four containers of scrap metal each quarter of the year.

Informal trade in waste takes the form of reusable old car parts imported as personal effects, but are actually waste scraps. Used tyres are also imported by small businesses and resold at reduced prices. While this trade is seen as benefiting those who are interested in second-hand parts, there is still concern that the bulk of the products imported as used spare parts have a very short lifespan. These imports add to the dumping of waste that Samoa should closely monitor.

## 4.11 Energy

### 4.11.1 Energy Generation and Consumption

Samoa is facing and suffering the widespread social and economic consequences of escalating energy costs. As a result, escalating energy prices are increasing levels of hardship. This in turn highlights the urgency to develop indigenous energy resources. Their development should, however, be consistent with requirements for reduction or elimination of environmental impacts.

The total energy supply in Samoa in the year 2000 was around 150 KToe[47]. Biomass for cooking and agricultural drying remains significant and is estimated at nearly half of the total energy supply[48]. The percentage of supply by biomass has been falling over the last two decades with petroleum imports rising annually to the present level of about 80 million litres per year with automotive diesel oil used for power generation and marine transport primarily, and unleaded petrol used for land transport and

[47] ADB. 2006. Renewable Energy and Energy Efficiency programme Technical Assistance, ADB TA 6102 – REG.
[48] SOPAC. 2005. Feasibility Study into the use of Coconut Oil Fuel in EPC Power Generation.

outboard motor operation. These fuels each account for 25% of total energy supply. The remaining 50% of the national energy supply is from biomass that under specific circumstances can be considered renewable. The important traditional role of biomass as a fuel, such as wood, is used for drying of agricultural produce and cooking, especially the Sunday *umu* or ground oven.

### 4.11.2 Renewable Energy

Renewable energy has been researched and encouraged through Government agencies working together in this area. Five private vehicles are currently successfully fuelled by 80% coconut oil and 20% kerosene (pers. Comm., Pacific Coconut Products). An organic waste biogas generation project was piloted at the Tafaigata landfill, but technical issues led to its premature closure.

Development of hydro-power in the large island of Savaii has remained in the planning stages for over many years and may take some additional time due to difficulties associated with securing support and consent of the landowners of the potential river systems for this development. Hence only those hydropower generators on Upolu are working and providing renewable energy to complement the existing diesel generators. New hydropower sites are being identified on Upolu and Savaii (see EPC reports).

Solar energy has been captured on the island of Apolima which used to depend on a diesel generator to supply electricity for only half the time. The EPC has installed the solar panels enabling the islanders of Apolima to access electricity 24hours a day. Plans are also in the pipeline for possible wind energy pilots on the lava fields of Savaii, as well as on Apolima. Two wind monitoring stations have been established on Upolu Island to help ascertain whether enough wind is available in Samoa to generate electricity. Geo-thermal generation of power always remains a possibility in Samoa considering its active geo-thermal activity, albeit too uneconomical at present as no geothermal surface activity has yet been identified.

**Figure 4.4 EPC Vehicle powered by Coconut Oil**


**Source: Hay and Suaesi 2006**

### 4.11.3 Impacts of Energy Development on Environment

The impacts of renewable energy resources in coconut oil development will lead to higher demand for coconut productions and thus possibly raising their prices. There may not be sufficient productive coconut trees, hence more land could be deforested for coconut plantations. Otherwise coconuts may need to be imported from Samoa's immediate neighbours. The development of further hydropower plants is expected to avoid the adversaries of the Afulilo Dam Hydro Project that resulted in the loss of a globally unique montane wetland forest that was earlier proposed for conservation. Selection of the most appropriate and technically feasible site for future hydro-power plants should, therefore, consider the environmental impacts of these developments. An Initial Environmental Examination

(IEE) has just been completed for the proposed hydro-power project on Savaii with some extremely valuable information and some vast improvements on the Afulilo Dam Hydro-Project.

## 4.12 Tourism

### 4.12.1 Objectives of Tourism

Tourism offers great potential for foreign exchange and employment creation throughout the economy, both in resorts and in tourist related services. Tourism development, however, must be consistent with Samoan culture and traditions and it must be sustainable. The Samoa Tourism Authority (STA) completed a project on Sustainable Tourism Indicator Monitoring, but the project was never followed through. Island activities based on nature, culture and adventure, with an increasing interest in a more sustainable form of community tourism development, will continue to be the core focus of future Samoan tourism development.

During the 1990s, there was evidence of a significant sectoral shift in the contributions of the services sector to GDP. Since 1994, tourism earnings have been the largest source of foreign exchange. Tourism receipts have grown from 5% of GDP in the eighties to 15% in the late nineties[49].

### 4.12.2 Tourism Development Plan 2003

A key feature of tourism development was the finalization of the 2002-06 Tourism Development Plan. The Plan highlighted the framework for tourism development for the next five years. In the marketing area, efforts concentrate on key markets and providing a clear and coordinated image for the country. Training in the hospitality area will be aggressively pursued to ensure skills are available to support and promote tourist-related services. The management of the Samoa Tourism Authority (STA) will be strengthened in order that the implementation of the Tourism Development Plan is made more effective and efficient.

### 4.12.3 Tourism Data – Annual Visits, Types of Tourists

Between 1990 and 2000, visitor arrivals grew from 39,414 to 87,688. In the last half of the 1990s total arrivals grew at an annual average rate of 5.1%. This increase has remained consistent, even including the recent 2006 figures. While historically, the bulk of the tourists is made up of visiting friends and relatives (VFRs), however, holiday-makers is currently the fastest growing market sector.

### 4.12.4 Contribution to National Economy

Gross foreign exchange earnings from tourism have increased from $SAT88.1 million in 1995 to ST$133 in 2000 to almost double this in 2006. On an average day, tourist expenditure in Samoa has been estimated by the South Pacific Tourism Organization (SPTO) at $SAT165. The total expenditure corresponds directly with the increase in the thousands of arrivals from mid 1990s to 2000.

Tourism data from 2000 suggests gross visitor spending to an equivalent of 33% of total foreign exchange earnings, and this share of Government revenue was thought at that time to stand at 13% while taking care of 8.5% of total employment. However, it is difficult to ascertain tourism contributions to the national economy without reliable data. Hence various estimates made over the years have ranged between 4-19%. Depending on how the calculation is made (tourism earning or tourism value added) it seems likely that the real figure should be between 7-12% which is consistent with tourism's GDP contribution in other small island states[50].

[49] GOS. 2003c.Tourism Development Plan 2002-2006. Samoa Tourism Authority, Apia.

[50] Government of Samoa. 2002b. Tourism Development Plan 2002-2006. Samoa Tourism Authority, Apia. p87

### 4.12.5 Ecotourism

The conservation and enhancement of Samoa's cultural and natural environment is fundamental to the sustainable development of tourism in Samoa. Currently, all areas of the natural and built environments are under threat from competing resource use. Tourism sites and landscapes have all been mapped and presented in brochures by either the STA or individual tourist reports or beach fales. A number of ecotourism operators conduct tours to heritage sites and conservation areas.

For sometime, there has been a mix of views as to how Samoa should be promoted as an international destination for tourists. Whilst some have advocated for marketing Samoa as a cultural destination, others see Samoa offering a beach product and still others would like to see Samoa exclusively promoted as an ecotourism destination.

It is, however, viewed that given Samoa's early stages of development in each of the core areas of its tourism focus, it would be sensible to pursue a combined product of nature, culture and marine environment that is all underpinned by the distinctive elements for the Samoan culture. In promoting the natural environment of Samoa, the Tourism Development Plan (TDP) 2002-2006 promotes tourism to revolve around the elements and themes of the 'Old Pacific', 'natural beauty', un-crowded beaches', authentic culture' and 'friendly people' of the destination, all of which emphasize the importance of Samoa's ecology.

### 4.12.6 Tourism Impacts on Environment

All tourism development and activities are stipulated by the Tourism Development Plan to be environmentally-friendly. Therefore, EIA procedures need to be followed. There are currently Codes of Environment Practise for roading and drainage which have recently been improved to also address telecommunication infrastructure, earthworks and landscaping. The Development Consent process under the PUM Act will also ensure the environment is protected while at the same time being utilised for tourism activities.
Two major resorts, namely Aggie Greys Lagoon and Spa Resort and Sinalei Reef Resort have both undergone full EIAs in their planning. Smaller hotels and motels in Apia have also followed the Development Consent process and the outcomes of their consultations have improved their design and management plans. Unfortunately for one or two hotel developments right in the middle of town and in prime coastal locations, their ignorance of environmental requirements has led to delays and uncertainty in their establishment.

## 4.13 Food Security and Environment

### 4.13.1 Agriculture Contributors

Food security for local consumption is a priority area for Samoa in achieving its sustainable development goals and MDGs. However, with global climate change impacts, food security will be under-mined. Additional and pro-active efforts need to be made now to ensure future food security in Samoa.

Agriculture remains the backbone of the Samoan economy with two thirds of households engaged in some form of agricultural activity, a mixture of subsistence and commercial agriculture. Many wage-earning households also engage in supplementary subsistence production. Agriculture, therefore, plays a critical role in both development of the rural area and also in ensuring food security for the country.

According to the 2002 Agriculture Survey, 77% of the households were classified as agriculturally active with the remaining 23% as non-agriculturally active. Households in Savaii remain predominantly agriculturally active (94.9% of all households) compared to Upolu households (71% agriculturally active). The rest of Upolu region exhibited similar characteristics with Savaii with 96% of households agriculturally active. The survey results provide a similar pattern with the 2000 survey.

An agricultural holding may consist of one or more parcels. Some 38,414 parcels were recorded in 17,829 holdings.

### 4.13.2 Food Crops

Information on crop areas for agriculturally active households only is also available. Furthermore, the crop areas referred only to single crop and mixed crop patterns. It does not include scattered crops which were collected in the 1999 Agricultural Census. Area under kava also decreased slightly from 130 acres reported in 2004 to 110 acres reported in 2005.

On the other hand, area under taro increased from 2002 level by 11% to 11,900 acres recorded in 2005. Land covered by taamu also increased from 5,100 acres in 2004 to 6,100 in 2005.

Area under banana portrayed a significant change with an increase of 46% from 13,400 acres in 2004 to 19,600 acres in 2005.

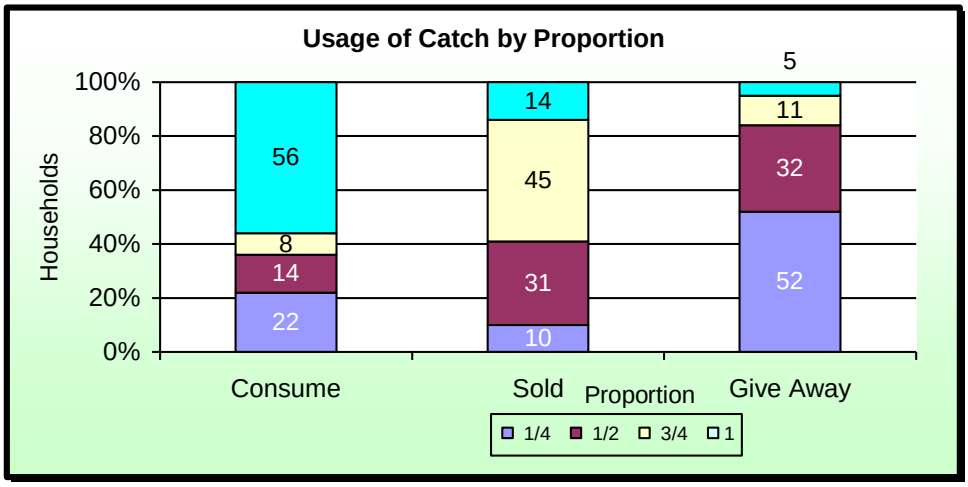
### 4.13.3 Fishing

The 2004 and 2005, agricultural surveys produced similar results where 21% of households were recorded as engaged in fishing activities during a reference period of within the last 14 days of the survey questionnaire.

The majority of persons engaged in fishing were males accounting for 96% of the fishing population compared to 92% recorded in 2004. In addition to this, the main fishing method used is spear as reported by about 8,600 persons, while the least being bottom fishing as reported by some 40 persons.

The usage of fish caught is three fold; consumed, sold and given away, the proportions of which are graphically presented in Figure 4.5. About a quarter of the catch is indicated to be given away, which is either to the extended family, neighbours or pastors. Catches for consumption is highest just for family sustenance but when sold about half or less is held back for family consumption with the rest sold.

**Figure 4.5. Usage of Catch by Proportion**




Source: MAFF, Agriculture Survey 2005.

### 4.13.4 Vulnerability of Food Supply to Cyclones

Food supply continues to be threatened by extreme weather phenomena, particularly in the form of cyclones. The devastations of Cyclones Ofa and Val in the early 1990s are illustrated in the earlier parts of this Report. The impacts of the most recent cyclone of similar although lesser extent is Cyclone Heta, demonstrate the significance of the agriculture sector in the supply of food as well as income-generation and the threats caused by cyclones.

According to the Cyclone Heta Survey by the MOF and MAFF in 2004 immediately after Cyclone Heta, about a third of those surveyed experienced a shortage of food, and most of them resided in the predominantly agricultural areas of North-West Upolu, while most of those residing within the Apia urban area and its peripheries experienced little to no impact on their incomes. However, nearly 40% of all involved in the survey also indicated a reduction in income, and they mostly pointed to the damage to agriculture as the main reason. Food supply and income that depend on agriculture therefore continue to develop overtime with the hope that cyclones do not occur more often.

## 5. Conclusions

The overall trend in the state of the environment in Samoa is one of progressive decline of a once traditional sustainable way of life that could still become sustainable once again, but it would be reliant on restoring the indigenous natural resources back to their original state, and much more. The SOE 2006 draws the following conclusions, paving the way for the Government of Samoa to continue building its environmental and developmental management capacity across all sectors. For example, the recent socio-economic and development trend in Samoa towards a modern way of life may only be sustainable with continued and increasing inputs of capital and products from external sources (notably remittances and aid) and without further impacts from existing and new environmental challenges (e.g. climate change). However, this is unlikely to prevail and the state of the Samoan environment is, therefore, cause for on-going considerable concern.

While claims have been registered of recovery for parts of the terrestrial and marine habitats since the devastations of two extreme cyclones in the early 1990s, most critical environments in Samoa still exhibit levels of on-going degradation and exploitation that are in excess of the capacity of the natural processes to sustain them. Compounding all this is a depressed rural economic sector left with few options but to continue this non-sustainable environmental resource exploitation (this sector will further deteriorate as global food security worsens). Alternatively, and this is where some hope is emerging, a more futuristic and sustainable economic paradigm is being mooted, one that relies heavily on carbon credit exchanges for fossil fuel displacement, standing forest as well as newly planted agro-forestry projects (e.g. as proposed by MNRE). Samoa needs to alter its emphasis, for example, by relying more on non-timber forest products (NTFPs) from agro-forests that not only stabilize soils within water catchments, but also produce oxygen, absorb carbon, produce exports such as bio-fuels and perfumes from *moso'oi* and other native plants.

However, if no conscious change is made immediately, the current exploitative 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 opportunities in the future. This actually represents a fundamental break with the real ethical essence of the *'faa-Samoa'* which had developed in the context of an abundant natural environment being shared by all generations, serving their immediate cultural and socio-economic needs.

Legislation for the protection of the environment has been somewhat progressed with policies and institutional mechanisms to help drive biodiversity conservation and the sustainable management of natural resources that key sectors of Samoa's economy depend on. The impacts of these conservation programmes and related community initiatives, which were purely designed to contribute to the national efforts for the sake of strengthening the integrity of the natural environments, are sporadic with only a few successes being recorded in a number of such community projects. However, the actual level of effectiveness is yet to be ascertained. This is where SEM indicator research must play a key role, however, no priority has yet been given to the funding and training required to successfully complete this monitoring and evaluation (M&E) task (i.e. the M&E of the SEM indicators).

The challenges being faced by the current natural resource and environmental management processes are to deal appropriately with the issues pertaining to the recent reforms in government institutions. In addition the new roles of all other development stakeholders in environmental management, management of watersheds, water supply and sanitation, climate-related environmental health concerns, land resources including forestry, marine resources, energy and tourism need to be exercised, including increased responsibility which comes with increased capacity building, and increased consultations between all stakeholders.

All these stakeholders in Samoa's sustainable development initiatives need to be steered towards some of the existing strategies and policies that are already in place for effective implementation. However, new socio-economic and cultural strategies and policies will need to be also put in place, but there is neither appropriate priority nor funding being given to such vital processes.

GOS needs to present a new innovative rural socio-economic paradigm for Samoa which includes environmental guardianship (i.e. taking responsibility for global oxygen production and other air quality control measures), bio-fuel production, etc. Villagers need to commit wholeheartedly to achieving the prime goal of serving the next generation with an intact culture, intact natural environment and a sound socio-economy that is truly a building block for all future generations of Samoans.

## 5.1 The Way Forward

Samoa's vision for the future is a nation that is characterized by macroeconomic stability; a thriving and competitive private sector and an efficient public sector; adequate employment opportunities for all; best practices being implemented for good governance and accountability; quality health and education services for all; dynamic development of its key agriculture, fisheries and tourism sectors; vibrant socio-cultural values and sustainable management of the physical and biological environments.

To achieve its vision, there is a need for the GOS to foster development by bringing people into the process through initiating policies that make development more participatory and equitable, involving all stakeholders in decision-making at all levels, particularly in natural resource management, improving incentives for people to manage their own resources sustainably, enhancing opportunities for low income earners to enter the formal economy, promoting a greater role for NGOs and CBOs in development, and using modern information technology for faster awareness raising.

In more specific terms, there is a need:

- To consider institutional arrangements for the promotion of sustainable development and the corresponding institutional capacity building in a number of areas, including information dissemination through communication networks and public outreach, training, strategic planning and participatory consultation workshops, the creation of expert panels to provide technical information as well as logistical support, equipment and materials;
- Priority should be given to the completion of the two remaining policies under the NEMS, as well as others in furthering the stand of legal instruments to enforce sustainable development approaches that prioritize environmental and developmental concerns.
- To review all existing legislation in order to provide a sound climate for an integrated operational arrangement between government agencies and its relevant stakeholders;
- To address the escalating population growth and impacts of urbanization, there must be concerted efforts to strengthen the established integrated planning and management system that is responsive to urban growth pressures. It should further build on the existing capabilities of agencies and village groups already servicing the urban area. The system should create and promote understanding of the regulatory policies and frameworks that would ensure good delivery of services required to sustain the quality of life desired and consistent with the Samoan culture;
- To create employment opportunities for the ever-increasing youthful population in both the formal wage and non-formal sectors and ensure parallel productive skills training;
- To reduce inequality and provide assistance to disadvantaged groups requires institutional advancements such as the devolution of responsibilities over natural resources to the local levels, improving social services delivery, redirecting investment to open up a greater range of environmentally-friendly economic opportunities and livelihood options, as well as promote entrepreneurial drive and small scale enterprise development (e.g. through micro-financing opportunities within Samoa);
- To ensure the proper utilization of land resources, hence the need to promote land capability guidelines and an integrated system of land information that developers can use to guide the best development methods to the most suitable land with strict consideration of climate change impacts on agriculture and forestry in Samoa. Such measures can now be strengthened under the umbrella of the approved Land Use Policy and Samoa's responses to revert the degradation of land;
- To further encourage this policy environment to evolve rapidly, it is important to enhance biodiversity conservation by broadening activities through projects that capture the value and security of biodiversity as expressed in these policies. In this way, the idea of sustainable

development is being complemented by sustainable conservation. The replication of Protected Areas (Marine and Terrestrial) demonstrates the concept of bio-regional planning as a step towards ensuring a good balance between conservation and development;

- To strengthen marine and terrestrial resources by strengthening and revitalizing management regimes, including re-instigating traditional conservation measures through enhanced awareness of related issues that are supported by scientific evidence and precautionary management approaches;
- To advise communities of the potential impacts of climate change and weather variability, such as progressive sea level rise that are likely to impact significantly on Samoa. There is a need to identify cost effective and adaptive management approaches and national disaster response strategies to these impacts, all of which must be incorporated rapidly into all national strategic and sector plans. There is a need to develop a policy for the protection of ambient air quality, as well as a supportive legislative framework to control emissions
- To curb the rapid demand growth in the commercial energy sector which brings with it increasingly urgent requirements for prudent energy efficiency management. Central to this is the development of a sustainable energy policy to be supported by strengthened institutional measures. Careful monitoring of government owned energy supply companies and facilities, as well as the promotion of viable renewable energy development, are some of the key priority areas yet to be fully addressed.
- To address the challenges faced in the water resources sector, such as a fragmented management approach and lack of understanding of related environmental and development issues. There is an urgent need to revise the Water Resources Master Plan. High priority should be given to the enforcement of Environmental Impact Assessment (EIA) regulations in order for water abstractions and associated developments to be sustainable in the long- term. A National Water Resources Management Strategy will help create the capacity building required to address these exact issues;
- To continue the review and monitoring of all national actions towards the achievement of international obligations of Samoa, many of which are also serving its own local environmental and developmental purposes if attaining sustainable development within Samoa is at all possible. In this connection, there is an urgent need to strengthen the links between the environment and integrated development by building capacity through education, training and awareness programmes, the development of appropriate benchmarks for sustainable development, information sharing and the use of quality data for decision-making. At least the starting point needs to be with the national SDS (2005-2007) which has carefully reflected most of the environmental and development issues and priorities, and;
- To improve and provide a framework for institutional and infrastructure development towards the sustainable management of hazardous and non-hazardous waste in an environmentally sustainable manner through an integrated approach.

## 5.2 Gaps to be filled

The 2006 State of Environment Report would benefit from a complete set of data and information indicating the status of Samoa's natural resources, and the extent of current impacts that have taken place due to existing environmental and developmental pressures. Also Samoa, whilst being informed of future devastating impacts on its society, culture, economy and natural environments from global pollution and subsequent trade practices, must take immediate mitigating steps to reduce these costly and possibly irreversible negative impacts on Samoa as a whole.

Many factors, however, contribute to inadequacies in, or total absence of, information on the current state of the environment in Samoa. These include insufficient technical equipment for monitoring of ambient conditions, insufficient financial resources and highly trained individuals with necessary expertise to help define and determine the on-going status of each identified sustainability (SEM) indicator. Environmental monitoring is also primarily placed solely on the MNRE rather than being maintained as a collective responsibility of all sectors, however, the latest strategies for shared responsibilities with all relevant ministries is emerging successfully (i.e. DMO has shared responsibilities across all sectors, environmental health strategies also has shared responsibilities across all relevant sectors, etc.). Such sharing of information is now recognized as very important and is becoming critical for future planning and implementation. Environmental and development

information, whilst abundant within the MNRE, however, still remains poorly accessed by other Ministries and stakeholders.

The main issues and challenges of information scarcity is in the areas of ambient air quality, data on greenhouse gases, ODS consumption, and indicators of impacts of climate change, economic valuation of natural resources and much more. In fact, without long-term monitoring of all the SEM Indicators (including Sustainable Forestry, Sustainable Agriculture, Sustainable Economic, Sustainable Fishers Indicators and many more), Samoa will never attain the information it needs to make on-going informed decisions on its development pathway unless the conclusions raised here are adopted urgently. Further negative impacts on our sustainable livelihood aspirations will, therefore, be avoided if this SOE 2006 is received warmly.

Whilst Samoa has in recent years seen a great deal of activity and progress being made in meeting its international and national obligations to the environment and development *per se*, simultaneously creating awareness of all these initiatives throughout the country, there is still a gap in mainstreaming the environment issues into Samoa's national development framework and linking it with SDS indicators. The effectiveness of all the policies at national and community levels has not really been tested, hence the need for urgent and critical evaluation.

There has also been increase in financing for the environmental restoration programme, but implementation is always challenged by personnel shortages and long time-frames in accessing these funds. However, much more remains to be done in terms of capacity building if standards of living and the quality of life of the current generation is to be improved, 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 most critical immediate development for the conservation and restoration of the natural resource-based environments of Samoa, and for its shifting trend of national development towards a truly sustainable base, is the completion and implementation of the NEMS process. It is most important that the Government make an immediate solid commitment to the implementation of NEMS, both in terms of government decision-making processes, and of adequate resourcing for key implementing agencies and end-user stakeholders.

The stakes are high. Not only is the health of the Samoan national environment a serious economic and social 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 *fa'aSamoa* itself. The question of exactly which are the pertinent human ethics that need to prevail in Samoa's management of its natural resources and society and culture, as under-pinned within the *fa'aSamoa*, needs to be carefully scrutinised in the context of future negative global impacts from outside Samoa.

### 5.3 Essential Investments in Environmental Programmes

Considerable progress has been made in the area of policy development and planning for the various environmental management priorities. Relevant plans and strategies have been prepared after in-depth consultations with most stakeholders, including wide community consultations by the GOS. However, the actual implementation of many of these plans and their related activities remains to be completed. The process incepted by the NEMS in 1994 should be revamped immediately. For example, areas of great importance that need to be developed further are (i) ensuring an enabling environment for sustainable development (ii) realization of accessible, affordable, sustainable and renewable indigenous energy supplies; (iii) more equitable and sustainable land management practices; (iv) achieving secure and affordable long-term access to nutritious foods; and (v) reducing vulnerability to natural disasters and social and economic pressures.

Further cross-cutting priority area for action have been identified, namely ensuring the capacity for attaining sustainable development through pro-active capacity development, involving sustainable tourism and sustainable waste management in this development initiative (including issues related to ozone depletion and POPs), and combining all of the above priorities with an International Waters

Programme that encompasses management of freshwater as well as pelagic fish stocks in open waters.

The best investment for the sustainable management of the environment is its people. Systems have been improved for the protection of the environment in a wholesome way through the institutional reforms of the MNRE and recent codification of the PUM Act. Unfortunately, the latter does not meet the expectations of all within the public and private sectors due to the lack of understanding and appreciation of the benefits that the processes therein can foster.

As the series of NEMS policies have identified, the key priority now is to manage this process of change, enabling Government and village decision-makers to adopt the best possible environmental and developmental management practices. This recent process of development management change, and implementation of the strategies proposed to achieve it, is dependent upon the full adoption of the integrated environmental assessment underpinned in the policies and long-term planning processes now in existence in Samoa.

### 5.4 Monitoring and Performance Reporting

The state of the three main components of the natural environment, in land air and water can be monitored through consideration of numerous parameters or indicators that are indicative of sustainability or otherwise in these natural environments. Measuring and monitoring such sustainability indicators will once again be a major challenge for Samoa with its current lack of resources and technical knowledge, however, they have all been included in the SDS (2005-2007). Whilst there may never be sufficient resources on hand to do what is needed, a certain degree of improvisation is urgently required. Hence, Samoa needs to be innovative in addressing this indicator research (hence government's involvement in also identifying its own list of indicators, most of them now included in the SDS) and also approaching novel funding mechanisms (especially climate change funds) and showing its on-going increasing level of commitment to truly attaining sustainable livelihoods for all within the foreseeable future by implementing environmental and developmental projects and programmes.

Development that does not take into consideration at the outset the wider costs, as reflected in the impacts, on the community and natural environment means that the burden of repair falls on the community and future generations. In development planning, a wider framework needs to be used that can be traced all along the development direction. In order to be able to plan and develop the environment in a sustainable manner, knowledge of all facets of the environment need to be known and understood. This is not always possible given the difficulties associated with resources allocation. But the there will never be sufficient resources to go around. Hence, to be innovative in approaching funding mechanisms and showing commitment that Samoa is able to monitor its progress and effectiveness will ensure continuity of this process.

Also, in development planning, a wider framework needs to be applied that can be used at all stages of the development. In order, therefore, to be able to plan and develop the environment in a sustainable manner, knowledge of all facets of the environment needs to be known and understood simultaneously. This is not always possible given the difficulties associated with accessing pertinent information. And this is exactly the pertinent role to be played by SEM Indicator research, close monitoring that embraces all sectors, with information from this long-term monitoring truly indicative of project performance levels.

Financial indicators are also used in the area of performance budgeting, with further indicators for output descriptions and measures. Externally funded projects have also adopted indicators which were utilized elsewhere for measuring mainly the progress of activities. The effectiveness of the projects, which may only be realized in the long-term, will be difficult to assess unless more short-term indicators are employed.

Samoa is now poised to address all the issues raised within the SOE 2006: it has most of the policies in place, it has most of the capacity needed for project implementation (or can afford to buy it), and it has much of the funding required that is now being offered by a widening array of stakeholders.

## References

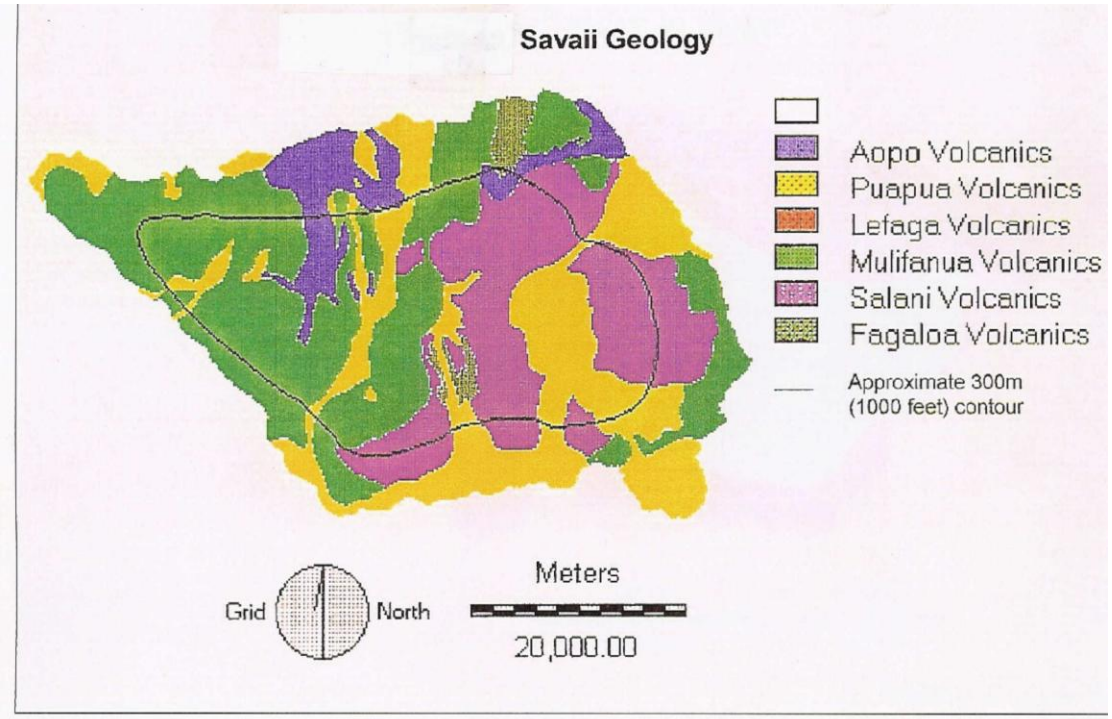
Asian Development Bank. 2000. Samoa 2000: Building on Recent Reforms. *Pacific Studies Series.* Manila, Philippines.
Asian Development Bank. 2002. Implementation of Urban Planning and Management Strategy. Development of Drainage and Sanitation Plans. Draft Report. TA No. 3044-SAM.
Asian Development Bank. 2006. Renewable Energy and Energy Efficiency programme Technical Assistance, ADB TA 6102 – REG.
ANZDEC Limited Consultants. 1990. Land Resources Planning Study: Western Samoa. Final Report. Asian Development Bank TA No. 1065-SAM. New Zealand, DSIR Division of Land and Social Sciences.
BECA International. 2005. National Disaster Management Plan. Produced as part of the SIAM II Project under the World Bank.
Bell, L.A.J., & Mulipola, A.P. 1998.Status of aquaculture and stock enhancement research and development in Samoa.
Bell, L. A. J., and Ropeti, E. 1995. Western Samoa Aquaculture Profiles. *Forum Fisheries Agency. Report No. 95/18(b)*. pp. 51.
Brown, L. R., et al. 1996. State of the World – A Worldwatch Institute Report on Progress Toward a Sustainable Society. W.W. Norton & Company Inc., USA.
Central Bank of Samoa. 2005. Monetary Policy Statement for the Financial Year 2005/2006. Apia, Samoa.
Chase, R., & Veitayaki, J. 1992. Implications of climate change and sea level rise for Western Samoa. *SPREP Reports and Studies Series no. 59.* x + 44 pp.
Connell J and Lea J. 1998. Urban management in Micronesia: learning from Kiribati? *Development Bulletin*, Number 45, Australian National University, Canberra, Australia.
Convard, N. 1993. Land-Based Pollutants Inventory for the South Pacific Region. SPREP, Samoa.
Crawley, T. B. 2003. Climate change and Samoa – sustainable development. *In* T. I. TAULEALO *et al*. eds. *Samoan Environment Forum. 2003: No. 4 Proceedings of the National Environment Forum 2002.* Apia: MNRE. Pp 27-31.
Department of Statistics. 1991. Report of the Census of Population and Housing, Apia. GWS, Samoa.
Department of Statistics. 2001. Census of Population and Housing - A special release of census selected tabulations Apia'. GoS, Samoa.
Dorsch Consult. 2001. Apia Water Supply Consolidation Project. FINAL REPORT. Apia, Samoa.
Dorsch Consult. 2004. Rural Water Supply and Sanitation Study. Draft Final Report. Volume Two. Appendices J-M. Dorsch Consult/KEW Consult Ltd Apia, Samoa.
Education Policy and Planning Development Project. 1995a. Western Samoa – Education Strategies 1995 – 2005. Department of Education, Samoa.
Education Policy and Planning Development Project. 1995b. Western Samoa – Education Policies 1995 – 2005. Department of Education, Samoa.
Etuale, I., Freifeld, H., Utzurrum, R. & Whistler, A. 2001. Environmental Assessment of the Salelologa Township Development Project, Savaii. (Compiled by J. Atherton). Apia, Samoa.
Fergusson, A. 2001. Ozone Depletion and Climate Change: Understanding the Linkages. By authority of the Minister of the Environment, Canada.
Food and Agriculture Organization. 2005.'Strengthening the Institutional Capacity of the Samoan Forestry Division to Effectively Plan and Manage Forest Resources. Final Project Report. TCP/SAM/2901(A). Apia, Samoa.
Forestry Department/FAO. 2005. Global Forest Resources Assessment Update 2005'SAMOA Country Report. Forest Resources Assessment Programme.
Gangaiya, P. and Wele, I. 1994. Land-based Pollution Sources of the Marine Environment in Western Samoa: A case study. SPREP, Western Samoa.
Government of Samoa. 1996. Statement of Economic Strategy 1996 – 1997. Apia, Samoa. Treasury Department, Apia, Samoa.
Government of Samoa. 1996. Statement of Economic Strategy 1998 – 1999. Treasury Department, Apia, Samoa.
Government of Samoa. 1998. National Report to the Convention on Biological Diversity. Division of Environment and Conservation, DLSE, Samoa.
Government of Samoa. 1999. Agricultural Census. Ministry of Agriculture, Forestry, Fisheries, and Meteorology. Apia, Samoa.
Government of Samoa. 1999. First National Communication to the United Nations Framework Convention on Climate Change. DLSE, Apia, Samoa.
Government of Samoa. 2000. Statement of Economic Strategy 2000 – 2001. Treasury Department, Economic Policy and Planning Division, Samoa.
Government of Samoa. 2001a. Keep the Remainder of the Basket. Samoa's Biodiversity Strategy and Action Plan: 95pp.
Government of Samoa. 2001b. Report on the Status of Women in Samoa 2001. Combined Initial, First and Second Periodic Report on the Convention on the Elimination of All Forms of Discrimination Against Women. Ministry of Women Affairs, Apia, Samoa.
Government of Samoa. 2001c. Samoa National Youth Policy 2001 – 2010. Ministry of Youth, Sports & Cultural Affairs, Apia.
Government of Samoa. 2002a. Strategy for the Development of Samoa 2002 – 2004 – Opportunities for All. Treasury Department, Economic Policy and Planning Division, Samoa.
Government of Samoa. 2002b. Tourism Development Plan 2002-2006. Samoa Tourism Authority, Apia. p87
Government of Samoa. 2002c. World Summit on Sustainable Development: National Report. Apia, Samoa.
Government of Samoa. 2003a. National Assessment Report for Barbados Programme of Action. Apia.
Government of Samoa. 2003b. Samoa's First National Report to the United Nations Convention to Combat Desertification. DLSE, Apia, Samoa.
Government of Samoa. 2003c.Tourism Development Plan 2002-2006. Samoa Tourism Authority, Apia.
Government of Samoa. 2004. Samoa's National Biosafety Framework. Final Draft. MNRE, Samoa.
Government of Samoa. 2005a. Report on the Status of the Rights of the Child in Samoa 200'. Apia, Samoa.
Government of Samoa. 2005b. Strategy for the Development of Samoa 2005 – 2007: Enhancing People's Choices. Ministry of Finance, Apia, Samoa.
Government of Samoa/Asian Development Bank. 2001a. Developing an Integrated Urban Planning and Management System for Samoa. GOS, Samoa.

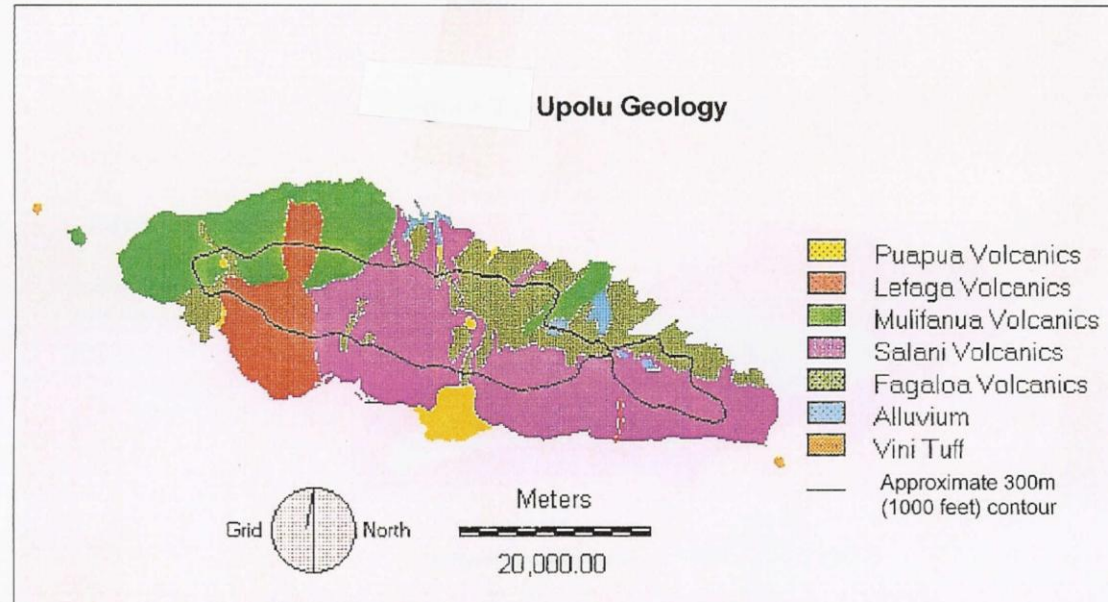
Government of Samoa/Asian Development Bank. 2001b. An Integrated Urban Planning and Management System for Samoa. GoS, Apia.
Government of Samoa/Department of Statistics. 1998. Fuainumera o le Siosiomaga o Samoa – A Compendium of National Environment Statistics. An ADB-Funded Project. Apia, Samoa.
Government of Samoa/MNRE. 2006a. Recovery Plan for the Ma'oma'o or Mao *(Gymnomyza samoensis)* – Samoa's Large Forest Honeyeater 2006 – 2016. MNRE, Apia.
Government of Samoa/MNRE. 2006b. Recovery Plan for the Manumea or Tooth-Billed Pigeon *(Didunculus strigirostris)* 2006 – 2016. MNRE, Apia.
Government of Samoa/UNDP. (undated). National Capacity Needs Self-Assessment For Global Environmental Management. Apia, Samoa.
Government of Samoa/United Nations System. 2005. T.A.L.A.V.O.U. (Towards a Legacy of Achievement, Versatility and Opportunity through Unity) Samoa Joint Young People's Programme. (DRAFT). Ministry of Women, Community & Social Development Apia, Samoa.
Government of Western Samoa. Undated. Fale Mautu. Stronger Buildings. Public Works Department, Buiding Survey Unit, Savalalo, Samoa.
Green, A. 1996. Status of the Coral Reefs of the Samoan Archipelago. Department of Marine and Wildlife Resource, Pago Pago, American Samoa.
Gutteridge Haskins & Davey Pty Ltd. 1998. Apia Waste Water Project. Report on Review of Wastewater Management Options. Asian Development Bank TA No. 3044-SAM. GHD Pty Ltd, Melbourne.
Hay, J.E. 2006. Climate Risk Profile for Samoa. John E. Hay & Associates Ltd., New Zealand.
Hay, J. E. and Suaesi, T. 2006. Samoa Country Environmental Analysis – Mainstreaming Environmental Considerations in Economic and Development Planning Processes. Draft Report. Asian Development Bank TA No. 6204-REG.
IPCC. 2001. Climate Change 2001: Scientific Basis. In: J.T. HOUGHTON. et al. eds. Contribution of Working Group 1 to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University, United Kingdom.
Jones, P. and Kohlhase, J. 2002. Planning in Samoa – A short guide. PUMA Project Team, Apia, Samoa.
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.
Kellogg Brown & Root/IPA Ltd. 2007. Institutional Strengthening for Drainage and Wastewater Management. Interim Report – Component B. TA No. 4229-SAM.
King, M., and Faasili, U. 1998. Community based management of fisheries and the marine environment. Pp.115-125., In Seeto, J., & Bulai. N. (eds). Fisheries and Marine Resources - Papers presented at Symposium 8, VIIIth Pacific Science Inter-Congress. The University of the South Pacific, Fiji. 13-19 July 1997. Marine Studies Programme Technical Report 98/3. The University of the South Pacific.
Kingston, P. A. 2004. Surveillance of Drinking Water Quality in the Pacific Islands: Situation Analysis and Needs Assessment. Country Reports – Samoa. [online]. Available from:http://www.wpro.who.int/NR/rdonlyres/EBBFCA6B-BC08-48A0-B4C5-5ECA02B6BD65/0/Samoa.pdf
Kirkham, W. S. 1999. The Forest and the Market: Agricultural Intensification and Market Participation in Samoa. Published Thesis. Ohio University, USA.
Lovell, E. *et al.* 2004. Status of Coral Reefs in the South West Pacific: Fiji, Nauru, New Caledonia, Samoa, Solomon Islands, Tuvalu and Vanuatu. Status of Coral Reefs of the World 2004.
Malua, T.L. Undated. Modeling the Dispersion of Contaminant Emissions from a Point Source. Project Assignment. School of Environment and Marine Science, Auckland University.
Malua, T.L. 2000. Municipal Solid Waste Assessment and its Application for the Development of an Integrated Solid Waste Management Strategy for Apia, Samoa. Published Thesis. University of Auckland, New Zealand.
Ministry of Agriculture, Forestry and Fisheries. 2005. Situation and Outlook for Samoa Agriculture, Forestry and Fisheries. MAFF, Samoa.
Ministry of Commerce, Industry & Labour. Industrial Relations & Works Permit Division. INFORMATION BOOKLET.
Ministry of Education Sports and Culture. 2006. Strategic Policies and Plan July 2006 – June 2015. MESC, Samoa.
Ministry of Finance. 2006. Public Sector Investment Programmes 2005/06-2007/08. GOS, Apia. pp 16-20.
Ministry of Natural Resource & Environment. 2004a. Conservation and Management of Threatened Lowland and Upland Forests of Savaii. (unpublished report). MNRE, Apia.
Ministry of Natural Resource & Environment. 2004b. Proposal for a National Marine Biodiversity Conservation Project for Samoa. MNRE, Apia.
Ministry of Natural Resources Environment Meteorology. 2005. National Adaptation Programme of Action. MNREM, Apia.
Ministry of Natural Resources, Environment and Meteorology. 2006a. Draft report of the National Capacity Self Assessment: Thematic Assessment on National Capacity Needs, Constraints and Priorities for Implementation of the Convention on Biological Diversity (UN-CBD). MNREM, Samoa.
Ministry of Natural Resource & Environment and Meteorology. 2006a. Corporate Plan 2006-2008. MNREM, Apia.
Ministry of Natural Resources, Environment and Meteorology. 2006b. Draft report of the National Capacity Self Assessment: Thematic Assessment on National Capacity Needs, Constraints and Priorities for Implementation of the Convention on Biological Diversity (UN-CBD). MNREM, Apia.
Ministry of Natural Resources Environment Meteorology. 2006c. Draft report of the National Capacity Self Assessment: Thematic Assessment on National Capacity Needs, Constraints and Priorities for Implementation of the Convention on Combating Desertification (UN-CCD). GOS, Samoa.
Ministry of Natural Resources, Environment and Meteorology. 2006d. Draft report of the National Capacity Self Assessment: Thematic Assessment on National Capacity Needs, Constraints and Priorities for Implementation of the Framework Convention on Climate Change (UN-FCCC). GOS, Samoa.

Mohd-Shahwahid, H.O. 2001. Economic Valuation of the Terrestrial and Marine Resources of Samoa. DEC/DLSE, Samoa.
Mwandosya, M. J. 1996. Survival Emissions: A Perspective from the South on Global Climate Change Negotiations. The Centre for Energy, Environment, Science and Technology, United Republic of Tanzania.

National University of Samoa. 2006. Samoa National HumanDevelopment Report 2006. Sustainable livelihoods in a changing Samoa. Centre for Samoan Studies, Le Papaigalagala, Apia.
Onorio, K. & Tamata, B. 1997. Environmental Impact Assessment Report. Augmentation Phase of Afulilo Hydro Power Scheme, Samoa. SPREP, Samoa.
Park, G., et al., 1992. The National Ecological Survey of Western Samoa: The Conservation of Biological Diversity in the Coastal Lowlands of Western Samoa. New Zealand Ministry of Conservation, NZ.
Public Service Commission. 2000. Working Conditions & Entitlements, Policies & Procedures – To Guide their Management in the Government of Samoa Public Service. GOS, Apia, Samoa.
Rofe, Kennard & Lapworth/GMA Ltd. 1995. National Water Resources Master Plan Study (Stage 1). DRAFT FINAL REPORT. RKL, Surrey, England.
Saifaleupolu, T. S. 2000. Climate change: Challenges for Samoa. *In:* T. I. Taulealo *et al.* eds. *Samoan Environment Forum April 2000, No. 1.* Apia: Department of Lands and Environment. pp 12 – 17.
Samoa Water Authority. 2006. Water for Life – Water Sector Plan and Framework for Action. Updated Draft. [unpublished report]. SWA, Apia.
Schuster, C. 1993. Western Samoa. *In* Scott, D.A., (ed), *A Directory of Wetlands in Oceania.* International Waterfowl and Wetlands Research Bureau, and Asian Wetland Bureau. pp. 427-444.
Schuster, C. 2001. Samoa's First Report to the Convention on Biological Diversity. December 2000 Updated Version. Government of Samoa, Apia.
Schuster, C., Whistler, .A., Tuailemafua, T.S. 1999. The Conservation of Biological Diversity in Upland Ecosystems of Samoa. (Compiled and edited by D. Butler). Division of Environment and Conservation of the Department of Lands, Surveys & Environment. Apia, Samoa.
SOPAC. 1991. Coastal Morphology, Shoreline Stability, and Nearshore Mineral Resources of Upolu, Western Samoa. CCOP/SOPAC Technical Report 90.
SOPAC. 1998. Coastal Protection in the Pacific Islands: Current Trends and Future Prospects. SPREP, Samoa.
SOPAC. 2005. Feasibility Study into the use of Coconut Oil Fuel in EPC Power Generation.
SPREP. 2005a. Action Plan for Managing the Environment of the Pacific Islands Region 2005 – 2009. SPREP, Samoa.
SPREP. 2005b. Annual Report of the Secretariat of the Pacific Regional Environment Programme. Working to sustain and protect the Pacific Islands environment. SPREP, Samoa.
SPREP. 2005c. Strategic Programmes 2004 – 2013. SPREP, Samoa.
SPREP/ Western Samoa NEMS Task Team. 1993. National Environment and Development Management Strategies. Western Samoa, SPREP.
Taulealo, T. I. 1993. 'Western Samoa: State of the Environment Report. SPREP, Samoa.
Taulealo, T. I., et al. (eds.) 2000. Samoan Environment Forum. April 2000, No. 1. Department of Lands & Environment, Apia.
Taulealo, T. I. & Wulf, V. (eds.) 2002. Samoan Environment Forum. 2002, No. 3. Department of Lands, Surveys & Environment, Apia.
Taulealo, T. I., Wulf, V. & Duffy, L. (eds.) 2003. Samoan Environment Forum. 2003: No. 4 Proceedings of the National Environment Forum 2002. MNRE, Apia.
Ward, R. G. and Ashcroft, P. 1998. Samoa: Mapping the Diversity. Institute of Pacific Studies, Suva and National University of Samoa, Apia.
Whistler, W. A. 1992. National Biodiversity Review of Western Samoa. In D. R. Given. ed. Overview of the Terrestrial Biodiversity of Pacific Islands: Including those Islands Covered by the Biodiversity Programme of SPREP. SPREP, Apia.
World Health Organisation. 1996. Healthy Cities – Healthy Islands: Guides for Municipal Solid Waste Management in the Pacific Island Countries. Documents Series No. 6. WHO, KL, Malaysia.
Wulf, V. 2004. Community Vulnerability & Adaptation to Climate Change Assessment. A Report based on the study of Saoluafata and Lano in Samoa. A CBDAMPIC-CIDA Funded Project. MNREM, Apia.
Zann, L. 1991. The Inshore Resources of Upolu, Western Samoa. New Zealand Department of Scientific and Industrial Research Soil Bulleting no. 22, Wellington, NZ.
Zann, L.P., and Mulipola, A.P. 1995. The inshore resources of Western Samoa database: Coastal Inventory and Fisheries. pp. 1-5. *In* Dalzell P., & Adams, T.J.H., eds. *South Pacific Commission and Forum Fisheries Agency Workshop on the Management of South Pacific Inshore Fisheries. Integrated Coastal Fisheries Management Project. Technical Document* **12**(II): 1-700

**Appendix A: MAIN VOLCANIC FORMATIONS OF SAMOA**
**Source: Kear and Wood 1959**



**Appendix B: INFLUENCE OF BASALTS ON LANDSCAPES AND SOILS**
**Source: ANZDEC 1990**

| 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<br><br>Lefaga Volcanics | Slight | 15-50 cm | Boulders and stones | Clay, silty clay<br>Silty clay loam |
| Puapua Volcanics | Very slight | 15-50 cm | Boulders, stones and rock | Silty clay loam<br>Silt loam<br>Silty clay |
| Aopo Volcanics | Very slight | 0-25 cm | Rock, boulders and stones | Sandy gravels<br>Silt loam |
| Vini Tuffs | Moderate | > 100 cm | Few stones | Clay, silty clay loam |

## Appendix C: ENDANGERED OR THREATENED VASCULAR PLANT SPECIES
**Source: Art Whistler (Schuster *et al.* 1999)**

| **1. Species which should be removed from the list of "potentially endangered and threatened plants"** |
|---|
| **A. Angiosperms** |
| *Haplolobus floribundus* (Burseraceae) was found in Upolu plot nos. 3, 4, 5, and 7. The identification of this species is still in doubt, because it is very difficult to distinguish from *Canarium harveyi* when sterile. However, all of the recordings during the survey are probably *Haplolobus.* |
| *Diospyros christophersenii* (Ebenaceae), a synonym of *Macaranga grayana*, was found in Upolu site nos. 5 and 12 and Savaii site nos. 6 and 7. |
| *Macaranga reineckei* (Euphorbiaceae), a synonym of *Macaranga Grayana*, was found in Upolu site nos. 11 and 12 and Savaii site nos 7, 8, and 9. |
| *Macaranga sp. Nova* (Euphorbiaceae) an unnamed species, was found in Upolu site nos 7, 11, and 12 and Savaii site nos 4, 5, 6, and 7. |
| *Peperomia pallida* (Piperaceae) was found in Savaii site nos 3, 4, 5, 6, and 7. |
| *Pittoporum samoense* (Pittosporaceae) was found in Savaii site nos 7, 8, 9, 10, and 11. |
| *Calanthe nephroglossa* (Orchidaceae), a synonym of *Calanthe triplicate*, was found in Upolu site no. 3 and Savaii nos 2, 3, and 4. |
| **B. Ferns and Fern allies** |
| *Dryopteris hirtipes* (Aspidiaceae was found in Savaii site nos. 7, 8, 9, and 11. |
| *Asplenium powellii* (Aspleniaceae), a synonym of *Asplenium multifidum,* was found in Upolu site nos. 5, 6, 7, 8, 9, and 10 and Savaii site nos. 9, 11, and 12. |
| *Athyrium oosorum* (Athyriaceae) was found in Savaii sites 9 and 11. |
| *Blechnum procerum* (Blechnaceae) was found in Savaii site nos. 11. |
| *Dennstaedtia samoensis* (Dennstaedtiaceae) was found in Upolu site nos. 3 and 7. |
| *Trichomanes caudatum* (Hymenophyllaceae) was found in Upolu site nos. 5, 11, and 12. |
| *Tricshomanes maximum* (Hymenophyllaceae) was found on Savaii |
| *Marattia Smithii* (Marattiaceae) was found in Upolu site nos. 5 and 11 and Savaii site nos. 2 and 8. |
| *Pleisoneuron attenuatum* (Thelypteridaceae) was found in Upolu site no. 10. |
| *Antrophyum subfalcatum* (Vittariaceae) was found in Upolu site no. 11 and Savaii site nos. 2, 5, 6, and 7. |
| *Lycopodium phlegmarioidea* (Lycopodiaceae), a synonym of *Lycopodium phlemaria*, was found in Upolu site no. 4 and Savaii site no.4. |
| **2. Species that should remain on the list of "potentially endangered and threatened plant species"** |
| **A. Angiosperms** |
| *Abutilon whistleri* (Malvaceae) was found in Savaii site nos. 7 and 8. |
| *Syzygium neurocalyx* (Myrtaceae) was found in Upolu site nos. 3 and 7. |
| *Chinanthus vitiensis* (Oleceae) was found in Savaii site nos. 1. |
| *Spirianthes senensis* (Orchidaceae) was found in the ash plain near Mata o le Afi in montane Savaii, but not in a site. |
| *Boehmeria sp. Nova* (Urticaceae), which belongs in the genus Cypholophus, was found in Upolu site no. 12 |
| **B. Ferns and Fern Allies** |
| *Dryopteris decomposita* (Aspidiaceae), a synonym of *Lastreopesis pacifica* (Aspifiaceae), was found in Savaii site no. 8 |
| *Asplenium lobulatum* (Aspleniaceae) was found in Savaii site nos. 8 and 9. |
| *Asoplenium sphenolobium* (Aspleniaceae), a synonym of *Asplenium erectum*, was not found in any of the sites, but was collected twice during the survey (given voucher nos. 10239,10255 in Whistler's collection of Samoan plants) |
| *Diplaziopsis javanica* (Athyriaceae) was found in Upolu site nos. 11 and 12. |
| *Diplazium esculentum* (Athyriaceae) was found in Upolu site no. 11. |
| *Teratophyllum wilkesianum* (Lomariopsidaceae) was found in Savaii site no. 5. |

**ENDANGERED/THREATENED VASCULAR PLANT SPECIES – Complete Updated List**
Source: GOS/DoS 1998.

| Plant Family | Species | Times Collected | Last Collected | Status a/ | Elevation range (m) |
|---|---|---|---|---|---|
| Dicotyledons | | | | | |
| Annacardiaceae | *Dracontomelon vitiense* | 5 | 1921 | I | Lowlands |
| Annonaceae | *Polyalthia sp. nova* | 1 | 1974 | E | 600 |
| Apocynaceae | *Cerbera odollam* | 4 | 1974 | I | 600 |
| Asteraceae | *Blumea milnei* | 5 | 1907 | I | NA |
| | *Centipeda minima* | 5 | 1989 | I | 1-700 |
| | *Dichrocephala integrifolia* | 1 | 1830 | P | NA |
| | *Sigesbeckia orientalis* | 5 | 1929 | P | Lowlands |
| Boraginaceae | *Cordia Aspera* | 4 | 1991 | I | 30-250 |
| **Burseracaea | *Haplolobus floribundus* | 3 | 1968 | I | 150-375 |
| Capparaceae | *Grataeva religiosa* | 3 | 1925 | I | 40 |
| Ceratophyllaceae | *Ceratophyllum demersum* | 2 | 1895 | I | Near sea level |
| Chrysobalanaceae | *Parinari insularum* | 8 | 1931 | P | Lowlands |
| Convolvulaceae | *Ipomoea indica* | 3 | 1931 | I | 100 |
| Cucurbitaceae | *Benincasa hispida* | 5 | 1972 | P | Lowlands |
| | *Cucumis melo* | 11 | 1991 | P | Lowlands |
| | *Trichosanthes reineckeana* | 4 | 1989 | E | 200-800 |
| **Ebenaceae | *Diospyros christopersenii* | 4 | 1991 | E | 50-600 |
| **Euphorbiaceae | *Macaranga reineckei* | 4 | 1931 | E | 1200-1300 |
| | *Macaranga sp. Nova* | 4 | 1980 | E | 650-1300 |
| Fabaceae | *Pongamia pinnata* | 2 | 1968 | I | Near sea level<br>Lowlands |
| | *Serianthes malanesica* | 1 | 1875 | I | Near sea level |
| | *Sophora tomentosa* | 8 | 1991 | I | 400<br>NA |
| Flacourtiaceae | *Caesaria sp. nova* | 1 | 1989 | E | NA |
| Gesneriaceae | *Cyrtandra campanulata* | 4 | 1905 | E | Uplands |
| | *Cyrtandra funkii* | 4 | 1895 | E | 600 |
| | *Cyrtandra gurkeana* | 3 | 1905 | E | Near sea level |
| | *Cyrtandra mamolea* | 2 | 1895 | E | 2-150 |
| Gyrocarpaceae | *Gyrocarpus americanus* | 4 | 1989 | I | 30<br>300 |
| Lamiaceae | *Leucas decemdentata* | 15 | 1931 | I | Near sea level |
| Lauraceae | *Crytocarya turbinata* | 4 | 1991 | I | 1140-1400 |
| Loganiaceae | *Strychnos vitiensis* | 1 | 1975 | I | Near sea level |
| Lythraceae | *Pemphis acidula* | 3 | 1990 | I | |
| Malvaceae | *Abutilon whistleri* | | | | |
| Meliaceae | *Xylocarpus moluccensis* | 2 | 1975 | E | |
| | | 12 | 1991 | I | |
| Menispermaceae | *Stephania forsteri* | 11 | 1991 | I | 1-750 |
| Myrtaceae | *Metrosideros gregoryi* | 2 | 1931 | E | 1500 |
| | *Syzygium effusum* | 2 | 1895 | I | Uplands |
| | *Syzygium graeffei* | 2 | 1905 | E | Uplands |
| | *Syzygium neurocalyx* | 14 | 1974 | I | 10-700 |
| | *Syzygium vaupelii* | 2 | 1931 | E | 900 |
| Nyctaginaceae | *Boerhavia albiflora* | 3 | 1980 | I | Near Sea |
| Oleaceae | *Chionanthus vitiensus* | 2 | 1991 | I | 50-150 |
| **Piperaceae | *Peprromia pallida?* | 1 | 1973 | I | 800 |
| **Pittosporaceae | *Pittosporum samoense* | 4 | 1975 | E | 900-1650 |
| Rubiaceae | *Ixora elegans* | 3 | 1991 | I | c. 100 |
| | *Psychotria chlorocalyx* | 6 | 1974 | E | 350-500 |
| | *Psychotria juddii* | 2 | 1931 | E | 1000-1100 |
| | *Psychotria sclerocarpa* | 4 | 1973 | E | 700 |
| Sapindaceae | *Guioa rhoifolia* | 2 | 1931 | I | 300 |
| Sapotaceae | *Manilkara dissecta* | 4 | 1977 | I | 1-200 |
| | *Manilkara samoensis* | 1 | 1875 | E | NA |
| | *Northiopsis hoshinoi* | 4 | 1991 | I | 30 |
| Scrophulariaceae | *Limnophila fragrans* | 10 | 1991 | I | 1-700 |
| Solanaceae | *Solanum amicorum* | 1 | 1875 | I | Near Sea Level |
| | *Solanum repandum* | 3 | 1905 | P | Lowlands |
| | *Solanum viride* | 19 | 1991 | P | Lowlands |
| Sterculiaceae | *Waltheria indica* | 3 | 1905 | I | c. 200 |

| | | | | | |
|---|---|---|---|---|---|
| Surianiaceae | *Suriana maritime* | 1 | 1979 | I | Near Sea Level |
| Ulmaceae | *Celtis vitiensus* | 3 | 1989 | I | 5-30 |
| Urticaceae | *Boehmeria sp. nova?* | 1 | 1978 | E | 400-1030 |
| Monocotyledons | | | | | |
| Orchidaceae | *Bulbophullum longiflorum* | 3 | 1989 | I | 300 |
| | *Bulbophyllum trachyanthum* | 2 | 1931 | I | 400-1030 |
| | ***Calanthe nephroglossa* | 3 | 1931 | E | 1000 |
| | *Chrysoglossum ornatum* | 1 | 1973 | I | 600 |
| | *Corybas betchei* | 1 | 1881 | E | NA |
| | *Cryptostylis archnites* | 4 | 1976 | I | 600-1200 |
| | *Dentrobium macrophyllum* | 3 | 1977 | I | 600 |
| | *Geodorum densiflorum* | 2 | 1907 | I | Lowlands |
| | *Habenaria monogyne* | 7 | 1931 | E | 300-900 |
| | *Luisia teretifolia* | 3 | 1931 | I | 500-600 |
| | *Microtatorchis samoensis* | 3 | 189 | I | 800 |
| | *Pomatocalpha vaupeii* | 4 | 1985 | I | 400-600 |
| | *Schoenorchis micrantha* | 3 | 1978 | I | 50-1600 |
| | *Spiranthes sinensis* | 1 | 1975 | I | 1550 |
| | *Tropidia effuse* | 2 | 1972 | I | 400 |
| | *Cenchrus calyculatus* | 6 | 1907 | I | Lowlands |
| | *Erianthus maxima* | 3 | 1989 | I | 700 |
| | *Heteropogon contortus* | 2 | 1905 | I | c. 200 |
| | *Microstegium glabratum* | 4 | 1985 | I | 150-200 |
| Ruppiaceae | *Ruppia maritime* | 1 | 1962 | I | Near Sea Level |
| Taccaceae | *Tacca maculate* | 2 | 1973 | I | 100-300 |
| Ferns & fern allies | *Cheilanthes tenuifolia* | 2 | 1974 | I | 30 |
| Adiantiaceae | *Doryopteris concolor* | 9 | 1990 | I | Near Sea Level |
| Aspidiaceae | *Doryopteris decomposita* | 1 | 1931 | I | 1400 |
| | ***Dryopetris hirtipes* | 6 | 1907 | I | 800-1500 |
| | *Dryopetris samoensis* | 8 | 1895 | E | 600 |
| | *Tectaria crenata* | 6 | 1905 | I | 200-700 |
| Aspleniaceae | *Asplenium lobulatum* | 6 | 1905 | ? | 600?-1700 |
| | *Asplenium powellii* | 2 | 1922 | E | Montane |
| | *Asplenium sphenolobium* | 2 | 1907 | I | 1500 |
| Athyriaceae | *Athyrium oosorum* | 5 | 1931 | E | 800-1400 |
| | *Diplaziopsis javanica* | 5 | 1931 | I | 750-1300 |
| | *Diplazium esculentum* | 6 | 1905 | I | Lowlands? |
| **Blechanceae | *Blechnum procerum* | 5 | 1931 | I | 1500-1700 |
| Cyatheaceae | *Cyathea subsessilis* | 3 | 1931 | I | 900 |
| Davalliaceae | *Oleandra christophersenii* | 1 | 1931 | E | 700 |
| **Dennstaedtiaceae | *Dennstaedtia samoensis* | 5 | 1980 | E | 300-500 |
| Gramatidiaceae | *Ctenopteris* | 3 | 1907 | E | 900 |
| | *deltoideophyllum* | 1 | 1965 | E | 1080 |
| | *Grammitis monicola* | 2 | 1907 | I | NA |
| Hymenophyllaceae | *Hymenophyllum feejeense* | 7 | 1907 | I | 1300? |
| | *Hymenophyllum samoensis* | | 1931 | I | 400-500 |
| | *Trichomanes bimarginatum* | 9 | | | |
| | ***Trichomanes caudatum* | 3 | 1895 | I | 600 |
| | ***Trichomanes maximum* | 4 | 1931 | I | 550-600 |
| | *Trichomanes nymani* | 1 | 1907 | I | 800 |
| | *Trichomanes pallidum* | 5 | 1907 | E | NA |
| | *Trichomanes powellii* | 3 | 1991 | E | 500-820 |
| | *Trichomanes samonese* | 3 | 1907 | I | NA |
| | *Trichomanes taeniatum* | 4 | 1905 | I | 500 |
| Lindsaeaceae | *Lindsaea repens* | 3 | 1881 | I | NA |
| | *Lindsaea tetragona* | 11 | 1905 | I | 500 |
| | *Microlepia nudisora* | 3 | 1905 | E | Lowlands |
| Lomariopsidaceae | *Scleroglossum sulcatum* | 5 | 1895 | I | 1000 |
| | *Teratophyllum wilkesianum* | 5 | 1931 | I | 1000 |
| **Marattiaceae | *Marattia smithii* | 8 | 1905 | I | 50?-600 |
| Ophioglossaceae | *Botcrychium daucifolium* | 3 | 1905 | I | 700-800 |
| Polypodiaceae | *Calymmodon latealatus* | 4 | 1905 | I | Montane |
| | *Polypodium reineckei* | 5 | 1931 | E | 500-700 |
| Thelypterridaceae | *Christella adenaopelta* | 2 | 1965 | I | 600? |
| | *Christella arida* | ? | ? | I | NA |
| | *Christella pacifica* | 2 | 1921 | I | NA |
| | *Christella subpubescens* | ? | ? | I | NA |

| | | | | | |
|---|---|---|---|---|---|
| | *Plesioneuron attenuatum* | 5 | 1931 | I | 400 |
| | *Plesioneuron savaiense* | 1 | 1865 | I | NA |
| | *Pneumatopteris bryanii* | 6 | 1965 | E | 200-300 |
| | *Pneumatopteris costata* | 3 | 1931 | I | 400-500 |
| | *Pneumatopteris rodigasiana* | 7 | 1920 | I | 50-600? |
| | *Pneumatopteris transversaria* | 9 | 1921 | I | 150-600? |
| | *Pneumatopteris persimillis* | 3 | 1965 | E | 1220 |
| | *Sphaerostephanos heterocarpus* | 2 | 1965 | I | NA |
| | *Sphaerostephanos hochreutineri* | 5 | 1905 | E | 600-700 |
| | *Sphaerostephanos polycarpus* | 4 | 1881 | I | NA |
| | *Sphaerostephanos pycnosorus* | 4 | 1965 | E | NA |
| **Vittariaceae | *Antrophyum subfalcatum* | 4 | 1931 | I | 500-750 |
| **Lycopodiaceae | *Lycopodium phlegmarioides* | 2 | 1931 | I | 720 |
| Psilotaceae | *Tmesipteris tannensis* | 3 | 1931 | I | 1300 |

** Species which should be removed from the list.
a/ I=indidenous; E=endemic; P=Polynesian introduction

## Appendix D: CHRONOLOGY OF MARICULTURE AND RESOURCE ENHANCEMENT PROJECTS IN SAMOA

**Source: Bell & Ropeti 1995, and Bell & Mulipola, 1998**

| Project | Species | Year Started | Responsible agencies | Purpose | Organism source | Status |
|---|---|---|---|---|---|---|
| Turtle hatchery | Hawksbill *(Eretmochelys imbricata)* | 1970/19 | Fisheries Division | Augment local turtle populations | Local (turtle eggs dug up from nests) | Closed in 1983 |
| Seaweed culture | *Kappaphycus alvarezli* and *K. denticulatum* | 1975 | ?? | Culture experiment? Details not known. | Introduced but details not known | |
| Marine Shrimp | Tiger prawn *Penaeus monodon* | 1979 | Fisheries Division/Canadian Aid/UNDP | Experiment on growth in baitfish ponds for commercial | CNEXO (now AQUACOP) Tahiti | Never developed |
| Mussel (marine) | Philippine green mussel, *Perna viridis* | 1981 | Fisheries Division/Canadian Aid/UNDP | Culture/feasibility experiment | CNEXO (now AQUACOP), Tahiti | Discontinued by 1990 but plans to re-visit if spats source identified |
| Giant clams | *Tridacna spp. & Hippopus spp.* | 1987 | Fisheries Division/SPADP | Restocking/farming | Palau, Tokelau, Australia, Solomon Is, Fiji, American Samoa | On-going |
| Oyster | Pacific oyster, *Crassostrea gigas* | 1990 | Fisheries Divisions/SPADP | Culture trials for commercial | Kuiper Mariculture, California, USA | No follow-up after harvest in 1991 but plans to re-investigate. |
| Top Shell | Trochus, *Trochus niloticus* | 1990 | Fisheries Division/FAO | Seeding for resource enhancement | Fiji | Plans to continue |
| Seaweed | *Euchema* | 1991 | Fisheries Divisions/SPADP | Culture trials | Fiji | Discontinued in 1992 |
| Giant clam | *Tridacna derasa* | 1995 | Fisheries/APADP/AusAid/Villages | Reserve stocking & Aquarium | American Samoa | On-going |
| Mullet/rabbit-fish | | 1997 | Fisheries/AusAID | Culuture trials | Local | Just started |
| Green snail | *Turbo marmorata* | 1999 | Fisheries/SPADP | Reef Stocking | Tonga Fisheries | Just started |

**Appendix: E: MARINE ORGANISM INTRODUCTIONS INTO SAMOA**
**For aquaculture, reef seeding and other purposes, sorted by organism common name.**
Source: Bell & Ropeti, 1995, Bell & Mulipola, 1998

| COMMON NAME | SPECIES | YEAR | PURPOSE | LOCAL DISTRIBUTION |
|---|---|---|---|---|
| Marine Shrimp | *Penaeus monodon* | 1979 | Culture trial | Vaitoloa baitfish ponds. |
| Mussel Philippine green mussel | *Perna viridis* | 1982 | Culture trials | Mulinuu lagoon & Fisheries Harbou. |
| | *Perna viridis* | 1983 | Culture | Safata Bay & Asau Bay. |
| Seaweed | *Kappaphycus alvarazii & K denticulatum* | 1975 | Culture trials | Vaiusu –Faleula Lagoon? |
| | *K. alvarazii* (Euchema) | 1991 | Culture trials | Aleipata & Mulinuu |
| | *K. alvarazii* (Euchema) | 1992 | Culture trials | Aleipata |
| | *K. alvarazii* (Euchema) | 1992 | Culture trials | Aleipata |
| | *K. alvarazii* (Euchema) | 1999 | Culture trials | Asau Saluafata, Mulifanua |
| Trochus | *Trochus niloticus* | 1990 | Seeding | Namu'a and Nuutele Islands received 40 |
| Oyster (Pacific) | *Crassostrea gigas* | *1990* | Culture trials | Fusi Safata Bay |
| Giant clams | *Tridacna derasa* | 1988 | Culture | Fisheries & Moataa Lagoon |
| | *T. squamosa* | 1989 | Breeders | Fisheries hatchery |
| | *T. gigas* | 1990 | Culture | Namua Farm At Aleipata |
| | *Hippopus hippopus* | 1990 | Culture | Fisheries/hatchery but None survived |
| | *T. gigas* | 1991 | Culture | Fisheries/Namu'a Farm at Aleipata |
| | *H. Hippopus* | 1991 | Culture | Fisheries/Namu'a Farm at Aleipata |
| | *T. gigas* | 1991 | Culture | Fisheries/Namu'a Farm at Aleipata |
| | *T. derasa* | 1992 | Culture | Fisheries/Namua Farm |
| | *T. squamosa* | 1992 | Culture | Fisheries/Namua Farm |
| | *T. derasa* | 1993 | Culture | Fisheries/Namua Farm |
| | *T. squamosa* | 1993 | Culture | Fisheries/Namua Farm |
| | *T. squamosa & T. derasa* | 1993 | Culture | Fisheries/Namua Farm |
| | *T. derasa* | 1995 | Reserve stocking & development | Moamoa & Tauoo village reserves |
| | *T. derasa* | 1996 | Reserve stocking & development | Fasitoo (Upolu) Faleu, Lepuai, Salua & Apai villages on Manono Island |

| | | | | |
|---|---|---|---|---|
| | *T. derasa* | 1997 | Reserve Stocking | Satoalepai and Saleaula villages, Savaii Island |
| | *T. derasa (With a few speciment of T. Maxima and H. hippopus* | 1997 | Reserve Stocking | Tafitoala, Fausaga, Fusi Safata villages on Upolu Island & Asau, Auala, Fagasa, Sataua, Fagamalo, Pu'apu'a, Asaga, Faala and Vaitoomuli viilages on Savaii Island |
| | *T. derasa & T. squamosa* | 1998 | Reserve Stocking | Local villages |
| | *T. derasa* | 1998 | Reserve Stocking | Local villages |
| | *T. derasa* | 1999 | Reserve Stocking | Ulufaalalafa, Solosolo, Sapapalii, Papa & FD nursery |
| | *T. gigas* | 1999 | Reserve Stocking | Ulufaalalafa, Solosolo, Sapapalii, Papa & FD nursery |
| | *T. derasa* | 1999 | Reserve Stocking | 14 villages & FD nursery |
| | *T. derasa* | 1999 | Brood stock | 29 to FD nursery, I died during quarantine |
| Green snail | *Turbo marmorata* | 1999 | Reef Stocking | Quarantine at Fisheries for 3 weeks, released 100 at Papa Puleia on 18 May 1999, 50 to be released at Saluafata & 150 at Namu'a Island. |

## Appendix F: TREES SPECIES LIST
## Source: SamFris/FAO 2005

| Species code | Scientific | Family | Samoan name | Commercial | Invasive |
|---|---|---|---|---|---|
| ACRE | Acronychia refusa | | Tonai | No | No |
| ADPA | *Adenanthera pavonina* | Fabaceae | Lopa | No | No |
| AGSA | *Aglaia samoensis* | Fabaceae | Lagaali | Yes | No |
| ALCH | *Albizia chinenses* | Fabaceae | Tamaligi | No | No |
| ALFA | *Albizia falcataria* | Fabaceae | Tamaligi | No | No |
| ALLE | *Albizia lebbeck* | Fabaceae | Tamaligi | No | No |
| ALMO | *Aleurities moluccana* | Euphorbiaceae | Lama | No | No |
| ALZI | *Alphitonia zizyphoides* | Rhamnaceae | Toi | No | No |
| ALRE | *Alstonia reineckeana* | Apocynaceae | Manu'u togo vao | No | No |
| ANOC | *Anacardium occidentale* | Anacardiaceae | Apu Initia | No | No |
| ANMU | *Annona muricata* | Annonaceae | Sasalapa | No | No |
| ANCH | *Anthocephalus chinensis* | Rubiaceae | Katama | Yes | No |
| ANIN | *Antirhea inconspicua* | Rubiaceae | Puapua | No | No |
| ARHE | *Araucaria heterophylla* | Araucariaceae | Paina | Yes | No |
| ARHU | *Araucaria hunstenii* | Araucariaceae | Paina | Yes | No |
| ARAL | *Artocarpus altilis* | Moraceae | Ulu | No | No |
| ARHT | *Artocarpus heterophyllus* | Moraceae | Ulu Initia | No | No |
| ASDI | *Ascarina diffusa* | Cholranthaceae | Afia | No | No |
| ASLA | *Ascarina lancelota* | Chloranthaceae | Togo Vao | Yes | No |
| ATRA | *Atuna racemosa* | | Ifiifi | No | No |
| AVCA | *Averrhoa carambola* | | Vineka | No | No |
| BARE | *Balaka rechingeriana* | Palmae | Maniuniu | No | No |
| BAAS | *Baringtonia asiatica* | Barringtoniaceae | Futu | No | No |
| BASA | *Barrintonia samoensis* | Lecythidaceae | Falaga | No | No |
| BIJA | *Bischofia javanica* | Euphorbiaceae | Oa | Yes | No |
| BIOR | *Bixa orellana* | Bixaceae | Lo'a | No | No |
| BRPA | *Broussonetia papyrifera* | Moraceae | U'a | No | No |
| CIAN | *Calophyllum inophyllum* | Clusiaceae | Fetau | Yes | No |
| CANE | *Calophyllum neo-ebudicum* | Clusiaceae | Tamanu | Yes | No |
| CASE | *Calophyllum samoense* | Clusiaceae | Tamanu | Yes | No |
| CAOD | *Cananga odorata* | Anacardiaceae | Mosooi | No | No |
| CAHA | *Canarium Harveyi* | Burseraceae | Mafoa | Yes | No |
| CASA | *Canarium samoense* | Burseaceae | Ma'ali | Yes | No |
| CAVI | *Canarium vitiense* | Burseaceae | Ma'ali | Yes | No |
| CAME | *Canthium merrillii* | Rbiaceae | Olasina | No | No |
| CAEL | *Castilla elastica* | Moraceae | Pulu mamoe | No | Yes |
| CAEQ | *Casuarina equisetifolia* | Casuarinaceae | Toa | Yes | No |
| CIVE | *Cinnamomum verum* | Lauraceae | Tinamoni | No | No |
| CLIN | *Clerodendrum inerme* | | Aloalotai | No | No |
| CLON | *Clinostigma onchorhyncha* | Palmae | Niu vao | No | No |

| | | | | | |
|---|---|---|---|---|---|
| CLSA | *Clinostigma samoense* | Palmae | Niu vao | No | No |
| CLSV | *Clinostigma savaiiense* | Palmae | Niu vao | No | No |
| CONU | *Cocos nucifera* | Arecaceae | Niu | No | No |
| COFR | *Cordyline fruticosa* | | Ti vao | No | No |
| CREL | *Cryptocarya elegans* | Lauraceae | Lau Lilii | No | No |
| CYLU | *Cyathea lunulata* | | Oli Oli | No | No |
| DEHA | *Dendrochride harveyi* | Urticaceae | Salato | No | No |
| DISA | *Diospyros samoense* | Ebenaceae | Auauli | Yes | No |
| DISE | *Diospyros elliptica* | Ebenaceae | Anume | No | No |
| DYHU | *Dysoxylum huntil* | Melaiceae | Maotamea | Yes | No |
| DYMA | *Dysoxylum maota* | Meliaceae | Maota | Yes | No |
| DYSA | *Dysoxylum samoense* | Meliaceae | Tufaso | Yes | No |
| ELGR | *Elaeocarpus grandis* | Elaecarpaceae | Siapotua | No | No |
| ELTO | *Elaecarpus tonganus* | Elaecarpaceae | A'amatie | Yes | No |
| ELFA | *Ellattostachys falcata* | Sapindaceae | Taputo'i | Yes | No |
| ERVA | *Erythrina variegata* | Fabaceae | Gatae | No | No |
| FABE | *Fagraea berteroana* | Loganiaceae | Pualulu | No | No |
| FITI | *Ficus tinctoria* | Moraceae | Mati | No | No |
| FLRU | *Flacourtia rukam* | Flacourtiaceae | Filimoto | No | No |
| FLFL | *Flueggia Flexuosa* | Euphorbiaceae | Poumuli | Yes | No |
| FUEL | *Funtumia elastica* | Apocynaceae | Pulu vao | No | Yes |
| GAFL | *Garuga Floribunda* | Burseraceae | Magaui | Yes | No |
| GLRA | *Clochidion ramiflorum* | Euphorbiaceae | Masame | No | No |
| GOHI | *Gossipium hirsutum* | Malvaceae | Vavae | No | No |
| HEOR | *Heritiera ornithocephala* | Sterculiaceae | Ma | No | No |
| HEMO | *Hernandia moerenhoutiana* | Hernandiaceae | Pipi | Yes | No |
| HITI | *Hibiscus tiliaceus* | Malvaceae | Fau | No | No |
| INFA | *Inocarpus fagifera* | Fabaceae | Ifi | No | No |
| INBI | *Intsia bijuga* | Caesalpinaceae | Ifilele | Yes | No |
| IXSA | *Ixora samoensis* | Rubiaceae | Filofiloa | No | No |
| KLHO | *Kleinhovia hospita* | Sterculiaceae | Fuafua | No | No |
| LAIN | *Laportea interrupta* | Urticaceae | Ogoogo | No | No |
| MAHA | *Macaranga harveyana* | Euphorbiaceae | Laupata | No | No |
| MAST | *Macaranga stipulosa* | Euphorbiaceae | Laufatu | No | No |
| MAGL | *Mammea glauca* | Clusiaceae | Manapu | No | No |
| MAHO | *Manikara hoshinoi* | | Pau | Yes | No |
| MOCI | *Morinda citfrifolia* | Rubiaceae | Nonu | No | No |
| MYFA | *Myristica fatua* | Myrsticaceae | Atone | Yes | No |
| NEFO | *Neonauclea forsteri* | Rubiaceae | Afa | Yes | No |
| OMAC | *Omaranthus acuminatus* | Euphorbiaceae | Mamala | Yes | No |
| PAST | *Palaqium stehlinii* | Sapotaceae | Gasu | Yes | No |
| PIAR | *Pipturus argentus* | Urticaceae | Soga | No | No |
| PLLI | *Planchonella linggesis* | Sapotaceae | Alaa | No | No |

| | | | | | |
|---|---|---|---|---|---|
| PLTO | *Plancehonella torricelensis* | Sapotaceae | Mamalava | Yes | No |
| POPI | *Pometia pinnata* | Sapindaceae | Tava | Yes | No |
| RELA | *Reynoldisia lanotoensis* | | Vivao | No | No |
| RHTA | *Rhus taitensis* | Anacardiaceae | Tavai | No | No |
| SAPA | *Sarcopygme pacifica* | | Uunu | No | No |
| SOVI | *Solanum vitiense* | Solanaceae | Uagani | No | No |
| SPCA | *Spathodea campanulata* | Bignoniaceae | Faapasi | No | Yes |
| STFA | *Sterculia fanaio* | Sterculiaceae | Fanaio | No | No |
| SYCL | *Syzygium clusifolium* | Myrtaceae | Asivai | Yes | No |
| SYIN | *Syzygium inophylloides* | Myrtaceae | Asitoa | Yes | No |
| SYMA | *Syzygium malaccense* | Myrtaceae | Nonu fiafia | No | No |
| SYSA | *Syzygium samarangense* | Myrtaceae | Nonu vao | Yes | No |
| ACAL | *T??* | | ‘Aumanogi | No | No |
| TECA | *Terminalia catappa* | Combretaceae | Talie | Yes | No |
| TERI | *Terminalia richii* | Combretaceae | Malili | Yes | No |
| TRCA | *Trema cannabina* | Ulmaceae | Magele | No | No |
| VITR | *Vitex trifolia* | Verbenaceae | Namulega | No | No |

.

**Appendix G: NEW PLANT SPECIES**
**Source: Art Whistler (Schuster *et al.* 1999)**

| |
|---|
| 1. *Acalypha repanda* (Euphorbiaceae). It was recorded by A.C. Smith in the early 1980s, probably based upon some early record. However this specimen, Whistler 10142, collected above Sauniatu, is apparently the first cited specimen. Only a single tree was found. |
| 2. *Parasponia andersonii* (Ulmaceae). A new record for the archipelago. It was found in the Afulilo dam area, possibly a recent introduction with heavy equipment. It is very similar to Trema cannabina, for which it is often mistaken. |
| 3. *Aplaia sp. Nova* (Meliaceae) A medium sized tree, Whistler 10019, collected on a ridge east pf Afulilo, and subsequently collected above Uafato during another survey. |
| 4. *Robiquetia berthholdii* (Orchidaceae). A sterile specimen, Whistler 10213, appears to belong to this species. |

**Appendix H: INVASIVE ALIEN PLANT SPECIES**
**Source: Art Whistler (Schuster *et al.* 1999)**

| |
|---|
| 1. *Funtuma elastica* (Apocynaceae). This tree, **pulu vao**, is probably the most harmful weed in native habitats in Samoa. In some places it is in the dominant tree in all size classes, which means that native species are not able to compete with it, especially in disturbed habitats. For some reason, at the present time it is a problem only on the western half of Upolu, where it was found in four plots during the survey, Biological control of this species is urgently needed. |
| 2. *Castilla elastica* (Moraceae). This tree, **pulu mamoe,** tends to occur in the habitats as the Funtumia, but is not nearly as much of a problem. It was like Funtumia, originally introduced as an experimental rubber tree. It was found in three of the Upolu plots but none of the Savaii plots. |
| 3. *Spathodea campulata* (Bignoniaceae). This African tulip tree was probably introduced for its large showy orange-red-flowers, but has recently become a weed in secondary forests in Samoa (and elsewhere in the Pacific). It has wind-blown seeds that can rapidly spread the tree to new areas. It was found in three Upolu plots, but none of the Savaii plots. |
| 4. *Mikania micrantha* (Asteceae). This “mile-a-minute”, known as a **fue saina**, was apparently introduced by accident at around the turn of the last century, and has now become a weed throughout Samoa. It was found in all 12 Upolu plots and the lowest eight of the Savaii plots. |
| 5. *Clidemia hirta* (Melastomaceae). This shrub, known as “Koster curse”, has been reported from Western Samoa only in the last 20 years. However, it has spread rapidly and was found in all 12 Upolu plots but only three of the Savaii plots. (It may be still spreading on Savaii). |
| 6. *Passiflora laurifolia* (Passifloraceae). This vine known as a type of pasio, is casually cultivated for its edible passion fruits. It is now, however, somewhat of a pest in native forests and disturbed areas. It was found in nine of the 12 Upolu plots but none of the Savaii plots. |
| 7. *Cestrum nocturnum* (Solanaceae). This shrub, **alii o le po or teine o le po**, is cultivated for its flowers, which are fragnant at night, but is also the worst weed in the uplands of Upolu. It was found in all five of the higher elevation plots, where its was often the dominant species in the disturbed montane and cloud forest. It was not recorded from any of the Savaii plots. |
| 8. *Ishaemum timoriense* (Poaceae). This pasture grass, which is planted in upland cattle pastures, has invaded the forest, in some places completely dominating the understorey. It was recorded in one Upolu and one Savaii, but was a pest in both instances. |
| 9. *Paspalum conjugatum* (Poaceae). This grass, **vao lima**, is probably the second most common weed in Samoa, and was found in 11 of the 12 Upolu plots and the five lowest plots of Savaii. It is also a serious weed in plantations, especially in wetter places. |
| 10. *Elaecarpus grandis* (Elaeocarpaceae). This tree known as **siapatua,** is sometimes a dominant weed in disturbed areas on the western side of Savaii, and seems to be spreading eastward. It was found in three Savaii plots. The blue seeds are apparently spread by pigeons. |

## Appendix I: GLOBAL STATUS OF SAMOA'S BIRD SPECIES
**Source: MNREM 2006a**

| NO | SPECIES | | | GLOBAL STATUS |
|---|---|---|---|---|
| | Common Name | Scientific Name | Native Name | |
| 1 | Samoan Moorhen | *Gallinula pacifica* | Puna'e | CR |
| 2 | Shy Ground-dove | *Gallicolumba stairi* | Tuaimeo | VU |
| 3 | Many-coloured Fruit-dove | *Ptilinopus perousii* | Manuma | cd |
| 4 | Crimson-crowned Fruit-dove | *Ptilinopus porphyraceus* | Manutagi | cd |
| 5 | Tooth-billed Pigeon | *Didunculus strigirostris* | Manumea | EN |
| 6 | Blue-crowned Lorikeet | *Vini australis* | Segavao | cd |
| 7 | Flat-billed Kingfisher | *Todirhamphus recurvirostris* | Ti'otala | cd |
| 8 | Polynesian Triller | *Lalage maculosa* | Mititai | cd |
| 9 | Samoan Triller | *Lalage sharpei* | Mitivao | VU |
| 10 | Samoan Flycatcher | *Myiagra albiventris* | Tolaifatu | cd |
| 11 | Samoan Fantail | *Rhipidura nebulosa* | Se'u | cd |
| 12 | Samoan Whistler | *Pachycephala flavitrons* | Vasavasa | cd |
| 13 | Samoan White-eye | *Zosterops samoensis* | Matapapa'e | VU |
| 14 | Cardinal Honey-eater | *Myzomela cardinalis* | Segasegamau'u | cd |
| 15 | Wattled Honey-eater | *Foulehaio carunculata* | Iao | cd |
| 16 | Ma'o | *Gymnomyza samoensis* | Ma'oma'o | EN |
| 17 | Red-headed Parrotfinch | *Erythrura cyaneovirens* | Sega'ula | cd |
| 18 | Samoan starling | *Aplonis atrifusca* | Fuia | cd |
| 19 | Polynesian starling | *Aplonis tabuensis* | Fuiavao | cd |
| 20 | Scarlet robin | *Petroica multicolor pusilla* | | cd |

| Legend:++ | | |
|---|---|---|
| CR | Critically endangered | '…it is facing an extremely high risk of extinction in the wild in the immediate future, judged to be a probablility of 50% in 10 years' |
| EN | Conservation Dependent | '..it is not Critical but is facing a very high risk of extinction in the wild in the near future, judged to be a probability of 20% in 20 years.' |
| VU | Vulnerble | '...it is not Critical or Endangered but is facing a high risk of extinction in the wild in the medium-term future, judged to be a probability of 10% in 100 years.' |
| cd | Conservation Dependent | '… the focus of a continuing taxon-specific or habitat-specific conservation programme which directly affects the taxon in question, the cessation of which would results in the taxon qualifying for one of the threatened categories above within a period of five years. |

## Appendix J: SAMOA'S INVASIVE SPECIES

LISTINGS BY TAXONOMIC SPECIES & LIFE FORM

| Micro-Organisms | Macro-Fungi | Aquatic Plants | Land Plants | Aquatic Invertebrates | Land Invertebrates | Fish | Birds | Mammals |
|---|---|---|---|---|---|---|---|---|
| Avian Malaria *(Plasmodium relictum)* | Phytopthora Root Rot *(Phytophthora cinnamomi)* | Water Hyacinth *(Eichhornia crassipes)* | African Tulip Tree *(Spathodea campanulata)* | Marine Snail Species (*Marginella spp.*)? | Flatworm *(Platydemus manokwari)* | Mozambique tilapia *(Oreochromis mossambicus)* | Indian Myna Bird *(Acridotheres tristis)* | Domestic Cat *(Felis catus)* |
| Banana Bunchy Top Virus **(BBTV)** | Taro Leaf Blight *(Phytopthora colocasiae)* | Common Waterweed (*Elodea Canadensis*) | Koster's Curse *(Clidemia hirta)* | | Crazy Ant *(Anoplolepis gracilepis)* | Western Mosquito Fish *(Gambusia affinis)* | Red-vented Bulbul *(Pycnonotus cafer)* | Goat *(Capra hircus)* |
| ***Bacterial Wilt*** (*Pseudomonas solanacearum*) | Root and Corm Rot (*Pythium spp.*) | Algae (*Spatoglossum macrodontrum*) | Kudzu *(Pueraria Montana var. lobata)* | | Giant African Snail *(Achatina fulica)* | Topminnow *(Poecilia mexicana)* | Jungle Myna Bird *(Acridotheres fuscus)* | House mouse *(Mus musculus)* |
| Nematodes (*Meoidogyne spp.*) | Banana Black Leaf Streak (*Mycospherella fijiensis)* | Algae (*Codium geppiorum*) | Lantana *(Lantana camara)* | | Big Headed Ant *(Pheidole megacephala)* | Nile Tilapia *(Oreochromis niloticus)* | | Pig *(Sus scrofa)* |
| Kava Dieback (*Cucumber Mosaic Virus CMV*) | Black Pod Disease (*Phtophthora palmivora*) | Algae (*Codium bulbopilium*) | Leucaena *(Leucaena leucocephala)* | | Rhinoceros Beetle (*Oryctes rhinoceros*) | | | Ship rat *(Rattus rattus)* |
| Bacterial Stem Rot (*Erwinia spp.*) | Peanut Leaf Rust (*Punccinia arachidis*) | | Mile-a-minute weed *(Mikania micrantha)* | | Fruit Piercing Moth (*Eudoccima fulonia*) | | | Brown rat *(Rattus norvegicus)* |
| Bacterial Wilt (*Pseudomonas solanacearum*) | Anthracnose (Various species) | | Privet *(Ligustrum robustrum)* | | Frut Fly Species (*Bactrocera spp.*) 7 species total 2 species of economic importance | | | Dog *(Canis lupus familiaris)* |
| | Head Rot (*Rhizoctonia solani*) | | Shoebutton ardisia *(Ardisia elliptica)* | | Diamond Back Moth (*Plutella xylostella*) | | | Polynesian Rat *(Rattus exulans)* |
| | | | Strawberry guava *(Psidium cattleianum)* | | Mealy Bugs (*Dysmicoccus brevipes, D. neobrevipes, Plancoccus minor, Nipaecoccus nipae, Pseudococcus jackbeardsleyi, P. cryptus*) | | | |
| | | | Wedelia *(Sphagneticola trilobata)* | | Giant Mealy Bug (*Icerya sechellarum*) | | | |
| | | | Ivy Gourd *(Coccinia grandis)* | | Scale species (*Ceroplastes rubens, Coccus hesperidum, Hemiberlesia palmae*) | | | |
| | | | Merremia (*Merremia peltata*) | | Cabbage Webworm (*Hellula undalis*) | | | |
| | | | Giant Sensitive Plant (*Mimosa diplotricha*) | | Cluster Catepillar (*Spodoptera litura*) | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Sensitive Plant (*Mimosa pudica*) | | Coconut Hispine Beetle (*Brontispa longissima*) | | | |
| | | | Nut Sedge (*Cyperus rotundus*) | | Corn Ear Worm (*Heliothis zea*) | | | |
| | | | Chain of Love (*Antigonon leptopus*) | | Brown Slug (Vaginulus plebeius) | | | |
| | | | Prickly Solanum (*Solanum torvum*) | | Garden Slug (Laevicaulis alte) | | | |
| | | | Clerodendrum (*Clerodendrum chinense*) | | | | | |
| | | | Navua Sedge (*Kyllinga polyphyla*) | | | | | |
| | | | Blue Rat's Tail (*Stachytarpheta urticifolia*) | | | | | |
| | | | Tamalini (*Paraserianthes falcataria*) | | | | | |
| | | | Rubber Tree (*Funtumia elastica*) | | | | | |
| | | | Rubber Tree (*Castilla elastica*) | | | | | |
| **Micro-Organisms** | **Macro-Fungi** | **Aquatic Plants** | **Land Plants** | **Aquatic Invertebrates** | **Land Invertebrates** | **Fish** | **Birds** | **Mammals** |
| **TOTALS/ LIFE FORM 7** | **8** | **2** | **23** | **1** | **25** | **4** | **3** | **8** |
| | | | | | | | | |

## Appendix K: FAUNA LIST

Source: GOS/DoS 1998.

### Land Birds

| Species | Common Name | Samoan Name | Island found a/ | Extinction risk | Endemism | Cultural Significance | Tourism significance b/ |
|---|---|---|---|---|---|---|---|
| Anas superciliosa | Grey Duck | Toloa | S,U,T,O Au,Ol,Ta | Medium | Medium | High | Low |
| Gallus gallus | Jungle foul | Moaai vao | S,U,T,O, Au,Ol,Ta | Low | Low | Medium | Low |
| Rallu philippensis | Branded rail | Vea | S,U,T,Ol O,N,Au,Ta | Low | Medium | Medium | Low |
| Poliolimnas cinereus | White-brown rail | Vai | S,U | - | Low | Very Low | Low |
| Porzan tabuensis | Sooty rail | - | S,Ta | Medium/High | Low | Very Low | Low |
| Pareudiastes pacificus | Samoan woodhen | Punai | S | High | High | Medium | Medium |
| Porphyrio porphyrio | Purple swmphen | Manualii | S,U,T,Ta, Au,O,Ol | - Low/Medium | Low | Low | Low High |
| Columba vitiensis | White throated pigeon | Fiaui | S,U | Low High | Medium | Medium | Low |
| Columa livia | Rock pigeon | Lupe | U,T | | Low | Very Low | High |
| Didunculus strigirostris | Tooth-billed pigeon | Manumea | S,U | Low | High | High | High |
| Ducula pacifica | Pacific pigeon | Lupe | S,U,T,O,Ol Ta | Low | Low | High | High |
| Ptilinopus perousii | Manycoloured fruit dove | Manulua | S,U,T,O,Ol Ta | Low | Medium | High | High |
| Ptilinopus porphyriaceus | Crimson-crowned fruit dove | Manutagi | S,U,N,T,Au O,Ol,Ta | Medium/High Low | Medium | High | High |
| Callicolumba stairii | Friendly ground dove | Tuaimeo | S,U,N,O,Ol | Low | Medium | Medium | High |
| Vini australis | Blue-crowned lorry | Sega vao | S,U,N,O,Ol Ta | Low | Low | High | Low |
| Eudynamis taitensis | Long-tailed cuckoo | - | - | Medium | c/ | Very Low | Low |
| Tyto alba | Barn owl | Lulu | S,U,T,Au,O Ol,Ta | Low | Low | Medium | High |
| Collocalia spodiopygia | White-rumped swiftlet | Peapea | S,U,N,T,O,A u,Ol,Ta | Low | Medium | Very Low | Medium |
| Halcyon recurvirostris | Flat-billed kingfisher | Tiotala | S,U,N | Medium | High | Medium | Medium Medium |
| Lalage maculosa | Polynesian triller | Miti tai | S,U,N | Low | Medium | Very Low | Low |
| Lalge sharpie | Samoan triller | Miti vao | S,U | Medium | High | Very Low | Medium |
| Pycnonotus cafer | Red-vented bulbul | Manu papalagi | S,U,T | | Low | Very Low | |
| Turdus poliocephalus | Island thrush | Tutumalili | S,U | | Medium | Low | |
| Petroica multicolor | Scarlet robin | Tolai ula | S,U | Low | Medium | Medium | Medium High |
| Myiagra albiventris | Samoan broadbill | Tolai fatu | S,U,N | Low | High | Medium | High |
| Phipidura nebulosa | Samoan fantail | Seu | S,U | Low | High | Medium | High |
| Pachycephala flavifrons | Samoan whistler | Vasavasa | S,U,N | Low | High | Very Low | High |
| Zosterops samoensis | Samoan white-eye | Mata paepae | S | Medium Medium/High | High High | Very low Medium | High |
| Gymnomyza samoensis | Mao | Maomao | S,U,T | Low | | | Medium |
| Foulehaio carunculata | Wattled honeyeater | Iao | S,U,N,T,O, Au,Ol,Ta | Low | Low | Medium | Medium Medium |
| Myzomela | Cardinal | Segasega- | S,U,T | | Medium | Medium | Medium |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| cardinalis | honeyeater | mauu | | Low | | | High |
| Erythrura cyaneovirens | Red-headed parrot finch | Manuai pau laau | S,U | Low | Medium | Very Low | Low |
| Apolonis tabuensis | Polynesian starlin | Miti ula | S,U,N,T,O,Au,Ol,Ta | Low | Medium | Very Low | Low |
| Apolonis atrifusca | Samoan starlin | Fuia | S,U,N,T,O,Au,Ol,Ta | Low | High | Very Low | |
| Acridotheres fuscus | Jungle myna | - | S,U | Low | Low | Very Low | |
| Acridotheres tristis | Common myna | - | U | | Low | Very Low | |

a/ S=Savaii; U=Upolu; N=Nuutele; T=Tutuila; Au=Aunuu; O=Ofu; Ol=Olosega; Ta=Tau;
b/ Higher ranks given to endemic species and to larger more colorful species which tourists are likely to wish to see
c/ Migrants only
Source: GOS/DoS 1998

**Waders and Sea Birds**

| Species | Common name | Samoan name | 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 |
| Phaeton 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 |
| Sterna minor | Great frigatebird | Atafa | Low | Medium | High |
| Sterna fuscata | Sooty tern | Gogo Uli | Low | High | Medium |
| Sterna Lunata | Soectacled(grey-backed) tern | - | Low | Very Low | Medium |
| Sterna sumatrana | Black-napped tern | Gogo sina | Low | Low | Medium |
| Procelsterna cerulea | Blue-grey noddy | Laia | Low | Low | Medium |
| Anous stolidus | Common(brown) noddy | Gogo | Low | Medium | Medium |
| Anos minutus | Black noddy | Gogo | Low | Medium | Medium |
| Gygis alba | White(fairy) tern | Manusina | Low | Medium | Medium/High |
| Pluvialis domonica fulva | Lesser golden plover | Tulle | Low | Very Low | Low |
| Numious tahitiensis | Bristle-thighed curley | - | Medium/High | Very Low | Medium/High |
| Heteroscelus Incanus | Wandering tattler | Tuli alo-mamala | Low | Very Low | Low |
| Arenaria interpres | Ruddy turnstone | - | Low | Medium | Low |
| Egretta sacra | Pacific reef heron | Matuu | Low | Very Low<br>Medium | Low |

Source: GOS/DoS 1998

**Native Land mammals**

| Species | Common name | Samoan name | Island found a/ | Extinction risk | Endemism | Cultural significance | Tourism significance | Ecological Significance |
|---|---|---|---|---|---|---|---|---|
| Ptreopus Samoensis | Samoan Flying Fox | Pea vao | S,U,T,O, OI,Ta | Medium/high High | Low | High | High | High |
| PteproPus Tonaganus | Tongan flying fox | Pea fanua | S,U,T,O | Medium | Low | High | High | High |
| Embalonura semicaudata | Shealth-tailed bat | Tagiti | S,U,T, Au,O,Oi, Ta | Medium/High | Low | Low | Medium | Medium |

Source: GOS/DoS 1998

**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 | Low |
| Megaptera novaengliae | Humback whale | Tafola | Medium | Low | High |
| Physeter catadon | Sperm whale | Tafola | Medium | Low | High |
| Stenella longirostris | Tropcial spinner dolphin | Manua | Medium/high | Low | Low |

Source: GOS/DoS 1998

**Marine Reptiles**

| Species | Common name | Samoan name | Island found a/ | Tourism significance |
|---|---|---|---|---|
| Laticauda | Sea snake | Gata Sami | | |
| Chelonia mydas **b/** | Green turtle | Laumei | S | High |
| Eretmochelys imbricate | Hawksbill turtle | Laumei | S,U,N,R | High |
| Lepidochelys olivacea | Olive Ridley turtle | Laumei | U | High |

a/ S=Savaii; U=Upolu; N=Nuutele; R=Rose
b/ The most common turtle in Samoa waters but may not nest
Source: GOS/DoS 1998

**Native Land Reptiles**

| Species | Common name | Island found a/ | Extinction risk | Endemism | Cultural significance |
|---|---|---|---|---|---|
| Gehyra mutilata | Stump-toed gecko | U,S | Low | Low | Medium |
| Gehyra oceanica | Oceanic gecko | U,S | Low | Low | Medium |
| Hemidactylus frenatus | House gecko | U,S | Low | Low | Medium |
| Hemidactyus garnotti | Fox gecko | S | Low | May not occur | Medium |
| Lepidodactylus lugubris | Mourning gecko | U,S | Low | Low | Medium |
| Nactus pelagicus | Pacific slender-toed gecko | U,S | Low | Low | Medium |
| Cryptoblepharus poecilopleurus | Snake-eyed skink | U | Low | Low | Medium |
| Emoia adspersa | Micronesian skink | U,S | Medium | Low/medium | Medium |
| Emoia murhpyi | Murphy's skink | U,S | Low | Low/medium | Medium |
| Emoia nigra | Pacific black skink | U,S | Low | Low | Medium |
| Emoia samoensis | Samoan skink | U,S | Low | High/Medium | Medium |
| Emoia impar | Blue-tailed skink | U,S | Low | Low | Medium |
| Emoia cyanura | Cryptic skink | U,S | Low | Low | Medium |
| Lipinia noctua | Moth skink | U,S | Low | Low | Medium |
| Candoia bibroni | Pacific boa | U,S | Medium | Low | Medium |

a/ S=Savaii; U=Upolu
Source: GOS/DoS 1998

## Appendix L: MNRE Current Corporate Structure 2006

Source: Draft MNRE Corporate Plan 2006