Samoa 2013

State of the Environment Report

diversity coral reef
Fa'a-Samoa environment
integrated management
community conservation island nation
climate change livelihood indicators water
sustainable Pacific Ocean forests
development culture

Government of Samoa

Ministry of Natural Resources and Environment (MNRE)
Government of Samoa

SAMOA'S STATE OF THE ENVIRONMENT (SOE) REPORT 2013

Australian Government
AusAID

Government of Samoa

SPREP
Secretariat of the Pacific Regional Environment Programme

MNRE Resource Information Centre

Ministry of Natural Resources & Environment (MNRE)

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1. Community consultation at Uafato Village
2. Fine mat weaving at Salua village, Manono
3. Samoa fale at Tiavea-tai village
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5. Native bird - Vasavasa (Samoan Whistler)
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We are indeed grateful to everyone who has contributed towards the SOE review which we hope will greatly assist government officials and all stakeholders in further developing environmental monitoring and reporting as an effective tool for sustainable development. We hope the report proves useful to those who read it and we welcome any suggestions for its improvement in future editions.

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ASP	Agriculture Sector Plan
BioRAP	Biological Rapid Assessment Programme
CBD	Convention on Biological Diversity
CC	Climate Change
CFC	chlorofluorocarbons
CI	Conservation International
CIM Plans	Coastal Infrastructure Management Plans
CPUE	Catch per Unit Effort
DC	Development Consent
DCA	Development Consent Application
DMO	Disaster Management Office
DPSIR	Drivers-Pressures-States-Impacts-Responses
EE	Energy Efficiency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPC	Electric Power Corporation
FAD	Fish Aggregating Devices
FAO	Food and Agriculture Organization of the United Nations
FPAM	Forest Conservation and Protected Area Management
GEO	Global Environment Outlook
GCRMN	Global Coral Reef Monitoring Network
GHG	Green House Gases
ICCRAHS	Integrated Climate Change Risks into Health & Agriculture Projects
ICCRIFS	Integrated Climate Change Risks into the Forestry Sector
IUCN	International Union for the Conservation of Nature/World Conservation Union
IWRM	Integrated Water Resource Management
JICA	Japanese International Cooperation Agency
FPP	Forest Preservation Programme (JICS)
KBA	Key Biodiversity Areas
LMOs	Living modified organisms
MAF	Ministry of Agriculture and Fisheries
MEAs	Multilateral Environmental Agreements
MESCAL	Mangrove Ecosystem for Climate Change Adapatation and Livelihood
MDGs	Millennium Development Goals
MNRE	Ministry of Natural Resources and Environment
MOF	Ministry of Finance
MPAs	Marine Protected Areas
MSY	Maximum Sustainable Yield
NAPA	National Adaptation Programme Action
NP	National Park
ODS	Ozone Depleting Substance
PACC	Pacific Adaptation to Climate Change
PEAR	Preliminary Environmental Assessment Report
POPs	Persistent organic pollutants
PPCR	Pilot Project for Climate Resilience
PUMA	Planning and Urban Management Agency
RE	Renewable Energy
RED	Renewable Energy Division
SAICM	Strategic Approach to International Chemicals Management
SATFP	Samoa Agro Forestry and Tree Farming Project
SBS	Samoa Bureau of Statistics
SDS	Strategy for the Development of Samoa
SMEC	Snowy Mountains Engineering Corporation
SMSMCL	Strengthening Multi Sector Management of Critical Landscapes
SOE	State of the Environment
SPC	Secretariat for the Pacific Community
SPREP	Secretariat for the Pacific Regional Environment Programme
STMDP	Samoa Tuna Management Development Plan
UNEP	United Nations Environment Programme
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WRI	World Resource Institute
WRD	Water Resources Division, MNRE

FOREWORD

Reviewing and reporting the state of the environment of Samoa is an important part of the government's mandate for achieving environmentally sound and sustainable development. The Ministry of Natural Resources and Environment (MNRE) is entrusted with the responsibility of coordinating the monitoring and review of the state of Samoa's environment with the cooperation and support of its stakeholders in line Ministries, Non-Governmental Organisations and the wider community.

Samoa first completed and published its comprehensive SOE report in 1993 and the second in 2008. The review conducted provides a holistic understanding of the trends in Samoa's natural and human environments under the influence of economic, social and environmental forces over the reviewed period is fundamental to the determinants of future responses to these changes. The findings outlined in the report also indicates the level of effectiveness of policy and educational measures put in place to cope with the consequent impacts of these changes. It is also designed to improve environmental monitoring, education and training amongst decision makers and the general public

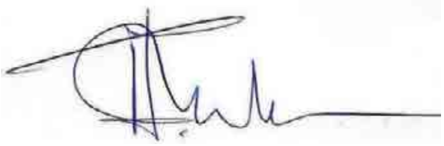
Samoa is among nations with the highest level of vulnerabilities to natural and anthropogenic changes, particularly the impacts of climate change. The latter being forecasted (IPCC 4) to become more pronounce this century. These requirements are further urged by both the projected long term global climate change impacts, as well as the increasing short to medium term impacts of variable weather patterns affecting the country, such as extended drought periods and frequent occurrence of severe cyclone.

The need for environmental monitoring is especially critical in Samoa where our people make substantial use of lowland and coastal habitats for farming and developments, nearshore forests and seafood for their day to day living requirements of food, shelter and energy. However, the sustainable development of our environment and resources requires comprehensive public awareness, education, strong partnership and creative management action in order to prevent irreversible decline in water quality, upland and lowland habitats or well as loss of coastal and marine habitats.

In this third SOE Review, the Ministry adopted the 'Integrated Habitat-based approach' and the DPSIR tool as the assessment method for environmental monitoring. It is the hope of Government through the MNRE, that the State of the Environment Report will enhance decision making for environmental protection and sustainable development at all levels of Samoa's economy. It is our hope that this edition of Samoa's SOE will attract attention that is due to the seriousness of environmental issues existing at national and local levels, as well clear doubts that hamper the positive progression of national initiatives in addressing these issues. Moreover, the information herein contained will bring about creative interest from our young generation and the general public to be more involved and take responsibilities for current and future environment management decisions.

Finally producing the SOE Report is not the highlight but making use of the systematic process where all the stakeholders in the country are actively driving and engaging their potentials for reading and acting on their state of the environment realities. Individual and collective actions can make a difference. Ideas, energy, enthusiasm and leadership can enable negative trends to be reversed, turning bad to good. Sustainable management policies and practices should help implement responsive strategies that contribite to stopping and reverse environmental degradation trend, and at the same time reduce the risk of unacceptable future losses. Key findinds from the review and a discussion of **Impacts** and **Responses** provides the substance for the National Environment and Development Sector Plan 2013 - 16 (NESP).

Conserving Samoa's unique environment is our collective responsibility as decision-makers, professionals, teachers, stewards and advocates to ensure that we meet the challenges and bequeath a better future to our children.



Taule'ale'ausumai Tuifuisa'a La'avasa Malua
Chief Executive Officer

EXECUTIVE SUMMARY

Global context
1. Environmental monitoring and reporting at the national level was highlighted by the Rio Agenda for Sustainable Development (Agenda 21) and has since been supported at the global level through the Global Environmental Outlook (GEO) report series that started in 1997. The GEO project itself was also initiated in response to the environmental reporting requirements of the UN Agenda 21 and to a UNEP Governing Council decision of May 1995 which requested the production of a new comprehensive global state of the environment report.

2. As a global report, GEO combines top-down integrated assessment with bottom-up environmental reporting. This approach, which depends on regional assessments from designated regional centres including SPREP, provides the framework for national level inputs into the rolling up of regional impacts and trends. GEO regional reporting preparation also contributed to strengthening national level capacity for the preparation of national SOE.

3. An important addition to environmental monitoring and reporting was the adoption at the Millennium Conference in 2000 of the Millennium Development Goals (MDGs). Samoa has since adopted them as national development goals for its national development strategy. The MDGs helped to promote environmental sustainability as a development goal for Samoa. It also coincided with the growing recognition by policy makers and planners of climate change as a major source of economic vulnerability and an important development issue, and thus contributed to the elevation of environmental sustainability as one of Samoa's four Priority Areas in the 2012-2016 Strategy for the Development of Samoa (SDS).

4. The new status given to the environment in national planning inevitably demand a higher level of transparency and accountability in the way the environment sector is performing. The SOE is the tool for addressing this challenge. The SOE thus offers policy makers, planners, developers, resource managers, school teachers and the general public a holistic assessment of environmental quality, and of the state of health of habitats, species and environmental resources. The SOE also analyses threats faced, causes and where available information allows, future trends emerging from environmental changes.

Approach and Methodology
5. Samoa's State of the Environment (SOE) Report is the result of a comprehensive review and assessment of the changes and trends occurring in Samoa's natural and human environments in response to the impacts of the economic, social and environmental forces. The Report assesses the states, changes and trends in Samoa's environment since last reported in the 1993 and 2006 SOE. The second part of this review is an assessment and updating of Samoa's 1993 National Environmental Management and Development Strategy (NEMS) which provided the broad framework of priority issues and actions for environmental management in the country. The updated document constitutes Samoa's Environment Sector Plan.

6. The approach taken to compiling this SOE report is fundamentally different from that adopted in previous assessments. Whilst the two previous SOE defined the environment by natural resources and human uses (issues based), this SOE organizes and analyses the same based on ecological habitats. It embraces the ecosystems approach and the concept of 'ridge to reef', extending it out to the offshore marine environment as defined by Samoa's EEZ boundaries. The combined assessment of the health of all the defined habitats thus constitutes the overall state of health of Samoa's environment.

7. The approach is generally termed in the environmental assessment literature as the Integrated Environmental Assessment (IEA) methodology or process which revolves around the following five questions:

1. What is happening to the environment and Why?
2. What are the consequences for the environment and humanity?
3. What is being done and how effective is it?
4. Where are we heading?
5. What actions could be taken for a more sustainable future?

8. The IEA assessment process makes use of the DPSIR analytical model (Drivers-Pressures-States-Impacts-Response) to analyse data and information on the states and trends environmental issues and the nature and extend of policy responses. It examines the causes-and-effects relationships between factors that are categorized as Drivers and Pressures of environmental change, and which analysis using measurable indicators provide a basis for describing the State of health of the environment, the Impacts on the health of species, ecosystems and on societies, and Responses for addressing them.

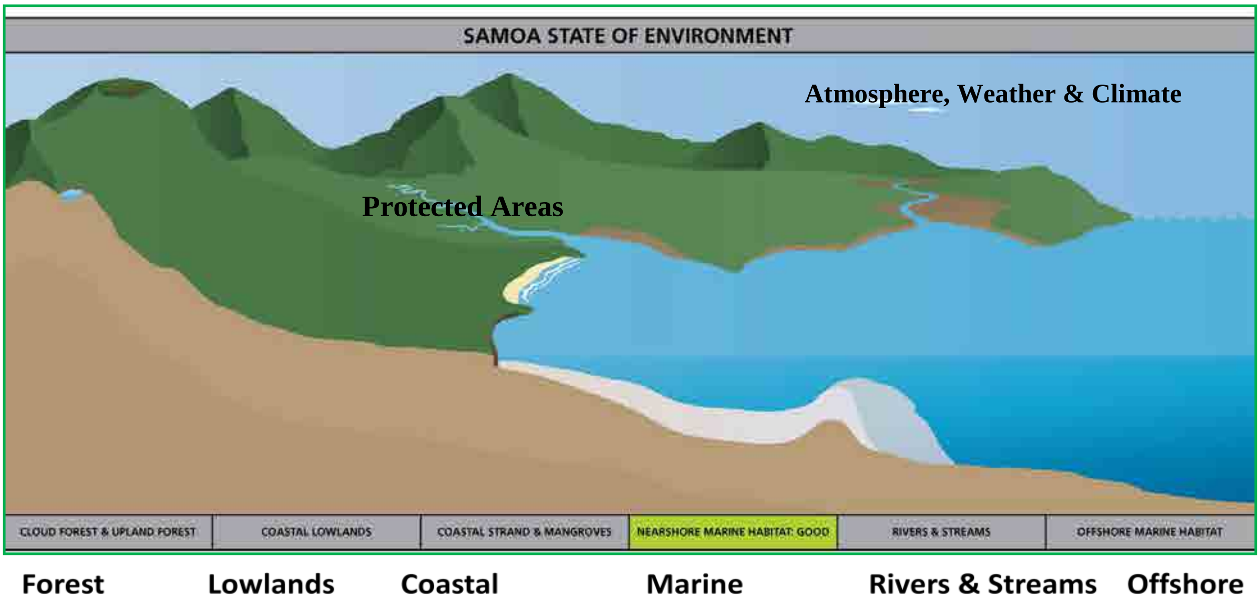
Constraints
9. A number of constraints hindered the preparation of this report. The main one is the lack of up-to-date quality data and information, and time series data. Data deficiency affected the choice of indicators and how metrics were defined and in some cases, eliminated the possibility of detecting trends or changes over time. Consequently, quantitative assessments of the state of different habitats and species are made where adequate

data is available. For some habitats, e.g. inshore and offshore marine habitats, and tuna stocks assessments, analyses and assessments were recently published by reputable scientific organizations; these assessments are simply used and cited in this report. Where quantitative information is unavailable, assessment is subjective and qualitative, drawing on the experience and knowledge of technical experts within MNRE and its consultants. In other cases, where there is no basis for an assessment, the indicator is simply left unassessed. Doing so highlights the need for its immediate monitoring for future SOEs.

10. The second constraint is inherent in the fact that the use of the DPSIR and habitat based approaches in Samoa's SOE represents the first time these approaches have been applied in the region. As a pilot, there is no existing body of knowledge and regional experience to draw on in dealing with a number of technical issues that emerged. Among these issues is that of defining boundaries between different terrestrial habitats, and deriving discreet states of 'goodness' or 'badness' by which different indicators can be assessed.

11. The mentality adopted in dealing with these constraints is that this is a work in progress with future SOEs to refine and finetune this framework taking into account this experience, and better quality information from monitoring activities which hopefully this SOE will trigger.

Figure 1 - Key habitats based on Samoa's island type



Habitat types

12. Samoa's biophysical environment is examined and assessed based on the following habitat-types –

- Upland habitats and cloud forests
- Lowlands
- Coastal habitats
- Inshore & Offshore Marine habitats
- Rural and Urban Built environment
- Rivers and Streams
- Protected areas
- Atmosphere, Weather and Climate.

The assessment of health of the key habitats are summarized as follows –

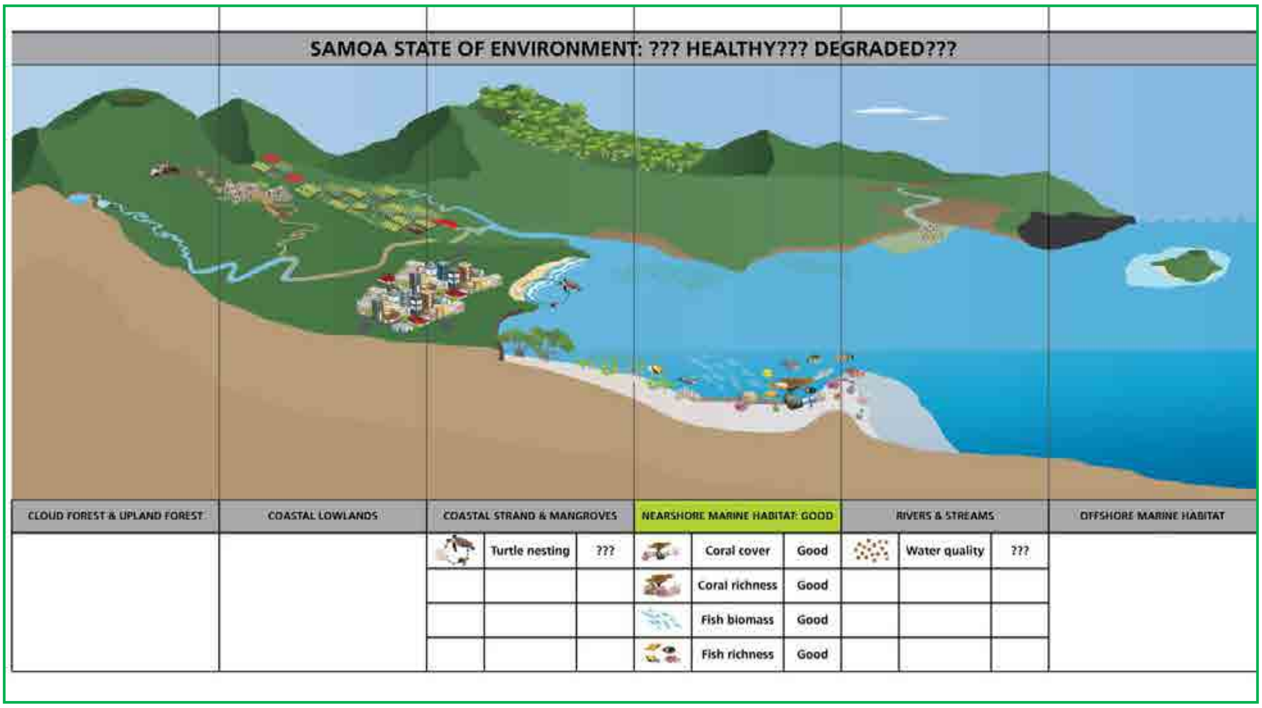


Figure 2

Summary of Assessments of Habitats

Upland Habitats and Cloud Forests

13. Samoa's upland habitats are largely intact and undisturbed by human activities with a high percentage of forest cover (99%) for both Upolu and Savaii. The nature and quality of forests in the uplands of the two islands are now significantly different. For Savaii, 91% of the upland forest area is dominated by native species. For Upolu, non-natives dominate 99% of the upland area. The impact of the invasive vine merremia is the main threat with recent estimates suggesting 24% of all forests affected including upland forests.

14. The data from the BIORAP[1] survey carried out in the upland (above 1,000 m) region of Savaii indicates that the vegetation is very healthy and that it has recovered from damage inflicted by two severe cyclones which hit two decades ago (Val and Ofa), and the forest is returning to its "natural" state. Only 17 alien species were recorded in the area, most of them occurring along a bulldozed track leading up to the upland. Of the 17 alien species, 2 species the *Clidemia hirta* (laau lau mamoe) and *Mikania micrantha* (fue saina) were found to invade native (secondary) forest as weeds, but were not found above 1,370 m elevation. The montane forest is in very good shape, with the worst threat being unauthorized roads being established in the area and related activities that allow the potential for weeds to enter the forest, thereby interrupting future natural succession (BIORAP Report of Upland Savaii, 2012).

15. Also the BIORAP survey found 2 new species of orchids and new to Samoa. Both orchids were recorded during the expedition and (*Calanthe sp. and Bulbophyllum sp*.) are now being studied; one or perhaps both of them representing new unnamed species. Other key findings include:

16. There was no sighting of the Puna'e bird or traces that it still exists, even though there are still significant areas in which searches for this bird have not been undertaken. The survey tends to confirm the view that it is extinct (last confirmed report 1873). Only a single uncorroborated sighting of the endangered Manumea or Tooth-billed Pigeon was made, despite the presence of large numbers of its food trees, raising concern that its situation may now be critical. Reasonable numbers were recorded in a previous upland survey in 1996 but the area no longer seems to be a stronghold for this species. In addition, no Tuaimeo or Friendly Ground-doves were seen. Small numbers of the endangered Ma'oma'o or Mao were found at the second and third sites, re-enforcing a picture that it has particular habitat requirements, which are now hard to find. Other forest birds were found in good numbers including the Matapaepae or Samoan White-eye which is found only in the Savai'i uplands and this may lead to a change in its current IUCN threat status (BioRAP Report 2012).

17. One seabird, a Tahiti petrel, was found at an inland crater, a first record for this species in Samoa. This suggests that the uplands may still be an important area for nesting seabirds and further surveys are needed during the breeding season. The survey found evidence that the uplands contain some of the same threats that have caused Samoa's rarest birds to largely disappear from the lowlands. There was evidence of weeds and rats,

[1] *Atherton. J. and Bruce. J, 2012, Rapid Biodiversity Assessment of Upland Savaii, Samoa.*

while wild cats and feral pigs and cattle encountered in other forest areas around other craters in the interior'. (BioRAP Report 2012)

18. Hunting was obviously occurring at the more accessible areas of the upland mountains. Clear-felling over the past few years of the lowland forests of A'opo-Letui-Sasina, identified in 1992 as one of 5 key sites for biodiversity conservation in Samoa, will also have had devastating consequences for the rarer biodiversity in that part of Savai'i. Although the upland area is remote and infrequently visited, the construction of the Mata o le Afi road shows how threats from invasive species, logging and habitat degradation can escalate very rapidly.
(BioRAP Report 2012).

19. Invasive species, in particular weeds, pest insects (eg, ants), rats, mice, cats and pigs are a major threat to the ecological integrity of the upland forests. Biosecurity is not well understood by the local community and should be the focus for awareness and training opportunities in the future, especially for farmers, foresters and hunters. (BIORAP Report 2012)

20. The interior uplands of Savaii are relatively free of exotic plants, insects and snails. Expert assessment interpreted from the BioRAP survey indicates that forest regeneration was strong and re-establishing composition and structure without competition from exotic plants. (BIORAP Report 2012)

Lowland habitats

21. There are two main lowland habitats – cultivated areas and lowland forests. The total lowland area of Samoa is 218,520 ha, of which cultivated areas comprises 80,589 ha and lowland mixed forests 137,931 ha. Cultivated areas are largely of small sized holdings and with some exceptions, are low tech, use composting and are largely of mixed cropping systems. This typical mixing of trees and crops is ecologically more stable and less vulnerable to outbreaks of pest and diseases. Having said this, invasive species are also widespread including meremia vines, African snails and Taro Leaf Blight.

22. The remaining forests in the lowland areas are predominantly of non-native species with Tamaligi, Pata, Pulu vao, and a host of other light demanding and fast growing species more prominent. These species are the earliest invaders into open spaces created by cyclones, wind throws and abandoned agricultural sites. These forests are less dense, of lower species diversity and don't offer the range of habitats to a diversity of native fauna species as would native forests. Ecologically they are less stable. These forests however will dominate Samoa's lowland, possibly in perpetuity, if the process of natural regeneration is regularly set back before climaxing by cyclones and man-made disturbances. The higher frequency and intensity of cyclones predicted as a result of climate change is thus likely to assist in perpetuating the dominance and continuing spread of non-native species.

23. Other than invasive species, the other main threat to lowland habitats is the indiscriminate clearing for cultivation, particularly of forests within sensitive environments including riparian strips and catchment areas, steep and erosion-prone slopes.

Coastal habitats

24. Of coastal habitats, mangroves are generally in good condition with a high number of viable populations for the two main species *Rhizophora samoensis* and *Bruguiera gymnorrhiza* scattered throughout Samoa's coastline, despite losses in some areas due to harvesting for firewood, land reclamation and waste disposal. The third species – *Xylocarpus moluccensis*[2] is represented by only a small population occupying about 2.5 acres of coast in Siutu Salailua. This species is urgently in need of conservation action. Additional populations need to be established in different locations to avert the possibility of local extinction. Recent studies reported the possibility of three other mangrove species for Samoa but these require scientific confirmation which MNRE plans to do under the current MESCAL project.

25. The health of beaches is indeterminable due to the lack of information on sand budgets, sand migration and replenishment patterns and others. But there is on-going exploitation in the form of sand mining for construction purposes, which MNRE is regulating using a licensing system tied to environmental assessment. Data shows that exploitation is increasing and anecdotal evidence suggests the prevalence of unlicensed commercial sandmining activities. In the absence of data on sand distribution and migration dynamics, it is unclear how sustainability is being monitored.

In-shore Marine and Offshore habitats

26. Within the inshore and offshore marine habitats, the health of corals and coral reefs vary throughout Samoa, but the most healthy reefs and coral assemblages are found in north-western Savaii, with the least healthy of coral reefs along the northern coast of Upolu from the Manono/Apolima strait to the Fagaloa coast. Similarly reef fish is more abundant in the same general areas with northern Savaii having the highest level of abundance, and the northern coast of Upolu the least. There are however more variety of fish species in the northern coast of Upolu, despite lower coral abundance, than north-western Savaii. The knowledge of higher diversity of fish in

[2] Recent expert assessment (Dr. Norman Duke) of this species under the MESCAL project, suggests that X. moluccensis might be X. grantum.. Scientific confirmation is pending.

northern Upolu is important for conservation purposes. It suggests the presence of unique coral assemblages not found elsewhere in the country that should be targeted for protection.

27. Tuna stocks are fundamentally healthy especially for Albacore, which is the mainstay of Samoa's tuna import industry. There is some overharvesting of larger and older tuna but the overall biomass is being exploited and harvested within the maximum sustainable yield level. The level of exploitation and fishing prescribed in the Samoa Tuna Management and Development Plan 2011-2015 is sustainable.

28. Many other marine habitats and species such as seagrasses, whales, turtles, are present in small numbers but there is insufficient information to make a determination of their health and population trends.

Rural and Urban Built Environment

29. Samoa's built environment is the highly modified artificial world of human settlements and its supporting physical infrastructure, amenities and services that in itself functions as an organism that consumes resources and generates waste while at the same time, constantly modifying itself in ways that put pressure on its biophysical surroundings. The key indicators for its sustainability examined in this report are population, waste, sanitation, energy, and environmental safeguards. Several other possible indicators were not used due to the lack of data.

Population

30. Samoa's population has been growing at a declining rate in large part due to a high level of outmigration. This trend is predicted to continue and, based on growth rates over the last 20 years, an annual growth rate of between 0.5% and 1.5% is expected. SBS (op cit) considers an annual growth rate of 1.0% to be within sustainable range. The current annual rate of 0.64% per year suggests this predicted growth rate is well within the realms of possibility.

Waste management

31. Waste is an area of concern. Only 11% of the estimated total volume of wastes generated reaches the two semi-aerobic landfills despite a nation-wide public-funded collection system. Green house gas inventories (2006) show a decline in the burning of household wastes compared to previous years, yet the percentage of waste reaching the landfills relative to the total generated is significantly low. There are four possibilities (i) a high percentage of households are not collecting and putting wastes out on the roadside for collection, (ii) waste collecting contractors are not consistently covering the entire 97% of households that should be accessible to collection service; (iii) waste collecting contractors are indeed collecting but are dumping wastes illegally at unapproved sites and (iv) all three possibilities are not mutually exclusive therefore they could all be occurring. It's an important issue for MNRE to look into.

32. Of the waste reaching the landfills, over 50% are compostable and recyclable, meaning the effective lifespan of the landfills are proportionally reduced and not optimised.

Environmental safeguards

33. The Planning and Urban Management Act 2004 and Environmental Impact Assessments Regulation 2007 provide an environmental planning framework that in theory safeguards against poorly designed and environmentally unfriendly development initiatives. Effectively implemented and enforced, it serves an important function of ensuring the built environment's sustainability.

34. There is increasing compliance and public acceptance of PUMA's development consent (DC) process with the number of DC applications received steadily increasing since 2007.

35. Available information is limited but shows that 99% of development proposals screened between 2007 and 2011 were approved and issued with Development Consent. The majority not approved (1%) is due to the lack of information.

36. The PUMA planning framework demonstrates that development is regulated and screened with an environmental filter. Major development proposals that previously would have received the green light based on technical and economic feasibility criteria are now required to satisfy the environmental sustainability criterion. Monitoring and enforcement and monitoring are areas for improvement.

Energy

37. Samoa's energy needs are increasing and Samoa's heavy dependence on imported petroleum products (Samoa Energy Review 2011) will continue in the foreseeable future as demand from a growing transport and infrastructure sector continue to increase. With world energy prices highly fluctuating and generally increasing, Samoa's dependence on imported fossil fuel is a major source of economic vulnerability.

38. The Government's National Energy Policy 2007 goal *'to increase the share of mass production from renewable sources to 20% by year 2030' and 'to Increase the contribution of Renewable Energy for energy services and supply by 20% by 2030*" was reviewed and realized that overall contribution of RE into Samoa total

energy has reduced. The increased demand for energy in the last ten years play a part in reducing renewable energy contribution and the impacts of climate change with prolong drought during EL Nino period and frequent flash flood closed hydro operation during raining season contributes a lot more. The hydrology contribution into generation of electricity reduced from 60% in the early 1990s (when a 4-megawatt hydro station installed at Afulilo) to 32% in 2011. The Energy Review conducted in 2012 recorded that the growth rate of renewable energy since year 2000 was only 0.8%. The result of the Review contributed in the development of the Energy Sector Plan 2012 to 2016, which change the Renewable Energy target to 10% by 2016. Building more hydropower schemes and utilizing of locally available biomass appears to be the main strategy but other resources including solar and wind, biogas digester are promoted and it is seeking funds for rolling out.

39. All renewable energy options impact the biophysical environment in different ways, such as impacts on downstream biodiversity of river diversion schemes for hydropower generation, and unknown risks for native flora and fauna of introduced energy crops. It is important that all introduced RE options are properly assessed for their potential environmental impacts before development.

40. The MNRE Renewable Energy Division (RED) is closely collaborating with SROS in research projects for alternative biofuels. This includes collaboration with other technical organizations to identify affordable and durable conversion technology to utilize waste and unused biomass into useful energy such as electricity, biogas and heat.

Rivers and Streams

41. Regular monitoring of rivers and streams for physical parameters including flow/discharge rates, temperature, turbidity, pH and dissolved oxygen (DO) is on-going under the Water Resources Division of MNRE. Available processed data indicates that river flow/discharge rates are highly dependent on seasonal fluctuations in precipitation making it highly vulnerable to climate change and climate variability. Already, there is an emerging declining trend in river flow rates in the main rivers of Samoa. This has far reaching economic implications particular for agriculture, drinking water, hydropower generation and biodiversity conservation.

42. Rivers and stream water quality is not a major issue based on indicators of turbidity, pH and dissolved oxygen but reported incidences of high *E.coli* counts in several villages water springs is a reminder of the impacts of land use, sanitation and waste management practises on underground water sources. Direct waste disposal into rivers and streams especially for the major rivers in the urban setting has contributed to a lot of pollution to the coastal areas and is now being targeted by the rehabilitation efforts of the Water Resources Division.

43. Increasing levels of demand on water sources for water supply and hydropower generation is also an important issue, with stream flow reduced significantly at developed river systems, and salt water upcoming degrading over developed groundwater sites.

44. Ground Water monitoring to assist in identifying impacts to surface runoffs and salt water intrusion as a result of over-extraction and for better resource use planning instead of adhoc borehole drilling for water supply.

Protected Areas, Sanctuary and KBAs

45. Samoa effectively redefined its protected area network following collaborative work between MNRE, CI and several international conservation organizations that reassessed Samoa's entire biodiversity based on conservation planning criteria of vulnerability and irreplaceability in 2009. The result is a network of 8 terrestrial and 7 marine Key Biodiversity Areas (KBAs) that incorporates the essential components of the existing parks and reserves network. The 8 terrestrial KBAs cover an area of 940km^2 or 33% of Samoa's total land area, capturing within it 12 representations of the 13 native vegetation communities in the country. This terrestrial area also constitutes 33% of Samoa's total land area, more than double Samoa's NBSAP commitment of 15%. The marine KBAs cover approximately 173km^2 or 23% of Samoa's total inshore reef area. Currently, 6 of the 8 terrestrial KBAs and 3 of the 7 marine KBAs have been completely or partially established as conservation areas by the Government of Samoa or by local villages.

46. The Central Savaii Rainforest KBA is singled out as having the highest priority for terrestrial conservation investment. It is the largest contiguous area of rainforest in tropical Polynesia and a site identified internationally[3] as one of the last remaining strongholds for one or more Critically Endangered or Endangered species.

47. The conventional national parks and reserves system which is now encompassed within the KBA network, was recently expanded with the addition of the Lata National Park, bringing the total of officially designated national parks to two in Upolu (Le Pupū Pu'ē NP and Lake Lanoto'o NP) and three in Savaii (Mauga o Salafai NP, Asau-Falelima NP and Lata NP).

48. Prior to the KBA assessment, Samoa's protected area network consisted of 10.794 ha of national parks and reserves, and 12,011,437 ha of marine areas. The marine protected areas include the Aleipata and Safata MPAs,

[3] *Alliance of Zero Extinction (AZE), a consortium of over 60 conservation organizations worldwide.*

Palolo Deep Reserve and the entire EEZ declared in 2002 as a sanctuary for turtles, dolphins, sharks and whales. This excludes over 60 active community fish reserves.

49. The current status of Samoa's protected area network (existing parks and reserves, MPAs and sanctuaries) is mixed. Only designated parks and reserves have legal status and MNRE is developing management plans under a JICA funded project. The marine sanctuary/EEZ is monitored albeit not regularly mainly for illegal fishing activities. The two MPAs managed by district committees with technical support by MNRE, IUCN and the World Bank. Village based fish reserves are community managed with technical support and regular biological monitoring provided by MAF (Fisheries Division).

50. The challenge for terrestrial biodiversity conservation for the Government now is to acquire legal status and protection for the KBAs and to invest in their management using approaches that integrates the livelihood needs of local villages and resource users that traditionally depend on them.

Atmosphere, Weather and Climate
51. Extreme events related to climate change such as cyclones and flash floods pose the biggest immediate threat to Samoa's biophysical environment as it is to its social and economic aspirations.

52. The changes in climate and climate variability predicted in the previous SOE 2006 are now a reality. These include: increased maximum air temperatures, increased frequency in extreme daily rainfall events, sea level rise of between 2.7 – 8.3 mm a year (PCCSP, 2012). The occurrence of Tropical Cyclone Heta (2004) and Evans (2012) is consistent with predicted climatic changes of increased frequency and intensities of cyclones and other extreme events such as flash floods.

53. But Samoa is also making good progress in reducing vulnerability and in building resilience. This is measured in part in the decreasing size of its carbon footprint based on findings of the 2006 GHG inventory as well as in the level of progress made in the implementation of its priority NAPA activities. Regarding NAPA implementation, a mix of hard (engineering) and soft solutions have been completed and under implementation that includes climate proofing of coastal infrastructure with seawalls, coastline revetments, mangroves replanting, reforestation of steep and erosion prone areas and catchments, capacity building initiatives including information dissemination and awareness raising, coastal infrastructure management (CIM) planning, and in southern Upolu, the relocation of entire vulnerable communities to higher elevations. Similar donor funded climate proofing initiatives are in progress for agriculture, forestry and tourism.

54. These measures flow from adjustments made at the national level of policies and sector plans wherein environmental sustainability and disaster reduction are priority goals in all levels of planning, particularly for vulnerable sectors including water, health, tourism, infrastructure and agriculture.

55. Samoa's Second Greenhouse gas abatement recorded that Samoa's contribution to GHG emission is very insignificant but the frequent occurrence of natural disasters that affects Samoa's economic development in the last two decades encourage the government to promote low carbon development as Samoa contribution to global effort in reducing GHG emission. This efforts starts with Low Carbon Development in the energy sector with promoting of renewable energy that emits no or less Carbon and methane into the atmsosphere. Having said this, projections of future energy needs show significant increases in energy demand in the short term. This will mean continued dependence on imported fossil fuel (petroleum products) and corresponding increases in GHG emissions. The Government is fully aware of this implication hence the emphasis placed on increasing renewable energy output and the use of energy efficient technologies and practises.

56. Samoa has also achieved its zero CFC consumption target and is currently phasing-out HCFC targeting total phase-out by 2040. Samoa is therefore in full compliance in terms of its obligations under the Vienna Convention on Ozone Depleting Substances (ODS) and the Montreal Protocol.

57. Monitoring of local and regional seismic (earthquakes) activities and tsunamis is gaining importance with the recent occurrences of life threatening earthquakes in Indonesia, Japan and New Zealand, and the Samoa earthquake and tsunami of 2009.

Overall Conclusion

58. Overall, Samoa's biophysical environment is continually changing as a result of a complex combination of drivers and pressures from natural and man-made sources. Underlying drivers include wide range of economic development activities (such as development in infrastructure, agriculture, tourism, fisheries), population growth, changing consumption patterns and lifestyles, traditional institutional arrangements governing access to and use of resources, and climate change and climate variability as a result of global warming. These underlying influences give rise to more direct pressure sources such as invasive species, overharvesting of resources, poorly designed development activities, proliferation of non-biodegradable wastes, natural disasters, poor sanitation systems and other factors. They operate singly and collectively, often times synergistically with the impact of one or more triggering others.

59. The biggest immediate threats to Samoa's biophysical environment are extreme events associated with climate change and climate variability, such as cyclones, floods and droughts. These and other climatic and weather pattern changes that were previously predicted are now a reality. Recent experience with Cyclone Evan saw the undoing of years of economic gain in infrastructure development and hard earned livelihood sources, loss of human lives and severe degradation of native habitats and species populations.

60. Other threats exist in the form of waste proliferation, poor sanitation systems, unsustainable harvesting and exploitation of resources, poorly planned development initiatives, and others. But these threats are more manageable with timely and effective interventions, some of which are progressing well to date in all climate change vulnerable sectors.

61. On the other hand, the level of preparedness indicated by the range of NAPA prescribed activities being implemented and planned in all vulnerable sectors, is quite advance. Drivers such as economic development, changing consumption patterns and lifestyles, climate change and climate variability, and others will continue to present challenging situations for environmental sustainability. But there is a heightened level of awareness amongst policy makers and planners of the seriousness of our vulnerability and of the ecological limits of our biophysical environment that are implied in a broad range of policies and strategies currently being pursued. There is also a clear sense of urgency in dealing with our ecological and economic vulnerabilities that is evident in the bold but achievable policies for achieving carbon neutrality and reducing fossil fuel dependence. Collectively, this heightened awareness, the plans now in place, the actions taken and achievements made in all habitats of the environment, constitute a increasing level of preparedness that is the closest indication of Samoa's resilience that can be discerned from the information available to this assessment.

Poster picture by a Saleaumua College student in 2005; Heritage in Young Hands Poster Competition

I. INTRODUCTION

The State of the Environment (SOE) report's primary purpose is to provide a succinct and objective assessment of the state of health of the country's biophysical environment. It should do so in a way that communicates effectively to its targeted audience, which include policy makers and planners as well as gatekeepers of information for stakeholder groups for which this information is relevant - to inform, educate, influence and catalyse positive action and changes in behaviour. Previous SOEs approached this report in different ways and in this new edition, the same search for effective approaches to analysing and reporting the states and trends in environmental health continues, with the adoption of the DPSIR model for analysis and the habitat-based approach as an organizational template for examining Samoa's complex environment.

Samoa's first State of the Environment report was released in 1993, coming in the aftermath of the United Nation's Conference on Environment and Development in Rio de Janeiro in June 1992. The SOE also followed the completion of Samoa's first and only environment sector strategy, the National Environment and Development Management Strategy (NEMS).

The second SOE was compiled thirteen years later in 2006. It followed a series of major initiatives in environmental management in Samoa. Several Multilateral Environmental Agreements (MEAs) were either ratified or acceded to, and Samoa was increasingly engaged in regional and national level initiatives related to obligations under the MEAs. The Planning & Urban Management Act 2004 was enacted, providing the legal foundation for an urban planning agency and the environmental planning framework for screening all development proposals. Major institutional rearrangements also saw the formation of a Ministry of Natural Resources and Environment (MNRE), under whose broad mandate was placed all environmental planning and conservation functions, and which also extended to include the Forestry Division, Meteorology, Water Resources Division, and later other areas such as energy, water sector coordination and disaster management.

A notable feature of the 2006 SOE was its broad scope. It provided an update on the state of the environment, but also prescribed recommendations and priority actions for future implementation. In the context of an outdated 1993 NEMS, it was an opportunity for directing and planning that was too good to miss.

This 2012 SOE follows a significant readjustment in the way the environment is integrated and positioned within the national planning framework. The Strategy for the Development of Samoa (SDS) 2008-2012 SDS was the first to explicitly prioritize environmental sustainability, elevating it alongside the economic and social pillars that previously were the focus of Samoa's national planning framework. This elevated status for environmental sustainability brought it in line with Samoa's MDG goals, and addressed an imbalance in the way sustainable development was conceptualized in earlier SDS.

The basic question of interest is 'what is the state of health of Samoa's biophysical environment?'. The cross-cutting nature of the environment makes answering a challenge on its own, but to achieve it based on reliable and consistent quantitative measurements demands a much greater commitment to environmental and resource monitoring than is presently the case. Due to the inconsistencies in the quality of the information available, the report and the assessments made are similarly inconsistent. But this are temporary teething problems that will be ironed out in future editions, as better designed and targeted information monitoring systems are put in place and data gathering is carried out consistently.

This SOE report is the first output dealing with Drivers, Pressures and States. The updated NEMS – a separate output – will focus on the Impacts and Responses components of the DPSIR model. Thus providing for the compilation of the National Environment & Development Sector Plan (NESP).

2. APPROACH AND METHODOLOGY

2.1 Background

A March/April 2011 workshop by MNRE and SPREP titled National Integrated Environmental Assessment (IEA) Mainstreaming Workshop, examined and subsequently endorsed the process to review Samoa's state of the environment with the application of the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework to analyse data and information on the states and trends of environmental issues and the nature and extent of policy responses. The outcome from this workshop produced the "Plan for Reviewing the state of Samoa's environment". The workshop also resolved to commence preparation for Samoa's 3rd SOE report.

Consultative Process

Consultations for the SOE took four main forms

(i) formal workshops engaging government agencies, SPREP and others

(ii) face-to-face meetings with different agencies and experts to discuss sector specific issues, gather information and in some cases, to clarify data and information previously provided;

(iii) email discussions and communications with key technical experts from government agencies, SPREP and others on specific issues, and

(iv) a series of multi-stakeholder consultations aimed at engaging and soliciting views and comments from other agencies, organizations and civil society at large.

These latter consultations involved five full-day workshops in April and May 2013 with three meetings held in Upolu (Apia) and two in Savaii. Often, issues discussed on email lead to semi-formal face-to-face group meetings to advance discussions or to view technical data (e.g. vegetation type maps) before they can be formalized.

The gist of the consultations undertaken was primarily to engage, solicit and exchange views and in some cases to reach consensus on a broad range of issues starting with the DPSIR model, the SOE report card and its format, indicators and metrics, the habitat-based approach, and the key habitats. Workshops were also used to identify probable sources of data and information, and to arrange further consultation meetings.

The series of public consultations held in Upolu and Savaii provided MNRE an opportunity to present a draft SOE report to the public with the summary of the main issues and findings. Comments from this series of workshops has been taken on board in finalising this report.

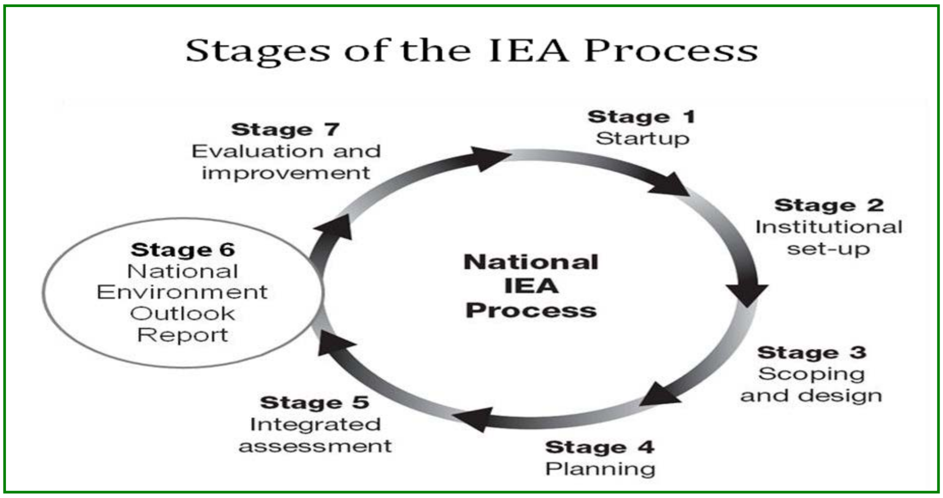
IEA Process and DPSIR

The structure of the IEA process is outlined below. It is aimed at providing relevant answers to the following five fundamental assessment questions on the state of the environment:

1. What is happening to the environment and Why?
2. What are the consequences for the environment and humanity?
3. What is being done and how effective is it?
4. Where are we heading?
5. What actions could be taken for a more sustainable future?

These questions help to clarify the states and trends of environmental change, the causes of those changes and how they impact the biophysical environment and the well being of its dependent human population. It also seeks to clarify the extent and effectiveness of policy responses that were implemented to address impact issues from the NEMS to the various thematic environmental policies (eg., climate changes, biodiversity conservation, SLM and others).

Figure 3: Stages of the IEA Process (UNEP IEA Training, Nairobi, 2010)

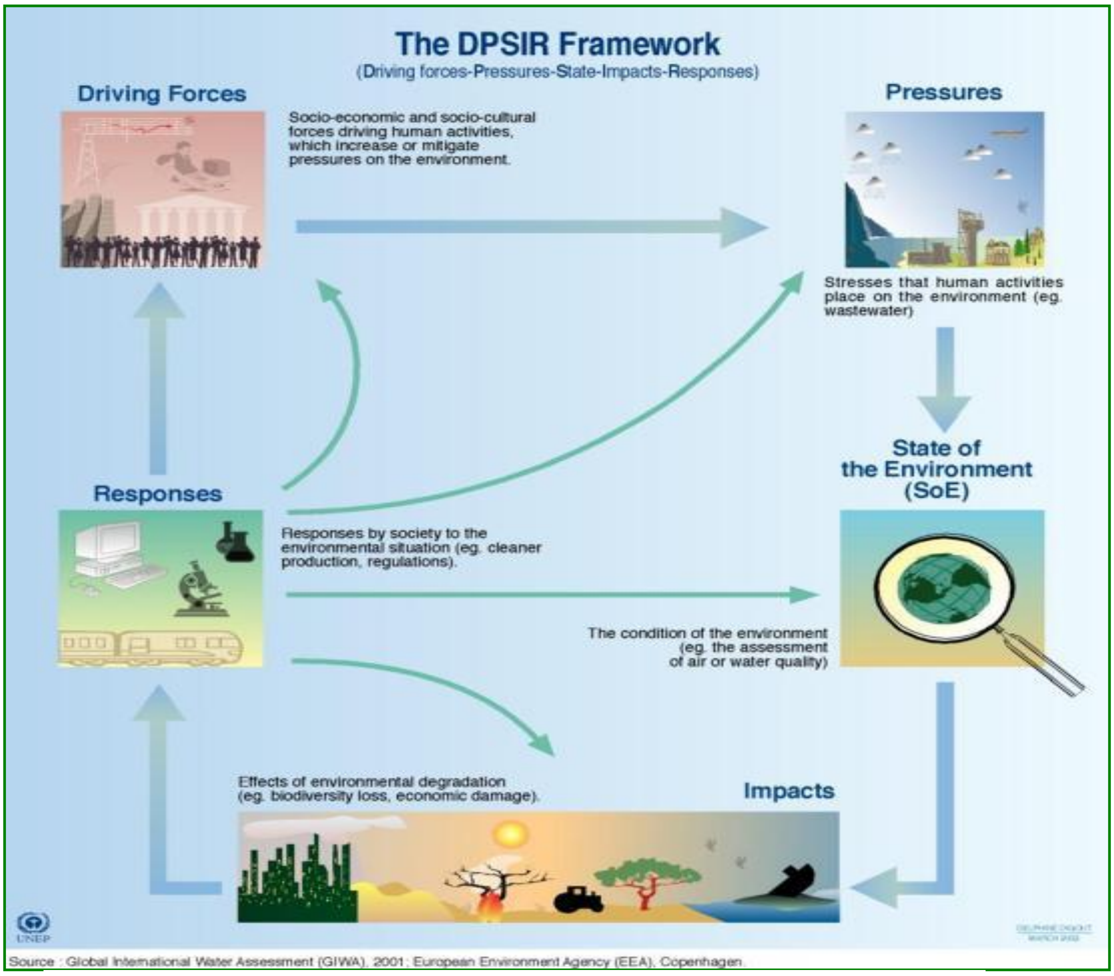


The Drivers, Pressures, State, Response and Impact Analysis of available data and information help provide answers to the first three questions of the assessment:
The Assessment of **State** clarifies what is happening to or the current conditions of the environment;
Drivers and **Pressures** clarify the causes of those conditions;
Impacts clarify the effects of those conditions on wellbeing of human society and the environment;
and **Response** clarifies how much work has been done to improve environmental conditions and how effective were those actions.

The framework assumes cause-effect relationships between interacting components of social, economic, and environmental systems, which are

- **D**riving forces of environmental change (e.g. industrial production)
- **P**ressures on the environment (e.g. discharges of waste water)
- **S**tate of the environment (e.g. water quality in rivers and lakes)
- **I**mpacts on population, economy, ecosystems (e.g. water unsuitable for drinking)
- **R**esponse of the society (e.g. watershed protection)

Figure 4: DPSIR Framework



Source: Delphine Gigout, UNEP/GRID - Arendal

Habitat based approach
In May 2011, a MNRE/SPREP workshop on environmental reporting launched the preparation of the SOE Report Card, and resolved to adopt a habitat-based approach to analysing Samoa's biophysical environment. A habitat based approach signals a significant departure from previous approaches which largely viewed and divided the biophysical environment into discrete chunks of natural resource sectors. As natural resources, environmental assessment became heavily driven by human-centred values that were no different from that of the economic sectors these environmental resources fall under.

A habitat-based approach is seen as providing a balanced, neutral and holistic perspective that recognizes the intrinsic and existence values inherent in ecological processes, habitats and species, while at the same time addressing issues of human use and exploitation that are, in most cases, synonymous with the drivers and pressures.

It divides and organizes Samoa's biophysical environment based on its major habitats, and assesses the state of each habitat separately, with the combined assessment of all habitats providing a composite but complete picture of the whole. The key habitats initially selected were: upland and cloud forests, lowland forests, coastal strands, rivers and streams, near shore marine and offshore marine. These were further refined as the SOE progresses to also take into account (i) habitats of special significance that are spatially cross-cutting e.g. rivers and streams, and protected areas and (ii) the human built rural and urban environment of residential areas, physical infrastructure, artificial landscapes which interactions with the natural environment is the cause of many stresses, and (iii) the atmosphere, weather and climate.

The assessment of environmental health is therefore less of how much of each resource is remaining and available for human consumption but of how well different habitats and species are faring given the impacts of natural, biological and human threats that are in operation.
To the extent possible, within the constraints of the information available, this is what this SOE sets out to produce.

2.2 SOE Format and Organization
Consistent with the DPSIR framework, the SOE is organized under the main headings of Drivers, Pressures and State of Environment assessment. There are overlaps in some drivers and pressures such as climate change and climate variability which can operate at both levels.

The Impacts and Responses components of the DPSIR model are related to but outside the scope of the SOE. These two areas of analysis, in particular the prescriptive 'Responses' component, constitute the main thrust of a separate but companion report to the SOE, which is the updated National Environmental Management and Development Strategy (NEMS).

2.3 Habitat-based approach to assessing the environment
The habitat-based approach to viewing and analysing the bio-physical environment of Samoa is a departure from previous approaches wherein the environment was organized and discussed in terms of its resource values. By assessing the environment within its various habitats, the SOE offers a perspective that is neutral of utilitarian and human centred resource values and provides for a consistent logical framework that is robust and within which all aspects of Samoa's environment can be consistently monitored and analysed over time.

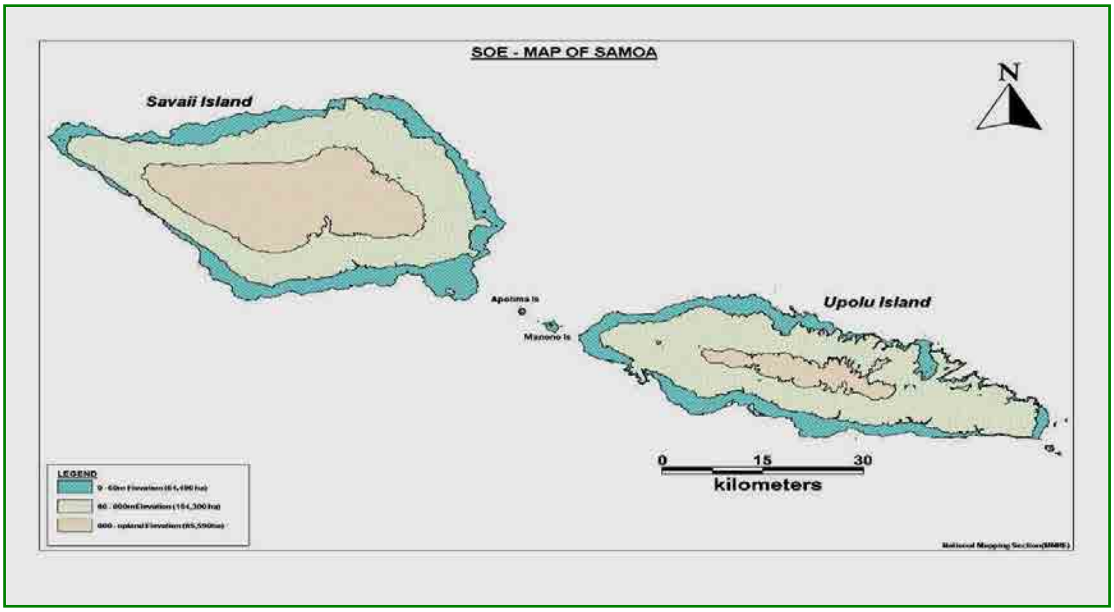
The following habitat-types make up Samoa's biophysical environment –

1. Upland and Cloud Forest habitats
2. Lowland habitats
3. Coastal habitats
4. Inshore and Offshore Marine habitats
5. Rural and Urban Built Environment
6. Rivers and Streams
7. Protected Areas
8. Atmosphere, Weather and Climate

The division between habitats is largely elevation-based but at the same time, tries to approximate the natural divisions between different ecological boundaries and vegetation types. It is a possible area of debate but in the absence of an ideal approach, this solution is deemed defensible and practical. Part of this rationale is to facilitate consistency over time in the spatial coverage for monitoring and data gathering purposes of MNRE going forward. It means even if there are shifts in vegetation types in the future as a result, for example, of climate change, these changes will be monitored within each unchanging spatially defined area, allowing analysts to observe the changes within respective habitat-type.

Some habitat-types identified above also do not comply with the elevation criterion. Rivers and Streams, Protected Areas and Built Environment are cross-cutting in the spatial dimension, extending through a range of elevation bands from uplands to the coast. While theoretically they can be discussed in all terrestrial zones in which they are present, doing so would be repetitive. To avoid this, these are treated as separate habitat-types.

Map 1: Samoa's Coastal, Lowland and Upland Habitats



Source: MNRE, 2012.

Boundaries/Zoning classification
Within each habitat-type, several habitats area discussed and assessed individually with a total assessment for the habitat-type, the sum of these analysis. Species groups of significance are also treated specially. Table 1 below breaks down each habitat-type into its various habitats and key species groups.

Note that this is not exhaustive, and over time with more information, some habitats and species groupings not included in this SOE may be added. The determining factor in the inclusion of the habitats listed below is the availability of information, even though they were still incomplete for many habitats discussed.

Table 1: Habitat-types and Main Species groupings

Habitat types	Habitats & Species Groups
1. Marine/Offshore habitats	Corals and coral reefs Seagrasses Algae communities Seamounts Marine mammals & dolphins Marine reptiles Benthic fishes Pelagic fishes (tuna) Marine molluscs Crustaceans Echinoderms
2. Coastal habitats	Mangroves and wetlands Coastal forests and strand vegetation Coastal marshes Beaches
3. Lowland habitats	Cultivated areas Lowland forests
4. Upland habitats	Upland and cloud forests
5. Freshwater bodies, rivers and streams	Rivers and Streams, lakes, freshwater, springs , groundwater, riparian zones, wetlands

6. Built Environment	Population Housing Sanitation Waste (different types of wastes) Environmental safeguards Energy consumption
7. Protected areas	Protected areas, sanctuary and Key Biodiversity Areas (KBAs)
8. Atmosphere Weather and Climate	GHG emissions Ozone emissions ODS emissions Eco-system based adaptation (NAPA implementation)

2.4 Constraints and Limitations

The habitat-based approach demands a new way of perceiving the biophysical environment and of organizing available data and information. Being new, it gave rise to many challenges some of which will need to be refined and finetuned for future SOEs, using the experience gained in this exercise and the ensuing SOE monitoring activities. These are discussed below -

- Much of the needed information is not available or is otherwise spatially neutral and not disaggregated by habitat-type.

- The key indicator of health for most habitats is area-coverage but the existing satellite images and aerial photographs dates to 1999, with some updating by ground-truthing carried out in 2004. Expert opinion have been sought to estimate and validate the change in area coverage since 2004 and notwithstanding its limitation, this baseline is used extensively in this report in the absence of better information.

- There is a lack of baselines with which to assess changes over time or trends. In most cases, there is considerable anecdotal information of changes over time that clearly point to consistent trends, but there is no quantitative data to support it. In such cases, expert opinion (of the consultants and MNRE technical experts) is used with comments added to qualify any limitations in interpretation.

- As evident in the range of 'habitat-types' Samoa's environment is divided into, some features of the environment such as 'rivers and streams' are cross-cutting in terms of their spatial spread, spreading over two or more of the defined terrestrial habitats. The same applies to 'Rural and Urban Built Environment' which, while largely concentrated in coastal areas, are also found outside these areas. Both are treated as separate 'habitat-types' for this reason.

- Protected areas are discussed as a separate habitat-type. This is more out of expedience because they are important in the context of the assessment, and at the same time, have a spatial spread that extends from the uplands to the sea.

- Assessing the state of health of different habitats and species is made easier with the use of classifications of 'low, medium or high' to indicate the degree of change reported. This is used throughout this report. However, in the absence of adequate and quantifiable data, much of this judgement is based on qualitative expert opinion using on anecdotal evidence and in some cases, together with available but limited data. There are some sources of assessments used here (e.g. Kendall and Poti) wherein these classifications are properly defined, and these are used directly in this report.

Taken together, the limitation in the available data and information means some indicators are either not assessed, or only assessed partially. As well, assessments of trends in most cases are based on qualitative observations and anecdotal information, and expert judgement. Importantly, the inclusion of the selected indicators, despite the absence of assessments for some, is intended to catalyse and encourage the responsible agencies in future monitoring and assessments.

3. DRIVERS OF ENVIRONMENTAL CHANGE IN SAMOA

3.1 Geographical smallness and isolation

Samoa is a small island country in the southwest Pacific, comprising of four main inhabited islands and six smaller, uninhabited islands (refer to Figure 1). Its total land area is 2,900 km2 and its Exclusive Economic Zone (EEZ) is 120,000 km^2.

Like many similar islands in the Pacific Ocean, the physical remoteness and isolation from continental landmasses played a key role in the evolution of its biodiversity. Millions of years of isolation from other genetic influences, and from natural predators and related competitors, allowed the uninterrupted speciation and the gradual evolution of sub-species and species in its fauna, giving rise to the relatively high level of endemism in its biodiversity. The flip side is the high level of vulnerability of these species with less developed natural defensive mechanisms, to alien invasive species, drastic environmental changes and extreme natural events. As a result, the dynamics of species diversity and populations are in a constant state of flux.

Samoa's small geographical area and EEZ is also at the root of many of its environmental challenges. Being of small islands, the coastal zone assumes a disproportionately large role in its biogeography, and the interface between the coastal area and the marine environment a prominent feature. Add to this a high human population and infrastructure concentrated along the coast, the result is a highly active zone where coastal habitats and species are under on-going pressures from land-based pollution, exploitation and other stresses. This is further compounded by the impacts of climate change and climate variability.

The limited size of Samoa's EEZ also plays a role in the population dynamics of the highly migratory tuna resource (Langer, 2006) as well as the dynamics of other migratory species in its biodiversity.

Map 2: Geographical location of Samoa in the Pacific Ocean

Pacific Map downloaded from www.pacifictravelguide.com

3.2 Demographics

Samoa's population as of the 2011 national census stands at 187,820 having grown at an average growth rate of 0.64% since the last census was taken in 2005. Before that, since the 1961 census, Samoa's population growth rate has been declining at around 0.4% per year over the last 48 years. The annual growth rate of 0.64% since 2006 continues a declining trend that, to a large extent, is attributed to the influence of emigration (Malaefono Ta'aloga, pers comm.., MAF and SBS, 2012[4]).

The increase in urbanization of population means the increase in the demand for natural resources and for environmental services. In synergy with increasing incomes, urbanization and changing consumption patterns

[4] *Ministry of Agriculture and Samoa Bureau of Statistics. 2012. Agriculture Census – Analytical Report 2009. Economics Statistics Division, SBS.*

and lifestyles, an increasing population exacerbates the problem of waste proliferation, putting pressure on landfills, as well as sensitive ecosystems.
The high concentration of population along the coast is directly related to a lot of stresses facing Samoa's environment. Seventy percent (70%) of Samoa's population and infrastructure is located within the coastal area and the combined impact of their land use, sanitation and waste management habits – all contribute to effects that are unsustainable. Some of these include the improper management of solid wastes and wastewater from household sanitation systems, which results in the contamination of underground water bodies, and the degradation of coastal lagoons and coral reefs. Land clearing for settlements and cultivation as well as poor cultivation practices contributes to coastal pollution, increased sedimentation and ultimately the degradation of inshore areas.

3.3 Access to resources and land tenure system

Access to environmental resources is intricately linked to the traditional land tenure system which controls over 80% of Samoa's land resources. The rules governing the allocation of access, use and ownership rights to land and resources under communal ownership are sometimes complicated, and is a subject of several published research and scholarly investigations. In some cases the land tenure system is perceived as a stumbling block to development, because of difficulties of accessing land for development and investment. In the view of others (e.g. O'Meara, 1987)[5], the apparent conservatism that is often perceived as synonymous with an impediment to economic development, is more superficial than fundamental.

Table 2: Land Distribution by Tenure in Samoa

	1989	1999	2009
Customary land	94%	90%	86%
Leased customary land	1%	1%	1%
Leased government land	2%	2%	3%
Own freehold land	3%	6%	9%
Leased freehold	0%	0%	1%
Others/not stated	0%	1%	1%

Source: Samoa Bureau of Statistics Census of Agriculture

In many cases, the communal ownership of resources within villages encourages open access regimes that results in the 'tragedy of the commons', a free-for-all situation wherein self-interested individuals maximize their own benefits until the resource is depleted (Boulding, 1966)[6]. Village inshore marine resources are a classic example where fishing effort is often unregulated. The inevitable result is overfishing leading to resource depletion in the inshore fisheries in many villages (Samuelu-Ah Leong, 2000; Kendall, M and Poti, M.(eds), 2011). But the same laxity in the way access and user rights are allocated is observed in the allocation of use-rights on customary lands - in particular the customary rule where the right of use (and de-facto ownership) of village communal land is acquired and claimed by whoever of the village clears the forest on it. This rule encourages many to clear forested lands merely to stake a claim with little or no long term commitment to its development. Moreover, as reported by O'Meara (op cit), the right of ownership is then inherited directly by those individuals' children.

The environmental consequences of these traditional arrangements are severe and are often manifested in the form of lost habitats, habitat fragmentation, and lost of vegetation cover in sensitive environments including catchments and erosion-prone areas.

Some resources that by law are state-owned, such as rivers and streams, are often disputed by villages with access to them through village-controlled lands needing protracted negotiations. Similarly areas of high conservation value that Government earmarks for protection and located on customary lands are not guaranteed protection with villages support often fickle and prone to reversal, often as a result of internal village politics and disputes. The case of the Uafato Conservation Area Project is an example of where internal village disputes and personality conflicts resulted in a village decision to withdraw its commitment for the conservation of this forest area. Sili village's refusal to allow a Government funded hydropower project on the Vaitai River in 2007 is another example. In 2011, Tafitoala also declined a Government proposal for joint development and ownership of a hydropower scheme using the Tafitoala Stream.

3.4 Economic development

The scope of economic development includes the process and policies by which a nation improves the economic, political, and social well-being of its people (O'Sullivan, A and Sheffrin, S.M.2003)[7]. Its role as a driver of

[5] O'Meara, J.T. 1987. "Samoa: Customary Individualism." Pp. 74-113 in R.G.Crocombe (ed.). Land Tenure in the Pacific. University of the South Pacific, Suva, Fiji.
[6] Boulding, K. 1966. "The economics of the coming spaceship Earth." In: Holden, P and Ehrlich, P.R. (eds.) 1971. Global Ecology: Readings Towards a Rational Strategy for Man. Harcourt Brace Jovanovich, Inc. New York. P. 180-187.
[7] O'Sullivan, A and Sheffrin, S.M. 2003. Economics: Principles in action. Pearson Prentice Hall, New Jersey.

environmental change is all pervasive and often times indirect and discreet. It encompasses the policies, strategies and priorities and the allocation of public funds and human resources as define by the Government and its agencies, the self serving activities of profit-motivated organizations and companies in the private sector, as well as actions of civil society and economically rational individuals.

In Samoa, while the Government promotes and fosters an enabling environment wherein the private sector can realize its potential as the engine of economic development, the Government itself remains the main developer. Its policies dictate and determine the way natural resources are allocated, extracted and use at the level of profit-making corporations, companies and resource-owning entities including villages. The same policies also have profound influence in the behaviour of economically rational individuals at the household level with respect to choices to make on the use of land, forests, marine areas and resources, the choices of technologies to invest in, and in the way people use their disposable incomes. All of these contribute to changes in the biophysical environment in ways that are sometimes sustainable, but more often not.

In the context of these observations, past and current development thinking as set out in Samoa's development strategies including the new SDS 2012-2016 is discussed to highlight the role of economic development as a driver for environmental change in the country. Samoa's economic development in the early sixties to the late nineties was heavily dependent on the exploitation of natural capital. In recent years, however, economic growth has been driven largely by growth in commerce, transport, communications and construction, all linked to and supported by increased numbers of tourists (Rath, 2011).

The diminished contribution of natural capital is partly the result of unsustainable exploitation of forests in the late seventies and eighties, the taro leaf blight in the early 1990's and the devastation wreaked by Cyclones Ofa, Val and Heta in the nineties and early twenties. But there were also inefficiencies and losses caused by more deep-seated institutional constraints such as the traditional land tenure system, lack of institutional capacities in several areas and in some cases, perverted resource policies (Sesega, 2005)[8].

The Government of Samoa's economic goal for the 2012 -2016 planning period maintains a strong emphasis on economic growth, "to rebuild macro-economic resilience and encourage inclusive growth, generate opportunities from global and regional integration as well as build resilience against natural disasters and climate change" (GoS, 2011; p.4)[9]. Predictably, constrained by a narrow resource base, the focus of investment will continue to be on the use of cultivable land, fisheries, forests, water and the natural environment for tourism. In agriculture, the call for scaling up from subsistence to 'semi-commercial' operations, from traditional tools to increased mechanisation, improved access to customary land through leasing, logically means the spatial expansion into existing forests the intensive use of underdeveloped lands, the introduction of new crops and the use of new technologies. The emphasis on renewable energy is likely to see the diversion of rivers for hydropower generation and the possible introduction of alien species – so called energy crops - for biomass gasification and oil production, in addition to a range of biofuel options currently being investigated. Fisheries will be encouraged to ensure its present quota of fishing licenses is fully subscribed. In the case of tourism, its interest in the environment is often related to the use of pristine natural sites, but sustainable tourism standards in promoting resource conservation and recycling and in waste management in tourism facilities are just as important.

Many of these pro-growth policies drive unsustainable impacts. The threat however is well recognized by national planners and both the current SDS 2012-2016 and its predecessor now designates the environment as a priority area with environmental sustainability among the key outcomes. Sector plans are also encouraged to factor in measures for mitigating all foreseeable environmental impacts. The PUMA Act 2004 and the PUMA (EIA) Regulation 2008 also provide the legal framework for screening all development initiatives for environmental sustainability, complementing other environmental frameworks regulating sand mining, coastal reclamation and the importation of living modified organisms (LMOs). This means the remaining question is whether government has the capacity for monitoring and the political will to make difficult pro-environmental decisions where trade-offs with short term economic benefits are inevitable.

For many economically rational individuals at the household level, as farmers or fishers or ecotourism operators with choices to make on the natural resources at their disposal, the pro-growth national and sector policies and strategies will accelerate the continuing shift from a predominantly subsistence existence to a cash based lifestyle. It's a change that has been steadily emerging (Martel, Atherton and Dewulf ,1997)[10] and will accelerate as Samoa willingly participate in an integrated globalized economy.

It is worth noting that noting that most if not all of the economic activities of the informal and semi-subsistence sector operate outside the formal planned sector where environmental filters i.e. PUMA's development consent process, operate. Yet collectively, often in tandem with lax rules governing access and use of resources under

[8] *Sesega, S. 2005. "Deforestation and Forest Degradation in Samoa". Working Paper FAO/SAPA SAM DEFOR 01/05.*
[9] *Government of Samoa. 2011. Strategy for the Development of Samoa 2012 – 2016. Ministry of Finance, Economic Policy and Planning Div, Apia.*
[10] *Martel, F. J.Atherton and T.Dewulf. 1997. "Pilot Community Deforestation Survey : Western Samoa and Niue – Final Report." SPREP.*

customary control, they are significant contributors to the transformation of the biophysical environment that is manifested in habitat fragmentation, the loss of vegetation cover in catchment areas, the sedimentation of coastal inshore areas and the pollution of coastal environments.

3.5 Changing consumption patterns and lifestyles

Samoa's vision for the 2012 – 2016 SDS is 'improved quality of life for all'. The intended outcome is that of a population that is healthier, better educated and prosperous. Inevitably however, the unintended consequence of this outcome is a population that often aspires to lifestyle changes and consumption choices that are environmentally challenging. Samoa has seen its per capita income growing steadily over the last fifteen years[11] (Rath, 2011)[12]. It has also made considerable progress over the years with most of the other MDG indicators. Not surprisingly, there is a direct correlation with changes in public consumption of several key basic needs. For instance, in the case of house construction, there is an obvious shift towards the use of imported construction materials. In energy consumption, biomass is increasingly being replaced by petroleum products and electricity for cooking[13]. Imported labour-saving technologies and household consumer goods comprise a major portion of Samoa's import bill. Increased consumerism and a throw-away mentality add to the proliferation of non-biodegradable wastes, pollution of the atmosphere and increases in greenhouse gas emission[14].

Some consumer choices have direct and indirect environmental benefits. For instance, the reduced dependence on biomass for cooking fuel should lead to lesser deforestation. A growing population of health conscious consumers are demanding organically grown agricultural produce. Recent declines in the use of agricultural chemicals in farming are partly attributed to this (MAF, 2009; p. 41). There is also growing interest in renewable energy and energy efficient technologies e,g, use of biogas digesters, solar panels and energy saving light bulbs, that collectively, will contribute to national efforts to reduce fossil fuel imports.

Changing lifestyles associated with urbanization is a contributing factor. Urban dwellers are less engaged in agricultural activities including backyard cultivation, more integrated into the cash economy and more likely to use electricity and LPG for lighting and cooking.

3.6 Climate change and climate variability

Climate change and climate variability are both a driver and a stressor of environmental change in Samoa. In a nutshell, climate change occurs when short -term weather patterns are altered — for example, through human activity. Global warming is one measure of climate change, and is a rise in the average global temperature.

Climate variability refers to variations in the mean state and other climate statistics (standard deviations, the occurrence of extremes, etc.) on all temporal and spatial scales beyond those of individual weather events. Variability may result from natural internal processes within the climate system (internal variability) or from variations in natural or anthropogenic external forces (external variability). **Climate change** refers to any change in climate over time, whether due to natural variability or anthropogenic forces. Climate variability goes hand in hand with climate change.

The impacts of both on the environment are widely documented. The following section discusses impacts of climate change in the various economic sectors (MNRE, 2006) –

- *Agriculture and Food Production* – Climate induced disasters such as tropical cyclones (its increase in frequency and intensity), flooding in low lying and coastal areas, saline intrusion, coastal erosion and increased rates of coral bleaching mean higher demands and unstable levels of food production affecting income generating activities for communities

- *Water Supply and Quality* – Drought is the most obvious and hard felt 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* – The common occurrence of tropical cyclones and drought temperature fluctuation and changes in precipitation patterns lead to changes in the habitats of endangered and endemic species highly affecting Samoa's biodiversity. The intense wave activity of storms overturned much of the coral near shore and severely damaged corals to depth of up to 10 meters (30ft). The changes in sea surface temperature causes bleaching of the corals impacting the habitats of fish species.

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[11] from S$3,650 in 1994 to S$6,969 in 2006 (GoS, 2008)[11] to S$7,138 (~ US$3,121) in 2009 (Rath, 2011)[11], making Samoa a medium human development country with a global Human Development Index (HDI) ranking of 94 out of 182 countries (ibid.).

[12] Rath, Amitav. 2011. Acceleration of Millennium Development Goals in Samoa: Policy Analysis with a Focus on Requirements for Industrial Growth. Final Report Prepared for UNDP – Samoa & UNDP Pacific Centre. UNDP.

[13] Government of Samoa. 2007. Samoa National Energy Policy. Ministry of Finance – Economic Policy and Planning Division. Apia.

[14] Greenhouse gas emission in the road transportation sector increased by 38% between 1994 and 2007 according to the Second National Communication report to the UNFCCC.

- *Health* – There is anecdotal evidence of growth in vector borne and water borne diseases that reconfirm the already changing climate and the impact it has on the health sector. The conditions for the occurrence and spread of these diseases are favoured by the changes in climate;

- *Forestry* – Prolonged periods of drought – usually lasting for three months or more, severely affect forests from high risk of forest fires. Samoa experienced four major forest fires from the drought/dry periods of 1982-83, 1997-98, 2001-02 and 2002-03; and more recently, 2011/12.

- *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 supply the urban areas.

- *Energy Production* – The droughts in 2002 and 2003 and low rainfall amount in 2008 to 2009 led to rationing of electricity, as the amount of hydro generated electricity dropped. Predicted future increases in the frequency of droughts as a result of climate change will again have severe energy implications until sufficient renewable energy sources are developed. The recent tropical cyclone Evan in 2012 inflicted damaged to hydropower stations.

- *Tourism* – The impacts of climate change on the tourism sector is directly related to the loss or degradation of tourism resources such as beaches, pristine forest habitats, coral reefs, coastal infrastructure and scenic villages. Causes are inundation, flooding, heat related stresses, wind damage, and saline intrusion.

- *Urban Settlement* – The impact of flash floods on Lelata, Vaisigano and other villages in Vaimauga I Sisifo and Apia town area during Cyclone Evan is a stark reminder of the extreme risk associated with settlements in flood prone areas. The extensive damage inflicted on private property and public infrastructure also highlights the shortfalls in urban planning with respect to poor drainage systems, and disaster preparedness. Cyclones and extreme rainfall events are projected to be on the increase both in frequency and intensities and these urban settlement issues will be recurring with the cyclone seasons.

- *Village Communities* – The livelihood of the communities is already seriously threatened by the impacts of climate change. These include physical damage to homes and properties, unstable water quantity; threats to food security as a result of losses in food crops for subsistence and income; coastal erosion and flooding of low-lying areas, and damage and losses to areas of cultural and heritage values (MNREM, 2005).

According to the Samoa's Second National Communication to the UNFCCC, climate change is already a reality with effects already being felt (MNRE, 2010)[15] and recent scientific studies on regional and national climate change scenarios (PCCSP report, 2012). These include – increased maximum air temperature, increased frequency in extreme daily rainfall events, and sea level rise of between 2.7 – 8.3 mm a year (PCCSP, 2012). These include – increased maximum air temperature, increased frequency in extreme daily rainfall events, and sea level rise of between 2.7 – 8.3 mm a year (PCCSP, 2012). Furthermore, best estimates of long-term, systematic changes in the average climate for Samoa indicate that by 2050, sea level is likely to have increased by 36cm, rainfall by 1.25%, extreme wind gusts by 7% and maximum temperatures by 0.7^{o}C (ibid.). Other impacts include a rainfall event of 300mm, which used to be extremely rare, being projected to occur on average of every 7 years by 2050 which is consistent with trends over the past 20 years if significant intensification of rainfall in the country; extreme high sea-surface temperatures, cyclones, as well as more frequent and long lasting droughts (ibid.).

Samoa's National Adaptation Program of Action (MNRE, 2005) calls for the implementation of a series of interventions to strengthen resilience and avoid direct damage to and loss of coastal infrastructure and local communities. The mix of hard and soft solutions proposed involved relocation of infrastructure and coastal population away from hazard prone areas, coastal revegetation, and other low impact options.

[15] *Ministry of Natural Resources and Environment (MNRE). 2010. "Samoa's Second National Communication to the United Nations Framework Convention on Climate Change." GEF/UNDP; Government of Samoa.*

4. PRESSURES ON SAMOA'S ENVIRONMENT

4.1 Invasive species

Invasive species poses a major threat to Samoa's biodiversity and economy. The impacts are costly and often irreversible. Impacts can range from adversely affecting the productivity and subsequent economic output of primary industry, such as agriculture, forestry and fisheries, to impeding cultural practices and traditions, household food security and sustainable livelihoods, and threatening the integrity and biodiversity of natural ecosystems including vital ecosystem processes, and the existence of rare and vulnerable species.

Samoa has experienced the devastating impact of invasive species on the environment, production systems (crops), and social values of Samoa particularly through invasions of taro leaf blight, the giant African snail (*Achatina fulica*), Myna species (*Acridotheres tristis, A. fuscus*) and Merremia vine (*Merremia peltata*).

The taro leaf blight was extremely costly from an economic perspective, for the impact it had on food security as well as exports. According to Chan (1995)[16], taro production in Samoa dropped by over 95% and the export value fell from $US 3.2 million in 1993 to only $US 53,000 one year later (IPGRI, 2002). From an environmental point of view, it marked the eradication of an exportable species, and ushered in the expansion of the genetic pool for the species in the search for new disease resistant and high yielding varieties of export quality.

The Merremia vine and mile-a-minute (*Mikania micrantha*), are notoriously aggressive species and are listed among the top 30 invasive plants in the Pacific (SPREP, 2000). They are prolific invaders of forest gaps and disturbed sites, with a smothering effect on growing trees, blocking sunlight to sub-canopy and undergrowth vegetation. Although the economic costs have not been quantified, the possible impacts of these vines on agricultural crops and habitats of high conservation value, including Key Biodiversity Areas already approved by the Government as priority for conservation action, is a major concern. The preliminary findings of the 2012 BioRAP surveys (Jeffries et al, op cit)[17] clearly confirm those concerns, with estimates now suggesting that up to 50% of the remaining lowland native forest is dominated by *Merremia* vines (fue lautetele).

Several other invasive forest trees species are also increasingly outcompeting native species in forest gaps regeneration, getting established and moving further and further into old secondary regrowth and primary forests. According to Jefferies et al (op cit), 24% of Samoa's forest is now classified as secondary re-growth- dominated by invasive weedy plant species such as *tamaligi, pulu mamoe, pulu vao and fa'apasī* - especially in Northern Upolu. The dominance of fast growing pioneers in the regeneration of forest gaps and disturbed areas is not an atypical phenomenon. It is the normal cycle of natural regeneration in tropical forests. Slow growing shade tolerant species may or may not regain dominance depending on many factors. But while fast-growing invasive tree species dominate, the quality of forests from a species richness view point will decline. And with it is the ecological stability that is anchored on species and systems diversity.

The known list of invasive species in Samoa is appended, including several birds and marine species. Several others are identified as potentially invasive, including a few that were introduced to control existing invasive species.

4.2 Waste and environmental pollution

Pollution and the growing volumes of solid and hazardous wastes are serious threats to Samoa's environment and to its sustainable development. Waste proliferation continues to accelerate with population growth, improved living standards, urbanization and increasing participation in international trade. These factors combine to push households towards consumer economies where imported, ready-to-consume and disposable products are often preferred for their convenience and labour-saving advantages. At the same time, a lot of these products are non-biodegradable, have short shelf lives, and non essential. The result is pressure on existing landfill facilities, increased threat of pollution and contamination of underground water sources, and degradation of coastal and marine environments.

Samoa however has made significant progress in the management of solid wastes. The following situation exists:

- Samoa generates 175kg of waste per capita per annum in the Apia urban area, and 130kg per capita in rural areas; (MNRE, 2010). Statistics show (ibid) that the rate has been declining over the last 10 years since data was collected.
- Most household waste are of organic refuse but plastics and other inert materials constitute a significant and growing share of waste output;
- A Government funded waste collection system is accessible to 97% of Samoa's households.
- Commercial operators especially in the urban area transport their own solid wastes to the landfill for disposal.

[16] Cited by MNRE.2008. National Invasive Species Action Plan 2008-2011. Division of Environment and Conservation, MNRE.
[17] Jeffries, B., Atherton, J. and Foliga, S.T. 2012. "Enhancing Knowledge and understanding of the Biodiversity of Upland Central Savaii". BioRAP Survey Debriefing to MNRE, October, 2012.

- Waste surveys conducted for Upolu indicates that 110.7 tonnes of waste is disposed of at the landfill annually; out of a total waste generated of 970.9 tonnes per year (Setoa, pers comm.). This means only 11.4% reaches the landfill; the remaining 88.6% is either burned in backyard incineration, used as green waste for mulching, buried or is disposed of somewhere. It is also possible that part of the waste collected by contractors is dumped illegally in unapproved sites.
- GHG emission data points to a decrease in backyard incineration of waste with total GHG emissions reduced from 33.09 $GgCO_2$-e in 2000 to 32.81 in 2007 (ibid), meaning backyard burning of waste has declined.
- Currently, there is no formal collection for recyclable materials.
- Waste water including raw sewage is relatively well managed in the central business district with the recently installed sewage pipeline conveying waste from about 300 commercial operations to the treatment facility in Sogi
- The two semi-aerobic landfills (Tafaigata and Vaiaata) that receive the collected waste are well managed. Both were extended in 2010 with the addition of sludge facilities for treating septage from household and commercial septic tanks.
- Biogas digesters technology is gaining acceptance and working well in specific contexts (e.g. YWAM campus in Falelauniu), recycling household organic, as well as animal and human wastes to produce electricity and cooking gas (methane), and in the process, improving the quality of the waste water released into the environment.

The management of hazardous wastes is less advanced. But there are key areas wherein significant progress has been made. Persistent organic pollutants (POPs) were inventoried in 2004 and the National Implementation Plan for POPs have in part been implemented. This included the enforcement of bans on importation of POPs as stipulated under the Vienna Convention, and identified in the 2004 inventory, the cleaning up of four priority contaminated sites or hotspots identified in that inventory and the re-importation of used electrical transformers and other hazardous wastes to Australia for disposal under a SPREP coordinated initiative in 2005 – 2006. The continued reduction of threats from POPs and its improved management is the focus of a new regional initiative implemented by UNEP[18]. Medical or hospital wastes are also well monitored, regularly collected and properly disposed by incineration using a dedicated incinerator facility at Tafaigata, with a proposal for an incinerator for Savaii in the pipeline.

Beyond these, the management of hazardous chemicals has generally been an area of low priority. MNRE data shows petroleum chemicals as constituting 82% of all chemicals imported with pesticides, pharmaceuticals, and others comprising the rest. There has not been any systematic monitoring or assessment of pollution due to the use and storage of these chemicals, or their effects on humans and the biophysical environment.

The current emphasis on reinvigorating the agricultural sector is likely to result in the greater use of agricultural chemicals notwithstanding the declining trend in the use of agricultural chemicals in recent years[19] (SBS, 2009). Data on sanitation also points to a high level of inferior household sanitation facilities (~80% of all reported septic tanks are not 'true' septic tanks, according to the 2012 National Infrastructure Strategic Plan) that means the level of contaminants entering the soil is higher than previously thought, increasing the risk of contamination and pollution of underground water sources and coastal marine habitats.

The low priority given to waste recycling has implications other than resource sustainability and conservation. It also means that landfills' potential life spans are not optimized. The reported 57% of wastes received that are recyclable or compostable constitutes a significant volume that, recycled or composted, would save space and extend landfill's useful life spans significantly.

4.3 Atmospheric pollution and greenhouse gases

High levels of emission of greenhouse gases (GHG) is polluting our atmosphere and affecting both the quality of the air we breathe, and contributing to climate change and climate variability. Another atmospheric pollutant – collectively referred to as ozone depleting substances or ODS, is largely limited in Samoa to CFCs hydro-chlorofluorocarbons (for refrigeration and air-conditioning) and methyl bromide (a fumigant in quarantine and pre-shipment applications). However data published by the World Resources Institute (WRI) shows not only a decreasing trend for Oceania, but for Samoa, the level of consumption of HCFCs is effectively reduced to zero (WRI, http:/wri.org)[20].

[18] PAS Pacific POPs Release Reduction Through Improved Management of Solid and Hazardous Wastes.

[19] the percentage of farming holdings using agricultural chemicals fell from around 59% in 1989 to 50% in 2009 acording to the 2009 Agriculture Census.

[20] Cited by UNEP and SPREP. 2009. Pacific Environment and Climate Change Outlook. UNEP & SPREP.

Table 3: Consumption of ODS in Oceania and Samoa 2000 – 2007

Region/Country	2000	2001	2002	2003	2004	2005	2006	2007
Oceania	635*	486	490	346	254	238	124	144
Samoa	**1**	**2**	**3**	**0**	**0**	**0**	**0**	**0**

Source: World Resources Institute Cited by UNEP & SPREP, 2008). * = metric tons

Of GHGs, total emission increased by 113 percent from 1994 to 2007 with 27% and 25% from transport and livestock farming constituting 27% and 25% respectively, and electricity in fourth place with 12%[21]. The shift from Left hand to Right hand driving is reported to have increased the number of vehicles imported since 2007. There are also plans in the pipeline for recycling oil and other recyclables from used car tyres that will also add to the GHG emission equation.

4.4 Natural disasters

Samoa is prone to natural disasters and in particular cyclones, earthquakes and fires. Climate change and climate variability has exacerbated this vulnerability with future cyclones and other extreme weather events predicted to be more frequent and more intense.

Samoa's vulnerability is partly due to its geographic location (south of the equator) which is an area known for the frequent occurrence of tropical cyclones with damaging winds, rains and storm surge between the months of October and May (SPC-SOPAC, 2011)[22]. Cyclones within living memory include Cyclones, Ofa and Val (1990 and 1991), Heta (2004) and, recently, Evan (2012). All caused extensive damage to important terrestrial and marine habitats and species populations, as well as infrastructure, settlements and crops. In 2009, a devastating tsunami caused significant damage to public infrastructure and private property, and claimed 147 lives in villages along the southern coast of Upolu. Similar impacts were witnessed in Vaimauga I Sisifo and Safata as a result of floods that accompanied Cyclone Evan in 2012.

Samoa is also vulnerable to seismic events because of its proximity to the Pacific "ring of fire" which aligns with the boundaries of the tectonic plates. It's a seismically active region capable of generating large earthquakes and, in some cases, major tsunamis that can travel great distances (ibid.).

Following the 29th September 2009 tsunami, there has been an increased demand to improve understanding of the medium to long-term risks posed by tsunamis to better mitigate their impacts. The historical tsunami database for Samoa, which extends back to 1837, indicates that these islands have been impacted from all the major source regions of the Pacific Ring of Fire, some of them thousands of kilometres away (e.g. Chile/Peru and Alaska). Unfortunately, the historical database only extends back as far as 1837 (Pararas-Carayannis and Dong, 1980; Williams and Leavasa, 2006), and as such is extremely limited for our long-term understanding of these events in terms of distribution, frequency, and magnitude. (Williams, Goff, Sale, Ah Kau, Davies, Wilson, 2008[23]).

Box 1: Country Risk Profile: Samoa

- Samoa is expected to incur, on average, 10 million USD per year in losses due to earthquakes and tropical cyclones.
- In the next 50 years, Samoa has a 50% chance of experiencing a loss exceeding 130 million USD and casualties larger than 325 people, and a 10% chance of experiencing a loss exceeding 350 million USD and casualties larger than 560 people.

Source: SPC-SOPAC. Sept 2011.

Local efforts to better understand seismic events, as well as in their early detection and monitoring inevitably rely on technical expertise and capacities in regional organizations and in more developed countries. These include studies (William et al, ibid.) that will inform the development of a platform for identifying tsunamis within Samoa's recent geological past, and will enable the existing historical tsunami database to be extended beyond 1830 AD.

This will improve our understanding of the long-term recurrence and impact of tsunamis at different coastlines, and of coastal vulnerability and distribution of tsunami risk. Ultimately, the information yielded may be used to strengthen mitigation efforts and help reduce tsunami risk

[21] *Samoa 2nd Greenhouse Gas Inventory Report 2010*

[22] *SPC-SOPAC. September 2011. Country Risk Profile – Samoa. Pacific Catastrophe Risk Assessment and Financial Initiative.* SPC, Noumea.

[23] Williams, S.P., J. Goff, J. Ah Kau, F. Sale (2010). Samoa Palaeotsunami Investigation: Interim Report of Field Survey, 31 July – 20 August 2010; Prepared for the Ministry of Natural Resources and Environment, Government of Samoa. Miscellaneous Report, September 2010.

through mainstreaming into local hazard and disaster management plans. (Williams, Goff, Sale, Ah Kau, Davies, Wilson, 2008). Others include SPC-SOPAC's (op cit) country risk profile for Samoa which gave the following sombre predictions of likely events with estimates of losses (refer to Box 1).

As in previous cyclones, the impact on the biophysical environment will be severe degradation of terrestrial and marine habitats of high conservation value, loss of vegetation cover for critical catchment areas, loss of fauna populations including species that are already threatened, and the overall fragmentation to ecosystems that in and by itself, will diminish their ability to function optimally as ecological services providers.

The degradation caused by natural disasters also often creates conditions favourable to the spread of invasive species of vines and trees, and the irreversible loss of habitats and local species extinctions.

Table 4: Natural Disaster Record of Samoa 2004 - 2009

Date	Location	Type	Disaster Name	Killed	Affected	Estimated Damage US$
December 13, 2012		Tropical Cyclone	Evan	4 (not including 10 missing)	2088 households, in 164 villages , approx. 14,777 people (based on 2011 Census)	$480 million SAT ($210.7 million USD)
29 September 2009	Eastern and South Eastern Coast of Samoa	Tsunami	Tsunami	143 (excluding including 5 missing)	Approx. 5274 people, approx 685 households	Damage – SAT$211.96 (USD$84m) and losses – SAT98.16m (USD$39m)
8 – 16 September 2008	Asau and Aopo, Savaii	Bush fire	Asau and Aopo Bush fire	0	0	SAT$163,995.07
January 25, 2008	Apia	Flash flood	Apia flood	0	0	0
6 February 2006	Apia	Flash flood	Apia Flood	0	Approx. 20 – 30% of 38,836 population of Apia (2001 Census)	Approx. SAT$300,000.00
February 16, 2005	Savai'i and Upolu Islands	Tropical Cyclone	Olaf	0	0	0
January 05, 2004		Tropical Cyclone	Heta	1	30,000	500,000

Source: Based on information from Filomena Nelson, DSMO, MNRE, February 2013.

4.5 Unsustainable exploitation of resources

Unsustainable exploitation of resources will continue to add stress to Samoa's biophysical environment. It has already significantly altered the distribution and composition of Samoa's forests. It is also reported in fisheries and water resources.

The unsustainable exploitation of native forest resources for sawmilling and agriculture is well documented (Sesega, S. 2005). It is the result of a combination of factors including food production, cash income generation, expansion in settlements and land profiteering (ibid.). At present, the low volumes extracted in the few remaining logging activities[24] are indicative of the largely depleted nature of Samoa's native merchantable forests. Existing logging is small scale and centres around the salvaging of remnant trees in previously logged areas and in agricultural lands. In the foreseeable future, the low level of logging is not expected to be an important

[24] *Estimated at around 3,000 – 5000m3 per year*

environmental issue except where it may affect water catchment areas, areas prone to soil erosion, and habitats earmarked for conservation within approved Key Biodiversity Areas. There are also recurring reports of harvesting of mangroves in some communities for fuel.

In the fisheries sector, overfishing in the inshore area is a major issue that will continue to threaten the integrity and sustainability of coastal resources and coral reefs. The underlying drivers are the combined effect of population, the open access nature of coastal fisheries resources, and the increasing demands of an increasingly cash based lifestyle in rural communities. Recent statistics (MAF, 2011)[25] showed that 24.8% of households were engaged in fishing. Ah Leong et al (2009)[26] noted that 86% of all fishing is carried out in the reef area, with 42% of the average household containing at least one fisherman. The catch per unit effort has steadily increased, from 1.8kg/hr in 1990, to 2.1kg/hr in 1997 to 2.24kg/hr in 2007 (Valencia et al. 2007)[27] which Ah Leong et al (op cit.) noted as indicating overfishing.

Of Samoa's tuna resource, the total annual tuna catch is within sustainable levels (i.e. within the Maximum Sustainable Yield), but there is overfishing of larger and older albacore stock. Langer (op cit) attributes this to the combined effect of a high level of fishing effort from Samoa's domestic long lining fleet and a small and restricted EEZ. The result of both is a dwindling stock of large and older albacore as the natural process of stock diffusion and replenishment from neighbouring seas lags behind the rate of exploitation.

MAF (op cit) also observes that the growing practice of sending consignment of seafood as gifts to relatives' overseas ('fa'aoso') is a contributing factor.

With respect to water resources, SOPAC et al (2007) noted that there has been no national assessment on the stress put upon the individual catchments and aquifers but the available qualitative information, particularly for Vaisigano and Fuluasou Rivers, indicates that there is significant over-abstraction with between 65-80% of the surface water flow from these catchments used in water supply (ibid.).

4.6 Land based Pollution

The impact of land based activities on coastal resources is closely associated with the high population densities along coastal areas. Land reclamation, sand and scoria mining and road construction have also been known to destroy fish nursery areas. Similarly, poor land management has led to erosion and consequent siltation of lagoons (Tuivalalagi & Morrison, 2004[28]; Ah Leong et al, 2009; Mulipola, et al.).

A SMEC (2011)[29] study of Afulilo dam's impact on the Fagaloa Bay best demonstrates the impact of coastal pollution from land-based sources. The reservoir is an old peat swamp with rotting logs and biomass that were not removed during dam construction. The result is the high level of tannin in the water that passes through the powerhouse into the Fagaloa Bay, discolouring the bay and limiting the amount of sunlight received by corals, algae and seaweeds for photosynthesis. But SMEC (ibid) also found significant levels of orthophosphate (PO4)[30] and nitrates which exceed thresholds[31] internationally considered unacceptable for tropical coastal waters supporting a healthy coral ecosystem. Following an intensive 11 month monitoring program of the Bay, SMEC (ibid) concluded that the three most likely causes of the water quality degradation are:

- Enrichment with orthophosphate and nitrate from faulty sewage systems of the residences of the hundreds of families living within 100m of the shore;
- The unrestricted livestock foraging (1000s of pigs and many cattle) along the shore leaving tons of manure and highly disturbed ground behind;
- The switch to kava production on steep slopes (due to the loss of coconuts, as a result of Heta 2004), leaving tracts of very loose soils on the slopes at each harvest time—leading to large scale increases in sediment levels and turbidity.

The use of agricultural pesticides and chemical fertilizers is relatively widespread but the level of usage (volume) has fluctuated over the years since 1989, possibly corresponding to the relative state of agriculture between the pre-Taro Blight and post-Taro Blight years. This is depicted in Graph 1.

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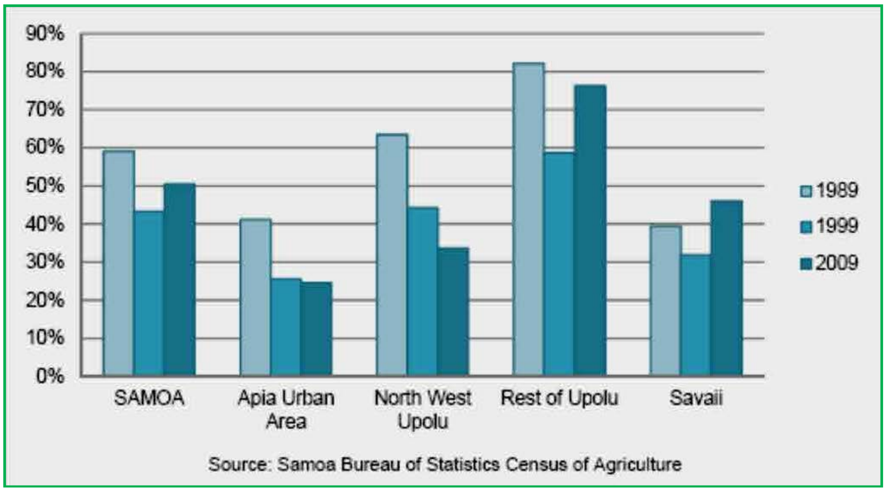
[25] Ministry of Agriculture and Fisheries. 2011. Agriculture Sector Plan 2011-2015.Vol 1. MAF Apia.
[26] Samuelu-Ah Leong, Joyce and Sapatu, Maria. 2008. Status of Reefs in Samoa 2007. In: Whippy-Morris (ed.). 2009. South-West Pacific Status of Coral Reefs Report 2007. Coral Reefs Initiative for the Pacific. SPREP, USP, GCRMN and ReefBase Pacific. SPREP, Apia.
[27] Cited by Ah Leong et al (2008).
[28] Tuivavalagi, N.S. & Morrison, J. 2004. Land based activities and impacts on coral reefs and the marine environment of Pacific Islands. In H.Yukishira (eds.), Towards the Desirable Future of Coral Reefs and the Western Pacific, 23-26 July 2003 (pp. 69-88). Palau PICRC.
[29] SMEC. April 2011. Preparing the Afulilo Environmental Enhancement Project. ADB TA: 7121 SAM. Phase 1 Final Report. SMEC International Pty Ltd..
[30] PO_4 combines with nitrogen stimulates algae growth and zooplanktons.
[31] The 0.03 mg/L standard used in Australia, New Zealand and in Carribean Islands

Graph 1: Proportional of Holdings Using Agricultural Chemicals



Statistics of chemicals imported show that the overall amount imported, and assumed used is relatively low. Concerns however are in usage within catchment areas and near surface water sources. Looking forward, the emphasis given in the SDS 2012-2016 and the Agriculture Sector Plan to re-invigorating the agriculture sector is likely to see an escalation in the use of a range of agricultural chemicals as the sector seeks to boost production with scaled-up semi-commercial and larger scale farming units.

4.7 Poor Sanitation

Poor sanitation resulting from the use of inferior household sanitation systems and practises contaminates underground water sources, pollutes and degrade coastal environments and poses a health threat to human populations from water borne diseases.

In Samoa, a high percentage of faulty septic tanks is highlighted in several reports suggesting that a high level of pathogens and nutrients end up in underground water bodies. Two recent independent studies confirmed this. Latu et al, (2012) tested water from village springs in three Upolu villages and found unacceptably high level of E.coli. SMEC's study of Fagaloa Bay (2010) also found similar correlations between the high number of unimproved and inferior sanitation systems and water quality, as well as the high level of pollutants and degradation of the inshore marine environment. Moreover, SMEC also postulates that wastes from free-ranging domestic animals especially pigs and cattle is a major contributor to the high level of pollution found in the Fagaloa Bay.

4.8 Poorly planned development activities

Despite efforts on the part of the Government to provide a framework within which all development activities are properly screened and vetted for environmental sustainability, many local initiatives and activities are occurring without proper vetting. Many are coastal in nature involving sand mining, coastal reclamations and constructions within hazardous zones. Many mangrove areas are destroyed to make way for construction, by waste dumping and for firewood. Water is abstracted without proper licenses and formal assessments. Cultivation in sensitive habitats including catchments, forests of high conservation value and on steep erosion-prone slopes is widely observed.

The larger issue is the lack of integrated land and resource use planning but it's a complicated issue with drivers including the land tenure system coming into play. However some positive developments and progress can be seen with the host of planning frameworks and guidelines now in place for regulating developmental initiatives. Prominent among these are PUMA's regulatory mechanisms as set out in the PUMA Act 2004, PUMA (EIA) Regulation 2006 and the Environment Code of Practice (2006). The PUMA legislation's requirement for the development of Sustainable Management Plans (SMPs) was recently tested using the Vaitele peri-urban area. District Coastal Infrastructure Management (CIM) Plans is a useful guide with specific recommendations to Government, private developers and communities for improving the resilience of coastal communities and developments.

PUMA's regulatory framework for Development Consent Applications (DCAs) framework is complimented and supported by similar permitting systems for regulating sand mining and coastal reclamation activities administered by the Land Management Division of MNRE, for underground water exploration and abstraction administered by the Water Resources Division. In agriculture, the pesticides registry lists approved agricultural chemicals that are safe and environmentally friendly for importation. MAF has also developed the technical capacity for matching crops to land use productivity to optimize land use and productivity and this advisory service is available to farmers to guide crop selection. Risk assessment procedures are in place for screening potential biosecurity threats posed by any imported living modified organisms.

Photo from the Vaisigano Flood of Dec 2012, Cyclone Evan: Report by MNRE & GHD Ltd

Tafitoala Bridge

5. INDICATORS FOR ASSESSMENT

Environmental indicators measure the state of and pressures on the environment. Properly used, they inform planners and managers of the state of health of specific aspects of the environment at specific points in time, enabling the tracking of changes and trends in environmental health. Good indicators are widely understood to have the following characteristics –

- 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.

Indicators for this SOE were developed and debated in a consultative workshop on the (date), May 2012. MNRE staff and technical staff from other agencies were grouped largely according to areas of expertise to identify and recommend indicators and metrics for different habitats. The full range of indicators discussed is appended. The use of specific indicators not only allows for better measurement of key aspects of the environment, but it also assisted in identifying the relevant information to target in information gathering.

In this SOE exercise, many indicators initially identified were not supported by the available data. Consequently, some indicators were culled with those supported by the available data used. In most cases, there are no baselines against which to measure 'change' and to assess trends, except those defined for the SDS 2012-2015 indicators. These have been used where appropriate.

As a result, assessment of condition and trends were made based on expert judgement where there is sufficient anecdotal evidence to make an informed assessment. Otherwise, the condition is described but no assessment is made using the selected indicator, or the trend is simply noted as 'Not known'. In the case of biodiversity, IUCN's assessments of conservation statuses and population trends for redlisted species are heavily relied on to validate findings from available information. In most cases, the IUCN's redlist classification and trend assessment is used.

One of the major challenges is to capture the degree of change that has taken place. In this report, categories of 'low', 'medium' and 'high' are used in a matrix to indicate how much of a positive change has taken place. Determining the break-point between 'low', 'medium' and 'high' is done subjectively in most cases where the quality of the data is poor. Most commonly, where triangulation is possible, the general consensus view is taken. Otherwise, it's a judgement call by the author or of relevant experts in the specific area being assessed.

In some reports, for instance, the coral and fish assessment by Kendall and Poti (2011), assessment of several datasets of Samoan corals, reefs and reef fish were combined and analysed together. To define the break-points between low, medium and high, a computer generated algorithm was used to make this determination.

The final list of indicators used in this report is given in the table below. Indicators for environmental sustainability reported in SDS 2012 – 2016 are also provided for comparisons.

Table 5: Indicators Used by Habitat Type

Habitat-type	Habitat	Indicators and metrics
Marine/Offshore habitats	Corals and reefs	Area coverage - % change in area coverage relative to baseline Abundance/biomass - % change in biomass relative to baseline Species richness – - no. of incidences of occurrences of species in sample population Coral community structure – - subjective assessment based on expert observation
	Fish	Abundance/Biomass - % change in biomass relative to baseline (MSY) Species richness - no. of incidences of occurrences of species in sample population

Coastal habitats	Mangroves	Area coverage – - Total area coverage - # of viable mangrove communities Species richness – - % of native species with viable populations
	Beaches	- volume (m^3) of sand approved for mining/year; - # of sand mining licences granted/year; - # of new beaches mined / year
Lowland habitats	Lowland forests	- % of lowland areas under forest cover - % of lowland forests dominated by non-native species - % of lowland forest areas affected by Merremia peltata vine - % of native bird/mammal species present
	Cultivated areas	- % of cultivated areas using inorganic fertilizers and agricultural chemicals - % of cultivated areas using organic fertilizers only - % of cultivated areas under multiple cropping systems
Upland habitats	Upland & Cloud forests	- % of upland areas under forest cover - % of upland forests dominated by non-native species - % of upland forest areas affected by Merremia peltata vine - % of native bird/mammals species present - % of native bird/mammal spp with increasing or stable populations
Built environment	Population	- annual growth rate less than 1.0% - population density in urban/ rural areas
	Waste	- % change in waste generation rate per capita per day relative to an established baseline; - % of hh waste reaching landfill relative to total waste generated - % total hh population accessible to public-funded waste collection system; - % increase in vol of solid waste recycled relative to baseline
	Sanitation	- % of hh with improved sanitation systems - % increase in households etc. using biogas digesters - % change in confirmed cases of diarrhea
	Environmental safeguards	- % of development consents issued over total application received - % of proposals modified on environmental grounds relative to annual total - % of proposals for DC declined on environmental grounds
	Energy	- % petroleum products imported - 10 - 20% in RE generation for consumption relative to total energy used. - % of improved energy efficiency and conservation implemented
Rivers and Streams	Water Quantity	- % change in average flow/discharge rates of rivers and streams - change in groundwater level - No. of perennial streams with minimum environmental flow requirements defined
	Water Quality	- % of village springs with *E.coli* count exceeding national standards - Turbidity - DO - pH - Trends in freshwater abundance/biomass

	Watershed health	- % of catchment areas with forest cover exceeding 70% of total catchment area - % increase in area (ha) of watersheds rehabilitated (fenced, planted and with human activities effectively controlled) - No. of watershed management plans approved and under implementation
Protected Areas	KBAs, parks and reserves	Area coverage - % of area designated as protected area with legal status - % of total KBAs with legal status - % of total KBAs with management plans.
	Species of high conservation value	- As per IUCN RedList categorization and assessment
Atmosphere Weather and Climate	GHGs	- Net GHG emitted (emission minus removals)
	Ecosystem based adaptation (NAPA etc implementation)	- # of climate adaptation and mitigation projects completed and under implementation
	ODS	- # compliance companies and technicians - 10% by 2015 (HCFC)

Table 6: Environmental Sustainability and Disaster Reduction Indicators from SDS 2012-2016

Goal 7: Environmental sustainability and Disaster Risk Reduction

Indicator/Target	Baseline Figure 2007/2008 (or earlier dated)	2008/09	2009/10	2010/11	Source
Percentage of land area covered by forest increases	90,444 ha (13%)	121,000 ha	171,000 ha	154,987 ha	MNRE
No. of trees provided under the community forestry programme increases	136,884	158,184	170,784	175,200	MNRE
Number and area of protected areas rises	120,840 ha (42%)	120,840 ha (42%)	120,840 ha (42%)	136,853 ha	MNRE
Percentage of power from renewable energy sources	42.1	36.2	43.0		EPC
Percentage of urban population with access to improved sanitation increases	91% in Apia urban area with flush septic (2006 Census) 834 households (10%)			1,457 households (82%)	MNRE
Percentage of population with access to treated water supply increases	22.4% (July 2004) 65% of SWA customers have access to treated water supply	65% of SWA customers have access to treated water supply	75% of SWA customers have access to treated water supply	80% of SWA customers have access to treated water supply	SWA
Percentage of development consents issued over total applications received	83%	97%	82%	98%	MNRE

6. STATES AND TRENDS

Figure 3: Samoa's conceptual diagram of its unique habitats and culture

Source: Tracey Saxby (Univ of Maryland) 2012 & MNRE SOE Working Group 2012.

Photo of Upland Savaii from the BIORAP Report 2012

6.1. UPLAND HABITATS

6.1.1. Upland and Cloud Forests

The upland and cloud forests of Samoa that lies above elevation of 600m asl, and covers a total area of 65,380 ha with 49,038 ha (17%) in Savaii and 16,342 ha (6%) in Upolu. The Upland and Cloud forests were last assessed by Schuster et al 1999. There have not been any further studies since, until the 2012 BioRAP survey.

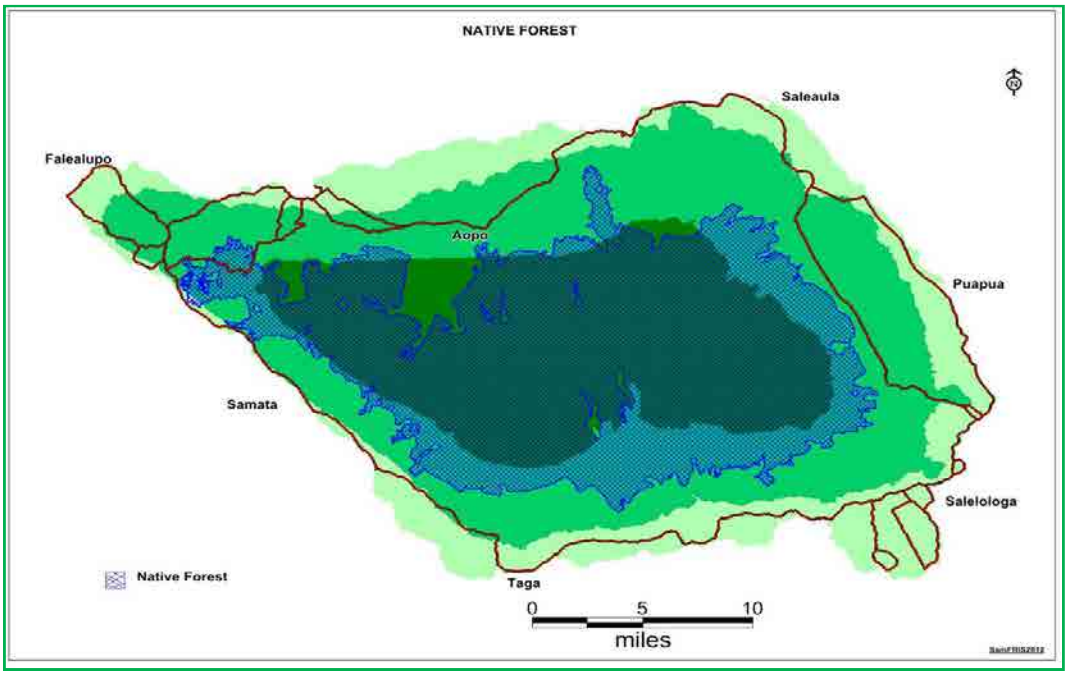
MNRE's forest cover analysis based on 2004 data provided the following breakdown between native and non-native forests on both Upolu and Savaii. It is understood that this area is largely unchanged to date.

Table 7: Upland and Cloud forests in Upolu and Savaii (elevation of 600 m and above)

	Native Forests		Non-native forests		Total forested area		Non-forested areas	TOTAL AREA
	% (a)	ha	% (a)	ha	% (a)	ha	ha	ha
Savaii	91.2	49,038	8.8	4,732	100	53,770	0	53,770
Upolu	0	0	99.0	11,489	99.0	11,489	121	11,610
Samoa	75	49,038	0.23%	16,221	99.8%	65,259	121	65,380

Source: MNRE 2012. Note: (a) = as a percentage of each island's total area

Map 3: Distribution of native forests in Savaii



Source: MNRE (2012)

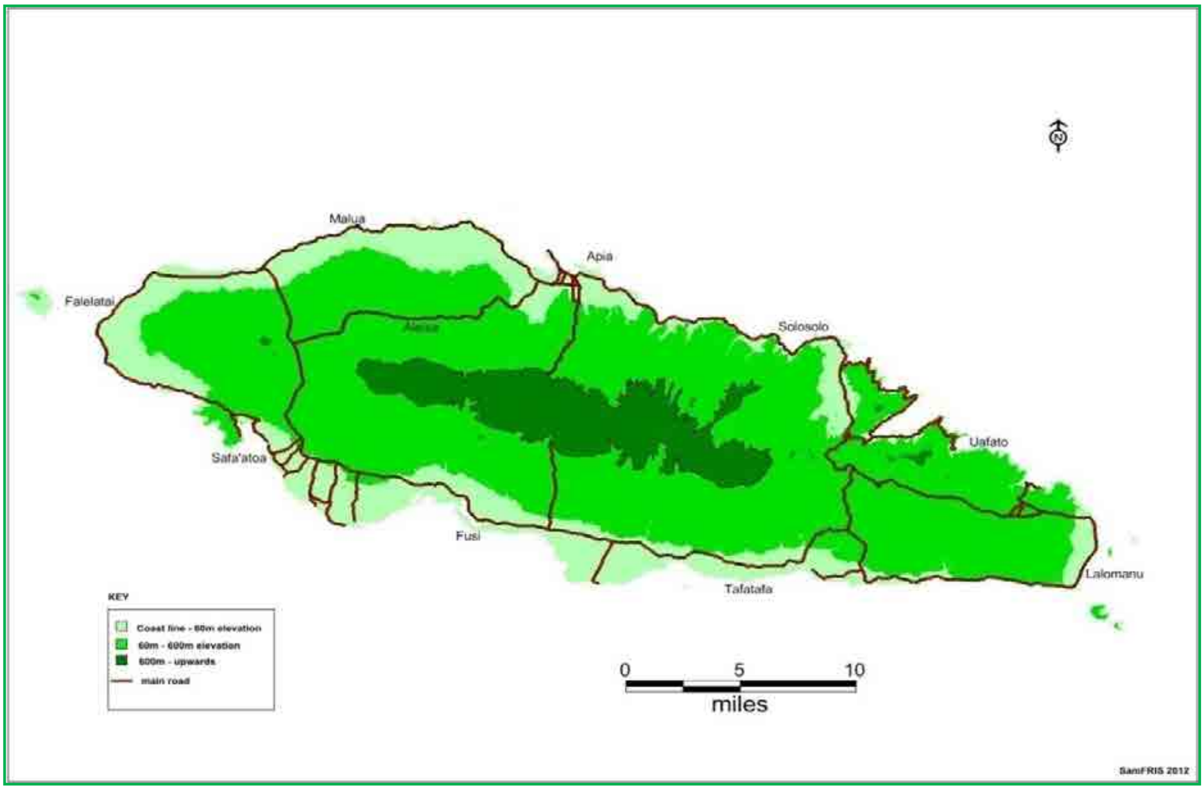
The upland and cloud forests conditions was last described by Schuster et al (op cit), coming not long after Cyclones Ofa and Valerie in the early 1990's, as follows -

"The whole country was heavily damaged by the two recent cyclones, with northern Savaii and Upolu suffering the most damage. At the higher elevations of Savaii, where there is no additional human interference, the forests are recovering. At the lower elevations, such as the foothills and montane forests at Salega, Safune and Gagaifomauga, and Asau, where there has been additional damage due to forest cutting, they are recovering more slowly.

The BIORAP (Biological Rapid Assessment Program) survey conducted by SPREP, Conservation International Pacific Islands Program (CI), MNRE and with technical assistance from its development partners (Critical Ecosystem Partnership Fund/CEPF; Birdlife Pacific partnership, New Zealand Department of Conservation/ DOC;

United States Geological Survey/USGS) in May 2012 provided some key data and observations in particular to the forests and biodiversity of upland Savaii.

Map 4: Distribution of native forests on Upolu



Source: MNRE (2012)

On Upolu, the damage to the montane forests is much more extensive. No montane sites (those above 600m) were found that either have good forests or are clearly on their way to recovery (although Solosolo and Sauniatu had fairly intact lowland forests). This is largely because of direct and indirect human interference. The area of central Upolu between Tafuaupolu and Lepue has been extensively cut in recent years. The vegetation is now largely dominated by several aggressive introduced species that thrive in this disturbed habitat. The worst three of these introduced species are the African rubber tree, Koster's curse, and night-blooming cestrum. The latter species is particularly damaging to the Lepue area" (ibid. p: 9).

Current Status -
Available information from MNRE shows that the upland and cloud forests in Savaii are largely free of human activities including cultivation. There is limited access to the top of Mt Silisili in Savaii and mainly used by visiting tourists and scientists and possibly bird hunters.

The BIORAP survey analysis assessment (2012) was not available at the time for the review, however, the MNRE forest cover analysis in Table 7, is used based on 2004 data. Expert assessment (J.Atherton, 2012) and anecdotal observations, however, suggest that not much has changed in area coverage with losses due to limited logging and clearing compensated for by previously cleared areas reverting back to forests as agricultural activities decreased during the last 20 years. On this basis, the following observations can be made –

1. The combined upland areas of Upolu and Savaii are well vegetated with 99% forest cover assessed; with Savaii fully covered (100% and Upolu having 75% coverage.
2. Most of the upland forests of Savaii (91%) are of native species while the upland forests of Upolu are now virtually all non-native (99%).
3. The Upolu upland forest is, as a result, less diverse in terms of flora and fauna species. This also means it is less ecologically stable.

Like the lowland forests, while there is good area coverage to maintain ecological functions of water storage, soil stability, microclimate variations etc., forest quality in terms of native species richness has degraded, particularly in Upolu. The lack of forest biomass (density) data limits the assessment in terms of forest quality but it is likely that density has decreased in Upolu where non-native species are dominant.

There is no specific information on whether *Merremia* has extended its spread to upland forests but this is highly likely in the non-native Upland forests of Upolu.

6.1.2 Overall Assessment -

Upland and Cloud Forests Health indicators	Low	Medium	High	Very High	Trend	Comment
% of forest area coverage is high			✓		→	.
forest density/biomass is high					Not known	No information.
% of area under non-native species is low			✓		↑	High due to 100% coverage of Upolu.
% of area affected by *Merremia* and other vine species is low.		✓			↑	*Merremia spp* affects about 24% of all forests in Samoa.

The BIORAP survey which was carried out by a team of experts (locals and internationals) provided the following status as noted in the Rapid Assessment of Upland Savaii Report;

Due to the rare ecosystems, the threatened terrestrial species in the upland and its natural values, the upland area above 800 m elevation should be given some form of official protection and for the forests to be managed sustainably in a way that puts conservation as a priority. In addition to conserving the upland forests, emphasis should also be placed on the conservation of adjacent lowland forests, especially for birds and flying foxes which make daily and seasonal movements between the two areas following the flowering and fruiting of different trees. Although the upland area is remote and infrequently visited, the construction of the Mata o le Afi road shows how threats from invasive species, logging and habitat degradation can escalate very rapidly.

The report confirmed five plant communities to exist in the area: montane forest, cloud forest, volcanic scrub, and Carex bog, and perhaps Pandanus swamp forest. Most of the area above 1,000 m elevation is montane forest, followed in total area by cloud forest. From the data and observations, it appears that the vegetation is very healthy and that it has recovered from damage inflicted by two severe cyclones that hit two decades ago (Val and Ofa), and the forest is returning to its "natural" state. Only 17 alien species were recorded in the area, most of them occurring along the bulldozed track. Of these, only Clidemia hirta and Mikania micrantha (fue saina) invade native (secondary) forest as weeds, but were not found above 1,300 m elevation. The montane forest is in very good shape, with the worst threat being unauthorized roads being established in the area.

Montane forest blends into cloud forest, with the main difference being perhaps the dominance of Reynoldsia pleiosperma (vī vao) in the latter. Montane forest probably has the most diverse flora of any community of Samoa. It is home to more species of trees, lianas, ferns, and orchids than any other vegetation type in Samoa.

The cloud forest community is found at the highest elevation on Savai'i. It imperceptibly blends into montane forest at its lower boundary, which, based upon the data and delineation of the vegetation communities during the present study, can be placed at about 1,500 m elevation. During the daytime, the upper slopes of the island are usually cloaked in clouds. The warm, moist trade winds ascend the mountains and cool down, causing the condensation of water into clouds and rain, making the climate of the cloud forest decidedly cool and damp.

The cloud forest is virtually untouched by man because it is too remote, too wet, and too cool to be used by the villagers. The only visitors are the occasional pig hunters.

Key biological findings:

- The geological diversity caused by many episodes of volcanic activity has promoted a rich pattern of biodiversity in the landscape.
- Many plants, birds, insects and snails have an ancient association with the Samoan islands and have their stronghold in Savai'i's montane and cloud forests.
- Many moths and snails documented in this survey are examples that are unique and new to science.
- Invasive plants and insects typically impacting islands elsewhere in the Pacific are mostly not found in the upland forests and measures to limit their spread are possible.
- Wild cats, rats and pigs have penetrated some remote higher altitude areas with impacts on birdlife and native vegetation but natural values still persist and active management could conserve these values.

Based upon the BIORAP field study, several recommendations were noted from the report.

a. Extend the montane Savai'i botanical survey - More botanical surveys and more plots are needed to give a more complete picture of Upland Savai'i.

b. Enforce existing laws - Laws are in place to regulate timber cutting in Samoa. However, logging still occurs on Savai'i despite the absence of logging permits. It is sometimes difficult to reconcile differences of opinion between local land owners and the government, making protection of the native forests problematic. Although laws are on the books, they are often not enforced. The bulldozer road up to Mata o le Afi is illegal and potentially devastating to the area, as it opens up an avenue for the introduction of new weeds to the area. The road is the biggest threat to the integrity of Upland Savai'i.

c. Protection of the whole area - The whole upland area above 800 m elevation or lower should be given official protection. This is a very difficult goal, because the villagers around the island are unaware of how important the area is as a watershed and for its biodiversity. The island of Savai'i has been rated as the 23rd most important island in the South Pacific in terms of its conservation value. The area is remote and infrequently visited, so the biggest threat is the currently existing (but deteriorating) road and future plantation roads. With new roads comes logging and the establishment of temporary plantations, leading to irreparable harm to the environment.

d. Education - The importance of Upland Savai'i for its biodiversity and watershed value should be the focus of an education program in schools and to the public. The MNRE should embark on a programme that highlights the great importance of the upland area of the island.

e. Flora of Samoa - The flora should go along with a biodiversity survey of Samoa's forests because just knowing what plants occur in Samoa is not enough. Their range in Samoa and possibly rarity should also be known.

6.1.3 General Recommendations

1. MNRE should invest in a new aerial photography exercise to update its outdated data sets on forest coverage.

2. Ecological studies and surveys recommended by the recent BioRAP report should be supported.
   - ✓ Conserve the upland and adjacent lowland forests
   - ✓ Raise awareness on and enforce environmental laws
   - ✓ Manage the threat to the upland forests from invasive species
   - ✓ Manage ecotourism to the upland forests sustainably
   - ✓ Improve knowledge of the ecology and biodiversity of the upland forest
   - ✓ Implement management regimes for highly threatened species

3. Avoid and discourage at all cost the construction of access track to the Savaii Upland Forest.

Track road along the Mata o le Afi @ 1520 meters above sea level, Photo from BIORAP Survey

6.2. LOWLAND HABITATS

The lowland habitat includes all terrestrial areas between elevation 60m and 600m, It includes 48% of Savaii (80,930 ha) and 69% of Upolu (73,460 ha) (MNRE, 2012). Combined, the lowland area includes 154,390 ha or 56% of Samoa's total land area.

The state of health of Samoa's lowland zone is examined within the two dominant habitat types namely, (i) cultivated areas and (ii) lowland forests.

6.2.1. Cultivated areas

The impact of cultivation on the environment varies widely based on the types of agricultural practices used. Agriculture in Samoa continues to evolve from purely subsistence to semi subsistence and commercialization, due to the demands on a growing population, the continuing shift to a cash-based economy, and technologies. The current Strategy for the Development of Samoa (SDS) 2012-2016 and the Agriculture Sector Plan (ASP) 2012-2016 clearly sets out goals and strategies for the re-invigoration of the agricultural sector both for local food security and for exports. Scaling up from subsistence to semi-commercial and larger scale production, with increased mechanisation and use of modern technologies clearly envisions the transformation of all cultivable lands to crops. Efforts to promote mechanisation are already underway with MAFF hiring out excavators to assist farmers clear rocks and other debris that hinder the use of machines.

The risk of adverse impacts of agriculture on the environment is well recognized and both the SDS and ASP call for appropriate mitigation measures to ensure environmental sustainability.

The main environmental impacts from cultivation are (i) the threats to sensitive environments including habitats of high conservation value and catchment areas; (ii) excessive use of inorganic fertilizers and chemicals, (iii) the loss of ecological stability as a result of large scale mono cropping. There are implications for climate change and greenhouse gas emissions of increases in land conversion and increase in livestock populations. Similarly there are adverse impacts on coastal environments and underground water sources of the free-roaming approach to the management of domestic pigs.

Current Status -

The Agriculture Census 2009 reported a total area under cultivation of 92,310 acres representing 13% of Samoa's total land area of 2,841 km^2 (MAF, 2012). FAO (2004) provided this distribution (Refer to Table 8) by various cropping types and land uses.

Table 8: Land Use Distribution

	%	ha	Comments
Plantation crops (sole)	18.6	53,000	
Mixed cropping	3.6	10,000	
Grasslands	6.2	17,500	
Forests	68.0	192,000	
Others	3.2	10,800	Includes urban areas

Source: FAO cited by MAF 2012[32]

There is however no disaggregated data by habitat types used in this SOE. As a result, it is not possible to determine the impacts of cultivation activities on different habitats.

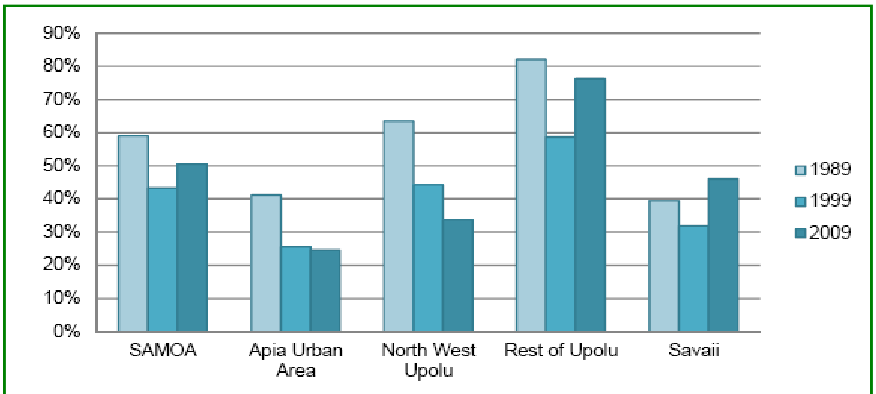
Are current cultivation practises environmentally sustainable? The lack of data limits the scope of investigation possible, but a partial answer to this question may be discerned by examining the following indicators –

a. the extent to which cultivation uses inorganic fertilizers and agricultural chemicals
b. the relative area coverage between more ecologically stable mixed cropping systems and mono-cropping arrangements, and
c. the amount of cultivation on erosion prone lands including steep slopes and catchment areas;
d. the types of cultivation and farming methods used.

According to MAF & SBS (2012), the use of organic fertilizers consistently increased throughout all regions of Samoa between 1999 and 2009, increasing from 15% of all holdings to 29%. Prior to that, there was little change between 1989 and 1999 for Savaii, but Upolu showed some fluctuations dropping to 13% in 1989 before increasing to 24% of holdings.

[32] *Ministry of Agriculture (MAF) and Samoa Bureau of Statistics. 2012. Agricultural Census Analytical Report 2009. Economic Statistics Division, SBS.*

Graph 2: Use of Organic fertilizers (compost)

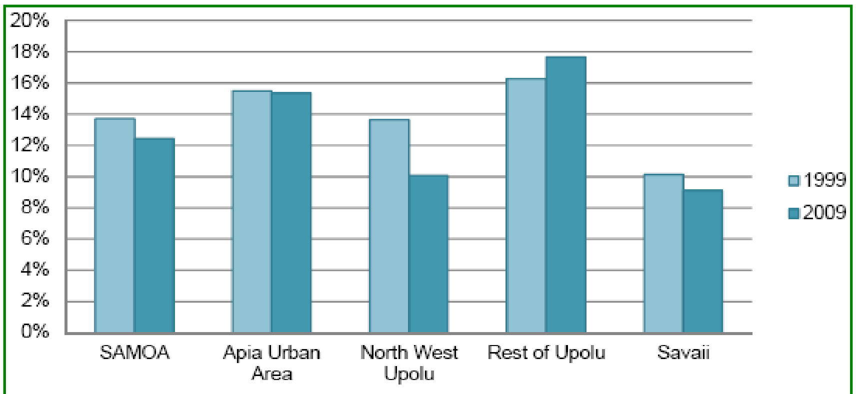


Source: Samoa Bureau of Statistics Census of Agriculture

The overall level of organic fertilizer use in Samoan agriculture in 2009 is around 50% of all farm holdings, having decreased from around 59% in 1989 to around 42% in 1999. Northeast and Southern Upolu (Rest of Upolu) appears to have the highest use of organic fertilizer use with over 75% of all holdings using compost, slightly down from over 80% in 1989.

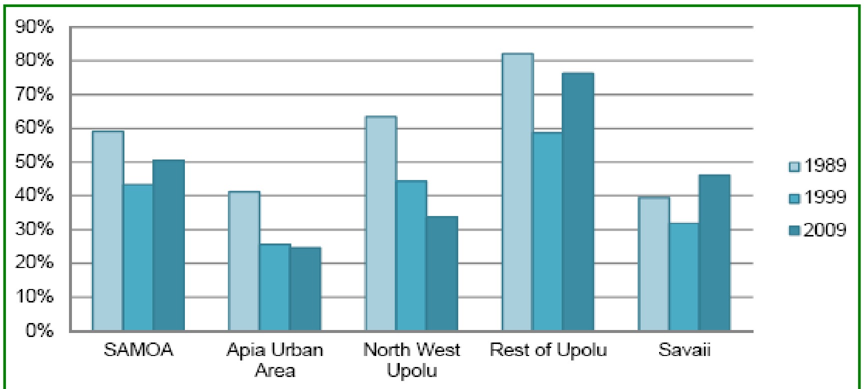
Of inorganic fertilizers, their use has generally declined in the last 10 years. This is depicted in Graph 3 below.

Graph 3: Percentage of farm holdings using inorganic fertilizers



Source: Samoa Bureau of Statistics Census of Agriculture

Graph 4: Proportion of farm holdings using agricultural chemicals



Source: Samoa Bureau of Statistics Census of Agriculture

The fluctuations in the use of agricultural chemicals over the last thirty years appear to correlate to the ups and downs in commercial taro production, before and after the Taro Leaf Blight. It is possible that the increase in 2009 will continue with the present sector emphasis on reviving agriculture.

It is difficult to assess the environmental impacts of agro-chemical use except for specific locations and uses. On a general scale, the total volume of agro-chemicals imported is relatively limited. (refer to Table 9 below).

Sector plans now being mobilized to reinvigorate the agricultural sector is likely to also lead to a significant increase in the use of agro-chemicals. This concern is well recognized in the Agriculture Sector Plan 2011-2015 which calls for the use of environmentally friendly production and farming systems especially within watershed areas from affecting water supplies. The larger issue here is the need for an integrated land use plan wherein all legitimate land uses are taken into consideration, to ensure the legitimate needs for agriculture, water resources management, biodiversity conservation and many others are properly coordinated and integrated.

Table 9: Chemical Categories by Use, 2009

Chemical Category	Production	Volume (kilolitres*/tonnes)	Estimated value (ST)	% of total cost
Petroleum	None	88,580 k/litres	117M	82%
Consumer	None	1,640 tonnes	10M	6%
Pharmaceuticals	None	Unknown	7M	5%
Industrial	None	800 tonnes	7M	5%
Pesticides	None	50 tonnes	2M	2%
Fertilizers	None	50 tonnes	100,000	<0.1%
Other Chemicals	None	Unknown	60,000	<0.1%

Table 10: Types of agricultural chemicals used

	Herbicides			Insecticides	Fungicides
	Total	Sting	Gramoxone/ Paraquat	Total	Total
SAMOA	50%	13%	30%	0.9%	0.4%
Upolu	52%	13%	31%	1.1%	0.4%
Apia Urban Area	22%	11%	9%	2.8%	1.8%
North West Upolu	33%	12%	18%	1.3%	0.1%
Rest of Upolu	76%	14%	48%	0.6%	0.4%
Savaii	46%	12%	29%	0.4%	0.3%

Source: Samoa Bureau of Statistics Census of Agriculture

Assessment of Cultivated Areas

Cultivated Areas Health indicators	Low	Medium	High	Trend	Comment
% of agricultural holdings using organic fertilizers		✓		↑	
% of agricultural holdings inorganic fertilizers		✓		No information	Trend likely to increase with expected expansion of cultivated area
% of holdings of mixed cropping		✓		No information	
% increase in volume of pesticides and fertilizers used	✓			→	Trend likely to increase with current efforts to re-invigorate the agricultural sector.
% increase in cultivations on catchment areas				?	No information available.
% increase in cultivation in sensitive ecosystems and protected areas				?	No information available.

6.2.2. Lowland forests

Available data for Samoa's forests is dated to 2004. No recent data has been generated since. However expert opinion (J. Atherton, 2012) is that very little has changed in terms of the total forest area coverage. This observation is consistent with trends in three main factors that were influential in shaping the remaining forests of Samoa, (i) the decrease in the total area of land under cultivation since 1989[33]; (ii) the end of large scale commercial forest logging and (iii) the absence of any cyclones since Cyclone Heta in 2004.

Logging, agricultural clearing residential clearing, relocation due to tsunami, rising sea level and cyclones caused extensive damage and fragmentation to the once dense native forests, opening up the undergrowth to sunlight and creating conditions that favour, and were taken advantage of, by wind dispersed, light demanding and fast growing pioneer species, most of them non-native and invasive. Most prolific and common among these invaders are tamaligi spp (*Albizzia falcataria and Albizia chinensis*), Pulu vao (*Funtumia elastica*), Pulu mamoe (*Castilla elastica*), fa'apasi (*Spathodea campanulate*), and a host of others. The same open conditions are also conducive to the spread of highly invasive vines notably fue lautetele (*Merremia peltata*) and fue saina (*Mikania micrantha*). These species quickly outnumber remnant native trees, dominating the canopy layer and the undergrowth. And while the process of ecological succession will eventually result in the replacement of short term pioneers by long term shade tolerant species, mostly natives, this is not guaranteed if more cyclones breaks this cycle before it has climaxed, returning it to the open spaces and in the process, perpetuating the dominance of light demanding pioneers.

This phenomenon is presently being played out in Samoa's remaining forests in all areas including lowlands. So much so, latest analyses now categorize the entire lowland forests as 'non-native'. This categorisation means while there are native species present, it is now largely dominated by non-native species. MNRE[34] analysed forests by forest types and came up with the following results -

Table 11: Lowland forest cover in Upolu and Savaii (60 – 600m elevation)

Lowland forest cover in Upolu and Savaii (60 – 600m elevation)

	Native Forests		Non-native forests		Total forested area		Non-forested areas	TOTAL AREA
	% (a)	ha	% (a)	ha	% (a)	ha	ha	ha
Savaii	0.08	146	48	80,784	48.08	80,930	0	80,930
Upolu	0	0	69	73,460	69.0	73,460	200	73,660
Samoa		146		154,190		154,190	200	154,390

The main change therefore in the character of Samoa's remaining lowland forests is its composition. From a biodiversity conservation perspective, the new non-native dominated forests are of low quality. The old stands of secondary forests were relatively stable because of its multilayered structure hosting complex interdependent and

[33] *From 166,485 acres in 1989 to 92,310 acres in 2009 (SBS, cited by MAFs Agricultural Census Report 2009.*
[34] *New maps of forest cover based on 2004 data.*

symbiotic interrelationships between flora and fauna species, which diversity ensured ecological stability. Such include native birds that depend on specific fruit trees for food and epiphytes that live off large dominant canopy species, fruit trees that depend on specific bird species for seed processing and dispersal, sometimes ferns that found niches in the shady but cool understorey and many others.

The lowlands of both Savaii and Upolu now comprise of only 0.08% and 0% of native forests respectively. In terms of the whole country, 54% of Samoa's lowlands are forested albeit with non-native trees. Compounding the degradation of lowland forests, the recent BioRAP survey estimates that "…perhaps 50% of the remaining lowland native forest is dominated by *Merremia* vines (fue lautetele)." The prolific nature of *Merremia* suggests that this is a worsening problem, with expansion into more forests to be expected.

There is no data relating to biomass but in general, young secondary forests of non-native species now dominating lowland areas are less diverse and less dense, therefore of lesser biomass than the old secondary forests they replaced.

Assessment

Lowland Forests Health indicators	Low	Medium	High	Trend	Comment
% of lowland habitats under forest cover			✓	→	54% total for Samoa; 48% Savaii; 69% Upolu.
% of lowland forests dominated by non-native species				↑	About 100% of both Upolu and Savaii lowland areas are of non-natives.
% of area affected by Merremia and other vine species.		✓		↑	*Merremia spp* affectes about 24% of all forests in Samoa.
% of native bird species present				No information	

6.2.3. Overall assessment of Lowland Habitats

The two main habitats assessed in the lowland region namely cultivated areas and lowland forests can only be assessed qualitatively given the lack of scientific data.

Current cultivation practices are relatively sustainable. They are irrigation-free, have a relatively high usage of organic fertilizers and are generally low impact due to their small scale holdings and the use of traditional and simple tools including machetes and chainsaw for land clearing. Being irrigation-free, there is no dependent on underground or surface water sources that normally put stress on underground aquifers and rivers. The traditional cropping system wherein trees and crops are mixed in a traditional form of permaculture or agroforestry design is ecologically more stable.

The volume and types of imported agricultural chemicals are properly regulated. This is not likely to pose issues except where they are used excessively in sensitive ecosystems or near rivers and streams. These concerns are recognized and taken on board in the current Agriculture Sector Plan.

The spread of cultivation areas is a concern, particularly where it threatens sensitive environments including catchment areas, erosion-prone areas and areas earmarked by KBAs for conservation. It calls for proper coordination between sectors but it's a complex issue where customary land tenure interests are involved.

Lowland forests are widespread. There is high area coverage but the quality of non-native dominated forests is low in biodiversity conservation terms. Species richness and diversity will decline as non-native species become more dominant. Biomass is likely to be lower in these non-native dominated forests although there is no quantitative data to support that observation. The spread of *Merremia spp* and other invasive vines is a serious concern from an ecosystem health and biodiversity conservation perspective. They are difficult and costly to contain, and will therefore most likely to continue to expand in the foreseeable future.

6.2.4. General Recommendations

1. Close coordination and collaboration with MAF is needed to ensure planned expansion in agriculture does not impact negatively on sensitive habitats including catchment areas, riparian strips, steep slopes prone to erosion and slips and areas earmarked for biodiversity conservation.

2. Mixed cropping systems should be encouraged in the place of large scale monocultures as agriculture seeks to expand into larger holdings and mechanised agriculture for increased production.

3. Data gathering is needed including mapping data to enable future assessment of the environmental impacts of agriculture on the environment.

4. Replanting of native species of trees should be encourage nation-wide to stem the increasing spread and dominance of non-native trees in Samoa's forests.

5. Effort should be made to contain the spread of invasive vines especially Merremia peltata. These measures should also be incorporated into management plans for national parks, KBAs and catchment areas.

National replanting events at the Togitogiga National Park with schools, 2009/ Photo by MNRE

Widespread of the Merremia vine in the lowlands

6.3. COASTAL HABITATS

Samoa's coastal environment is defined in this SOE are "all areas from the high water mark to 60 meters in elevation including mangroves, marshes and coastal strand vegetation." It encompasses the coastal and nearshore ecosystems that are significant in terms of resources that Samoa depends on for their livelihood, recreation and for tourism development. These ecosystems are the most heavily impacted and are the most susceptible to changes by natural and human activities (McLean 1991 cited by SPREP 1994)[35].

The following ecosystems and habitats are examined and assessed –

- Mangroves and wetlands
- Coastal Strand Vegetation
- Coastal marshes
- Beaches
- Cultivated areas and
- Forests

6.3.1. Mangroves

Mangroves are unique ecosystems that live halfway between the land and the sea. There are over 80 known species worldwide, of which three are found in Samoa. These are *Rhizophora samoensis* (Red mangrove), *Bruguiera gymnorrhiza* (Oriental mangrove) and *Xylocarpus moluccensis (grantum).* The latter is extremely rare and is found in only one location (2 acres in size) in Siutu Salailua in Savaii.

The total area of mangroves has been variously estimated – Zann (1991)[36] estimated 1,250 ha and Bell (1985)[37] 1,000 ha. Its distribution is confined mainly to Upolu and Savaii, often along sheltered coastlines where sediments deposit, such as river estuaries.

Despite the relatively small area covered by mangroves, the Vaiusu Mangal near Apia is considered the largest mangrove area in Eastern Polynesia. The Vaiusu Bay and Saanapu-Sataoa mangrove stands are the two main mangrove stands in Samoa, with a number of other stands scattered throughout the two main Islands.

Mangroves form a very productive ecosystem playing an important ecological role as nursery grounds and as a physical habitat for a wide variety of vertebrates and invertebrates. In addition, they recycle nutrients, and maintain the nutrient mass balance of estuarine ecosystems. Mangrove leaves, wood, roots, and detritus material provide essential food chain resources and habitat to a wide variety of wildlife. They also serve as storm buffers, and their roots stabilize shorelines and filter sediments from rivers, enhancing water clarity.

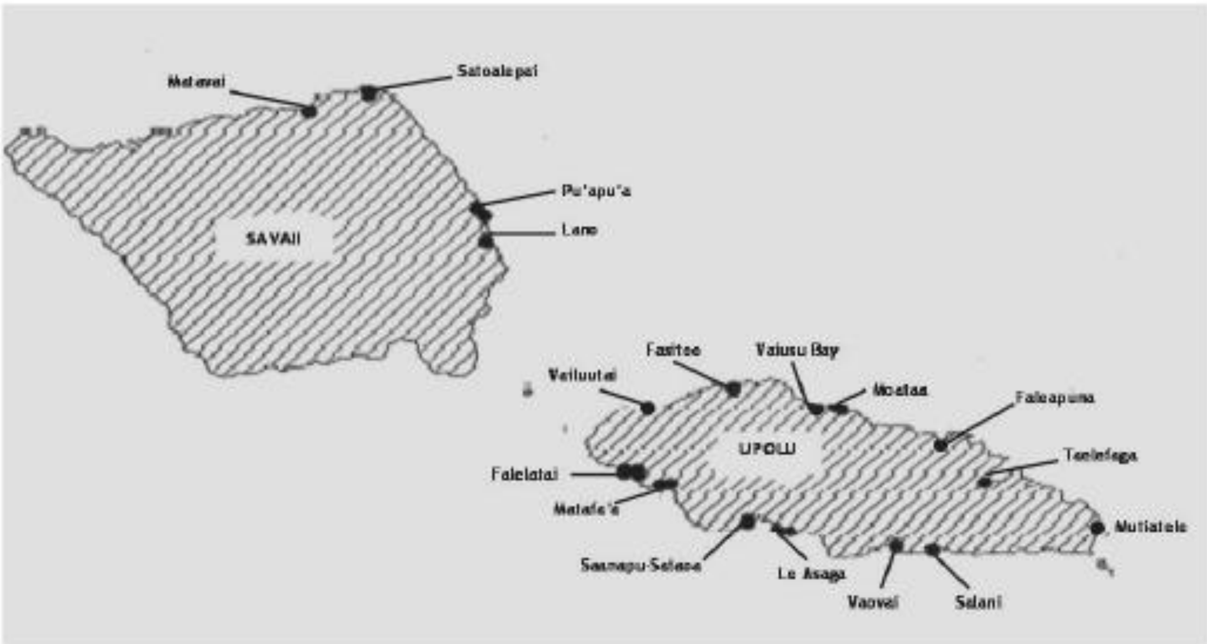
Significantly, mangrove areas provide shelter for many marine fauna species including a diversity of fish species, crabs, shellfish, seabirds and others, and nursery grounds for important fish species such as eels, mullets and trevallies. These species breed and spend most of their juvenile life stages in the safety of the mangrove root systems. Here they are provided with food and protected from the big predators, moving back into the seas only when they mature. Other animals include shrimps, prawns, mangrove crabs and certain bivalve species which live in the muddy areas, while oysters grow up the mangrove roots. Several bird species known to utilise mangrove habitats include the Pacific Reef Heron, and Golden Plover.

Photo 1: The tallest remaining Bruguiera trees in the Matafa'a mangrove forest. Source: Mataese & Saifaleupolu (2011). Photo by © Fiu Mata'ese Elisara, OLSSI.

[35] SPREP. 1994. Assessment of coastal vulnerability and resilience to sea-level rise and climate change: case study-Yasawa Islands, Phase II. South Pacific Regional Environment Programme, Apia.

[36] Cited by Lopeti, E and T.Foliga. undated. Samoa Country Report. MNRE/MAF-Fisheries. Unpublished report.
[37] Iakopo. M. 2006. Mangroves of Samoa: Status and Conservation. Ministry of Natural Resources, Environment and Meteorology, Samoa. 40pp.

Map 5: Distribution of mangrove forests in Samoa



Source: M. Iakopo. 2006.

Current State

Assessments of Samoa's mangrove forests are in progress under the MESCAL project. Under this project, a number of new mangrove areas previously unreported have been found (M. Momoemausu, pers com, 2012) and in some areas, existing stands have expanded with young seedlings colonizing surrounding areas including seawalls (ibid.). As a result, the existing mangrove areas is estimated to be larger than previously estimated by Zann (10,250ha; op it) and Bell's (10,000; op cit), even taking into account losses due to anthropogenic activities.

Elisara and Saifaleupolu (2011[38]) conducted a biodiversity audit of five mangrove areas[39] and reported some areas in better condition (e.g. Faleseela-Matafa'a) than others (Taelefaga and Tiavea). The main threats identified in this report are summarized in Table 12 below.

Table 12: Mangrove Crabs and Threats

Main Threats	Mangrove areas assessed			
	Matafa'a-Faleseela	Taelefaga	Tiavea-tai	Siutu-Salailua
Wood harvesting	✓	✓		
Invasive species				
Agriculture	✓	✓		
Grazing		✓		
Dwellings		✓		
Infrastructure		✓		
Natural disasters		✓	✓	
Coastal surges/ Climate Change	✓			✓

Source: Based on Saifaleupolu and Elisara (2011) op cit.

The only known stand of *Xylocarpus moluccensis* (Schuster, 1993) - located in Siutu Salailua - remains in a healthy state with no sign of threats from human activities (Elisara et al, 2011). But there are natural changes to its habitat with areas previously described to be dried swamp now observed to be inundated and under seawater (Elisara and Saifaleupolu, op cit). Whether or not these changes are seasonal, or detrimental to the health of

[38] *Saifaleupolu, T.S. and Elisara, FM. 2011. Biodiversity Audits for the Mangrove Stands in Matafaa-Faleseela, Tiavea-tai and Taelefaga Villages. Unpubl. OLSSInc.*
[39] *Tiavea-tai, Matafa'a, Faleseela, Taelefaga and Siutu-Salailua.*

X.moluccensis remain to be seen. An area of 2.0 acres remains, which is slightly less than the 2.5 acres reported in 1993 by Schuster (op cit).

The likely increase in the total area under mangrove (Momoemausu, pers com) is good news, however, the fact remains that mangrove forests are continually lost (MNRE, 2006), as a result of number of factors including land reclamation, waste disposal and harvesting for firewood and building materials.

Overall, from a species conservation perspective, *Rhyzophora* and *Bruguiera spp* have healthy viable populations based on existing reports of biomass and coverage. Their greater value however is the critical role they plays in the lifecycles of many marine and estuarine species, and the protection function it provides for fragile coastal ecosystems against wave surges, winds and erosive currents.

The severely limited biomass and population of *X.moluccensis* is a matter of serious conservation concern.

Assessment of habitat health

Habitat health indicators	Low	Medium	High	Trend	Comment
% of area coverage remaining			✓	↓	
No. of viable populations of native species remaining		✓		→	*Rhysophora* and *Bruguiera* are well represented but *X. moluccensis* is critically threatened.
Species health indicators	**Low**	**Medium**	**High**	**Trend**	**Comment**
Species abundance - % of area coverage remaining					
Rhizophorasamoensis		✓		↓	Probably declining in total area coverage but no immediate threat of depletion and extinction.
Bruguiera gymnorrhiza –		✓		↓	Probably declining in total area coverage but no immediate threat of depletion and extinction.
Xylocarpus molluccensis -	✓			↓	Critically threatened and in need of urgent conservation action.
Species richness – no. of viable populations remaining					
Rhizophora samoensis		✓		↓	
Bruguiera gymnorrhiza –		✓		↓	
Xylocarpus molluccensis -	✓			↓	Only one small community surviving in Savaii. Critically threatened.

6.3.2 Coastal forests and strand vegetation

Samoa has 403 km of coastline (Goven, 2009). The ecology of this coastline consists of a range of coastal plant communities including herbaceous strands, littoral shrubland, pandanus strand, mangrove forests and littoral forests (Whistler, 1992)[40]. Plant communities within this area are low in species diversity because not many can tolerate the harsh conditions of high winds, battering salt spray, and extreme high temperatures in the summer. Plants must also be adapted to sandy saline soils, with extremely low nutrient loads, and low water holding

[40] *Whistler, A. 1992. Flowers of the Pacific Islands Seashore: A guide to the littoral plants of Hawaii, Tahiti, Samoa, Tonga, Cook Islands, Fiji and Micronesia. Univ of Hawaii Press. Hawaii, USA.*

capacity[41]. The full range of species of plants in Samoa's coastal area is described and listed by Whistler (1992), with the diversity of species of various types of vegetation given in Appendix 9.

Table13: Diversity of Coral Species in Samoa

	Type of vegetation	No. of species in Polynesia[42] & Micronesian	No. of species in Samoa
1	Trees	29	24
2	Shrubs	28	15
3	Herbs	37	14
4	Vines	16	12
5	Grasses & sedges	10	7

Source: A.Whistler (1992)

Whistler (ibid) noted that much of these types of communities have been lost or degraded, with the best remaining examples being at Aleipata Islands, O le Pupū Puē and sites on the south (central) coast of Savaii[43].

In general, over 80% of Samoa's coastline is highly impacted and modified by human population and settlements. Most remaining vegetation are either domestic trees and crops of some social or economic value, (e.g. coconut, breadfruits, bananas, coconuts etc), or trees that are spared for coastal protection purposes including pulu (*Ficus spp*), talie (*Terminalia spp*), fau (*Hibiscus spp)* or littoral species adapted to coastal salt water sprays that have naturally regenerated and got established in open unused areas.

Forest cover analysis by MNRE (2012) show the following percentages of vegetation cover in the coastal zone by native and non-native species.

Table 14: Coastal habitats forest cover in Upolu and Savaii (0-60m elevation)

	Native Forests		Non-native forests		Total forested area		Non-forested areas	Total Area (ha)
Savaii	0.0 %	0 ha	20%	34,596 ha	20 %	34,596 ha	1,804 ha	36,400
Upolu	0%	0 ha	20%	22,086 ha	20%	22,086 ha	5,644 ha	27,730
Samoa	0%	0 ha	20%	56,682 ha	20%	56,682 ha	7,448 ha	64,130

Source: MNRE, 2012

An important addition to the coastal zone vegetation is the Government's One Million Tree initiative for climate change mitigation. Maps show that over 60% of tree planting under this program were within the coastal zone. (Refer to maps in Appendices 3 and 4).

Current Status

There is no recent update of the status of unique littoral plant communities identified by Whistler (op cit) including those communities within the Le Pupu Puē National Park and the Aleipata MPA. The new plantings under the One Million Tree Program are a mix of natives and non-native species, and predominantly of timber quality. These are planted mostly in association with existing infrastructure including seawalls, and coastal roads.

Assessment

Coastal forests/strand health indicators	Low	Medium	High	Trend	Comment
% of area under forest cover	✓			**?**	Currently under protection and conservation management.
% of area under protection				**?**	No information.
% of known native coastal species					No information.

[41] *En.wikipedia.org/wiki/Coastal_Strand*

[42] *The Polynesian countries this referred to are Hawaii, French Polynesia, Cook Islands, Samoa, Tonga and Fiji*

[43] *Whistler, A. 1992. National Biodiversity Review of Western Samoa. Unpublished Report for SPREP Apia, Western Samoa. 1992.*

6.3.3. Coastal Marshes

Samoa's documented coastal marshes consists of the following –

Table 15: Coastal Marshes in Samoa

	Name and Location	Description
1	Falealili Marsh, Upolu	A series of small herbaceous marshes on the south coast of Upolu, degraded by human impact. The small marsh at Malaemalu was identified as a priority site for conservation by Pearsall and Whistler (1991), but this site is now very degraded and is no longer considered to be a priority.
2	Apolimafou Marsh, Upolu	A small herbaceous marsh at the west end of Upolu, the least disturbed of any coastal marsh in Western Samoa.
3	Pu'apu'a Marsh, Savai'i	A small marsh near the east end of Savai'i, degraded by human settlement and not considered to be a priority area for protection.
4	Faga Marsh, Savai'i	A small marsh near the east end of Savai'i, degraded by human settlement and not considered to be a priority area for protection.
5	Falealupo Marshes (Cape Mulinu'u), Savai'i	Two areas of coastal marsh at the extreme western end of Savai'i, degraded by past exploitation and human settlement, and severely damaged by Hurricane Ofa in 1990. The preservation of the village forest under a covenant agreement has in the last few years increased awareness of the conservation importance of this area. The southern marsh (Tofutafoe) was recommended for designation as a Nature Reserve by Holloway and Floyd (1975), and identified as a priority site for conservation by Pearsall and Whistler (1991).
6	Sato'alepai Marsh, Savai'i	A large degraded marsh near Matautu Bay at the northern tip of Savai'i. The cyclones of 1990 and 1991 opened up an outlet to the sea, and sea water now flows freely into the marsh.

Source: MNRE 2012

Current Status

There is no recent data for updating the respective status of the listed marshes.

Assessment of habitat health

Monitoring is urgently needed to update the conservation status of Samoa's marshes. Anecdotal reports indicate that the Apolima-fou marsh is critically threatened by coastal reclamation and other local community activities.

Coastal marshes health indicators	Poor	Medium	Good	Very Good	Trend	Comment
% of area under protection					**Unknown**	

6.3.4. Beaches

Most of the beaches in Samoa are formed by coral particles broken up by storms or passed through the guts of coral-eating fish, such as parrotfish, and washed ashore by waves and currents. Some beaches are also formed by particles carried from inland by rivers. Beaches prevent waves eroding and washing away the shore and are homes for some eatable bivalve species as well as other species the shells of which are used to make traditional necklaces and other handicrafts.

Beaches are also a major attraction for tourists. Consequently activities such as sand mining can also be quite ruinous to beach aesthetics and therefore tourism. Conversely, tourism developments on or in close proximity to beaches including fale constructions and land reclamation, are putting stress not only on beaches but also the coastal environment that receives wastewater discharges and other pollutants.

Current status

There is no information on beaches as habitats other than the few that are nesting sites for hawksbill turtles within the Aleipata MPA. Information on sand resources is also limited.

The main interest in beaches is as a source of sand for construction purposes, and for tourism and recreational purposes. MNRE regulates the mining of sand through a licensing system that is supported by environmental/resource assessment. But the limited information makes sustainable management impossible.
The enforcement of permit conditions by the Ministry is difficult due to limited capacity and resources but also due to the customary ownership nature of land, which in the view of communities, extend to beaches even if they are below the high water mark. Not surprisingly, anecdotal information suggests that exploitation is higher than the level of extraction formally approved and reported.

Table 16: Sand mining permits and volumes 2008 - 2011

	2008 - 2009		2009 - 2010		2010 - 2011	
	# of permits	**Vol (m3)**	**# of permits**	**Vol (m3)**	**# of permits**	**Vol (m3)**
Commercial	19	7,630	13	2,055	16	1,665
Individuals	51	n.a.	53	732	49	517
TOTAL	70	7,630	66	2,787	65	2,183

Source: Based on data from MNRE (2012)[44]

The information collected on the number of permits and volumes approved (Table 16) for mining have little value for sustainable management in the absence of data on total available sand budgets and information on sand migration patterns for different locations.

Of seawalls, 27.0 km of seawalls were constructed during the period 2008 – 2010, with approval from MNRE. A further 3.0 km is planned for Upolu, while about 67 requests for seawall/riverwall are being reviewed by the Ministry. There are reports of coastal erosion and scouring of coastlines that are threatening seawalls themselves. This indicates poor designing of seawalls and or that seawalls may not have been the best option for coastal protection for some locations.

The impact of mining and seawall construction on beaches is important from a coastal protection point of view. Excessive mining of sand especially in already vulnerable beaches compound erosion and scouring and can lead to the loss of protection of coastal assets and infrastructure from wave surges and tsunamis. According to MNRE[45], this is already observed in villages that have unsustainable sand mining activities on their beaches. Worse still, adverse transboundary impacts are reported triggered by or compounded by sand mining in neighbouring villages (ibid.). A coastal study to determine and confirm the speculated effects of seawall structures on the natural beach sand movement and sedimentation process, is in the pipeline (ibid.).

Assessment of habitat health

Beach habitat health indicators	**Low**	**Medium**	**High**	**Trend**	**Comment**
Vol. of mined sand		✓		↑	Mining is likely to be higher than reported.
No. of mined beaches				No information	No. of beaches not known.

6.3.5. Overall Assessment of the Coastal Habitats

The coastal habitats assessed consist of mangroves, marshes, coastal strands and beaches. Except mangroves, there are significant gaps in our knowledge of the state of marshes, coastal strands and beaches. This is an important area for information gathering for future assessment.

Based on what is known, mangrove habitats are relatively healthy with the two main species (*Rhizophora mangle* and *Bruguiera gymnorrhiza*) well represented by intact and viable communities throughout Samoa. Work currently carried out by MESCAL point to new mangrove areas being identified that were not previously documented. A number of replanting initiatives by local communities and MNRE is adding to the total mangrove biomass. Having said this, Saifaleupolu and Elisara (2012)[46] observed continuing harvesting by locals for firewood and for local house constructions in some mangrove areas, which is consistent with anecdotal and informal reports.

The only stand of *Xylocarpus molluccensis* still found in Samoa is an urgent priority for protection. MNRE is strongly urged to take direct restoration measures including the option of establishing a second population elsewhere.

Coastal marshes need reassessment to ascertain their conservation status and to inform conservation planning.

Beaches are generally valued for the sand resource it provides but are also important as habitat for some high priority conservation species i.e. hawksbill turtles. The level of extraction is under Government management through MNRE's licensing system but, in the absence of data on sand budgets and in-house expertise in coastal processes, sustainable management is ineffective. Consequently the overall status of our beaches is unknown.

[44] *Faainoino Laulala, MNRE, pers comm.. 2012.*
[45] *Moira, MNRE, pers comm.. 2013.*
[46] *Op cit*

6.3.6 General Recommendations

1. Sand mining from coastal beaches need to be more stringently monitored for their wider impacts on nearby coastlines and neighbouring beaches.

2. Research on sand migration and sand budget and accompanying coastal processes is needed to assist MNRE is managing its sand licensing and coastal reclamation activities.

3. An assessment of Samoa's coastal marshes is long overdue with several that are of high conservation value and of regional significance to be given priority.

4. The only stand of *Xylocarpus molluccensis* found in Siutu Salailua should be an urgent priority for protection. MNRE should implement restoration measures for the existing stand and should also at establishing other *X.molluccensis* populations in other sites.

5. Soft solutions such as coastal replanting using appropriate tree species should be encouraged in the place of seawalls for some coastal locations.

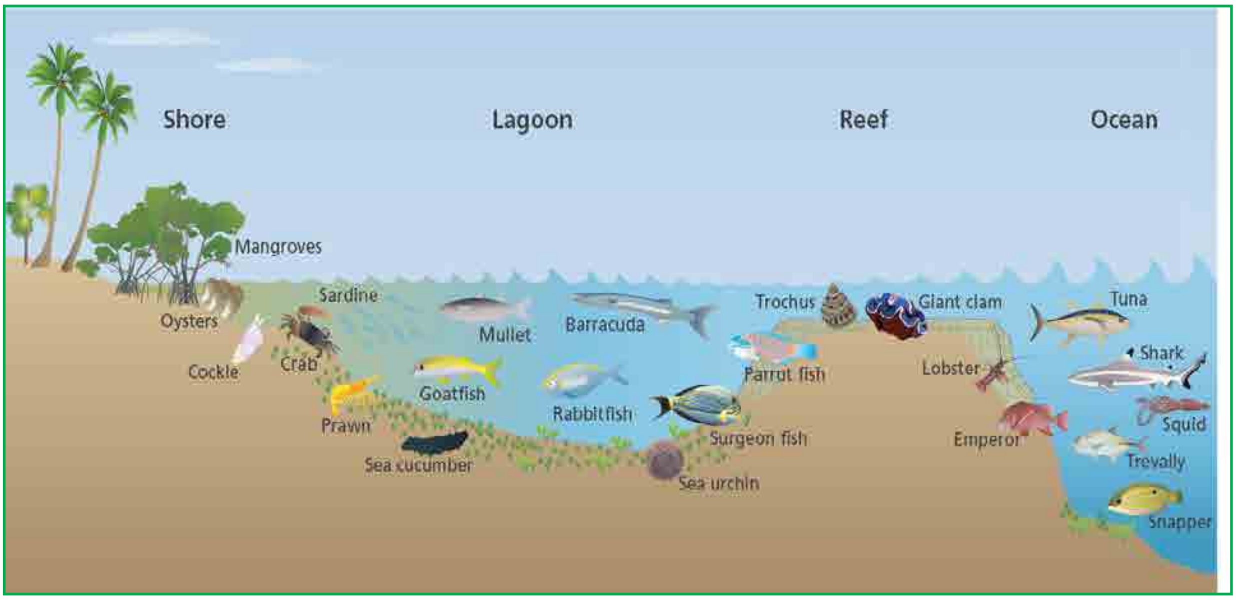
Sand minig at Solosolo/ photo by MNRE, March 2013

Tafitoala coast, Post-cyclone Evan Jan 2013

6.4 INSHORE and OFFSHORE MARINE HABITATS

Samoa's marine environment extends from the high water mark to the boundary of its EEZ and including the inshore area, coral reefs, seagrass beds, lagoons and other deep sea habitats such as sea mounts, etc.. Exception to this definition is mangroves and beaches which are zoned under 'coastal environment' in this SoE. Off shore environment extends from the reef outwards.

Figure 6: A typical profile of Samoa's marine/offshore habitats showing distribution of fish and other marine species



Source: Graphics by Tracey Saxby (Univ Maryland, 2012) based on King and King, 1995

6.4.1. Corals and Coral Reefs

Coral reefs are the most complex, diverse, species-rich as well as highly productive biological systems in the world. They provide habitats to one-third of all marine fish species and tens of thousands of other species. Although Samoa is not as well endowed with coral reefs compared to other Pacific Islands (MNRE, 2006), they provide ecological services that are extremely important to Samoa's marine biodiversity, economy, food security and coastal protection.

A total reef area of 10,000km^2 to a depth of 50metres (Samuelu-Ah Leong et al, 2008[47]) is estimated for Samoa. The general distribution of Samoa's coral reefs are illustrated in Map 6.

According to Zann (1991) [48] , the reefs have shown all stages of reef evolution: recent lava flows with only a veneer of corals, young, incipient fringing reefs growing on older lava flows; mature, wide and well-developed fringing reefs; young barrier reefs with relatively deep lagoons; mature barrier reefs with infilled lagoons; offshore ancient drowned barrier reefs; and platform or patch reefs. Zann (ibid.) also estimated reef age to range from a few centuries old to over 10,000 years.

The largest reef in Samoa is on the north-west Upolu from Apia to Manono Island. Savaii has a relatively small area (about 52 km^2) of coral reefs, surrounding the island. Off the lava coasts, there is an additional 10-15 km^2 of rocky shelf, which supports some coral growth. Reefs are best developed from Salelologa to Puapua in the east; Saleaula to Manase in the north; Asau to Sataua in the west and Satupaitea in the south east. Savaii's reefs are mainly fringing reefs with reef flats or shallow lagoons.

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[47] *Samuelu-Ah Leong, Joyce and Sapatu, Maria. 2008. Status of Reefs in Samoa 2007. In: Whippy-Morris (ed.). 2009. South-West Pacific Status of Coral Reefs Report 2007. Coral Reefs Initiative for the Pacific. SPREP, USP, GCRMN and ReefBase Pacific. SPREP, Apia.*

[48] *Zann, L. P. (1991). The inshore resources of Upolu, Western Samoa: coastal inventory and fisheries database. Report prepared for the Government of Western Samoa. FAO/UNDP SAM/89/002 Field Report. Unpubl.*

Map 6: Distribution of coral reefs in Samoa

Source: MNRE Mapping Section, 2012

During the early 1990s, the status of the coral reefs ranged from highly degraded to very good (Norseman and Mulipola, 1995)[49] . However, population of fish and invertebrates on reef surveyed had been reduced by heavy fishing and collecting, indicating that no area had been unaffected by human activities. The two consecutive cyclones, Ofa and Valerie had impacted considerably on Savaii's coral reefs (Zann and Bell, 1991). Massive damages and destruction occurred to all reefs as rubble sediments were piled on the reef forming cyclone banks. Moreover, outbreaks of crown-of-thorn starfish (alamea) have seriously affected reefs on Savaii during 1978-1983 and 1993 (Zann and Su'a, 1991). Zann and Mulipola (1997) also reported extensive areas of dead coral off Salelologa in the early 2000s. In additional to naturally induced damages on coral reefs, dynamite fishing has also attributed significantly on the destruction of inshore reefs.

Current status

The assessment presented in this report on coral reefs and coral fish is based on two reports (a) the Kendall and Matthews et al (2011) report and the 2009 IUCN Red List of Threatened Species (cited by CI, et al. 2010). Kendall and Matthews et al (op cit) combines data from many pre-existing studies and datasets (including those of the MAF Fisheries and GCRMN) into a more robust characterization of the reef communities in Samoa that none of the studies could have achieved alone. It does not eliminate certain challenges inherent in normalizing and combining results from many studies, but it maximizes the use of available information, provides the broadest possible geographic scope and reduces sensitivity of the findings to the biases associated with any one dataset. The 2012 IUCN Red List provides information on species coral species and their conservation statuses. (Appendix 2).

Using datasets from 61 sites (Savaii 23, and Upolu 38), the current state of health of Samoa's coral reef is assessed based on three indicators – coral cover, coral richness and coral community structure.

Coral cover

The assessment of coral cover by Kendall and Poti (eds., 2011)[50] drew on data from 61 sites (Savaii 23 and Upolu 38), using a standardized approach to classify values of each variable at each site as 'high', 'medium' or 'low' relative to other sites surveyed with the same study methods. It was not possible to simply pool site values for each variable from all datasets into a single analysis for a number of reasons, including differences in the method of data collection, differences in site characteristics and because different studies quantified different aspects of the coral and reef community that were not directly comparable (ibid.).

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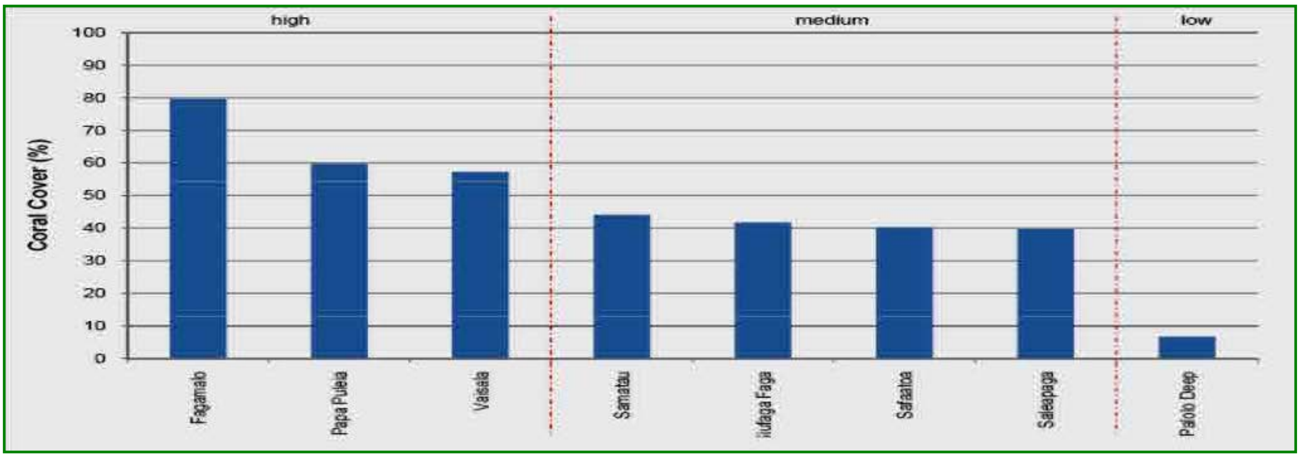
[49] Horseman, N and Mulipola, A. (1995). Catch data and collection from market surveys in Western Samoa, (BP. 65). In: Dazell, P and T. Adams (Eds). South Pacific Commission and Forum Agency Workshop on the Management of South Pacific Inshore Fisheries. Manuscript collection of country statements and background papers Volume 1. Integrated Coastal Fisheries Management Project Technical Document No. 12. SPC, Noumea, New Caledonia.

[50] Matthew Kendall and Matthew Poti (eds.). 2011. A biogeographic assessment of the Samoan Archipelago. NOAA Technical Memorandum NOS NCCCOS 132. NOAA, USA.

Assigning breakpoints between 'high', 'medium' and 'low' required the application of a algorithm (the Natural Breaks Algorithm) that identified natural break points in the data that maximizes similarity of values within classes and maximizes differences. The result of this analysis is as follows -

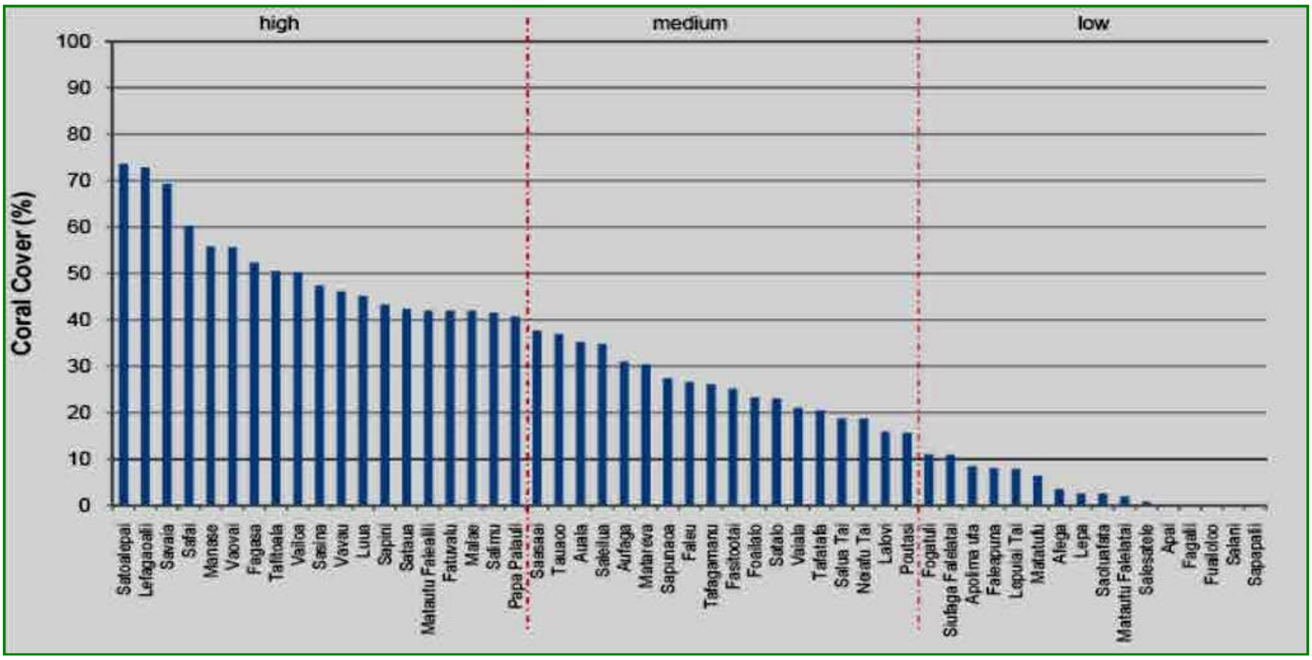
- Overall, over 40% of Samoa's coral reefs have 'high' percent of coral cover ('high' = 50% or better based on GCRMN assessment and 40% or better based on MAF's Village Fisheries Reserves analysis).
- By island, a much larger proportion of Savaii (~60% of coastline) was rated as having 'high' coral cover compared to Upolu (~30%).
- The north and northeast facing coasts of Savaii possess a large proportion of sites with high coral cover (Map 7). In contrast, Upolu has more moderate and variable values with areas of low coral cover along the north and west coasts, especially for Manono Is/Apolima Strait and between Apia and Fagaloa Bay.

Graph 5: Coral cover assessment based on GCRMN[51] data



Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

Graph 6: Coral cover assessment based on MAF's Village Fisheries Reserves data



Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

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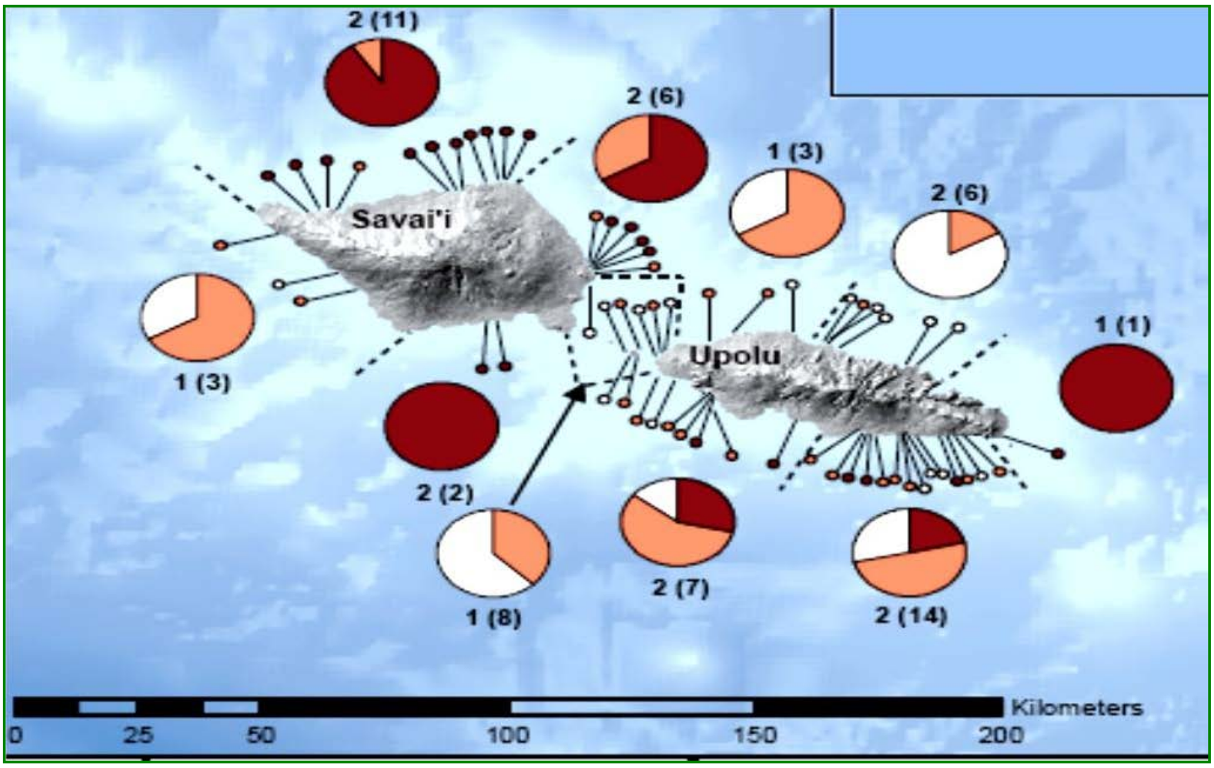
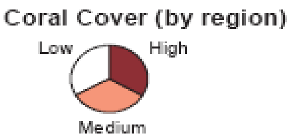
[51] *Global Coral Reef Monitoring Network*

Map 7: Coral cover survey sites across Samoa.



Sites and pie charts are coded high, medium and low coral cover values.

Legend



Compared to the 2006 SoE which reported a ‘reasonably high’ coral cover throughout Samoa based on 2004 reports, Kendall and Poti et al (ibid)’s assessment shows a continuing trend of improvement in coral reef cover.

Coral Richness (or diversity)

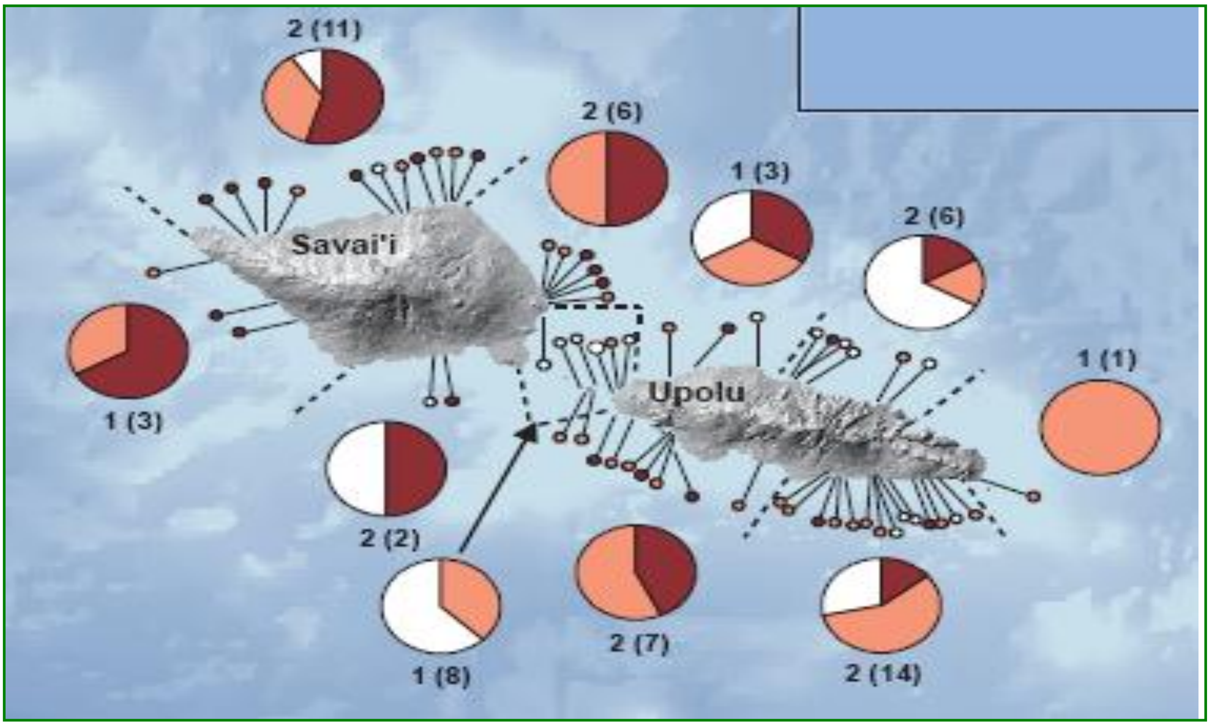
MAF-Fisheries estimates a coral reef fauna comprising of approximately 50 species of hard coral and around 900 fish species and numerous other reef-dependent organisms (MAF-Fisheries 2003). IUCN (2012) included 52 species of corals in its Red List of Threatened Species, with the Staghorn Coral (*Acropora rudis*) the only species considered ‘endangered’[52]. Appendix 2 lists coral species redlisted by IUCN.

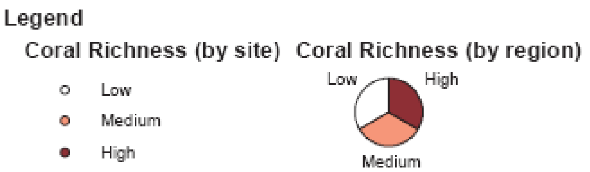
Overall coral richness for Samoa is rated ‘high’ for about 35% of the country’s coastline (Kendall and Poti (op cit). By island, about 50% of Savaii’s coastline and 25% of Upolu’s coastline is rated as having high coral richness.

There are some distinct biogeographical patterns of coral richness within each island or within the island group as a whole. For instance, Savaii has a small proportion of sites with low coral richness relative to Upolu. Also the proportion of sites with high coral richness generally declines eastward in Samoa. Compared to Savaii, Upolu has somewhat more moderate and variable values with concentrated areas of low coral richness in the Manono Island/Apolima Strait area and between Apia and Fagaloa Bay.

[52] *An **endangered species** is a population of organisms which is facing a high risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters.*

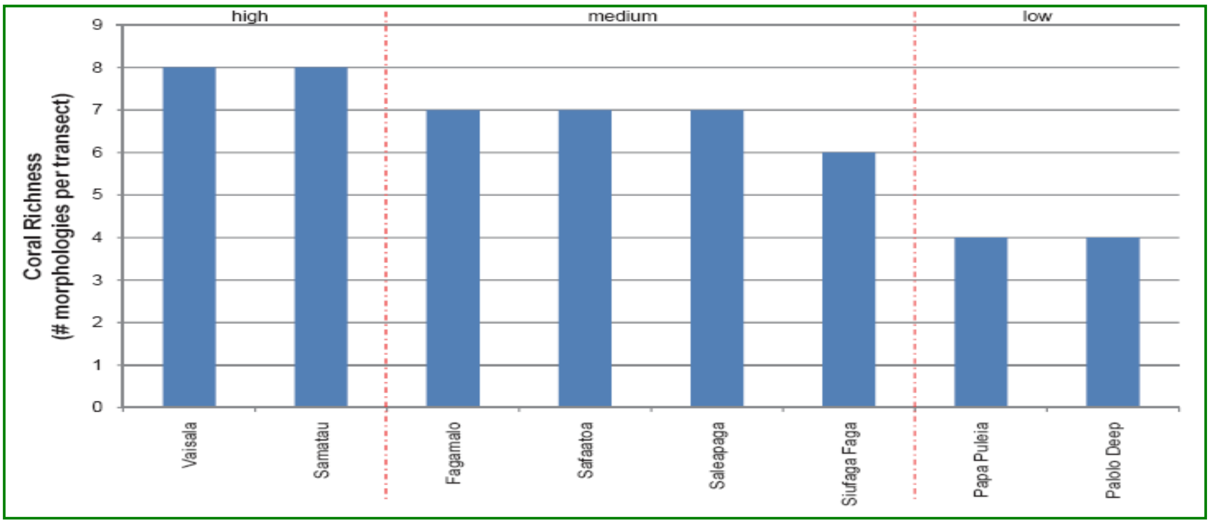
Map 8 – Coral richness at survey sites across Samoa.





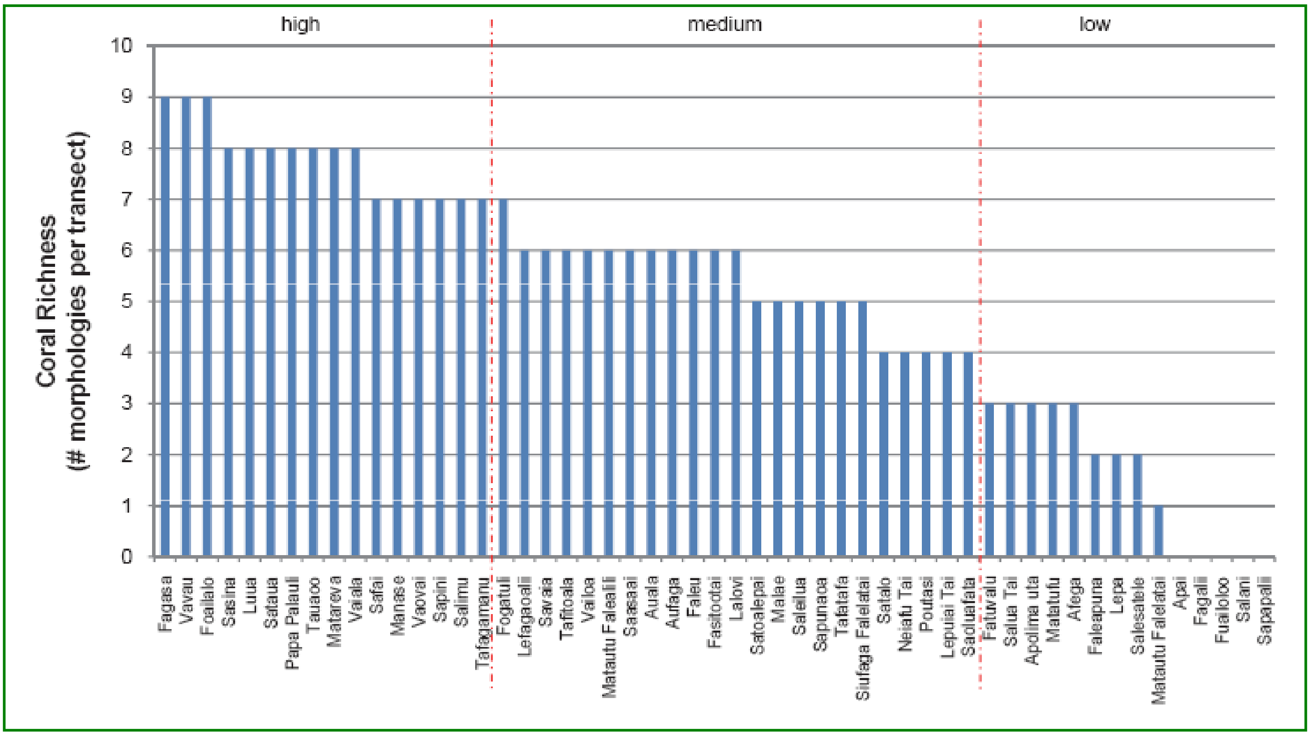
Sites and pie charts are coded as high, medium or low coral richness values.
Source: Kendall & Poti. (eds.) 2011.

Graph 7: Coral Richness Assessment based on GCRMN sites



Source: Kendall & Poti (eds.). 2011.

Graph 8: Coral Richness Assessment in Villages Fisheries reserves



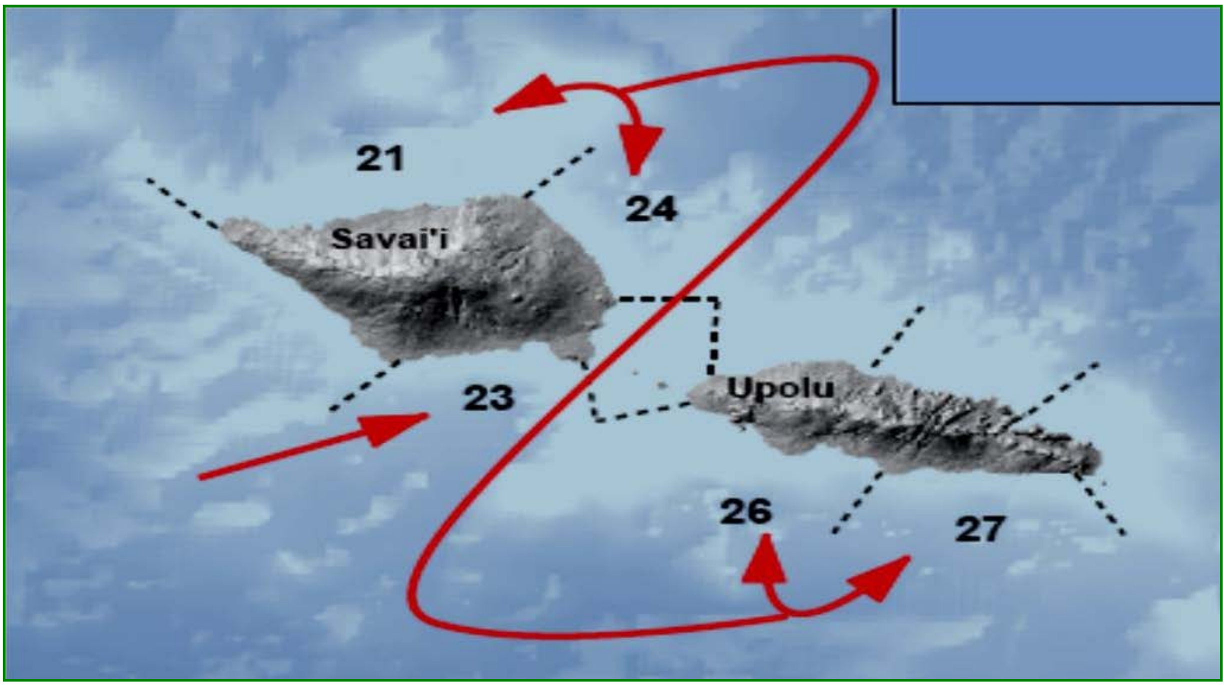
Source: Kendall & Poti (eds.). 2011.

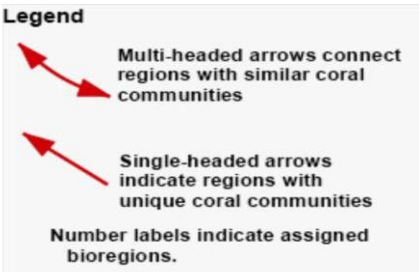
Coral community structure

Data for assessing coral community structure are both sparse and inconsistent (Kendall and Poti et al, 2011). However the available GCRMN and SFR datasets revealed consistent patterns of overlap among sites around southern Upolu and northern Savaii as well as a separate and unique coral community in sites on southern Savaii.

As indicated in Map 9, coral patterns observed in bioregion 21 and 24 in northern Savaii are also found in bioregions 26 and 27 in Southern Upolu. The coral community structure in Southern Savaii (bioregion 23) is not found anywhere else in Samoa. Notably the northern coast of Upolu from Manono/Apolima Strait to Fagaloa in the east has very poor community structure, which is consistent with its assessed low rating in coral cover.

Map 9 – Bioregions of Samoa that share similar coral communities and those with unique coral communities.





Source: Kendall & Poti (eds). 2011.

Assessment

The above assessment based on coral cover, coral richness and coral community structure show a variable state of health between different bioregions of Samoa. In a 2008 assessment, Ah Leong-Samuelu et al observed that Samoa's coral reefs are recovering well since after Cyclone Heta relative to an earlier assessment by Zann (1991) who observed following Cyclone Valerie that coral reefs throughout the country were 'seriously degraded'. Taken in the context of these qualitative observations, the Kendall and Poti et al's assessment confirms improvements in some bioregions, while others are in much poorer state. A 'high' assessment for coral cover and coral richness indicates higher quality reefs that may be more resilient to some stressors including human impacts (Edinger et al. 1998, Houk and Musberger 2008)[53]. The reverse is true for a 'low' assessment for coral cover.

[53] *Edinger et al. 1998, Houk and Musberger 2008 cited by Kendall and Poti (ibid).*

Overall Coral Reef Health Assessment

Habitat condition	**Low**	**Medium**	**High**	**Trend**	**Comments**
Coral cover/abundance					Trend assessment is mainly based on IUCN (2012) assessed trends for 31 coral species as ‘decreasing’, 1 as ‘stable’ and 20 species are ‘unknown’.
- N W Savaii			✓	↓	
- Northern Upolu	✓			↓	
- Southern Upolu		✓		↓	
- Southern Savaii				?	Unknown. No information.
Coral richness					One coral species, *Acropora rudis* (Staghorn coral) is categorized as Endangered by IUCN.
- N W Savaii		✓		→	
- Northern Upolu			✓	→	
- Southern Upolu		✓		→	
- Southern Savaii					Unknown. No information.
Coral community structure					The increasing trend assessment is based on qualitative and anecdotal observations including comments by Kendall & Poti (op cit).
- N W Savaii			✓	↑	
- Northern Upolu	✓			↑	
- Southern Upolu		✓		↑	
- Southern Savaii	✓			↑	

General Recommendations

1. Supporting on-going monitoring and regular assessment of areas where coral diversity is high to inform resource management and conservation planning. Ensure consistent use of methodologies and indicators to maximize data comparability and utility.

2. Target areas of Northern Upolu where coral diversity is high for marine conservation purposes.

3. Encourage, provide technical support and where possible, facilitate access to funding of communities for marine conservation projects.

4. Encourage coral replanting interventions in marine areas that are degraded but with high coral diversity i.e Northern Upolu.

5. Maintain collaboration with GCRMN and other similar organizations for marine monitoring activities.

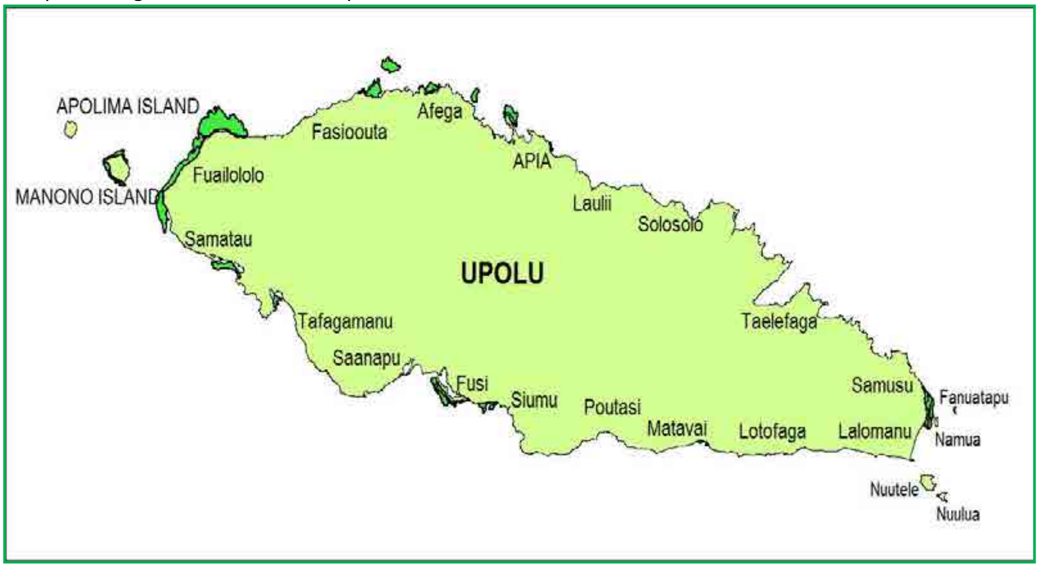
6.4.2. Seagrasses

Sea-grasses are found in shallow soft muddy sand areas and are similar to flowering plants on land. They provide shelter and food for many marine animals and stabilize foreshores. Typically, seagrasses are found in water depths of 2-12 metres where light can penetrate and allow them to photosynthesise. They are an important food source for many herbivorous fish species, marine turtles and invertebrates. Seagrass leaves provide shelter to many small animals, sheltering them from predators, the weather and strong water currents. Other than providing shelter for marine animals, they also play an important role by acting as sediment traps and nurseries for many species. They are special habitat areas because they are important to the livelihood of many marine organisms such as fish, crabs, prawns, octopus and turtles. Big sea animals like turtles forage on these seagrass beds while small animals live amongst them. Seagrasses are not directly used by humans, and because of this their importance is often overlooked.

Map 10: Seagrass distribution in Savaii

Source: Juney Ward, MNRE. 2012.

Map 11: Seagrass distribution in Upolu



Source: Juney Ward, MNRE. 2012.

Current Status

Seagrass bed distribution in Samoa is limited with the best patches found around Manono Island and the Northern coasts of Upolu[54]. Only two species of seagrasses have been reported to occur in Samoa, *Halophila ovalis* and *Syringodium isoetifolium* (Hartog 1970, cited in Skelton et al. 2000). Some researchers (Skelton et al, op cit). are of the opinion that *H. ovalis* reported in Samoa is probably endemic or belongs to another species, *H. minor. Halophila spp.* specimen collected from the Palolo Deep Marine Reserve recently showed it to resemble *H. minor* morphologically.

There has not been any detailed survey of the status of seagrasses in Samoa since 1992.
Not enough information is available to assess seagrasses using indicators of area coverage, biomass and richness. The main threats are sedimentation from land based sources, and activities such as sand-dredging.

Assessment

Not enough is known about Samoa's seagrass ecosystems to make an informed assessment. It is an information gap that needs to be addressed for future assessment.

[54] *MAF-Fisheries(b). 1 June 2002. Marine Environments – Educational materials. Fisheries Division.*

Overall Health Assessment

Habitat condition	Low	Medium	High	Trend	Comment
Area coverage	✓			Unknown	Limited distribution to a small no. of sites.
Abundance (biomass)	✓			Unknown	No information.
Richness (species diversity)				Unknown	Two confirmed species only both present in small but viable population.

General recommendations

1. Encourage village based conservation of representative populations of seagrasses ecosystems using existing community based conservation tools.

2. Monitor seagrass ecosystems on a regular basis and gather other relevant information to inform future assessment and conservation planning.

6.4.3. Algae/Seaweed

Marine algae or seaweed consist of a large and diverse group of primarily plantlike organisms. They use photosynthesis to obtain their food. They vary in form from small, single to complex multicellular forms such as the giant kelps of the eastern Pacific that grow to more than 60 meters in length and form dense marine forests. Marine algae play very important roles in the marine environment in that they are primary producers thus forming the base of the food chain that contribute to economic well-being in the form of food, medicine and other products.

Algae diversity consists of 198 taxa, comprising comprising 15 Cyanophyceae, 89 Rhodophyceae, 33 Phaeophyceae and 61 Chlorophyceae. This represents about 50-60 percent of the potential algal flora from Samoa (Skelton & South 1999). Results of a floristic survey of Palolo Deep by Skelton (2000) reveal a total of 128 species of which 89 are new records, bringing the total of known marine algae from Samoa to 360 with 205 species present in Palolo Deep alone. Four red alga from Palolo Deep are recognised as new to science, viz *Amansia paloloensis, Ceramium upolense*, *Ceramium kramerii* and *Ceramium rintelsianum* (South & Skelton 1999; 2000). *Ceramium rintelsianum* is found only in the Palolo Deep Reserve; however, extensive research of the flora of neighbouring islands may reveal the presence of this alga (ibid.).

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. These are *Kappaphycus alvarezii* and *K. denticulatum.* Another one, *Eucheuma denticulatum*, is reported to have been introduced to the Vaiusu-Faleula area in 1975 but farming was not successful[55]. The status of these introduced seaweeds in our marine environment is unknown[56].

Marine algae in tropical environments are very important as they are considered primary producers which form the complex association with higher species diversity (Dahl 1972). Keat (1996) mentioned that coralline algae are important in cementing and strengthening coral reefs and large algae help provide shading for some benthos.

Current Status

Mulipola (2002)[57] observed that the state of knowledge on the diversity of marine algae in Samoa was nonexistent until Skelton's work on algae up to 2005 (J Ward, pers comm.). Results from this study reclassified the Samoan archipelago to third richest in terms of total species for genera Chlorophyta, Phaeophyceaae and Rhodophyta from 20 places throughout the Pacific. The same report also speculated that the Apia flora includes unique algal species that are not yet recorded from the rest of Samoa (eg, *Gracilaria ephemera, Codium arenicola, Spatoglossum macrodontum and Ceramium rintelsianum*). Of the 360 total species, 57% are represented in the Apia flora. The Apia district hosts more than half of the species found in the rest of Samoa in a 10km stretch of coastline (Skelton, 2005)[58].

A MAF-Fisheries (2010) report noted that algae and seaweeds represented 20% of the substrates within all 16 fish reserves monitored but there is no listing of the 16 reserves wherein this observation was made.

[55] *Skelton et al. 2002.*
[56] *MAF Fisheries(a). 8 June 2003. Marine Resources I – Educational materials. Fisheries Division.*
[57] *Mulipola, A. 2002. Marine Resources of Samoa – Report prepared for Samoa's National Report for the World Summit on Sustainable Development, Johannesburg, South Africa, July 2002. MAF-Fisheries. Apia.*
[58] *Skelton, P.A. 2005. A survey of the benthic marine algae of the Apia District, Samoa, South Pacific. (Thesis for the Degree of Doctor of Philosophy. University of the South Pacific). 628pp.*

Overall Health Assessment

An informed assessment is not possible in the absence of data on the selected indicators.

Habitat condition	Low	Medium	High	Trend	Comments
Area coverage				?	No information
Abundance/Biomass				?	No information
Species Richness/Diversity			✓	?	No information. High diversity based on Skelton, P A. 2005.[59]

General Recommendations

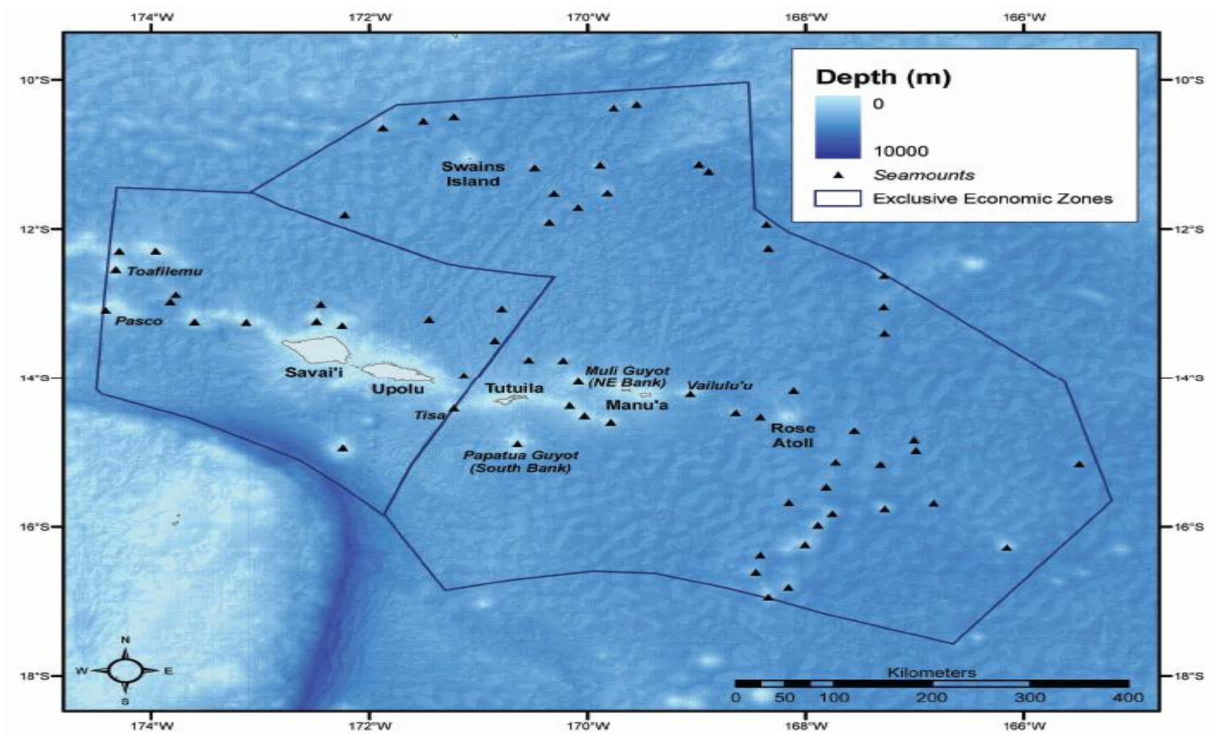
1. Monitoring of seaweed colonies is important and should be a priority in DEC's monitoring activities.

2. MNRE should explore options for the conservation of representative habitats of seaweeds and algae including the use of village fisheries reserves.

6.4.4. Sea mounts

Seamounts are underwater mountains of volcanic origin. In this report, Bauer et al's (2011) definition is used i.e. seamounts are totally submerged underwater mountains but extending to a minimum of 150m above the seafloor. They are often formed near mid-ocean ridges or subduction zones at the edge of tectonic plates but also occur over upwelling plumes (hotspots) within plate boundaries (Wessel 2001)[60].

Map 12: Seamounts in the EEZ of Samoa and American Samoa



Like all geologic formations, seamounts change in shape and height over millions of years as a result of gradual processes of volcanic growth upward out of the seafloor, growth of coral reefs if emergent or shallow enough, and eventually the processes of erosion and subsidence or sinking of the reshaped structure back into the seafloor. The Samoan Archipelago is part of a hotspot chain that extends from the volcanically active Vailulu'u seamount in the east to west of the island of Savaii (Hart et al. 2006) and includes examples of many stages in the seamount life cycle.

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[59] *Ibid.*

[60] *Cited by Bauer, Laurie B and Kendall, M.S. 2011. Seamounts within the Exclusive Economic Zones of Samoa and American Samoa. In: Kendall, M and Poti, Matthew (eds.). A Biogeographic Assessment of the Samoan Archipelago. NOAA. NOAA Technical Memorandum NOS NCCOS 132. NOAA –US Department of Commerce.*

Seamounts are not only interesting features geologically as described above, but also biologically in that they represent oases of biodiversity relative to the comparatively barren ocean floor and seafloor surrounding them. Seamounts offer an array of habitat opportunities, current fields, and depth zones for planktons, fish and coral to occupy, they play a role as "stepping stone" features connecting populations of reef fish and coral between islands, are known gathering sites for many pelagic fish species , and consequently are popular destinations for fishing and scientific study (Rogers, 1994).

Current State

Sixteen (16) seamounts have been identified within Samoa's EEZ and one (called the Tisa Seamount) is situated on the EEZ boundary between Samoa and American Samoa[61]. Their distribution in Samoa's EEZ is given in the map above. Locations and morphological conditions are tabulated in Table 17.

Table 17: Locations and Morhological Characteristics of Samoa's 16 seamounts

Name	EEZ	Source	Longitude	Latitude	Depth of top (m)	Height (m)
Agavale seamount	Samoa	1,2	-168.1543	-15.6757	4,887 (3)	269 (3)
Pasco Seamount	Samoa	1,2	-174.4157	-13.0865	94 (4)	3.051 (3)
Si'usi'u Seamount	Samoa	1,2	-173.6039	-13.2414	1,269 (3)	2,359 (3)
Taumatau Seamount	Samoa	1,2	-172.2503	-13.2894	842(3)	1890 (3)
Toafea'I Seamount	Samoa	1,2	-173.9573	-12.2925	488 (3)	2,976 (3)
Toafilemu Seamount	Samoa	1,2	-174.3238	-12.5384	30(4)	2,737 (3)
Tuapi'o Seamount	Samoa	1,2	-173.1259	-13.2477	425 (3)	2,966 (3)
Uo Mamae Seamount	Samoa	1	-172.2427	-14.9441	645 (3)	3,169 (3)
Unnamed seamount 27	Samoa	1	-170.7861	-13.0671	3,796 (3)	1,004 (3)
Unnamed Seamount 30	Samoa	6	-173,7718	-12.8724	3,032 (3)	601(3)
Unnamed Seamount 38	Samoa	6	-173.8263	-12.9707	2,349 (3)	1,379 (3)
Unnamed Seamount 39	Samoa	6	-174.2913	-12.2940	1,711 (3)	1,250 (3)
Unnamed Seamount 40	Samoa	6	-172.4459	-13.0042	3,098 (3)	698 (3)
Unnamed Seamount 41	Samoa	6	-171.4520	-13.2108	3,451 (3)	1,326 (3)
Unnamed Seamount 42	Samoa	6	-170.8492	-13.4912	3,711 (3)	941 (3)
Unnamed Seamount 43	Samoa	6	-171.1356	-13.9646	2,430 (3)	1,297 (3)

Source: Kendall and Poti (eds). 2011.

There is a general lack of information on the biological communities of Samoa's seamount. The limited information that is known points to two seamounts having a high possibility of hosting mesophotic reefs[62]. These two – Pasco Seamount and To'afilemu Seamount - rise up to less than 150m below sea level. Generally mesophotic reefs range from 30 to 150m.

Assessment of Habitat Health

There is insufficient information to make an informed assessment of the health of Samoa's seamount, particularly of the two noted above to have the potential for supporting mesophotic reefs.

Seamount health indicators	Low	Medium	High	Trend	Comments
- coral biomass of mesophotic reefs				No information	

General Recommendation

1. Encourage research and exploration of seamounts within Samoa's EEZ.

[61] *There are 48 seamounts within American Samoa's EEZ for a total of 65 between the EEZs of the two Samoas (ibid.).*

[62] *Mesophotic Coral Ecosystems (MCEs) extend from 30 m (100 ft) to greater than 100 m (330 ft) and are characterized by the low availability of light for photosynthesis and the presence of corals, sponges and algae as the dominant structural components. Little is known of their distribution, abundance, productivity and susceptibility due to difficulties of working at depths beyond the range of conventional SCUBA diving (http:// ccri.uprm.edu).*

6.4.5. IMPORTANT MARINE SPECIES

6.4.5.1. Mammals – whales and dolphins

Marine mammals found in Samoa's offshore environment include whales and dolphins [[Cetacea which fall under two large groups, Odontoceti (those with teeth [toothed cetaceans] and Mysticeti (baleen cetaceans - those which do not have teeth but have baleen [comb-like structures used for filtering food].

Latest MNRE data shows that twelve (12) species of cetaceans are present in the waters of Samoa (Ward, J., pers comm.) all of which are known to be widely distributed in the South Pacific area[63]. This is 30% of the 40 species that have been reported within the Pacific Islands region (Miller, 2007)[64], which is half of all the known species of whales worldwide (ibid.). These are listed in the table below.

Table 18: Whales and Dolphins Present in Samoa's Waters

Common Name	Scientific Name	Documented Presence or Likely to be present	IUCN Assessment	
			Abundance	Conservation status
Humpback whale	*Megaptera novaeangliae*	Present	Low	Vulnerable
Sperm whale	*Physeter macrocephalus*	Present	Low	Vulnerable
Minke whale	*Balaenoptera sp.*	Present	Low	Vulnerable
Dwarf sperm whale	*Kogia sima*	Present	Not Redlisted	Data deficient
Melon-headed whale	*Peponocephala electra*	Present	Not Redlisted	Least concern
Bottlenose dolphin	*Tursiops truncatus*	Present	Not known	Least concern
Rough-toothed dolphin	*Steno bredanensis*	Present	Not Redlisted	Least concern
Short-finned pilot whale	*Globicephala macrorhychus*	Present	Low	Data deficient
Cuvier's beaked whale	*Ziphius cavirostris*	Present	Not Redlisted	Least concern
Blainville's beaked whale	*Mesoplondon densirostris*	Present	Not Redlisted	Data deficient
False killer whale	*Pseudorca crassidens*	Present	Low	Data deficient
Spinner dolphin	*Stenella longirostris*	Present	High	Data deficient
Bryde's whale	*Balaenoptera edeni*	Likely	Low	DD
Killer whale	*Orcinus orca*	Likely	Low	DD
Pantropical spotted dolphin	*Stenella attenuata*	Likely	Not known	Least concern
Striped dolphin	*Stenella coeruleoalba*	Likely	Not Redlisted	
Risso's dolphin	*Grampus griseus*	Likely	Not Redlisted	
Fraser's dolphin	*Lagenodelphis*	Likely	Not Redlisted	

Source: J. Ward, MNRE. 2012. Likely = likely to be present

Current Status

Aside from knowing the species of whales and dolphins that frequent Samoa's offshore environment, the status of cetacean species in Samoa is still poorly known.

Oremus et al (op cit) observed that further research is needed to ensure the protection of these species in the future; this should include the assessment of population abundance, habitat use, residency pattern and genetic diversity. MNRE has been documenting and collecting dorsal fin photographs of spinner dolphins, rough-toothed dolphins and short-finned pilot whales for individual identification and these data will help to determine the pattern of residency and the abundance of these populations of dolphins in Samoa. Photographs of the underside of the tail (fluke) and dorsal fins of the migratory and vulnerable humpback whales are also catalogued to monitor the trend of these whales in Samoa during the months of August - November. Based on the photo catalogue for humpback whales, a total of 65 unique animals have been documented over 9 years of survey, signifying that the population of humpback whales in Samoa is still considered low and vulnerable. MNRE has also collected genetic

[63] *Premus, Marc, Ward, Juney, Penaia, Lillian, Ifopo, Pulea, and Pesaleli, Toetu. 2007. Report on dolphin and whale watching feasibility survey in Samoa and biopsy training, May-June 2007 . Unpubl. SPREP, Samoa.*

[64] *Cited by Oremus et al. op cit.*

samples for DNA testing that could shed light on whether locally observed individuals are genetically linked to other mammals elsewhere in the region or if these are genetically isolated and unique to Samoa.

IUCN however has red-listed ten (10) of the twelve with confirmed presence in Samoan waters. Of this ten (10), seven are assessed 'Low' in abundance and are considered Vulnerable[65]. Three are "Not Known" possibly because there is no available data. Annex 10 shows the locations of sightings of whales and dolphins from MNRE surveys done between 2001 and 2012.

Overall Assessment
On the basis of abundance, only one – the spinner dolphin *Stenella longirostris* - is reported by IUCN to have a 'high' population. Spinner dolphins are the most commonly documented species observed in high numbers with around 100 animals in a group. The other cetaceans confirmed by IUCN to be present are of low decreasing populations and considered vulnerable.

Of species diversity, although there is a difference between IUCN and MNRE as to the diversity of species present in Samoa's waters, 25% to 30% is a high level of representation based on the total of 40 species observed in the Pacific Ocean.

It is not yet known if any species present in Samoan waters are genetically isolated from others in the region but MNRE has collected the genetic samples that when analysed (mitochondria analysis), will provide this information.

Population health indicators	Low	Medium	High	Trend	Comments
Abundance/Biomass - % increase in population	✓			↓	Many species are assessed vulnerable by IUCN.
Richness/diversity – - no. of different species of total native diversity observed			✓	→	No change to species diversity

6.4.5.2. Marine Reptiles
Three species of turtles have been recorded in Samoan waters of which two are more common. These are (i) the Hawksbill turtle (*Eretmochelys imbricata*) and (ii) the Green turtle (*Chelonia mydas*). The Leatherback turtle (*Dermochelys coriacea*) is rare. The Hawksbill turtle is the only turtle with rookeries or nesting grounds well established in the Aleipata Islands of Nuutele, Namua and Nuulua. The Green turtle is known to only feed within our waters.

All three turtle species are listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES]. This means all turtle species are endangered worldwide and are banned from international trade.

Witzell et al (1980) and Zann (1991) reported that the nesting population of hawksbill turtles were small with no more than 45 females nesting annually on the Aleipata islands alone. Surveys conducted by MNRE during the nesting season reported declining numbers of nesters. Nesting season of 2003-2004 and 2005-2006 only recorded at least 1 turtle nesting on the islands. This decline in numbers of nesting turtles is of enormous concern and is an indication that hawksbill turtles in Samoa are still low in numbers (Ward and Asotasi, 2008).

Two species of sea snakes have been reported to inhabit Samoa's waters, the banded sea snake (*Laticauda sp.*) and *Pelamis ploturus*. However, it is likely that there are more than two sea snake species found in Samoa. Little information is known about their status in our waters.

Current Status
MNRE (2003) noted that turtle numbers have slumped in the past decades and are still declining due to over exploitation for their meat (food) and shell, habitat destruction, entanglement in fishing nets and other debris, and harvesting of eggs from nests.

IUCN's 2012 Redlist gives a more recent assessment of the conservation status of the two turtle species found in Samoa with the hawksbill turtle considered 'critically endangered'[66], with a decreasing population, and the green turtle classified under the less-at-risk category of 'vulnerable' with a decreasing population.

[65] *'Vulnerable' means a species faces a considerable risk of extinction in the medium term.*
[66] *Critically endangered = faces an extremely high risk of extinction in the immediate future*

Overall Health Assessment

Population health indicators	Low	Fair	Good	Very Good	Trend	
Abundance/Biomass - *Eretmochelys imbricata*	✓				↓	Critically endangered and facing extreme risk of extinction!
- *Chelonia mydas*		✓			↓	IUCN – Vulnerable with declining population.
Richness/diversity	✓				→	Diversity is limited and there is a high risk of extinction for the hawksbill turtle!

General Recommendations

1. Maintain priority on monitoring turtle populations to inform conservation planning.
2. Raise community awareness of the critical condition and low numbers recorded of E. Eretmochelys imbricate and seek relevant villages (where nesting beaches are located) support and collaboration in enforcing turtle conservation measures.
3. Maintain regular monitoring surveys and identification of whales and dolphins.
4. Establish database for long term whales and dolphins data storage.
5. Analyze genetic materials previously collected.

6.4.5.3. Marine fish

Fishbase™[67] lists 26,710 known finfish species. Of this total 12,848 are listed as primarily marine, 11,311 primarily freshwater and 2,553 brackish or diadromous.

The marine fish species in Samoa can be categorized as nearshore and offshore fishes. The nearshore fish species comprise of those associated with nearshore reefs, lagoons and mangrove areas whereas offshore fishes can be divided into the deep bottom-dwelling species and pelagic species.

A total of 991 fish species have been recorded in Samoa of which 890 are considered shallow-water or reef-inhabiting species [generally at depths <60 m], 56 deep-water bottomfish species [at depths 60-500 m] and 45 pelagic [surface] species. It has also been reported that about 40 fish species are known only from Samoa although FishBase™ does not record any endemic fish species from Samoa. There is a belief that it is likely that there are more endemic fish species in Samoa than those recorded.

Current status

The number of species considered endemic (40) according to Wass (op cit) is questioned by Skelton et al (2000)[68] who suggest that some may well be present in neighbouring islands. There is no available information as to their conservation status.

The IUCN 2012 Red List of Endangered Species includes 13 species of Samoa's marine fish fauna under the categories of either 'endangered' or 'vulnerable'. IUCN's assessment is summarized in Table 19 .

[67] *a software programme developed by the International Centre for Living Aquatic Resource Management-ICLARM*
[68] *Skelton, P; Bell, L; Mulipola, A; and Trevor, A. 2000. The Status of Coral Reefs and Marine Resources of Samoa. Internal Report, Fisheries Division. MAF, Apia.*

Table 19: IUCN Red Listed Marine Fish Species of Samoa

Species #	Scientific name	English name	Samoan name	Threat category	Population Trend
1	Cheilinus undulatus	Humphead Wrasse	Malatea	Endangered	Decreasing
2	Epinephelus lanceolatus	Giant Grouper	Ata'ata-uli	Vulnerable	Decreasing
3	Nebrius ferrugineus	Nurse shark	Malie	Vulnerable	Decreasing
4	Negaprion acutidens	Lemon shark	Naiufi	Vulnerable	Decreasing
5	Rhicodon typus	Whale shark	Faaeme	Vulnerable	Decreasing
6	Rhyncobatus djiddensis	Guitarfish	No Samoan name	Vulnerable	Not known
7	Sphoeroides pachygaster	Puffer fish	Sue	Vulnerable	Not known
8	Bolbometopan muricatum	Bumphead Parrot Fish	Galo	Vulnerable	Decreasing
9	Stegostama fasciatum	Zebra Shark	Malie	Vulnerable	Decreasing
10	Carcharhinus longimanus	White Tip Shark	Malie Aloalo	Vulnerable	Decreasing
11	Carcharhinus limbatus	Black TipShark	Malie Aloalo	Vulnerable	Not known
12	Plectropomus areolatus	Polkadot Cod	Ata'ata-utu	Vulnerable	Decreasing
13	Plectropomus laevis	Blacksaddled Coral Grouper	Ata'ata-utu	Vulnerable	Decreasing

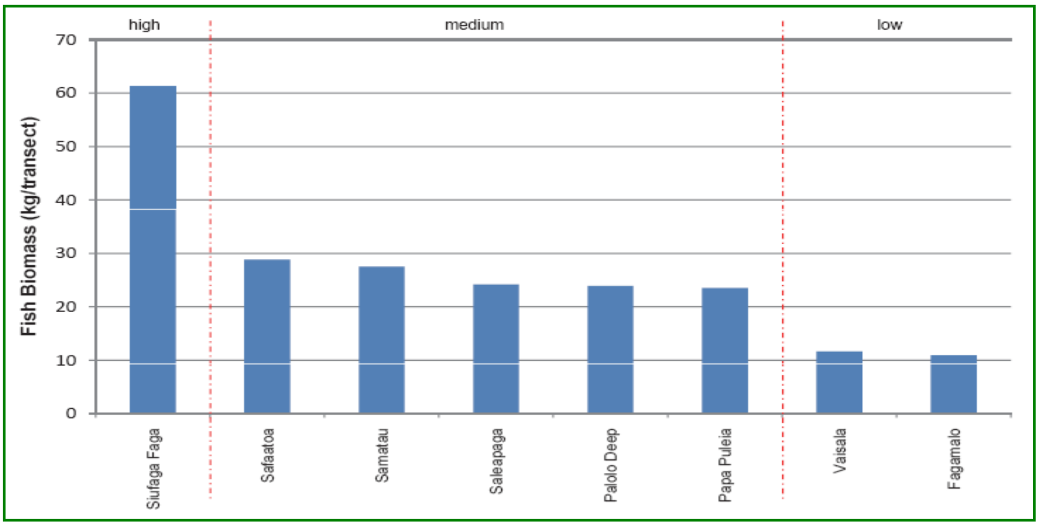
Source: Based on CI-Pacific Islands Programme, MNRE and SPREP. 2010. Priority Sites for Conservation in Samoa: Key Biodiversity Areas. Apia, Samoa.

Fish abundance or biomass

Kendall and Poti's (2011; op cit) provides the latest and by far the most comprehensive assessment incorporating datasets from GCRMN and MAF-Fisheries Village Reserves. The following findings are presented -

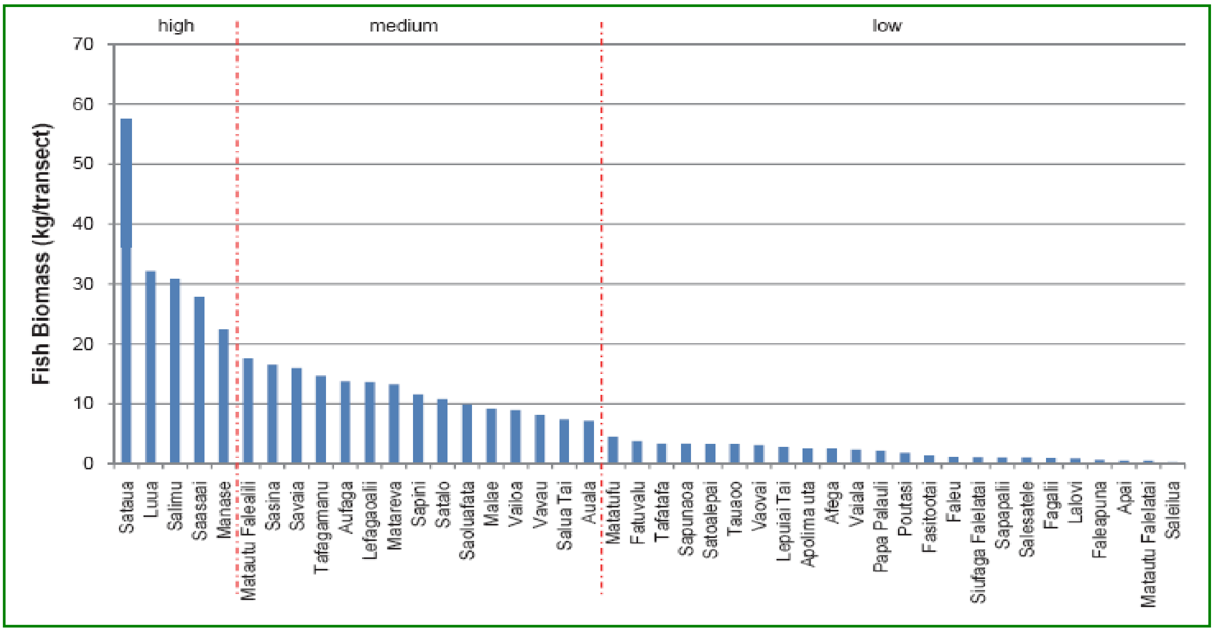
- Only about 10% of Samoa's coastline has high biomass. The remainder of the Samoa's coastline is evenly divided between the low and medium categories.
- A relatively large proportion of Savaii, ~ 22% of coastline, had high fish biomass whereas none of Upolu's coast was classified as high.
- The northern coasts of Savaii between Falealupo village and Apolima Strait possess a large proportion of sites with high biomass (i.e. the hot spot for fish in Samoa).
- Upolu has large regions of low biomass in the Manono/Apolima Strait area, between Apia and Fagaloa Bay and on the southern coast between Falealili and Aleipata Islands.

Graph 9: Fish biomass/abundance assessment using GCRMN sites



Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

Graph 10: Fish abundance assessed in MAF's village reserves



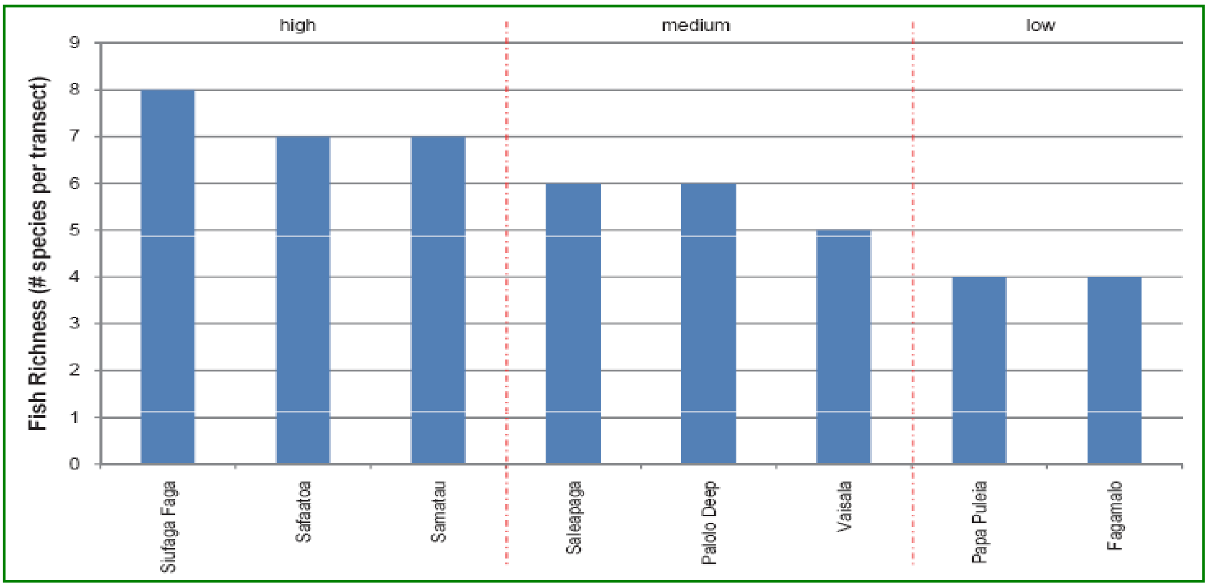
Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

Fish richness/diversity

Kendall & Poti et al (2011) found that the coastlines of Samoa were approximately evenly distributed among high, medium and low fish richness values. In contrast to other variables (i.e. fish biomass, coral richness etc.), Upolu had a greater proportion of sites classified as high richness and fewer classified as low richness relative to Savaii.

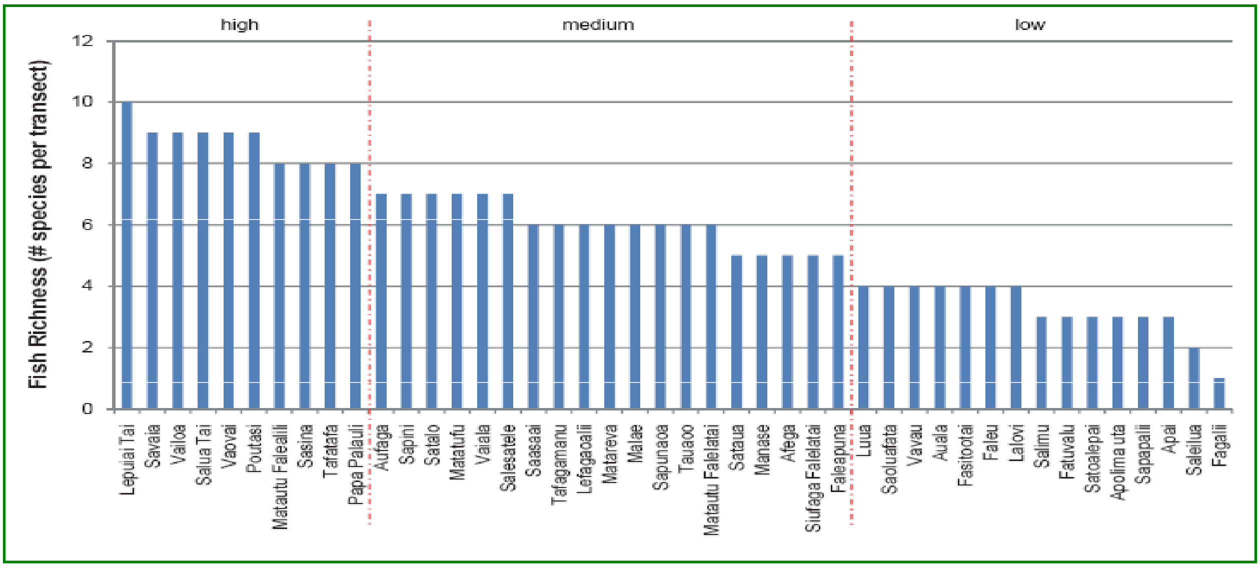
- Savaii possesses fewer high values and large proportion of low value sites for fish richness on its northern coasts.
- Areas of low richness were again found in Manono Is/Apolima Strait area and eastward past Apia to Fagaloa Bay.

Graph 11: Fish richness assessed in GCRMN sites



Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

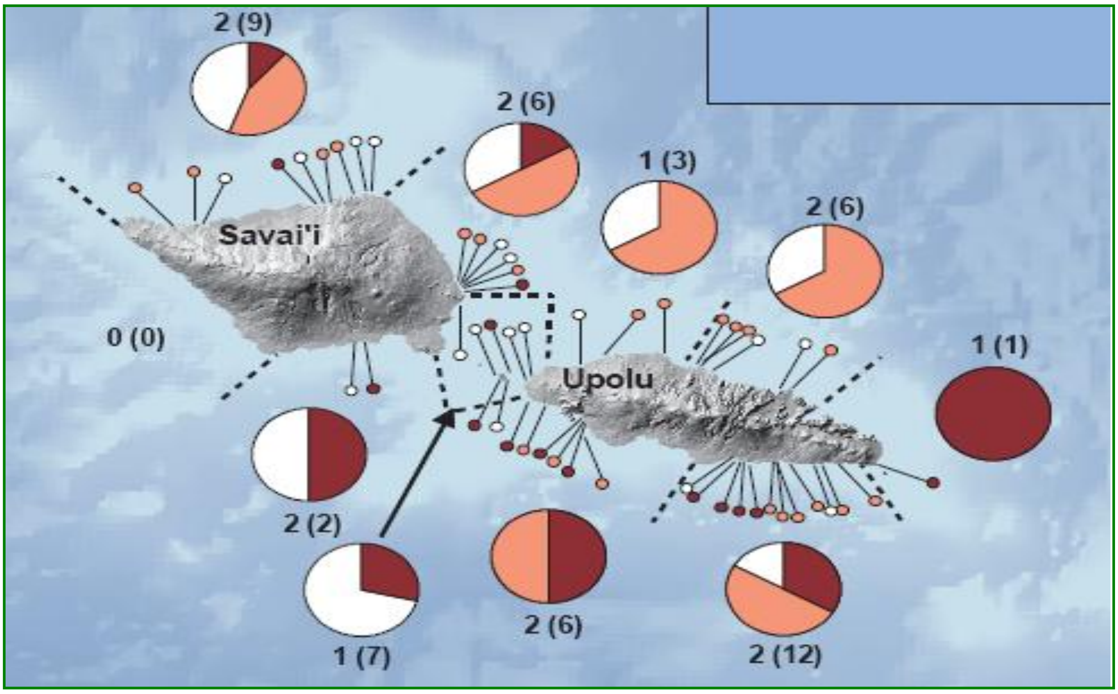
Graph 12: Fish richness assessed in MAF's village reserves



Source: Kendall & Poti (eds.). 2011. *A Biogeographic Assessment of the Samoan Archipelago*. NOAA, USA.

Overall, Kendall and Poti (ibid) observed that fish is more plentiful (high abundance) along the north western coastline of Savaii and fewer (low abundance) along the northern Upolu coast from Manono/Apolima Strait past Apia to the Fagaloa Bay. But there are more kinds of fish (fish richness or variety is high) in northern Upolu coast and along the north western coastline of Savaii. The 'high' variety of fish species in northern Upolu - despite being low in coral cover and coral diversity - may well point to the presence of unique coral communities in this area (ibid.).

The possible presence of unique coral communities that are indicated by the high fish species diversity in north western Upolu is important information for the location and design of future management and conservation initiatives by MNRE and MAF-Fisheries.



Map 13: Fish richness at survey sites across Samoa

Source: Kendall & Poti (eds). 2011.

Overall assessment –

Species health indicators – Northern Upolu	Poor/Low	Fair/Medium	High/Good	Trend
Fish abundance	✓			↘
Fish richness		✓		→

Species health indicators – Northern Savaii	Poor/Low	Fair/Medium	High/Good	Trend
Fish abundance			✓	Unknown
Fish richness	✓			Unknown

Species health indicators – South Upolu	Poor/Low	Fair/Medium	High/Good	Trend
Fish abundance		✓		Unknown
Fish richness		✓		Unknown

6.4.5.4. Tuna

Tuna is a highly migratory species and the stock of tuna within the collective EEZ of the Pacific Islands Countries and Territories (PICTs) is highly variable. Models developed to estimate the available tuna stock are generally regional in scope and scale.

Samoa's EEZ is the smallest in the Pacific and its tuna resource is estimated to comprise less than 1% of the total tuna resources of the western and central Pacific (MAF, 2010)[69]. Langley (2006:14)[70] estimated this regional resource stock to be in the order of 300,000 mt spread over 14.5 million square kilometres of Pacific Ocean. At any given time, the level of abundance of the tuna resource in a specific area such as Samoa's EEZ is dependent on the combination of the following three factors - total stock size, the prevailing oceanographic conditions and location depletion effects (Langer 2005:18)[71].

Samoa's tuna resource is made up of the following main species namely albacore tuna, yellow fin tuna and big-eye tuna. The indicative percentage distribution for Samoa is given in the table 20 below, FAO (2009).

Table 20: Tuna Species and % Total Stock

Tuna Species	Scientific name	% of total stock
Albacore Tuna	*Thunnus alalunga*	80%
Yellowfin Tuna	*Thunnus albacares*	8%
Big-eye Tuna	*Thunnus thunnus*	3%
Other spp (wahoo, dolphinfish, swordfish, others)	Various spp	9%

Source: FAO. October, 2009. National Fisheries Sector Overview. FAO.

Langer's (ibid.) 2006 assessment of the regional tuna stock shows that overall, the South Pacific albacore stock is well above the established Maximum Sustainable Yield (F_{MSY}); and the adult biomass is substantially higher than the adult biomass at the level corresponding to Maximum Sustainable Yield (MSY) (i.e. SBcurrent > SBMSY). Langer (ibid.) estimated that 2006 exploitation rates were much lower than the fishing mortality rate required to produce the MSY (i.e. Fcurrent < FMSY). Therefore, overharvesting was not occurring.

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[69] *Ministry of Agriculture and Fisheries. 2010. Samoa Tuna Management and Development Plan 2011 – 2015. Government of Samoa.*

[70] *Langley, Adam.M. 2006. The South Pacific Albacore Fishery: A summary of the status of the stock and fishery management issues of relevance to Pacific Islands Countries and Territories (PICTs). Technical Report 37. Noumea, New Caledonia: Secretariat of the Pacific Community.*

[71] *Langley, A.D. 2006. The South Pacific albacore fishery: a summary of the status of the stock and fishery management issues of relevance to Pacific Island countries and territories. Technical Report 37. Noumea, New Caledonia: Secretariat of the Pacific Community.*

Current state
Key features of the regional tuna assessment are highlighted in Box 2 below to clarify the broader context within which Samoa's tuna resource exists. This is due to the highly migratory nature of the tuna resource and therefore the interconnected nature of the resource within Samoa's EEZ with that of the wider Pacific region.

The most recent assessment of the Pacific regional tuna resource is provided by Harley et al (cited by Kinch et al 2010).

Box 2: Summary of Regional Stock Assessment –

Big-eye tuna stocks –
- not yet in an over-fished state with respect to total biomass;
- adult biomass projections indicate that the stock will become over-fished in the next few years with regards to both total biomass and spawning biomass.

Yellow-fin tuna stocks –
- a small probability (~ 6 %) that the yellow-fin stock is in an over-fished state due in part to the fishing effort by purse-seiners that generally catch smaller and younger fish.

Skipjack tuna stocks
- highly productive, and over-fishing is not occurring within these stocks

Albacore tuna –
- there is some uncertainty regarding the sustainability of fishing effort targeting these stocks although current fishing effort is well within sustainable levels.

Source: Harley et al cited by Kinch et al 2010)

The regional stock assessment indicates that substantially higher long-term sustainable yields could be taken from the stock — MSY is estimated to be about 180,000 mt, approximately three times the level of recent annual catches (about 55,000 mt). However, given the current distribution of fishing effort, effort by all fisheries would have to increase by 19-fold to achieve the MSY (i.e. FMSY). The resulting reduction in biomass (to BMSY) would result in a reduction in catch rates in all fisheries, although the magnitude of the decline in vulnerable biomass and the corresponding reduction in CPUE would vary between fisheries. In brief the regional stock is relatively healthy with the current biomass of albacore fishery in excess of the biomass (B_{MSY}) that would support a Maximum Sustainable Yield (MAF, 2010)[72].

MAF's (2010)[73] assessment of Samoa's tuna resource is largely based on the albacore stock, which is the mainstay of the country's longline fishery. Other tuna species are also important but the availability of the albacore tuna dictates the operation of the fishery (ibid.).

MAF Fisheries estimates Samoa's annual maximum sustainable yield (MSY) at around 7,000 metric tons. Figures of tuna landings between 2008 and 2011 show that levels of exploitation are well within the MSY.

Table 21: Fish landings 2008 - 2011

Fish landings	2008 - 2009	2009 - 2010	2010 - 2011	Comments
Tuna	3,700 mt	2,350 mt	2,937 mt	
Troll & bottom fish	133.6 mt	146.9 mt	281.0 mt	Increase between 2011 and 2008 is due increase in catches of skipjack around FADs.

Source: MAF-Fisheries (ibid) provided the following assessment -

"An update of the 2010 stock assessment for southern albacore was conducted in 2011 and shows that this stock is still in a healthy state and is not being overfished. However, it is cautiously recommended that further increase of fishing mortality may impact on the longterm sustainability of the SP Albacore stocks." The caution relates to the high fish mortality of larger and older albacore stock which is heavily targeted by long lining fishery.

In terms of species richness, the four tuna species found in Samoan waters are of relatively healthy populations and are widely distributed within Samoa's EEZ. Projections of biomass for the foreseeable future see a relatively healthy regional stock. Albacore is particularly healthy with current biomass in excess of the biomass (B_{MSY}) that

[72] *MAF Fisheries Division. 2010. Samoa Tuna Management and Development Plan 2011-2015. MAF-Fisheries, Apia.*
[73] *MAF Fisheries Division. 2010. Fisheries Division Annual Report 2009 – 2010. unpl. MAF, Apia.*

would support Maximum Sustainable Yield (MSY). Moreover current and estimated fishing mortality (base on the STMDP 2011-2015) is lower than the fishing mortality (FMSY) that results in the MSY.

Overall Health Assessment for tuna

Species health indicators	Low	Medium	High	Trend	Comments
Fish abundance - albacore			✓	↓	Decreasing stock of old and larger size albacore due to commercial exploitation.
- big-eye	✓			→	
- yellow fin	✓			→	
Fish richness			✓	**Not known**	No change to species diversity.

General Recommendations

1. Encourage the rehabilitation and restocking of fish in depleted coastlines with priority focus on the northern Upolu coastline.

2. Conduct regular coral and fish assessments as part of a scientifically designed fish and corals monitoring program using standardized methodologies and indicators to allow data comparability and exchange.

6.4.5.5. Marine Molluscs

Animals that belong to the mollusc phylum are diverse but "are related by being soft bodied with organs covered by a sheet of tissue called the mantle". Although the most obvious characteristic of molluscs is often one or two shells secreted by specialized cells in the mantle, not all molluscs have shells. There are more than 50,000 species of living molluscs in the world.

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

Bivalvia

Bivalves are characterized by two shells [valves] that are hinged on the animal's dorsal surface and include animals such as Clams, Oysters, Scallops, Mussels and Cockles. The most common bivalves found in Samoa include 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].

Current Status

Two species of native giant clams, *Tridacna squamosa* and *T. maxima,* exist in Samoa. *T. squamosa* is considered functionally extinct. A third species, *Hippopus hippopus*, is believed to have existed in Samoa before but became locally extinct. This species has been re-introduced in addition to two other giant clam species, *T. derasa* and *T. gigas.*

Overall Assessment

Species health indicators	Low	Medium	High	Trend	Comment
Species abundance		✓		↑	Increasing trend is largely as a result of reintroductions in village fisheries reserves
Species richness			✓	↑	Total species diversity has increased with reported introductions.

Gastropoda:

Gastropods commonly have a single, usually spirally coiled shell into which the body can be withdrawn although some have either lost or reduced shells. Animals in this Class include snails and slugs. The important gastropods used for food in Samoa include the topshell, *Tectic pyramis* [aliao] and the turban shell, *Turbo chrysostoma* [alili]. One source listed another species of topshell and four other of turban shells to be found in Samoa. These require confirmation. Other common gastropod species found in Samoa include, the 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). The most widely known sea slug in Samoa is the green seahare (*Dolabella auricularia* – gau). Several other species of sea slugs have been recorded in Samoa. Two species of marine gastropods have been introduced into Samoa. These are the trochus, *Trochus niloticus*, and the green snail, *Turbo marmoratus*.

Current Status –
There is no recent information since 2006 of the current status of gastropoda. The following overall assessment is based on consultations and expert views.

Overall Health Assessment

Species health indicators	Low	Medium	High	Trend	Comment
Species abundance		✓		Not known	
Species richness			✓	↑	Species diversity has increased with recent introductions

Cephalopoda:
Animals found in this diverse group have foot that lies close to the head. A shell is sometimes present. Most cephalopods have chromatophores, which are special pigment cells that allow them to change colour rapidly and have a sac that secretes sepia [an ink-like substance]. This group includes octopus, squids, cuttlefish, nautilus. At least one species of octopus [fee] and cuttlefish [gufee] are found in Samoa.

Overall Health Assessment

Species health indicators	Low	Medium	High	Trend	Comment
Species abundance		✓		Not known	
Species richness			✓	Not known	

Polyplacophora
This class includes animals known as chitons, which are flattened, elongated animals with eight overlapping dorsal shell plates or valves bordered by a thick girdle formed from the mantle. Most chitons are small except for one species that reach 30cm in length. All chitons are marine with most species living in the rocky intertidal zone. There are currently around 600 species known in the world. Ten species of chitons have been recorded in Samoa with two having Samoa as their type locality. One species has been described as a new species and two species may be endemic to the Samoan archipelago.

Current status –
There has not been a recent survey of this group to confirm its status. This assessment is based on anecdotal information and expert consultations.

Overall Health Assessment

Species condition	Low	Medium	High	Very High	Trend	Comment
Species abundance		✓			→	Expert assessment only.
Species richness –			✓		→	There are no changes to the existing diversity. Reports of new and endemic species need to be confirmed.

General recommendations

1. Encourage assessments of molluscs for conservation planning and resource management purposes.
2. Encourage and support the reintroduction of clams in inshore areas using community based reserves.

6.4.5.6. Crustaceans

Crustacean is a group of animals with hard exoskeletons, jointed legs and segmented body that is bilaterally symmetrical. There are about 40,000 known species of crustaceans in the world of which most are marine. The group includes animals such as crabs, lobsters, shrimps, prawns, copepods and barnacles. In Samoa, the number of crustacean species is not known.

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.

Crabs

Crab species more commonly known in Samoa include:

Table 22: Crab species found in Samoa

Common name	Scientific name	Local name
Coconut crab	*Birgus latro*	Uu
Mangrove crab	*Scylla serrata*	Pa'alimago
Land crab	*Cardisoma carnifex*	tupa
Land crab	*Cardisoma sp.*	mali'o
Red claw mangrove crab	*Sesarma erythrodactyla*	u'a
Hermit crab	*Pagurus sp*	'uga
Reef crab	*Carpilius maculatus*	kuku
Reef crab	*Leptodius sp.*	vaevaeuli
Reef crab	*Zosymus aeneus*	
Ghost crab	*Ocypode ceratophthalmus*	avi'ivi'i
Rock crab	*Grapsus sp.*	amaama
Fiddler crab	*Uca sp.*	
Swimmer crab	*Thalamita sp.*	pa'a tala
Burrowing crab	*Calappa sp.*	tapola

Current status –

There is no on-going monitoring of population except data from MAF market surveys of fish landings wherein harvested crabs are reported. Elisara and Sagapolutele (2011) biodiversity audit report of several mangrove ecosystems in Samoa included observations of mangrove and coconut crabs.

Overall Assessment

The following assessment is based on expert consultations and anecdotal information.

Species health indicators	Poor	Medium	Good	Very Good	Trend	Comment
Species abundance			✓		➔	
Species richness			✓		➔	There are no reports of local extinctions.

Lobsters

The more commonly known lobster species in Samoa are tabulated:

Table 23: Common Lobsters Species in Samoa

Common name	Scientific name	Comments
Spiny lobsters	*Panulirus penicilatus*	Local name – ula sami
Spiny lobster	*P. versicolor*	Rare in Samoa
	P. longipes femoristriga	Very rare in Samoa
Slipper lobster	*Parribacus antarcticus*	Local name – papata
	Par. caledonicus	Local name – papata
Deep water lobster	*Palibythus magnificus*	Only known specimen were caught in Samoa

Shrimps/prawns
Indigenous freshwater prawns recorded and utilized in Samoa include *Macrobrachium lar* [fa'ivae/ula vai] and Palaemon sp. One author listed two Palaemon sp. found in Samoa. The giant Malaysian freshwater prawn, *Macrobrachium rosenbergii,* was introduced on several occasions into Samoa starting in 1979 for aquaculture purposes. It is not known whether this introduced species has established itself in our local freshwater environment.

The more commonly known marine shrimp species recorded in Samoa are tabulated below:

Table 24: Marine Shrimps Species Recorded in Samoa

Type	Common name	Scientific name	Local name
Coastal shrimps	Mantis shrimp or banded prawn killer	*Lysiosquilla maculata*	Valo
	Clam shrimp	*Pontonia sp.*	
	Cleaner shrimp	*Lysmata sp*	
	Banded coral shrimp	*Stenopus sp.*	
Deep water shrimps	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*	
		Penaeid sp.	

The marine shrimp known as the giant tiger prawn, *Penaeus monodon*, was introduced into Samoa from Tahiti in 1980 for culture trials. It is suspected that a small population may have escaped into the wild and established (MAF-Fisheries, 2003)[74]. Similarly a small unidentified shrimp also exists near the shore especially near mangroves where there is some fresh-water influx (ibid).

Current Status
No recent quantitative survey of marine shrimps was conducted. Fisheries Division monitoring of catch at the Apia Fish Market provide limited information on biomass/abundance.

Overall Health Assessment

Species health indicators	Poor	Medium	Good	Very Good	Trend	Comment
Species abundance			✓		Not known	
Species richness			✓		Not known	Increasing diversity with recent introductions.

General recommendations

1. Enforce minimum regulations for mangrove crabs.

2. Support replanting and conservation initiatives for mangrove forests.

6.4.5.7. 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. They are classified into 5 related classes, *Holothuroidea* (sea cucumbers or holothurians), *Echinoidea* (sea urchins, heart urchins and sanddollars), *Asteroidea* (sea star or starfish), *Ophiuroidea* (brittle stars, serpent stars and basket stars), and *Crinoidea* (feather stars and sea lilies). Echinoderms are characterized by radial symmetry, several arms (5 or more) radiating from a central body. The body actually consists of five equal segments, each containing a duplicate set of various organs. They have no heart, brain nor eyes. There are about 6,000 living species of echinoderms in the world.

Several species of sea-urchins and sea cucumbers are utilized locally for food and are also sold either at market outlets or along the roadside.

[74] *MNRE. June 2003. Marine Resources II.*

Sea cucumbers
There are several sea cucumber species that are of importance and utilized in Samoa. The edible species are usually collected by women during their reef gleaning and sold in local markets or along the roadsides in bottles. Some of these species were utilized in the bech-de-mer commercial undertakings that were in operation in the early 1990's.

Hampus (2006) reported *Holothuria atra* to have the highest densities and highest occurrence with Stichopus *chloronotus* the second highest in numbers. *Bohadschia argus* and *B. vitiensis* were both found in moderate numbers and only 2 specimens of *Holothuria nobilis* were recorded in areas of high oceanic influence. *Holothuria hilla* and *Stichopus horrens* was irregularly encountered. He reports "the density records in general show a restrained stock despite absence of fishing pressure for over 10 years".

Sea cucumber species recorded in Samoa are tabulated below. Except *Holothuria hilla* (amu'u) and the two species of peva, *Synapta maculata* and *Euapta godeffroyi*, all are known to be utilizable.

Table 25: Sea Cucumber Species Recorded in Samoa

Scientific name	Common name	Local name
Holothuria (Halodeima) *atra*	lollyfish	loli
Stichopus horrens	Pricklyfish, dragonfish	Sea
Bohadschia argus	leopardfish	ulutunu/fugafuga gatae
B. marmorata	Tigerfish	fugafuga ai
	Brown sandfish	
Bohadschia vitiensis	surf redfish	mama'o
Actinopyga mauritiana		
A. echinites	Redfish	mama'o
	Blackfish	
A. miliaris	black teatfish	susu valu uliuli
Holothuria(Microthele) nobilis		
H. (Microthele) 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
S. chloronatus	greenfish	Maisu
Holothuria hilla		Amu'u
Synapta maculata		Peva
Euapta godeffroyi.		Peva

Source: MNRE, 2012.

Current status
GCRMN 2008 monitoring found very low density in population which is consistent with earlier assessments by Hampus (2006, op cit), 2006 assessments by SPC and the Fisheries Division. The latter report observed that stocks have never quite recovered from the early 1990's tropical cyclones. As a result, the Government is adopting the precautionary approach to close the commercial harvesting of these species (Leong –Samuelu and M Sapatu 2007). This arrangement is still in effect.

Assessment of health

Species health indicators	Poor	Medium	Good	Very Good	Trend	Comment
Species abundance			✓		➔	
Species richness			✓		Unknown	Recent introductions have increased diversity.

6.4.6. Inshore and Offshore Marine habitats – Overall Assessment

Five different marine habitats are discussed in detailed in the SOE. There are however many more habitats in Samoa's offshore/marine environment which are not discussed due to the lack of information and data. Consequently, the overall assessment of Samoa's offshore/marine habitats is incomplete. The challenge for the immediate future is to embark on a monitoring program for all important habitats, for future SOEs to present a holistic and comprehensive assessment.

Based on the information available, northwest Savaii has the highest coral biomass and the healthiest coral reefs in Samoa. But the diversity of coral species found is low compared to Upolu. Conversely, corals and coral reefs along the northern coast of Upolu from Manono/Apolima Strait to Fagaloa are significantly of poor health, with lower coral biomass. Despite this, coral species diversity is higher relative to other parts of Samoa.

Knowledge of the presence of seamounts is both of conservation as well as economic interest. There are two seamounts of potential interest given their shallower depth and the possibility of being host to underwater reefs. These are the Pasco Seamount and To'afilemu Seamount but no detailed studies have been conducted on their respective ecologies to enable an informed assessment.

Of seagrasses, the limited communities found in Samoa are situated in easternmost end of Savaii, and the westernmost end of Upolu along the coast of Falelatai. A few small communities are found off the coast of Aleipata and southern Upolu. Overall they are not well documented and monitored. They were last studied in 1992 with no recent information on their state of health other than confirmation of their continued presence.

Of marine fish, the distribution of coral fish populations is consistent with that of coral biomass, with fish populations high in Northern Savaii and in parts of Southern Upolu but consistently poor in the northern coast of Upolu. The decline in population increases as one move from west to east with the highest areas of concentration on the North West, and the lowest on the Fagaloa end of Upolu. There is however a greater diversity of species found in Northern Upolu than in the rest of Samoa's inshore and reef areas, pointing to the presence of unique coral assemblies in parts of this area.

Samoa's tuna resource - particularly the albacore stock that is the mainstay of Samoa's longlining fishing industry - is in relatively good condition. There is some concern with the higher level of mortality for larger and older tuna population, due to higher fishing effort, but overall, Samoa's total fishing effort for tuna is well within the estimated Maximum Sustainable Yield. The prescribed level of exploitation in the Samoa Tuna Management and Development Plan 2011-2015 is sustainable.

Whales and dolphins are regularly monitored with recent surveys confirming new species' presence. Of the 40 species of whales and dolphins known to be present in the Pacific Ocean, 12 are regularly observed in Samoan waters. Only one – *Stenella longirostris* – is known to have an increasing population while others are considered vulnerable with declining numbers. The statuses of others are unknown due to the lack of data.

The two turtle species are globally significant with the hawksbill turtle (*Eretmochelys imbricata*) critically endangered, and the green turtle considered vulnerable. Both have decreasing populations. Samoa's beaches (particularly in the Aleipata MPAs) are important nesting sites for the hawksbill turtle. Other main species groups of Samoa's marine fauna – molluscs, crustaceans and echinoderms – are not well monitored with limited information available on their populations.

6.4.7. General Recommendations

1. More regular surveys and assessments are needed to update and ascertain the status of various marine species' groups in Samoa's inshore and offshore habitats, and to inform conservation and management planning. This applies to seaweeds and algae, as well as molluscs, crustaceans and echinoderms.

2. The northern coast of Upolu from Manono and Apolima strait to Fagaloa should be the priority area for conservation management, including the establishment of fisheries reserves and the restocking of inshore areas with depleted species.

3. Nesting beaches of marine turtles should be more effectively protected. Close collaboration with custodian communities including the Aleipata and Safata MPA villages should form a central strategy for marine turtle protection.

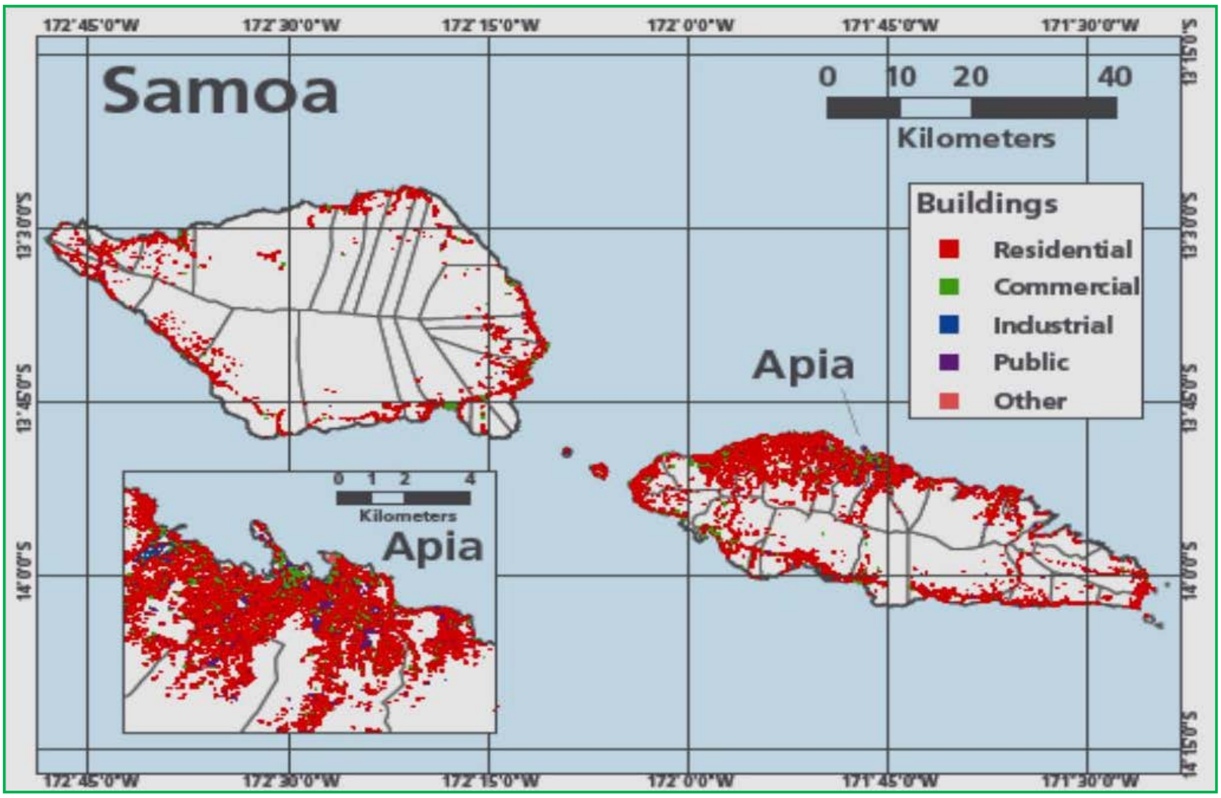
4. Monitoring of inshore and offshore habitats and species should be a priority and an on-going activity of both MAF-Fisheries Division and MNRE. The approved SOE indicators should be used for consistency. Similarly, collaborative arrangements with relevant regional organizations including SPC and SPREP, and other international conservation organizations such as IUCN and GBRMN should be cultivated and encouraged.

6.5. Rural and Urban Built Environment

The most dominant modification to Samoa's natural environment is the man-made world of structures that supports human life. This built environment is a distinct 'habitat' that provide the setting for human activity, ranging in scale from personal shelter and buildings to neighborhoods and sites that can often include their supporting infrastructure, such as water supply or energy networks. In planning terms, the built environment function as an organism in the consumption of resources, disposal of wastes and facilitation of productive enterprises within its bounds.

As a distinct albeit artificial 'habitat', the built environment is treated separately to reflect its cross-habitat and spatially expansive nature. For Samoa, the dominant feature is its coastal concentration although there is a close relationship in the rural spread of the built environment and the roading network.

Map 14: Distribution of buildings in Samoa



Source: SOPAC, 2011.

The main interest from an SOE perspective is the general question of - Is our built environment sustainable? This question can be answered by examining a range of indicators such as those below -

- Is our population sustainable?
- Is our built environment efficient in its use of energy resources?
- How dependent are we on fossil fuels and how far have we shifted to renewable energy?
- Are our buildings efficient in energy use?
- Are our constructions using hazardous materials that are damaging to the environment?
- Are new development projects effectively screened for environmental impacts?
- Are our wastes properly managed?
- Are our sanitation facilities healthy and not contributing to environmental degradation?
- Are our communities resilient against natural disasters?

The lack of information on many indicators indicated above restricts this examination to the following – population, houses, wastes, sanitation, energy and EIA application.

6.5.1. Population

Samoa's 2011 census reported a total population of 187,820 with male and female populations at 96,990 and 90, 830 respectively (SBS, 2012). Other salient features are summarized in the table.

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Table 26: Salient features of Samoa's Population

Annual growth rate betw. census 2001 - 2011	0.63%
Population density/km^2	67
Urban population	36,735
Urban population (% of total population)	19.6%
Rural population	151,085
No. private households	26,205
Ave. popn per household	7.2

The national census data does not disaggregate between the various habitats used in this SOE. Thus it is not possible to analyse population distribution in terms of the terrestrial habitats of coastal, lowlands, and upland environments. However, several reports estimate that 70% of Samoa's population and physical infrastructure is concentrated on low-lying coastal areas, a fact that has significant ecological implications on the health of coastal and marine environments and species.

Is our population ecologically sustainable? A sustainable population is one that can be maintained at that number of people indefinitely without adversely impacting the environment or the quality of life of the members of that population. The concept of carrying capacity dictates that our biophysical environment has limits and exceeding those limits will lead to irreversible environmental degradation and break-down in the ecological services that support life on our island environment. However the imaginary threshold above which a sustainable population becomes unsustainable is not easily definable.

Easier to discern however from the available information is the trend in population growth over the last 50 years. Similarly, expert opinion on demography is sought on what a sustainable growth rate might be for Samoa.

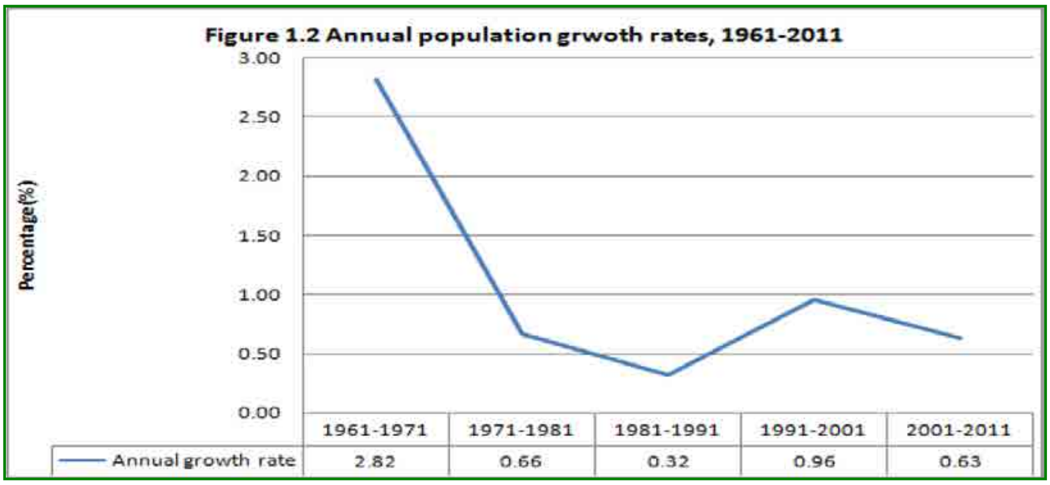
Samoa has had a declining growth rate in population since 1961 except for the period 1991 – 2001, wherein a surge in population growth is reported. Overall however, Samoa's average growth rate since 1961 is about -0.6%.

Table 27: Population densities by region 1981 - 2011

Region of residence	Population and census year				Land area (km2)	Population density			
	1981	1991	2001	2011		1981	1991	2001	2011
Samoa	156,349	161,298	176,710	187,820	2,785	56	58	63	67
Apia Urban Area	33,710	34,126	38,836	36,735	60	562	569	647	612
North West Upolu	40,360	40,409	52,576	62,390	251	161	161	209	249
Rest of Upolu	39,669	41,713	42,474	44,293	780	51	53	54	57
Savaii	43,150	45,050	42,824	44,402	1,694	25	27	25	26

Source: Samoa Bureau of Statistics, Population and Housing Census 2011

Graph 13: Annual population growth rates, 1961-2011



A declining trend in population growth is generally associated with a shift from an unsustainable level to a sustainable one. The current population growth cannot be related to the carrying capacity of our islands because that information is not available thus a sustainable rate cannot be determined.

However, in preparation for this report, consultations with the Samoa Bureau of Statistics (Malaefono, pers comm.), provided some insights. According to SBS, predictions of population growth is difficult because of the widely varying influence of migration, but growth over the next ten years is expected to be between 0.7% and 1.5%[75]. Within this range, an annual growth rate of 1.0% would be within sustainable limits for Samoa (ibid.). In view of this expert assessment, and considering that Samoa's annual population growth rate over the last 10 years is 0.63%, Samoa's population growth rate is already well within SBS's recommended sustainable level.

An interesting feature of the 2011 census data is the observable decrease in the population density of urban Apia and a significant increase in density for Northwest Upolu. Does it suggest a slowing down in the urban drift? Or is the urban drift shifting to the new settlements in nearby Vaitele, which is part of the Northwest Upolu area? These variables are important to monitor closely given the relationship between increasing population densities in coastal areas and the pressures put on coastal habitats, resources and on urban services.

Population health indicators	Low	Fair	High	Very High	Trend	Comment
Decreasing population annual growth rate		✓			↓	Declining since 1961
Decreasing population density of Apia Urban Area decreasing		✓			↓	Declined by 5.4% over 2001 density

6.5.2. Housing

Are our houses environmentally friendly? Is there a high component of materials that are hazardous to humans and the environment? Do our policies promote the use of 'green material and renewable resources, and building methods and standards of constructions that are environmentally sustainable? Does our National Building Code promote house constructions that are resilient to climate change induced extreme events?

The NGHGAS indentified reduction of GHG emission from building as one of eight priority areas to target for GHG emission reduction. To achieve this require strategies based on a good understanding of new building and conservation concepts such as 'green building' and low energy buildings and their environments.

New approaches to housing design for environmental sustainability promotes passive solar energy building design, low energy building or zero energy building techniques, using renewable heat sources. At the same time, existing buildings can be made more efficient through the use of insulation, high efficiency appliances, building orientation and siting, among other approaches. In addition to designing buildings which are more energy efficient to heat, it is possible to design buildings that are more energy efficient to cool by using lighter-coloured, more reflective materials in the development of urban areas (e.g. by painting roofs white) and planting trees.[65][66] This saves energy because it cools buildings and reduces the urban heat island effect thus reducing the use of air conditioning.

Green building materials are composed of renewable, rather than non-renewable resources. In addition, integrating green building materials into buildings can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials. Green building designs includes the utilization of biomass waste to energy technology to reduce emissions from electricity.

Some of these concepts are most likely relatively new to Samoa's construction industry. Similarly the expertise needed for their design and construction is likely to be limited.

Current Status

According to the 2011 National Census report, there are 51,240 houses of various designs in the country. The census data on the types of materials used in construction for roofs, floors and walls, are given in the table below, comparing 2011 and 2006.

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[75] *This estimate takes into account the outflow of migration (for instance, 1,100 leaving for NZ under the Quota system) and inflows of returning Samoans, and fertility being an average of 4 children per woman 15-49 years (Malaefono Fa'afeu-Taua, SBS).*

Table 28: Types of flooring materials

Types of floor materials used in private residences	2011		2006	
Total	51,240	100%	46,048	100%
Stone or sand	4,265	8%	4,877	10%
Traditional wood & untreated timber	12,867	25%	11,917	25%
Concrete	31,743	62%	29,348	65%
Tiles & others	2,047	4%	82	0%
n.s. (not stated)	318	1%	15	0%

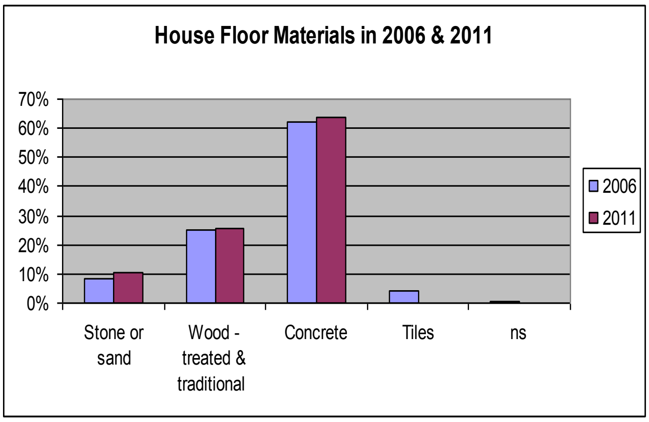
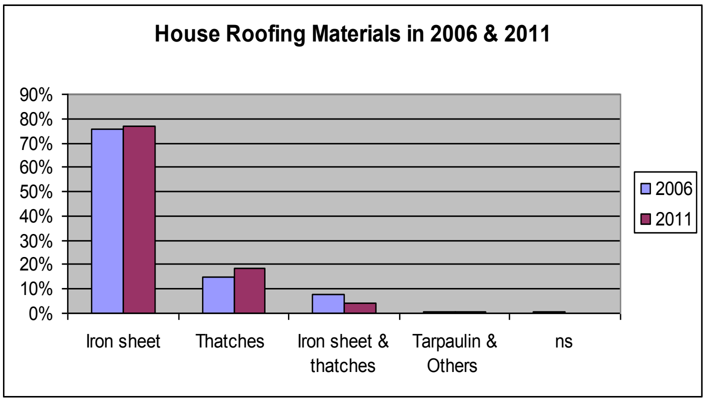


Table 29: Types of roofing materials

Types of roofing materials used in private residences	2011		2006	
Total	51,240	100%	46,048	100%
Iron sheets	4,265	8%	35,311	10%
Thatches	12,867	25%	8,434	25%
Iron sheets & thatches	31,743	62%	2,054	65%
Tarpaulin and others	2,047	4%	222	0%
ns (not stated)	318	1%	27	0%



Tables 29 and 30 and their corresponding graphs show the high level of use of imported concrete and iron roofs in local constructions. Likewise is the low level of use of local resources of thatches and poles.

The high level of dependence on imported construction materials implies reducing pressures on local resources. But this information is incomplete as a basis for assessing sustainability. There is a need for more data for a more informed and scientifically based assessment.

Assessment
Whilst information on housing is scant to allow assessment for environmental sustainability, the little that is evident from available data and anecdotal observations show the following –

- There is no evidence of continued use of hazardous asbestos materials.
- a small but growing use of solar panels (mainly for heated water);
- High usage of natural ventilation in the new large constructions in Apia.
- the traditional open pole design of houses is widely used
- High level of construction using timber and environmentally friendly materials.

Housing health indicators	Low	Fair	High	Very High	Trend	Comment
% of houses with asbestos and other hazardous materials					?	No information
% of houses in compliance with National Building Code incorporating climate change resilience safeguards.					?	No information.
% of househouses located within CIM plans defined hazard zones					?	No information

The MNRE (Renewable Energy Division) is to conduct House energy usage survey to find preferred energy types in various households and the results of the surveys will be published to inform policy development and the general public. The survey will also determine the formulation of appropriate action plan to promote energy efficiency and household renewable energy technologies that have no adverse impacts on the environment.

6.5.3. Sanitation

The management of household sewage is largely done through the use of septic tanks. The 2011 National Census reported 95.2% of all private households in Samoa using 'improved toilet facilities', with toilets flushed to a septic tank constituting 84.9%. These figures are consistent with a 2009 MOH survey reporting improved toilet facilities constituting 94.1% and toilets with septic tanks 85.3%. The significance of systems using septic tanks for on-site waste water management is its sealed water tight design which serves to provide an anaerobic environment for bacteria to digest wastewater as it passes slowly through the tank, breaking down pathogens before the wastewater is discharged into environment. By this process, waste water re-enters the soil without pathogens and nutrients that can contaminate underground water sources, carry water borne diseases and pollute fragile coastal environments. There is also the direct risk to human health from direct contact with wastewater on the ground surface or from consumption of contaminated food.

Table 30: Types of sanitation systems

Percent distribution of households and de jure population by type of toilet/latrine facilities, according to residence, Samoa 2009.

	Households			Population		
Type of toilet/latrine facility	Urban	Rural	Total	Urban	Rural	Total
Improved, not shared facility	95.1	93.7	94.0	94.3	94.0	94.1
Flush/pour flush to septic tank	90.6	83.5	84.9	89.5	84.3	85.3
Flush/pour to a pit latrine	2.9	6.8	6.1	3.3	6.4	5.9
Ventilated improved pit (VIP) latrine	0.9	1.6	1.4	0.9	1.6	1.5
Pit latrine with a slab	0.7	1.8	1.6	0.6	1.6	1.4
Non-improved facility	4.9	6.3	6.0	5.7	6.0	5.9
Any facility shared with other households	3.3	3.5	3.4	3.8	3.4	3.5
Flush/pour flush not to sewer/septic tank/lit latrine	0.0	0.4	0.3	0.0	0.4	0.3
Pit latrine without slab/open pit	0.5	1.1	1.0	0.4	1.1	0.9
No facility/bush/field	0.0	0.1	0.1	0.0	0.1	0.1
Other/ missing	1.1	1.2	1.2	1.6	1.1	1.2
Total	100	100	100	100	100	100
Number	371	1,576	1,947	2,726	11,645	14,371

Source: MoH et al. 2010. Samoa Demographic and Health Survey 2009.

Contrary to the high percentage of improved sanitation systems using septic tanks documented in census reports, several recent studies found (GoS, 2011[76]; ISF-UTS[77]) that about 80% of so-called septic tanks are not true septic tanks. They are not fully sealed, often have no concrete floors as well as other design deficiencies. It means therefore that the risk of contamination of underground water sources is considerably higher. This conclusion is supported by two recent studies; Latu (2011)[78] found excessively high levels of *E.coli* in a study of water wells in 3 Upolu villages while similarly high *E.coli* levels were reported by SMEC (2011)[79] in a study of five villages in Fagaloa[80]. Another related aspect reported by SMEC (ibid.) is the high population of free-roaming domestic animals which wastes enter the soil and compound the adverse impacts noted on groundwater sources, and coastal habitats.

The issue of inferior design of household septic tanks needs to be addressed, particularly for all new constructions. This is already advocated by the National Sanitation Policy (2010).

In other aspects of sanitation management in Samoa, however, good progress is reported in the implementation of the National Sanitation Management Plan. These include:

- the commissioning in late 2010 of a septage disposal lagoon at Tafaigata and, in early 2012, at Vaiaata. A third facility is in the pipeline for Togitogiga.
- MWTI have been working with the ADB TA7301-SAM to update the septic tank section of the National Building Code, with educational DVDs showing how to contruct proper septic tanks already available from MWTI.
- The Ministry of Health through the Health Promotion and Preventative Services (HPPS) Division has been incidences of water borne diseases and water quality data to check against the National Drinking Water Standards 2008. Community awareness activities in relation to sanitation have also been conducted including a hand washing programme in schools.
- A waste water treatment plant and pressure sewer system have been constructed and now serving over 130 commercial customers in the Central Business District, producing a flow of approximately 800 m^3/day against a wastewater treatment plant capacity of 1,000m^3 per day .
- MWCSD has been running a programme called 'Aiga ma Nuu Manuia' which works through Women's Committees in villages to collect data on the general well being of villages including sanitation. Its been active since 2008 and involves monthly inspections in all villages where there is an active Women's Committee.
- 108 septic tanks for schools and district hospitals were constructed under the WaSSP[81], under the Public Health Department of the Ministry of Health.
- Under the Samoa Sanitation and Drainage Programme (SSDP), a programme to supply septic tanks to low lying areas of central Apia was completed. This followed a sanitation survey of 859 households in 13 villages in Apia. These tanks were precast, and were raised out of the ground as mitigation against the high ground water levels. One hundred and one precast tanks were installed in Taufusi, Tufuiopa, Togafuafua and Tauese villages.
- A subsidy scheme for septic tank construction is under preparation to be funded by an ADB grant.
- MNRE through the Renewable Energy Division (RED) is promoting the use of biogas digesters that generates electricity and cooking gas (methane) using green waste and household waste and at the same time, an on-site waste management system.

[76] *Government of Samoa. May 2011. Samoa – National Infrastructure Strategic Plan. PRIF. 2011*
[77] *ISF-UTS. 2011. Samoa Water, Sanitation and Hygiene Sector Brief, prepared for AusAID by the Institute for Sustainable Futures, University of Technology Sydney, October 2011.*
[78] *F. Latū, P.Amosa, T.Imo, and V. Taufao. 2012. "The Microbiological survey of potential water borne pathogens in fresh water springs of the selected community located in the Upolu Island, Samoa." National University of Samoa.*
[79] *Op cit*
[80] *In the SMEC study, waste from free-ranging domestic animals was also noted as a contributing factor.*
[81] *Water and Sanitation Support Programme*

Figure 6: Main Pressure Sewer Alignment and Waste Water Treatment Plant Site in Sogi

Source: National Sanitation Master Plan 2011.

Assessment:

Sanitation health indicators	Low	Fair	High	Trend	Comment
% of households with improved ('true') septic tanks	✓			?	Due to high estimate of households (~80%) with 'not true' septic tanks.
% of reported incidences of illnesses due to water borne diseases				?	Data deficient

6.5.4. Solid and liquid waste

Is solid and liquid wastes properly managed in our built environment? Are we producing more or less waste per person? How much hazardous waste there is and how are they being managed?

Current Situation –

Municipal Waste

Samoa generates 175kg of waste per capita per annum in the Apia urban area, and 130kg per capita in rural areas; (MNRE, 2010). This translates to 0.47 kg/person/day for Apia urban area, and 0.36 kg.person/day in rural areas (ibid.). Other reports give a slight increase in the 2011 rate and present a decreasing trend between 1994 and 2011. This is given in Table 31 below.

Table 31: Waste Generation Rates for Apia Urban Area 1994 -2011

Parameter	1994	1999	2006	2011
Generation rate (kg/person/day)[82]	0.52	0.99	0.45	0.38

Waste surveys conducted by MNRE (2007, 2011) show that most household wastes are of organic refuse but plastics and other inert materials constitute a significant and growing share of waste output. Diapers constitute an important component in 2011 that was not reported in the 2007 study.

Table 32 gives waste types and their relative percentages.

[82] *Generation rates for 1004, 1999, and 2006 is cited from the MNRE – 2006 SOE (p.135). Rate for 2011 is based on MNRE data (Setoa Apo, pers comm.).*

Table 32: **Waste composition by percentage - 2007 and 2011**

	2007	2011
Green waste	40.01	38.7
Food scraps	11.65	3.8
Paper	1.6	6.93
Cardboard	6.0	0.27
Plastic bags/papers	7.5	6.52
Plastic bottles/containers	7.5	6.52
Diapers	-	6.52
Glass	2.2	2.17
Metals	7.2	8.83
Textiles	6.7	6.79
Others	11.0	4.35
Source: MNRE, 2011[83].		

Collection

Household waste is collected by a Government-funded collection service at no direct cost to the public. Ninety seven percent (97%) of the total population is accessible to this service including the islands of Manono and Apolima. Commercial operators are excluded; they transport their own solid wastes to the landfills for disposal. Likewise, the collection of septage from households is not covered under the Government contracted services but is carried out by the private contractors upon request with households responsible for the transport and disposal cost.

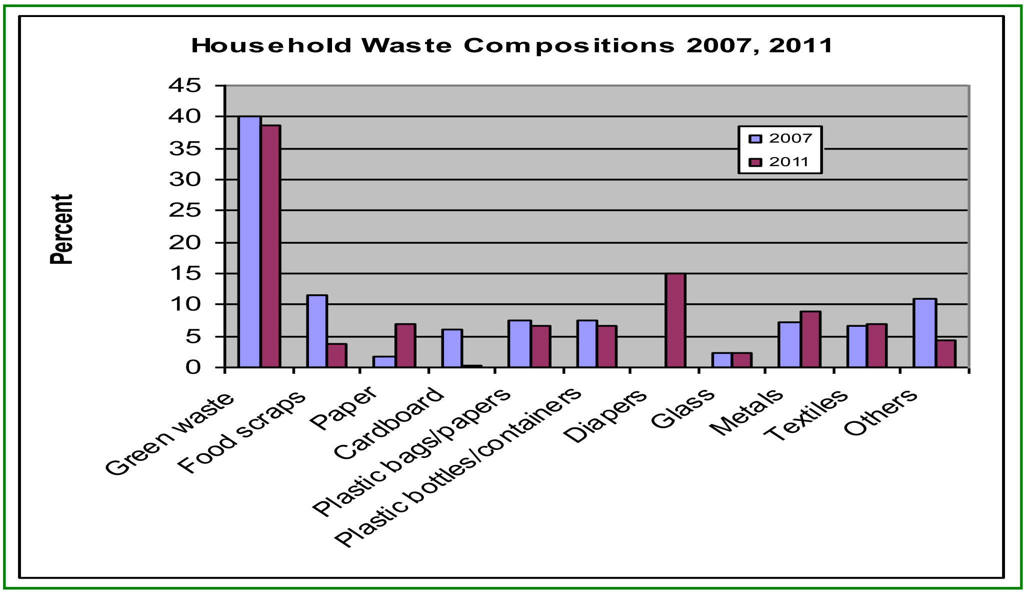
Of household wastes, MNRE estimates[84] that 110.7 tonnes is received and disposed of annually at the Tafaigata landfill, out of an estimated total waste generated of 970.9 tonnes per year. This means for Upolu, only 11.4% reach the landfill, with the remaining 88.6% generated either burned and or buried in backyards, or used as green waste for mulching, or disposed of inappropriately (into the sea, rivers, mangrove areas etc.). It is also possible that waste is collected at the household level and collected by contractors but disposed of inappropriately in unapproved sites. Most likely it is a combination of all these factors. Overall the high percentage of waste generated that does not reach the landfill is a concern. It points to the persistence of unsustainable waste management practices at the household level, low level of public support for the waste collection programme, and, possibly, illegal dumping by waste collectors.

MNRE also estimates that 57.9% of the total volume of household wastes reaching the landfill could be composted or recycled (ibid.). If this level is maintained, the landfills will fill up faster and new landfill facilities will be needed. This implication underscores the economic importance of increased composting and recycling; they promote not only sustainable resource use but also optimize the benefits from landfills by extending their economic life spans.

The high percentage of recyclable and compostable reaching the landfill is predictable. There is no formal collection of recyclable materials from households and only one recycling outfit operates out of the Tafaigata landfill. There are, however, MNRE plans for a large scale scrap metal recycling operation to be established at the Tafaigata landfill site equipped with specialized machines and equipment but these plans are yet to be implemented. The Japan funded Project for the Promotion of Regional Initiative on Solid Waste Management (J-PRISM) which includes Samoa, also focuses on waste reduction, recycling and landfill improvement and management.

[83] *MNRE. 2011. Solid Waste Characterization and Generation Study 2011 - Vaitele. Waste Division. MNRE.*
[84] *Setoa Apo, MNRE, pers comm., 2012.*

Graph 14: Household waste compositions, 2007 - 2011



Source: MNRE, 2007.

Samoa's waste management capacity has improved significantly over the last decade. The nation-wide solid waste collection system for household wastes is integral to the operation of the two semi-aerobic landfills in Tafaigata and Vaiaata. Both landfills were further expanded in 2010 with the addition of septage treatment facilities that receive and treat septage pumped out of septic tanks on Upolu and Savaii and, on occasions, dry sludge from at the new wastewater treatment plant for Apia during times of outage of the sludge processing system. A private sector led user-pays system for septic tanks pump-out and disposal is operating well at the level of households and commercial operators. According to MNRE (Fuatino Matatumua-Leota, pers comm., 2013), 2,688 truckloads from pump-out contractors are received annually for the Tafaigata facility (Fuatino Matatumua-Leota, pers comm.).

Under the Japanese Technical Cooperation Project for Promotion of Regional Initiatives on Solid Waste Management in Pacific Island Countries (J-PRISM), a weighbridge was constructed in November 2012 and has been operating since January 2013. The equipment is a crucial tool for data collection of the different categories of wastes that are transported to Tafaigata for final disposal. The importance of the computerised weighbridge is that a variety of reports can be retrieved when required from time to time.

A ban on the importation and use of non biodegradable plastic bags in Samoa came into effect with the passage of the Waste Regulation on 1st June 2006. This is complemented by on-going public awareness and educational programs targeting schools and local communities.

Chemicals and Hazardous Waste

Samoa's chemical sector is small but it is rapidly expanding with a wide range of chemicals used in industry, agriculture and in the home. All chemicals are imported. The important role that chemicals play in national development (e.g. improving agricultural outputs, control pests and diseases, supporting manufacturing, operating transport) is well recognized, but there are also growing concerns about the hazardous nature of chemicals and their adverse effects on human health and the environment. Because chemicals are now used in all sectors, its management is a crosscutting and a fundamental issue for national development for a wide range of stakeholders. To date, in general, knowledge of sound management of chemicals best practices is limited among many government ministries, private sector and the public.

The bulk of chemical imports to Samoa are petroleum products, and the main concerns are over their pollution of storage and supply sites. But several chemicals historically imported and used in old manufacturing operations, left contaminated sites. Many of these sites were identified as part of the 2004 inventory of persistent organic pollutants (POPs) and treated (since 2004) including four 'hotspots'[85] (PECL, 2004) that have since been cleaned up as part of a SPREP coordinated regional initiative.

[85] These hotspots were – Vaitele EPC compound, Vaitele Agricultural Store compound, old timber treatment plant in the former Samoa Forest Products sawmill in Asau and Island Pest Control facility at Vaivase. (PECL, 2004)

Table 33 below shows the dominant place of petroleum in volume and value terms, relative to all other imported chemicals.

Table 33: Chemical Categories by Use, 2009

Chemical Category	Production	Volume (kilolitres*/tonnes)	Estimated value (ST)	% of total cost
Petroleum	None	88,580 k/litres	117M	82%
Consumer	None	1,640 tonnes	10M	6%
Pharmaceuticals	None	Unknown	7M	5%
Industrial	None	800 tonnes	7M	5%
Pesticides	None	50 tonnes	2M	2%
Fertilizers	None	50 tonnes	100,000	<0.1%
Other Chemicals	None	Unknown	60,000	<0.1%

*1.1 kilolitres of petroleum products = 1 tonne. Source: Samoa Bureau of Statistics.

Of medical wastes, a feasibility study of health care wastes disposal options in Samoa (PECL, 2006) found 100% collection of all health care wastes generated in all hospitals in Upolu and Savaii. These are disposed of using a dedicated incineration facility operated by the Ministry of Health (MOH), in the Tafaigata landfill, with a second incineration facility to be built in Savaii.

Overall, with the exception of medical wastes, there has not been any systematic monitoring or assessment of pollution due to the use and storage of chemicals, or their effects on health and the environment. MNRE has proposed an integrated management system that will monitor the entire life cycle of chemicals, from procurement, to storage, use and waste disposal, as well as safety, health and environmental issues. This will require the strengthening of the Ministry's technical capacity to effectively implement, as well as adequate funds for monitoring, treatment and disposal of chemical wastes. The issue of importer or user responsibility for waste disposal is an important of aspect that is mandated in the new waste management legislation and requires effective enforcement to ensure compliance.

Samoa is party to the Vienna/Montreal Protocol, Basal, Rotterdam and Stockholm conventions and a number of international chemical agreements. It should take full advantage of available technical and financial assistance offered under these programs on capacity building and enabling activities as well as the opportunities to exchange information with other countries and organizations. One such initiative is the UNEP PAS Pacific POPs Release Reduction through Improved Management of Solid and Hazardous Wastes.

Assessment

Data collected from MNRE waste studies clearly shows that Samoa is producing less waste per person per year. A peak of 0.99 kg/person/year was reached in 1999 but this has reduced to 0.38 kg/person/yr in 2011.

In terms of waste management, the Government-run household waste collection service is accessible nation-wide with 97% of all households accessible to it. It is a significantly positive step taken to improving waste management. But the low volume of waste reaching the landfills relative to the estimated total generated suggests the persistence of unsustainable waste management practices at the household level, and the possibility of illegal dumping by waste contractors or both.

The reported decrease in CO_2 emissions (34% decreases from 2007 to 2011) in the waste sector (MNRE, 2010), indicates that backyard burning has declined. Of importance, the decline followed an intensive public awareness campaign against backyard burning.

Of the volume of household and commercial waste that reaches the landfills, about 58% are reusable as compost or recyclable. Recycling or reusing a portion of this volume will contribute to extending the useful life of the landfills.

The management of hazardous wastes is not well monitored. There is no information on hazardous wastes such as asbestos, and e-waste. But persistent organic pollutants identified and inventoried in 2004 have been largely addressed, with the identified four 'hotspots' cleaned, and other POPs (e.g. electric transformers, etc) transferred to off-shore secured sites under a regional initiative coordinated by SPREP. Hospital wastes are well monitored with management and disposal protocols in place and properly managed.

Waste management indicators	Low	Fair	High	Trend	Comment
% of population accessible to waste collection			✓	➔	97% is accessible to waste collection.
Rate of waste generation per person per day		✓		↓	2007 = 0.45; 2011 = 0.38 kg/person/day.
% of generated waste reaching the landfill	✓			Unknown	Only 11.4% of 2011 estimated household waste reached the landfill (Upolu only).
% of hazardous hospital wastes collected and incinerated			✓	➔	This assessment covers hospital wastes only.
% increase in the vol of septage received at the septage treatment facilities at Tafaigata and Vaiaata.	✓			Unknown	Assessment of Low is based on expert opinion, in the absence of information on which to base an assessment.
% increase in vol of waste recycled				Unknown	No data available.

6.5.5 Environmental Safeguards

A major source of threat to the sustainability of the rural and urban built environment is adverse environmental impacts generated by poorly planned development activities. This can take the form of poorly designed and sited constructions, others with unintended outputs or environmentally damaging by-products and others still involving the importation of inputs including living organisms and inert substances with known detrimental environmental and health effects.

To safeguard against these threats, a number of screening procedures are in place to ensure all development initiatives are properly vetted for adverse environmental impacts. The most wide-ranging and broad in powers are the PUMA Act 2004 and PUMA ((EIA) Regulation 2007 wherein a Development Consent (DC) is required for all development proposals subject to the satisfactory assessment of environmental impacts using an environmental impact assessment (EIA) or preliminary environmental assessment report (PEAR) tool. Other similar approval frameworks mandated under other legislation address specific threats and activities. These include the permit system under the Lands Surveys and Environment Act 1989 for sand mining and coastal reclamation, ground water exploration and abstraction permits under the Water Resources Act 2008 and a risk assessment procedure for imported animals, plants and living modified organisms under the Biosecurity Act.

How effective is the PUMA framework in weeding out unsustainable development proposals, or in modifying the design of approved projects to ensure environmental sustainability? How effective is the sand mining and coastal reclamation licensing system in ensuring sand mining coastal reclamation activities do not undermine environmental sustainability?

Current Status

Discussions of sand mining and coastal reclamation activities are covered under the Coastal Habitat section of this report. The assessment made is that while sand mining and coastal reclamation activities are on the increase, the sustainability of beaches and coastal environments affected by these activities is indeterminable due to the lack of information on coastal processes including sand migration, sand budgets and others. It is imperative for the sustainable management of beach sand that information on sand migration patterns and sand budgets for different locations are collected to assist with assessment.

For PUMA's Development Consent Application (DCA) process, Table 34 shows the number of development consent applications (DCAs) received by PUMA from 2007 to 2012, the number of proposals that were subjected to detailed environment impact investigations and assessments, as well as DCAs approved and declined. The question of effectiveness of the DCA framework in weeding out environmentally damaging projects cannot be easily answered with the available data, including the limited follow-up monitoring of approved developments to ascertain, at the very least, their immediate or short term impacts. However the effectiveness of the same as a regulatory mechanism may be inferred from the increasing trend in the number of applications received, which indicates an increasing level of public acceptance and compliance. An annual average of 13 proposals was required by PUMA to prepare detailed environmental assessments (EIAs and PEARs) and an approval rate above 99% can be derived from the data.

Table 34: No. of DC Applications received from 2007- 2012

Source: PUMA, MNRE. 2012.

Year	DCAs registered/submitted	# DCAs undertaking PEAR or EIA	DCAs approved (#/%)	# DCA declined for various reasons
2007	458	10 (2%)	457 (99%)	1
2008	417	14 (3%)	417 (100%)	0
2009	483	12 (2.5%)	483 (100%)	0
2010	719	10 (1.4%)	713 (99%)	6
2011	752	11 (1.5%)	751 (99%)	1
2012	**855**	**22 (2.6%)**	**852 (99%)**	**3**

Table 35: Number of EIAs and PEARs conducted and submitted to PUMA during 2007-2012

Year	EIAs	PEAR
2007	4	6
2008	6	8
2009	9	3
2010	6	4
2011	5	6
2012	**10**	**12**

Source: PUMA, 2012

There is anecdotal information of some non-compliance which is not unexpected but which suggests the need to strengthen PUMA's capacity for monitoring and follow-up. The same applies for the monitoring of sand mining and coastal reclamation activities by responsible Divisions of MNRE.

Assessment

Environmental Planning indicators	Low	Medium	High	Trend	Comment
% of development consents issued over total applications submitted.			✓	➔	Average of 90% of proposals reviewed from 2007 – 2011.
% of proposals modified to address environmental concerns.				No information	

6.5.6. Energy consumption

How efficient is our use of energy? To what extent is our built environment dependent on renewable energy sources?

Current Status

Population census data show that access to electricity for lighting in Samoa has increased significantly since 1981 from 38% to 93% in 2001 to 96% in 2011 (SBS, 2011). The 2011 census also shows the high level of usage among households of private vehicles, electrical appliances, and other electrical consumer goods.

Samoa's energy needs are supplied by biomass, petroleum products and hydroelectricity. A total installed capacity of 42 MW is reported for 2007, for a total primary energy supply (2007) of 75.6 ktoe, which is 65% biomass and 35% petroleum/electricity. In 2009, Samoa consumed 118.09 ktoe, 31% of which was biomass, 66% petroleum and 3% from hydro, coconut oil, biofuel and solar.

The data shows two important trends over the last 20 years - the continuing increase in energy consumption[86] and the shift towards commercial energy use based on imported petroleum products and hydropower-generated electricity (MoF, 2007)[87]. More recent information shows that Samoa Energy Consumption has not changed much from 2007 to 2011 but there was a notable increase in the contribution of petroleum from 65 – 68% of total energy consumption[88] during the same period. The contribution of biomass and hydro energy into energy consumption

[86] Demand for energy increased by around 6% per year during 1990 – 2000.
[87] Ministry of Finance. 2007. Samoa National Energy Policy 2007. Economic Policy and Planning Division.
[88] Ministry of Finance, National Energy Review, 2007, 2008, 2009, 2010, 2011

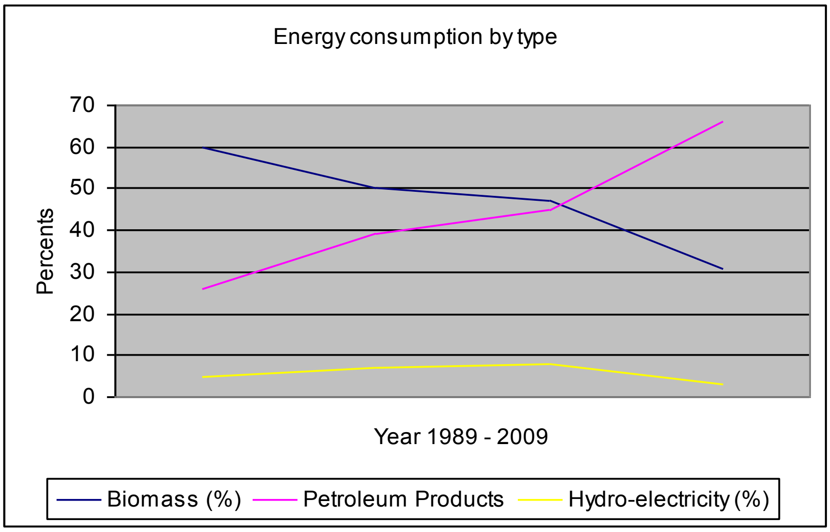
has decreased by 2.4% and 0.86% respectively in the same period. In 2011, biodiesel and solar contributed 0.07% and this is expected to increase to 10% of total energy consumption within the next 4 years.

The respective percentages of consumption between biomass, petroleum products and hydroelectricity are given in Table 36 from 1989 to 2011.

Table 36: Percent distribution of Energy Consumed by Type

Year	Biomass (%)	Petroleum Products	Hydro-electricity (%)	Source of information
1989	60	26	5	Hay et al, 2002[89].
1998	50	39	7	Hay et al, 2Ta002
2000	47	45	8	MoF, 2007[90]
2009	31	66	3	MOF, 2009[91]
2010	33.3	63.8	2.9	MOF, 2011[92]
2011	28.6	69.0	2.4	MOF, 2012[93]

Graph 15: Energy consumption by type



According to MoF (2007), the shift is driven primarily by the rapidly increasing demand for electricity as well as ground and sea transport[94].

How efficient are we using energy? Biomass is used mainly for household cooking and there is a steady decline in biomass usage between 1989 and 2009, mainly as households switch to LPG and electricity. In terms of generated power through hydro schemes and diesel generators, there are reported transmission losses which in 2006 were estimated at around 20% (MNRE, 2010). But the bulk of imported petroleum products are consumed by the transport sector (80% of imported fuel in 2005), and there is no data on how efficient energy is used. EPC is reported to have targeted a reduction in technical system losses of 10% by 2010 and 20% by 2012 by improving the efficiency of the transmission and distribution system (ibid.) however there is no information on whether or not these targets were achieved. There are also demand-side efficiency initiatives planned including the Greenhouse Gas Abatement project.

The Government has adopted a policy of achieving 20% renewable energy by the year 2030, which translates to a target of 8% by 2016 (MoF, 2012). The rationale is primarily economic but there are obvious environmental

[89] Hay, J. & Suaesi, T. 2006. Samoa: Country Environmental Analysis – Mainstreaming Environmental Considerations in Economic and Development Planning Processes. ADB TA:6204-REG. pp. 61.
[90] Ministry of Finance. 2007. Samoa's National Energy Policy 2007. Ministry of Finance – Economic Policy and Planning Division. Apia.
[91] Ministry of Finance. 2009. Samoa Energy Review. MOF. REEEP www.reeep.org. downloaded 31 Oct. 2012.
[92] Ministry of Finance. 2009. Samoa Energy Review. MOF. REEEP www.reeep.org. downloaded 31 Oct. 2012.
[93] Ministry of Finance. 2009. Samoa Energy Review. MOF. REEEP www.reeep.org. downloaded 31 Oct. 2012.
[94] Government of Samoa. 2008. Strategy for the Sustainable Development of Samoa 2008-2012. Ministry of Finance, Apia.

benefits[95]. The main strategies are to increase production of indigenous RE sources, with new hydropower schemes the obvious choice in the short term, and by encouraging efficiency and conservation measures[96].

Assessment -

Sustainable Energy indicators	Low	Medium	High	Trend	Comment
% of RE consumed relative to total energy consumption		✓		↓	Medium category lasrgey due to levels of biomass used for hh cooking.
% of energy losses due to inefficiencies in transmission				No information.	Energy losses baseline = 18%

6.5.7. Overall Assessment of the Built Environment

As in other habitats, assessing the health of the build environment is limited by the available data. Consequently while a larger number of essential indicators could have provided a better measure of the health of Samoa's built environment, this assessment is limited to the following (i) population, (ii) houses (iii) waste (iv) sanitation (v) environmental planning and (vi) energy consumption.

The overall assessment is made for each of the indicators used -

Population

- Samoa's population is growing at a rate that is within the estimated sustainable level according to the SBS (op cit). The 2011 census recorded a growth rate of 0.6% over the previous census, well below the annual growth rate of 1.0% indicated by SBS as the upper limit for sustainability. The decreasing trend over the last 20 years is expected to continue.

Houses

- Houses are increasingly being constructed with imported materials and cement. There is a steep decline in the use of local construction materials even for Samoan-style houses. There is no information on hazardous construction materials. The use of imported construction materials eases the pressure on local forests etc but introduces some alternatives that may not be easily disposable.
- There is no information on construction design to assess energy efficiency except anecdotal information that suggests a growing awareness of environmentally sustainable design.

Waste

- Waste collection services is highly accessible (97% of all households) but the low percentage of wastes reaching the landfill relative to estimates of total wastes generated, point to either the lack of public support in taking wastes to the roadside for collection, poor collection by contractors or illegal dumping by contractors or both or both. Reduced CO_2 emissions in the waste sector (from 2007-2011) is indicative of declining backyard burning.
- People are generating less waste per year with data showing a decrease in the waste generating rate per capita falling from 0.45 kg/person/year in 2007 to 0.38 kg/person/year in 2011.
- Sewage treatment and disposal facilities for both Upolu and Savaii have improved significantly in recent years with the operation of the pressure sewer pipeline and waste treatment plant for the Apia Central Business Area, and of septage treatment facilities at both Tafaigata and Vaiaata.

Sanitation

- Around 80% of all household sanitation systems using septic tanks are defective and leaky. Pathogens and nutrients from these facilities constitute a major threat to groundwater sources in villages (Latu, 2010; SMEC, 2010), to the health of coastal environments and people. Those particularly at risk are populations in low lying urban areas vulnerable to periodic flooding and in coastal areas where the water table is high.
- But good progress has been made in improving sanitation problems in some of the most vulnerable communities in the Apia urban area including Fugalei, Taufusi, Togafuafua and Tufuiopa. Implementation of the National Sanitation Plan is progressing well.

Environmental planning safeguards

- Safeguards have been established in the overall MNRE legal framework. The EIA process is also contributing valuable input to development design and construction. The safeguards also extend to existing activities that create amenity nuisances such as noise to ensure property rights are maintained, and negative impacts on the environment and to public health are addressed.
- The increasing trend in the number of Development Consent Applications received by PUMA since 2007 point to increasing public acceptance and compliance. But there is limited information to assess the effectiveness of DCA approval process. Since 2007, about 99% of all DCA received were approved with 2% required to conduct and submit detailed environmental assessments (PEARs and EIA).

[95] *GHG emissions for 2007 show Road Transport and Electricity Generation contributing 27% (the highest) and 13% respectively.*

[96] *Current energy efficient initiatives are (i) minimum energy performance standards and labelling for appliances and (ii) energy auditing for public buildings and street lighting (REEP, 2010).*

Energy

- Energy consumption is rapidly increasing and the resulting increase in demand for petroleum products will increase GHG emissions. Efficiency in energy use cannot be estimated with the limited available information. The Government has set a target of 20% RE by 2030 (8% by 2016) with hydropower the main short term option being pursued. In the meantime, Samoa remains heavily reliant on imported petroleum products and this is likely to continue in the short term.

Is our built environment sustainable? Other than the immediate threats of extreme events of cyclones, floods etc associated with climate change, the biggest immediate threat to the sustainability of the built environment is from poor waste management and sanitation. But both have improved significantly since the last SOE with improved waste collection and treatment facilities. Improvements in sanitation systems are being addressed in particular in vulnerable urban communities with other aspects of national sanitation master plan progressively being addressed. Of the other indicators, Samoa's population is growing within a sustainable rate. The regulatory framework for screening development proposals administered by PUMA is in place and working. A clear Policy goal for reducing our vulnerability to imported fossil fuels has been defined and a number of renewable energy options are being developed and or under investigation.

Notable progress has been achieved through all vulnerable sectors in strengthening resilience of coastal communities, in protecting coastal infrastructure and in disaster preparedness. Of energy, the present increasing trend of high consumption of petroleum products and electricity will continue in the foreseeable future. On balance, Samoa's built environment is more sustainable today than it was in 2006 (when last reported).

6.5.8. General Recommendations

Energy

- Facilitate and encourage the shift to renewable energy sources and energy efficient practises.
- Encourage landowning villages with lands adjacent to rivers earmarked for hydropower schemes to support hydropower power development. Use incentives and innovative arrangements such as EPCs business model to encourage support and participation.
- Assess thoroughly all proposed renewable energy proposals to ensure the effective safeguarding of environmental values and interests.
- Review and update the 2006 National Adaptation Plan of Action to take on board changes in priorities and policies, and progress in implementation.
- Implement the Samoa National Energy Policy 2007.

Sanitation

- Ensure that all septic tanks constructed are sealed watertight units with septic tanks built near the coast and in low lying areas to be above ground with an elevated toilet block.
- Review and update the National Building Code 1992 to incorporate revisions related to improving septic tank specifications and standards.
- Encourage the use of biogas digesters in schools hostels, prisons and other similar situations where adequate waste volumes are generated for renewable energy and improved sanitation.

Environmental safeguards

- Strengthen PUMA's capacity for monitoring and enforcement with additional qualified staff and supporting resources.

Waste management –

- Strengthen the monitoring and supervision of waste collecting contractors to eliminate any illegal dumping of wastes.
- Provide incentives for waste recycling and reuse to optimize the economic life and use of landfills.

Houses

- Encourage relocation of houses away from coastal erosion, land slips and flood hazard zones as a means of adaptation to climate change induced extreme events.
- Review and update District Coastal Infrastructure Management (CIM) Plans.
- Review and update National Building Code to incorporate appropriate climate change adaptation specifications.

6.6. RIVERS AND STREAMS

6.6.1 Current Status

Freshwater from both surface and groundwater sources exist across most of Samoa, although their distribution is not uniform as differentiated by geology.

The older volcanic terrain of the Fagaloa and Salani volcanics are most weathered and eroded, and the formed clay cover results in effectively impermeable strata, and therefore surface runoff. These older volcanics and associated surface water courses are mostly located on the eastern and southern halves of both the Upolu and Savaii islands.

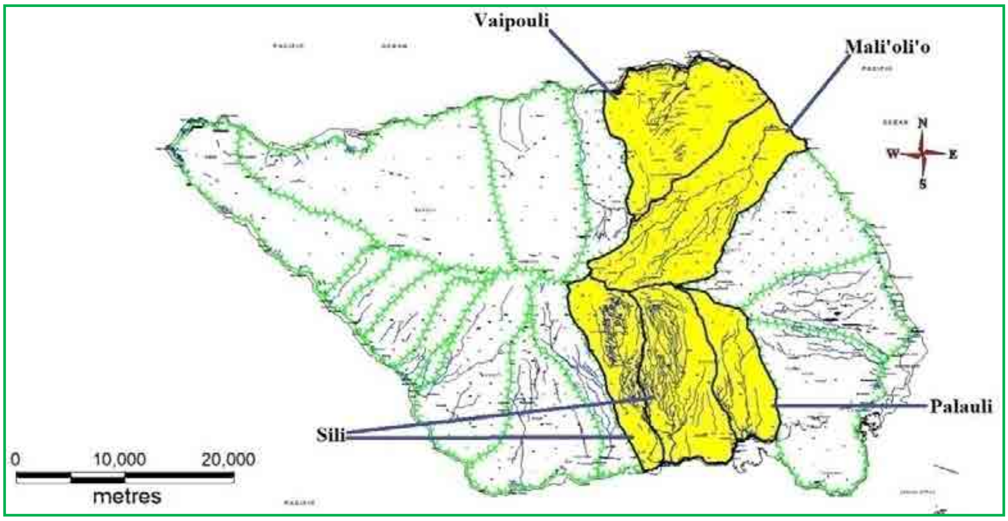
Conversely, the younger volcanics of the Mulifanua, Lefaga, Puapua and Aopo lava flows, have little or no soil cover and allow the infiltration of nearly all rainfall. These lavas are also highly permeable, with former lava tubes enabling rapid groundwater flow to the sea. The location of the younger volcanics along the north-west Upolu and Savaii regions coincide with the dominant distribution of coastal springs and good groundwater sources, and the absence of perennial river systems.

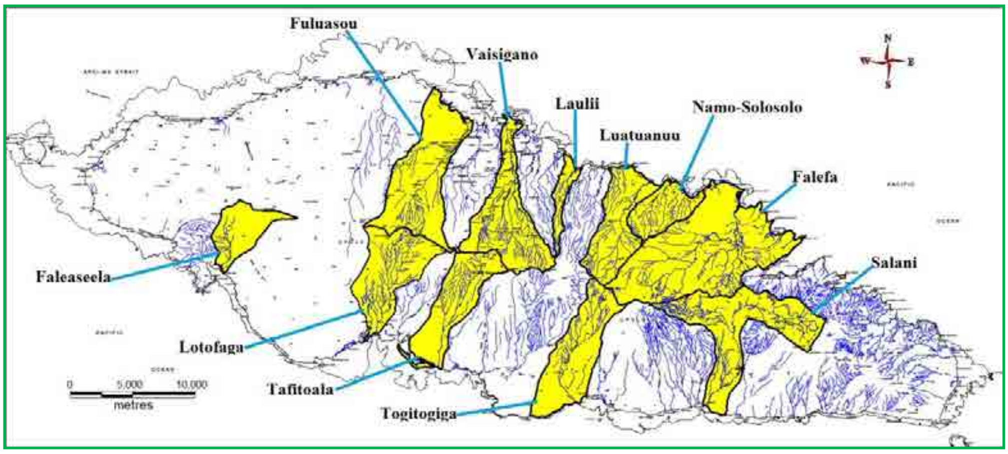
6.6.2 Rivers and streams

There are more than forty river systems in Samoa originating in the uplands and draining into the sea. The major perennial rivers on Upolu are the Fuluasou, Vaisigano, Laulii, Luatuanuu, Falefa, Namo, Luatuanuu, Falefa, Mulivai, Piu, Salani, Tafitoala, Nuusuatia, Lotofaga (Safata) and Faleseela Rivers. The only major perennial watercourses on Savaii are the Sili River (or Vaiola), Palauli River (or Faleata), Vaipouli and the upper reaches of the Maliolio River in Patamea.

Flooding often occur during the wet season (November-April) following prolonged or intensive rainfall events. River flow is good during this time with a lot of water available to satisfy development, social and environmental needs. After the wet season, ephemeral rivers and streams begin to dry up and perennial river systems experience low flows.

Figure 7 & 8: Main river systems in Savaii & Upolu





Water supply and hydropower operations are often affected during this time (June-November), resulting in alternative sources being utilized. During the latter parts of the dry season when surface water reserves are highly exhausted, other alternative water sources become significant for water supply, such as groundwater and freshwater springs.

There are five hydropower schemes operating in the country at Afulilo, Lalomauga, Samasoni, Faleolefee and Alaoa. The latter three schemes abstract water from within the Vaisigano watershed alone, in conjunction with a number of other intakes operated by the Samoa Water Authority catering for water supply. The Afulilo scheme includes the only dam in the country and stores water from a number of streams above the Vaipu wetland. This water is diverted into the Fagaloa Bay on the north eastern side of the island, as opposed to its original discharge point at the Salani Bay in the south. The 5 power stations provide about 40% of the annual national energy demand. During the wet season hydropower can provide up to 70% of the demand but this is dramatically reduced to only 20% in the dry season (May-October). During this time diesel is predominantly used to generate electricity.

The 2006 Population and Household Census stated that 97.3% of Samoa's population has access to water supply either through the SWA which operates 35 surface water intakes and 43 production boreholes[97], or through the 33 independent schemes operated by communities. It is estimated that 65% of the national water supply in the country is from rivers and streams, while the remaining 35% is sourced from groundwater.

6.6.3 Groundwater

There is an increase in the development of groundwater resources to supplement surface water supplies in the country. The SWA, some major hotels, beverages and water bottling companies, as well as other large establishments have constructed their own production boreholes to provide reliable water services, especially during the dry season when river and stream flows are low. This increase in groundwater development has led to the Ministry prioritising research into groundwater resources to collect baseline information.

Initial work has included the establishment of monitoring bores in Vailoa, Mulifanua, Leulumoega, Faleasiu, Manono, Vaitele and Faleapuna, with more bores being planned to give a better status of the country's groundwater resources. In addition, a Water Abstraction Licensing Scheme to monitor groundwater abstraction and drilling works has been enforced. The information from the implementation of this scheme, together with data from the monitoring bores, will provide a better status of this important resource in the next State of the Environment Report.

6.6.4 Lakes

There are a number of crater lakes in Samoa with Lake Lanotoo on Upolu being the largest. Some of these lakes and associated ecosystems have been surveyed by different experts in the past with many recommending most of these areas to be protected and reserved (Holloway and Floyd (1975); Dahl (1980); Pearsall and Whistler (1991)). Recommendations from these surveys also included the need to constantly monitor the physical and biological elements of the lakes.

Jenkins et al., (2008*)* provided some of the earliest physical quality analysis of some of the lakes in Samoa (Figure K), while Schuster (1993) in his attempt to put together a directory of wetlands in Oceania combined some of the previous literature on lakes and montane marshes across the country. He identified 11 lakes in Upolu and 2 in Savaii, and also stated that these lakes contained interesting wetlands to be protected. These lakes were:

Lakes	Descriptions
Lakes and marshes of the Aleipata Uplands, Upolu	A series of small lakes and herbaceous marshes in a chain of volcanic craters in the Aleipata Uplands of eastern Upolu
Mount Le Pu'e Lake and Marsh, Upolu	A small lake and marsh in a volcanic crater, protected in the O Le Pupu Pu'e National Park (2,857ha; established 1978)
Lake Lanotoo, Lake Lanoata'ata and Lake Lanoanea, Upolu	Three small lakes with fringing marshes in volcanic craters in the central highlands of Upolu. Lake Lanoto'o is the largest freshwater lake in Samoa
Olo Manu Uta Marsh (Maugaloa Marsh), Savaii	A large herbaceous marsh in the eastern highlands of Savaii
Lake Mafane and Lake Mautalano, Savaii	Two small lakes with fringing marshes in volcanic craters in the eastern highlands of Savaii

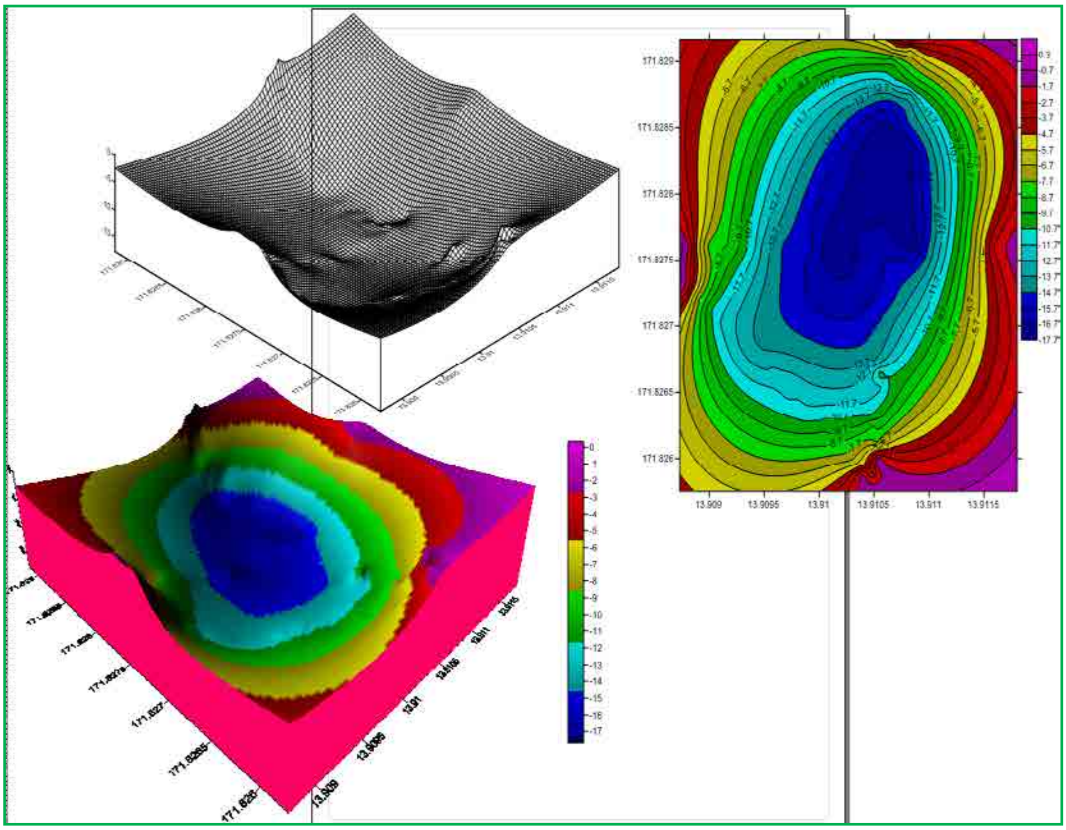
[97] *SWA Corporate Plan 2013-2015*

Source: Schuster, C. 1993. Western Samoa. In Scott, D.A. *(ed): A Directory of Wetlands in Oceania*. IWRB, Slimbridge, U.K. and AWB, Kuala Lumpur, Malaysia.

The MNRE is now looking at re-enforcing information on lakes of Samoa given not only their environmental values, but also the potential of water supply development in these areas. Lake Lanoto is now the major source for water supply for the Lepa and Lotofaga District in eastern Upolu, and there are proposals by water utilities to use Lake Lanotoo as another source for the urban water supply system.

In 2011 the MNRE made an attempt to carry out a full hydrological study of Lake Lanotoo and to use the methodology to facilitate the monitoring of other lakes in the country. Results of this survey indicated the depth of the lake to be approximately 17m, and a lake profile was also developed. An eco-sounder is being procured to enable better/more accurate profiling of lakes.

Figure 9: A cross-section and depth profile of Lake Lanotoo, surveyed by the MNRE, Water Resources Division



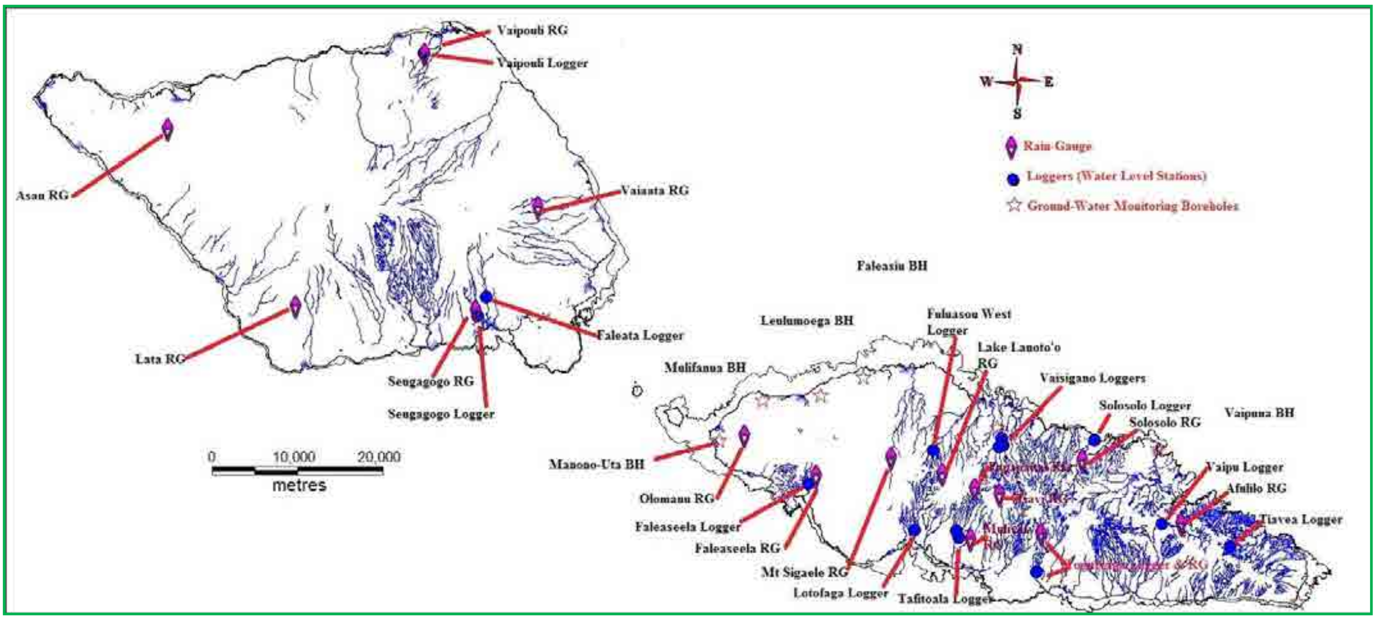
The Hydrometric Network
MNRE's surface water monitoring network (see Figure 10) tracks 16 streams for water level (WL) and river flow, with rain gauges installed at the upper reaches of 15 prioritised streams. River flow gauging is undertaken at sites above major developments like EPC headponds and SWA intakes which impact the flow of rivers and streams. Flood water levels are also investigated during and following flood events.

Groundwater monitoring is limited with baseline information being collected from the 7 existing sites, Faleapuna, Vailoa, Manono, Leulumoega, Faleasiu, Vaitele and Mulifanua. Investigation into abandoned SWA production bores are in progress to see if these sites can be rehabilitated and used for monitoring.

Monthly water levels are monitored for Lakes Lanotoo and Lanoto.

Expansion of the hydrometric network to cover the whole country (especially more of Savaii), and upgrading it into a telemetry system is a priority. All information collated from field surveys and monitoring are updated and stored in the National Water Resources Information Management System (NWRIMS).

Figure 10: Map of MNRE's Current Hydrometric Network



6.6.5 Watershed areas

Samoa has been divided into 65 watershed areas. They are generally small in size with steep slope gradients, resulting in rapid responses to rainfall events, and low flows in the dry periods. The catchments south of Apia are known to have experienced severe flooding in 1939, 1974, 1990, 2001, 2006 and most recently 2012 during Cyclone Evan. The 'time to peak' (time from rainfall to peak flood flow) for the Vaisigano river system has been approximated at 3 hours, raising concerns whenever there is prolonged or intensive rainfall events in this area.

Sustainable watershed management has become a core function of the MNRE. Maintaining watershed areas under good forest cover assists with regulating flood events during the rainy season, and sustaining river flows during the dry seasons. A lot of unmanaged developments within a watershed area can lead to increased removal of forest cover from riparian environments, increased evaporation, flash floods, and increased water pollution as a result of soil erosion and other land based activities.

Conservation efforts to protect watershed areas are ongoing ranging from insitu rehabilitation work to watershed development planning, awareness raising and education. A number of watershed management plans are being developed to facilitate the protection and sustainable development of some of the prioritised watershed areas. These plans are to be complimented by village bylaws, and promote the engagement of communities in sustainable watershed management efforts.

6.6.6 Current Status

The health of rivers and streams are assessed using the following indicators and metrics[98] –

Indicators	Metrics
Water Quantity Water Quality	River flow and river discharge, lakes and groundwater levels Turbidity, *E.coli* content, DO, pH, Solids, NH_4, N, P
Species Richness	Trends in freshwater fish species richness
Key species	Fish, prawns, eels, abundance/biomass
Catchment area forest cover	% of catchment area under forest cover; no. of catchments with forest cover exceeding 70% of total catchment area.

[98] *Additional indicators are included in the assessment table from the Water and Sanitation Sector Plan 2012-2016 but lacks data. These are recommended for future monitoring and data gathering activities.*

6.6.7 Water Quantity

Water Quantity – Surface water

Flowing rivers are critical to the survival of key aquatic and coastal biodiversity. As such, the analysis of river flow and discharge is a good measure of river and stream health, with perennial rivers and associated wetlands expected to be more biodiverse than ephemeral rivers.

Available water flow and discharge information indicate varying flow and discharge patterns for different rivers and streams correlating significantly with rainfall. The rainfall data available from monitored sites within the hydrometric network indicate normal to above normal rainfall for much of the country except for the dry western regions (see Figure 11).

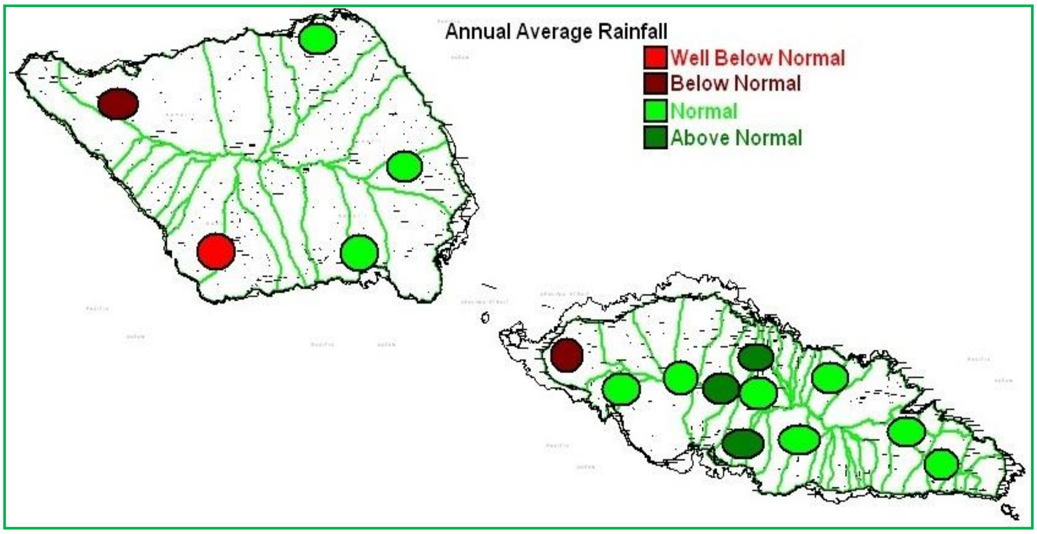


Figure 11: Average annual rainfall at monitored sites.

However, when comparing rainfall with available river discharge/flow information a contrasting pattern is observed in some areas, particularly in the Togitogiga, Vaipouli, Vaipu and Apia catchments (Fuluasou and Vaisigano) where below normal to well below normal flows were recorded, despite experiencing normal to above normal rainfall (see Figure, 12). This reflects the level of development and deteriorating state of the watershed areas in these 5 regions, being majorly cleared for settlements and agriculture.

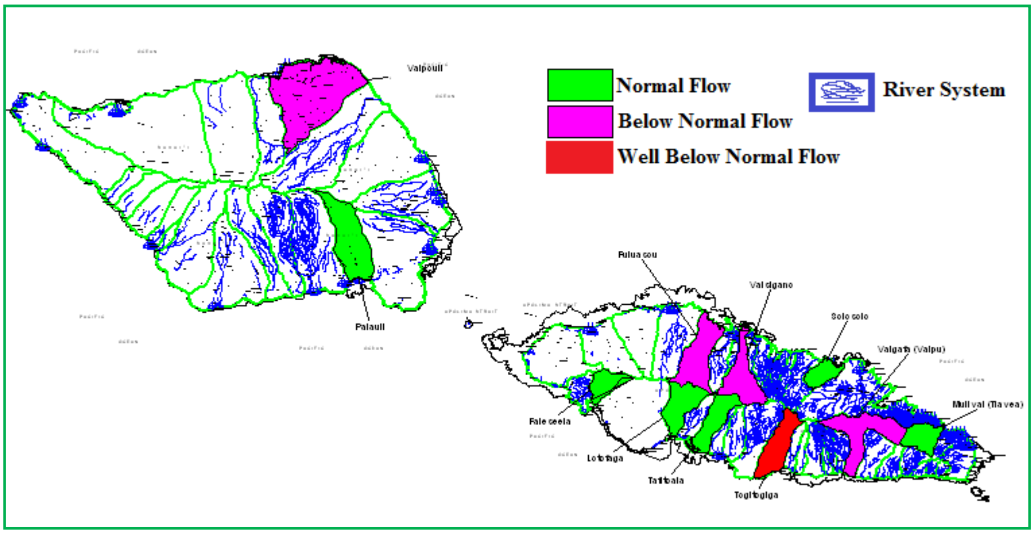


Figure 12: Average river flow/discharge rates at monitored sites.

In some areas river flow is intermittent along the river channel as a result of abstraction activities which remove water from the streams. Obvious examples are the Fuluasou and Vaisigano rivers which are perennial water courses that are majorly abstracted for water supply and hydropower demands. During the dry season the entire river flow is captured by intakes, resulting in no flow downstream for almost half of the year.

It is foreseen that any increase in demand as a result of increasing population and households, coupled with changing lifestyles, will contribute significantly to the increase in water takes to satisfy the growing water and energy needs. This will place increasing pressures on the quantity and quality of water resources available in the environment.

Water Quantity – Groundwater
The following table provides some of the baseline information and analysis on groundwater resources in Samoa. It is expected that in time, more information will be available for a more holistic view of the resource, including a more reliable trend of groundwater fluctuation.

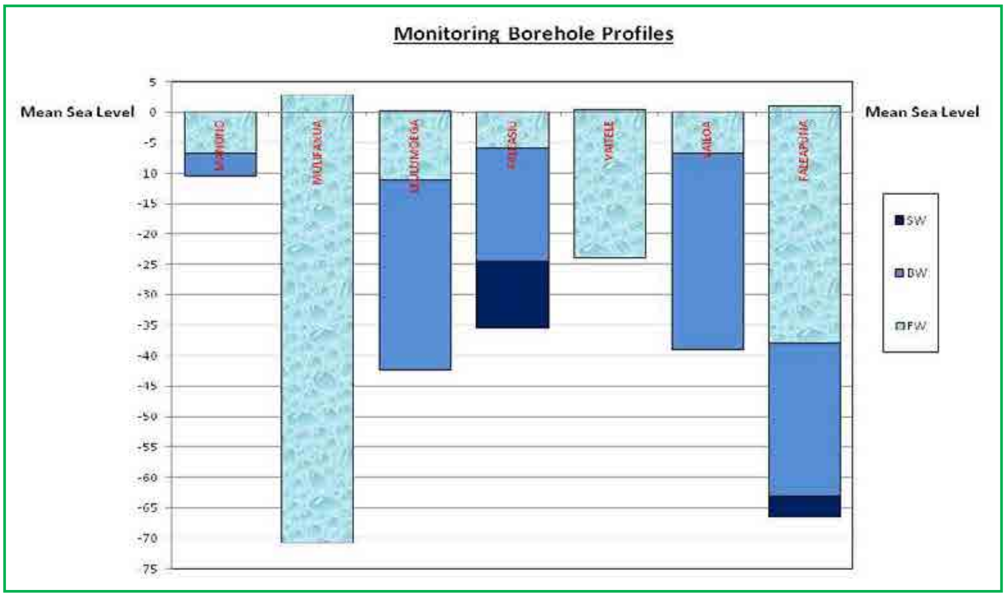
Figures 12 illustrate the different static water levels for the various groundwater areas being monitored, relating to the distance of each site from the coastline, ie. a bore situated close to the coast such as the Manono borehole will have a lower static water level than a bore that is situated far inland like the Mulifanua bore.

Table 37: Static groundwater levels for monitored sites.

Sites	Static Water Level (mbgl)	Recorded Water Levels (mbgl)						
		Jul 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013
Manono	6.668	6.90	6.90	6.99	7.01	7.02	6.90	6.86
Mulifanua	39.39	38.38	39.39	39.77	39.51	38.93	38.99	39.07
Leulumoega	13.65	13.34	13.46	13.27	13.44	13.55	13.04	12.49
Faleasiu	23.05	22.465	22.29	22.135	22.30	22.24	22.09	21.75
Vaitele	19.49	-	19.49	19.52	19.559	19.62	19.32	18.25
Faleapuna	18.03	-	18.067	18.28	18	18.08	17.562	17.59
Vailoa	20.70	-	20.757	20.673	20.60	20.69	20.683	20.563

Fig 13 illustrates the profiles of the water table at each of the sites being monitored. More sites will enable not only a national profile of groundwater but also the formulation of a Samoa groundwater map.

Figure 13: Groundwater profiles for monitored sites. (FW-freshwater, BW-brackish water, SW-seawater)



6.6.8 Water Quality -
The MNRE currently monitor water quality at 14 sites as part of its hydrometric network. The monitoring parameters are mainly the physical attributes of raw water quality such as, DO (dissolved oxygen), temperature, turbidity and pH. The sampling sites are mainly in the upper catchment areas to monitor water quality close to the sources of these major river systems. There are no samplings at the lower parts of the targeted rivers where there are a lot of anthropogenic impacts on the integrity of the resource. It is also important to note that no Environmental Standard for rivers and streams has been developed for Samoa, and data included in this report therefore act as baseline information for future comparisons. The normal water quality values given in Table 38 are the WHO drinking water standards.

Analysis of biological parameters such as *E.coli* and total coliform can only be undertaken by the laboratories operated by the Scientific Research Organisation of Samoa and the Ministry of Health which collect water samples at the end user point.

Table 38: Average Water Quality 2011-2012

Parameters	pH	Dissolved Oxygen (mg/1)	Temp (◦C)	Turbidity
Sites	**Normal 6-8**	**Below Normal <4mg/l Normal 4-10mg/l Above Normal >10mg/l**		**Drinking - 5NTU Normal - 20NTU Above Normal - 100NTU**
Alaoa West	8.3	7.2	26.4	5.71
Fuluasou East	8	6.5	25	4.9
Faleaseela	7.9	7.2	25.7	5.3
Fuluasou West	7.7	5.9	24.8	10.4
Togitogiga	7.72	6.1	26.3	12
Vaipouli	8	5.9	25.6	8.8
Tiavea	7	5.8	24.9	-
Alaoa East	7.8	6.5	24.6	-
Seugagogo	7.9	8.8	25.8	-
Vaipu	7.51	4.22	25.76	3.8
Namo	8.14	7.18	26.41	7.55
Faleaseela	7.94	7.15	25	5.3
Tafitoala	8.14	5.71	26.3	9.1
Lotofaga	8.3	4.02	26.3	11.8

Physical parameters
DO and pH values recorded in the upper reaches of rivers and streams around the country are generally within the normal levels, supporting aquatic life and vital ecosystems.

Similarly, turbidity values were mostly below 10NTU with none exceeding the 20NTU normal value.

Another recent record of water quality for some of the surface water bodies in Samoa was in 2008 during a preliminary survey of Samoan freshwater macro-faunal biodiversity. The results of this survey are given below:

Table 39: Water quality of surface water sources studied by Jenkins et al., 2008.

SITES	Tagaila River	Tagaila River	Namoi River	Lago Lake	Asi River	Tiaveatai River	Fuisipia River	Pineula River	Pineula River	Mataroa River	Vailima River	Vailima River	Lanoto'o Lake	Ogogo Spring	Pulei'a River
GPS - S	13.95145	13.95305	13.95039	14.00721	13.99856	13.97921	13.97902	14.02967	14.03454	14.01368	13.87021	13.87021	13.91046	13.69928	13.77500
GPS -W	171.51007	171.50975	171.51657	171.50092	171.48578	171.47177	171.59217	171.61672	171.61711	171.71768	171.76662	171.76662	171.81579	172.56284	172.37779
Altitude (m)	2	15-40	0-5	428	315	2	225	20	0-2	60	112	100	761	354	23
Temp (°C)	23.1	23.8	24.8	24.1	24.6	25.2	24	25.3	27.6	22.6	24	24	23.2	22.4	26.20
pH	7.44	7.43	7.7	9.27	7.45	8.05	6.24	7.2	7.2-8	7.7	8	8	9.9	7.6	7.59
Conductivity (µS)	65.5	59	88	46.7	60	65-500	35	89	72-3400	79	112	100	10.5	56.1	65.10
Dissolv'd O^2 (ppm)	30	30	NA	NA	NA	33	NA	NA	30	33	NA	NA	NA	NA	NA
Salinity (ppt)	0	0	0	0	0	0-8.1	0	0	18.3	0	0	0	0	0	0
Turbidity (NTU)	<10	<10	<10	15	<10	<10-12	NA	NA	<10-12	<10	<10	<10	15	<10	<10

Biological parameters

Studies of water quality conducted by Latu et al (2012) of three village springs (Tufuiopa, Malie and Vini-fou) using total coliform (TC) and faecal coliform (FC) as indicators, found all three springs to be contaminated with TC and FC to levels higher than the maximum microbial contaminant level established by WHO. The results imply that the springs were heavily polluted by bacteria of faecal origin suggesting that the springs were potential sources of health hazards from a health perspective (ibid).

Similar results were also recorded by a survey conducted by the SROS on water sources utilised by Independent Water Schemes in 2012.

Freshwater fauna and flora

Stream fish are excellent indicators of environmental quality because different species respond to pollution in different ways. As a result, stream quality can be assessed based on the diversity and abundance of fish species in a stream. There are 31 freshwater fish species known to occur in Samoan waters, 26 of which are native with five introduced (Jenkins et al*.,* 2008*)*. However, there are no river-specific data on fish diversity and species abundance/biomass, which would make it useful as an indicator of river quality.

This is an important area of future collaboration between the WRD and DEC to improve the monitoring of river and stream water quality, particularly for the main rivers and streams that are heavily dependent on for hydropower generation and drinking water supply. This is also useful and relevant for the determination of environmental flow as stipulated by the Water Resources Management Act 2008, to ensure the protection of downstream biodiversity values in streams where there is upstream diversion or abstraction.

There are future plans to expand water quality monitoring downstream to further ascertain the comprehensive health of rivers and streams, as it is expected that the physical, chemical and biological qualities will deteriorate with more anthropogenic impacts downstream.

6.6.9 Catchment area health

The protection of watershed areas is a priority to the sustainability of freshwater resources, in light of the roles forests and vegetation cover play in facilitating a range of water related environmental services, such as effective water infiltration into the soil to become part of the subsurface storage. In Samoa, forests within watershed areas that help regulate and maintain water resources have been largely felled for agricultural developments and settlements, and also by natural disasters like cyclones. This degradation of native forests provide corridors for invasive species, exacerbating the loss of biodiversity and the decrease in the quality and quantity of water available for social, economic, development and environmental needs.

The riparian environment or zone along rivers and lakes play an important role in regulating nutrients entering the surface water sources as well as controlling erosion. These zones also act as shelter, protecting both the terrestrial and aquatic biodiversity, and at the same time controlling algal growth which may result from increased sunlight exposure. Much of the riparian environments of major rivers remain intact, except for the urban watershed areas where settlement has removed much of the riparian zones in the lower catchments. This is evident in the settlement patterns along the Gasegase, Loimata o Apaula, Vaisigano and parts of the Fuluasou catchments, where 20-30% of the riparian zones have been developed.

Jenkins et al., (2008*)* surveyed the riparian environments of 15 sites during the preliminary survey of the Samoan freshwater macrofaunal biodiversity. The survey through site observations of in-stream characteristics and riparian conditions stated that "there is a need for concerted management of the anthropogenic activities within the majority of catchments that were visited". Over half of the sites visited showed clear signs of nutrient loading with a heavy coating of filamentous algae (likely genera *Ulothrix*, *Spyrogyra* or *Treparnaldia*) on the substrate. This was particularly profuse within the Namoi, Tiavea-tai, Mataroa and Puleia Rivers (Jenkins et al., 2008).

These observations were likely to be the result of a combination of factors including wastes from farmed and stray livestock (particularly pigs and cattle), subsistence gardening and plantations directly adjacent to riverways (no buffer zone), as well as unregulated village waste disposal within the riparian zones or directly into the rivers.

The study also recorded that over half of the sites surveyed had severely altered riparian vegetation due to agricultural activities, which contributes to erosion, increased water temperatures, and reduced abundance and diversity of in-stream fauna.

Table 40: Riparian environment analysis at water sources studied by Jenkins et al., 2008.

Name	Tagaila River	Tagaila River	Namoi River	Lago Lake	Asi River	Tiaveatai River	Fuisipia River	Pineula River	Pineula River	Mataroa River	Vailima River	Vailima River	Lanoto'o Lake	Ogogo Spring	Pulei'a River
Substrate	rock, boulder, gravel	rock, boulder gravel	rock, sand	silt, mud, clay	gravel	Rock& gravel	NA	Sand & mud	Sand & mud	rock, gravel, pebble	Rock & gravel	Rock & gravel	mud	Gravel	boulders, rocks
Flowtype	riffles, pools	riffles, pools	riffles, runs	still	riffles,runs	riffles, runs & pools	NA	runs	runs	riffles, runs, pools	riffles, runs & pools	Riffles, runs & pools	still	riffles, runs	runs
Instream cover	mild siltation	mild siltation	Filament algae	reeds	siltation	filamentous algae	NA	silt	silt	clean	mild sediment	mild sedim ent	silt	clear	filament algae
Aquatic vegetation	clear	clear	filament algae	reeds	spare	filamentous algae	NA	paragrass	paragrass	filamentous algae	Water cress	clear	reeds	roots	filament algae
Riparian vegetation	Native, exotic shrub	native shrub	Para grass	native trees	paragrass	native/exotic trees	NA	mangrove , paragrass	mangrove, paragrass	exotic trees,native grass	Water cress	exotic trees	native trees/ paragrass	native trees	paragrass
Land use	Bananas/ rainforest	rainforest	bananas, cocoa	Taro plantation	grassland	banana/taro/ cocoa	NA	coconut plantation	coconut plantation	Pastoral/ park	Park/ flowers	Park picnic	Park	none	Coconut
Disturbance type	Pigs mainly	subsistenc e logging	Village	Picnic site	bridge/ culvert	pigs/cattle	NA	drain &waste outlets	drain &waste outlets	Cattle/Picnic site	garden clearance	trash	Invasive fishes	none	Cattle/ village


Fresh water survey, 2008 (Uafato)

6.6.10 Assessment

Rivers and Streams Health Indicators	Low	Medium	High	Trend	Comment
Quantity – % increase in average discharge/flow rates; groundwater levels		✓		↓	Correlates both with rainfall patterns coupled with unsustainable watershed management practices; Groundwater levels are under threat from Sea Level Rise and over-exploitation
Quality – # of confirmed incidences of *E.coli* presence exceeding national standards;			✓	→	Better results upstream than downstream in the settled/developed areas; increasing awareness on sanitation improvements and watershed zoning may result in a decrease in the future.
Turbidity, pH, DO		✓		→	Better results upstream than compared to downstream where there is a lot of development
# of catchment areas with forest cover exceeding 70% of total area		✓		→	This is a major problem in the urban watershed areas where there is a lot of riparian zone development by settlements. The upper areas are mostly well forested as are the rural catchments.
Area (ha) of watersheds rehabilitated (fenced, planted and with human activities effectively controlled and/or declared as reserves)		✓		→	The 2011/12 figure stands at 196.6ha rehabilitated (Water and Sanitation Sector Annual Report 2011-2012)
No. of watershed management plans approved and under implementation		✓		→	5 Watershed Management Plans have been endorsed by the Cabinet Development Committee. A number of other plans are being developed together with ongoing rehabilitation and awareness work.
Minimum environmental flow requirements established for priority water sources (2 in Upolu and 1 in Savaii)	✓			→	A methodology has been developed at the Vaipu steam and will be used to calculate e-flow for other priority areas
Species richness and abundance		✓		↓	The diversity of Samoan freshwater fauna is still incompletely understood, although based on our current findings is certainly worthy of further study and targeted conservation efforts. Continuing degradation of watershed and rivers are a concern for species richness and abundance

6.6.11 Overall Assessment of Rivers and Streams

While a lot of activities in water resources management are being implemented, most are yet to reach a stage wherein adequate information is generated to enable an informed assessment of the current state and health of rivers and streams. The limited information available indicates however that river flow is highly dependent on seasonal fluctuations in precipitation, making it highly vulnerable to climate change and climate variability. Thus the declining trend in river flow rates indicated above is a concern with far reaching development implications for agriculture, drinking water and hydropower generation. Water quality for rivers and streams above the agricultural farms and community settlements is not a major issue based on indicators of turbidity, pH and dissolved oxygen (DO), but reported incidences of high *E.coli* counts in several village springs and drinking water sources is a reminder of the impacts of land use, sanitation and waste management practices on this vulnerable resource. This justifies the integrated ridge-to-reef approach to water resources management WRD has adopted.

Effective management will depend on quality data, thus the priority on monitoring. But there are also urgent management actions that need immediate implementation both at the national and at the community level including the development and implementation of catchment management plans to directly address urgent issues within different catchments. This is vital in view of the strategic importance of water for drinking, agriculture, hydropower generation, and biodiversity health.

6.6.12 General Recommendations

1. Continue and expand the current monitoring program for all perennial rivers and streams as well as groundwater resources using identified indicators and metrics used in this SOE, as a priority activity of the Water Resources Division.

2. Develop, adopt and implement water catchment management plans for all priority catchment areas.

3. Calculate environmental flows for rivers earmarked for development such as hydropower generation to protect downstream biodiversity and other values and to guide hydropower planning.

4. Collaborate closely (Water Resources Division) with MNRE's Technical Division and Forestry Division for forest cover assessment of catchment areas to support water resources analysis and the use of forest cover indicators in assessing the health of rivers and streams.

5. Encourage and facilitate cross-sector collaboration with agriculture, forestry, fisheries, infrastructure and energy sectors to promote effective integrated ridge-to-reef water resources management.

6. Engage community participation in facilitating sustainable water resources management initiatives such as cleaning rubbish from rivers and streams.

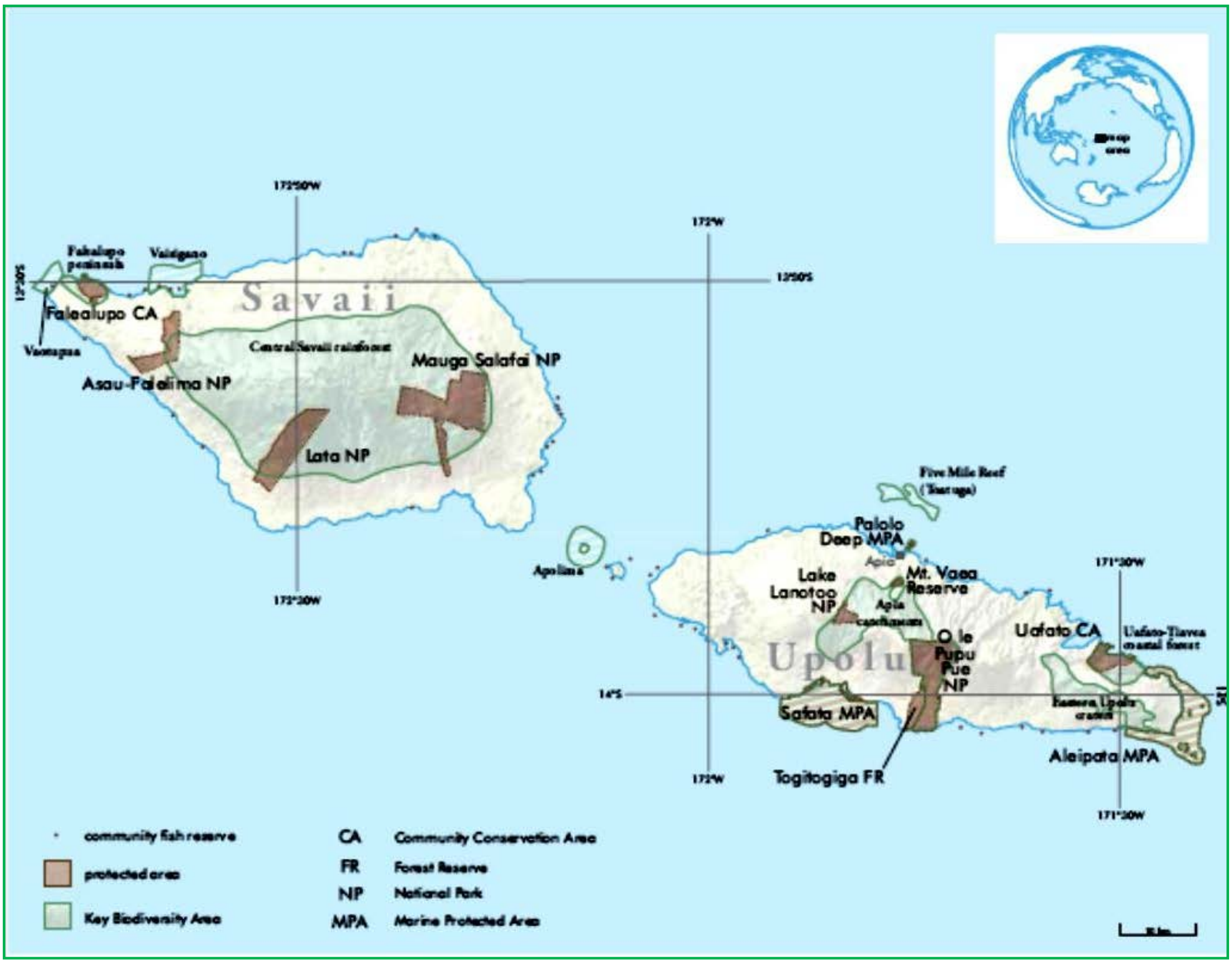
7. Data collection and analysis for future assessment for SOE should allow detailed assessment of the health of each of the major rivers in the country.

Tafitoala River, post cyclone Evan Jan 2013

6.7. PROTECTED AREAS

Samoa is part of the Polynesia-Micronesia Biodiversity Hotspot, one of 34 regions of the world where extraordinary levels of biodiversity and endemism are coupled with extremely high levels of threats (Mittermeier et al 2004)[99]. Eleven (11) terrestrial and 65 marine species found in Samoa are listed as globally threatened on the *2012 IUCN Red List of Threatened Species*, but the true number of threatened species in Samoa is significantly higher than this, perhaps in the hundreds according to Conservation International (2009, op cit). It is essential to Samoa's sustainable development that adequate representatives of this biodiversity are protected. Likewise, as a party to the Convention on Biological Diversity, Samoa is committed to protecting the same as part of the Earth's biodiversity.

Map 15: Protected Areas and Key Biodiversity Areas of Samoa



Source: CI et al., 2010. *Priority Sites for Conservation in Samoa: Key Biodiversity Areas.* Apia, Samoa.

Samoa has already determined that 15%[100] of its terrestrial area will be dedicated for protection, to preserve the essential ecological services it provides and to protect representative populations of its unique and native flora and fauna species, assemblages and ecosystems. Site based (in-situ) conservation is the approach used, in the form of national parks, reserves, community conservation areas (CCAs), and co-managed sites, where species are protected in-situ.

From an SOE perspective, the important questions are (i) how representative is Samoa's protected area network of the full range of its ecosystems and species, including those of global significance? (ii) and how well protected are they?

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[99] *Cited by CI et al, 2010.*
[100] *Government of Samoa. 2001. Samoa's Biodiversity Strategy and Action Plan: Keep the Remainder of the Basket. Government of Samoa, Apia.*

In terms of representativeness, ecosystems of national and international significance from a biodiversity conservation perspective were identified by Pearsall et al (1991), and formally recognized for conservation management in the NBSAP 2001 (op cit). Fourteen (14) priority sites were recommended to be protected within five Grade 1 and seven Grade 2 areas[101]. Whistler (op cit) also identified 13 different vegetation types comprising Samoa's flora. In 2008, MNRE in collaboration with CI and SPREP[102] conducted a gap analysis to analyse how effective the current protected area (PA) network was in achieving NBSAP's conservation targets. This analysis recommended 8 terrestrial and 7 marine Key Biodiversity Areas (KBAs) to ensure representative coverage of all native ecosystems. The geographical locations of these sites are shown in Figure VIII-1. The new KBAs have since replaced the recommended areas in the NBSAP 2001 and have been formally adopted as conservation targets for Samoa[103].

According to CI et al (ibid), the 8 terrestrial KBAs cover a total of 940km^2 or approximately 33% of the total land area of Samoa. This more than doubles Samoa's NBSAP commitment of 15% of land coverage as well as exceeding the 17% target under the PoWPA initiative. The new KBAs include representatives of 12 of the 13 native terrestrial vegetation communities in the country. The 7 marine KBAs cover approximately 173km^2 or 23% of the inshore reef area of Samoa (ibid.). The KBAs also incorporates existing parks and protected areas including existing MPAs.

6.7.1. Current Status

Samoa's Fourth National Report to the CBD (2009) listed 22 terrestrial reserves, 5 National Parks, 2 Marine Protected Areas (MPAs), 1 marine reserve and 71 village fisheries reserves (refer to Appendices 5 and 6) as constituting Samoa's protected area network. The national parks and reserves are managed directly by the Government through MNRE, while the two MPAs and the fisheries reserves are directly managed by villages and, in the case of the MPAs, by two districts. Samoa also formally designated its entire EEZ in 2002 as a sanctuary for whales, dolphins, turtles and sharks.

The KBA's redefined the boundaries of areas of high biodiversity values enlarging them and incorporating the existing parks and reserves. CI et al (op cit) also provided an assessment of their conservation statuses and this assessment remains the most current on the health of the areas and species involved. This analysis is presented in Table 33.

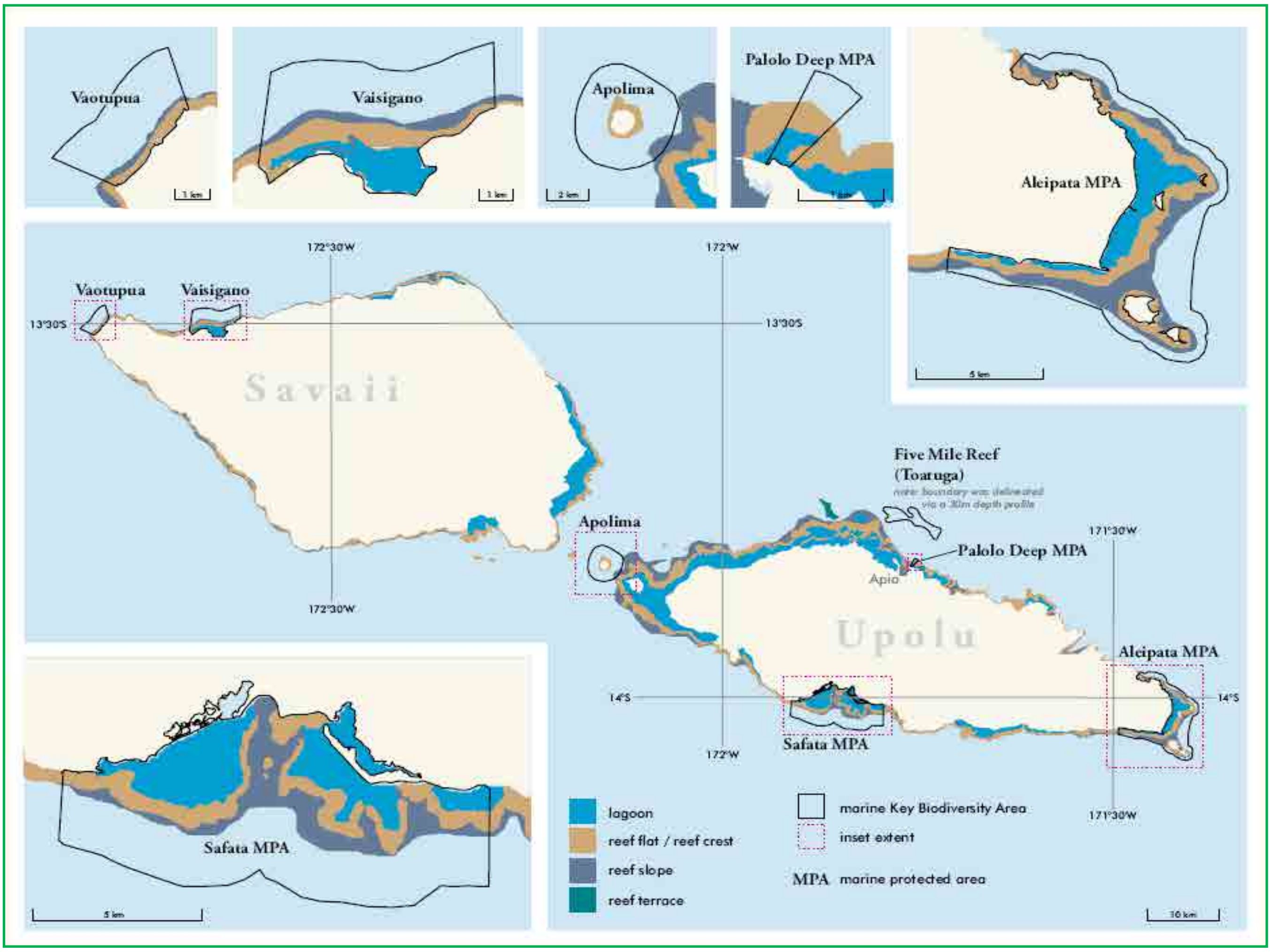
Part of the analyses involved assessing the statuses of native and endemic species of high conservation value, which CI et al (ibid.) termed as 'trigger species' because the extent of their vulnerability provides the trigger for the proposed KBAs. The original CI analysis was based on the 2009 IUCN's Redlist of Threatened Species, and is updated in this report based on the 2012 IUCN Redlist. These species are presented in Table 35 and Table 36.


[101] Grade 1 sites were - Uafato-Tiavea Coastal forest; Saanapu-Sataoa Coastal Wetland (Mangrove Forest), Aleipata Islands, Aopo-Letui-Sasina Coastal Forest and Vaoto Lowland Forest. Grade 2 sites were Apolima-Fou Coastal Wetland, Saleapaga-Lalomanu Coastal Forest, Vaiee-Tafitoala Peninsula, Vaipu Swamp Forest, Taga-Lata-Salailua Lowland Forest, Siuvao Point, and Mulinuu-Tufutafoe.

[102] With GEF funding under the Program of Work for Protected Areas (PoWPA)

[103] Faleafaga, T, pers comm..

Map 16: Samoa's Marine Protected Areas



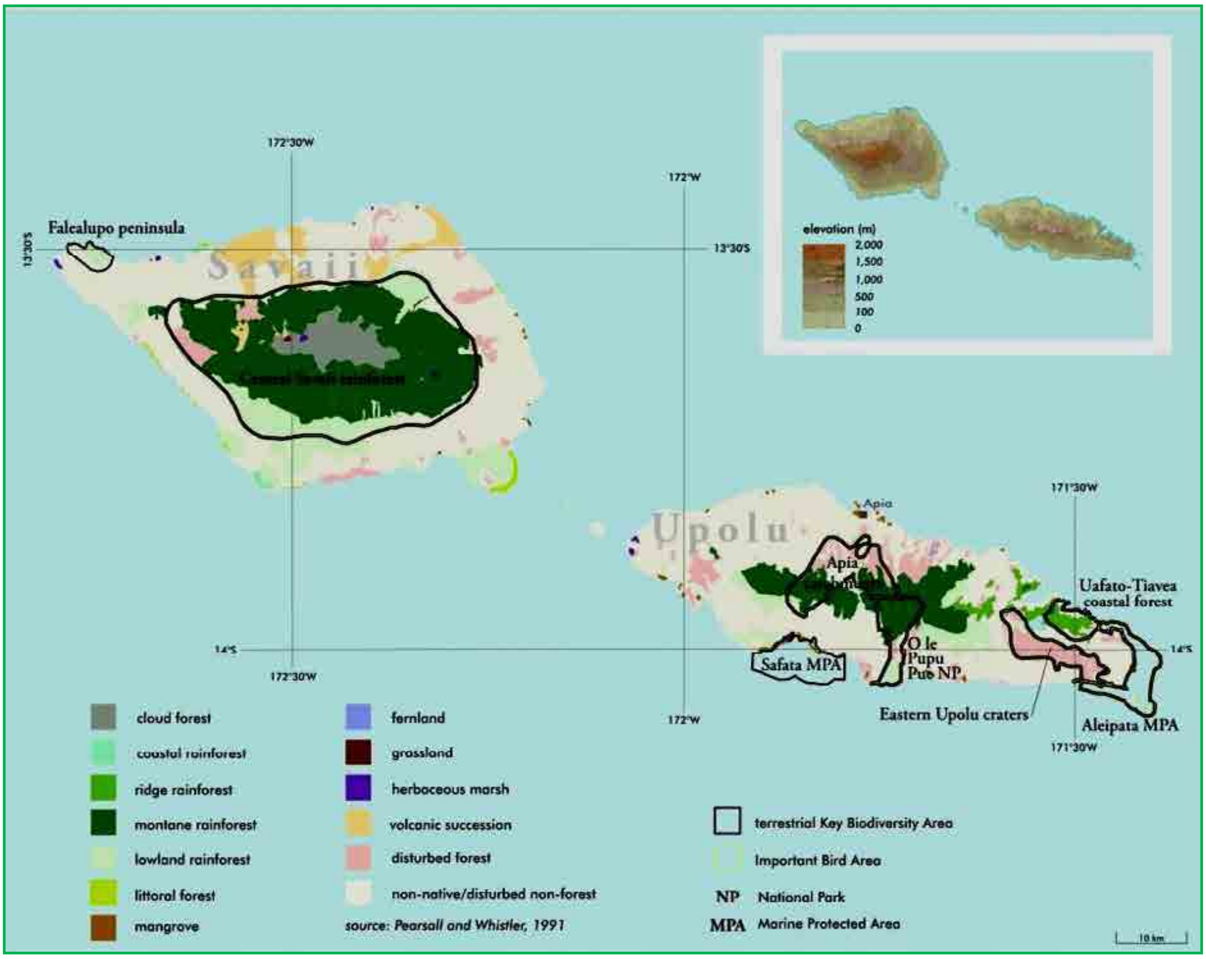
Source: CI et al., 2010. *Priority Sites for Conservation in Samoa: Key Biodiversity Areas.* Apia, Samoa.

Table 41: Profile of Terrestrial Key Biodiversity Areas

Site #	Site Name	Island	Faipule District	Approx Area (ha)	Current Protection Status	IBA (Y/N)	Terrestrial Trigger Spp in Site	Threats
1	Aleipata Marine Protected Area	Upolu	Aleipata	4,842 (marine); 156 (land)	Active Marine Protected Area	Y	Hawksbill and Green Turtles (*laumei*); Tooth Billed Pigeon (*Manumea*), Ground Dove (*Tuaimeo*), Bristle Thighed curlew (*Tuliolovalu*)	Invasive Species, fishing, development.
2	Eastern Upolu Craters	Upolu	Aleipata and Lepa	4,759	None	Y	Tooth Billed Pigeon (*Manumea*), Mao (*Maomao*), Samoan Broadbill (*Tolaifatu*)	Invasive Species, development
3	Uafato-Tiavea Coastal Forest	Upolu	Vaa o Fonoti	2,316	Inactive community Conservation Area	Y	Mollucan Ironwood (*Ifilele*), Tooth Billed Pigeon (*Manumea*), Mao (*Maomao*), Samoan Broadbill (*Tolaifatu*), Samoan Flying Fox (*Pea vao*)	Decline of keystone species Ifilele by unsustainable harvesting by wood carvers, management conflicts.
4	O le Pupu Pue National Park	Upolu	Siumu and Falealili	4,228	Active National Park	Y	Samoan Bush Palm (*Niu vao*), Tooth Billed Pigeon (*Manumea*), Ground Dove (*Tuaimeo*), Mao (*Maoma*o), Samoan Broadbill (*Tolaifatu*), Samoan Flying Fox (*Pea vao*)	Invasive species, hunting
5	Apia Catchments	Upolu	Vaimauga West, Faleata, Siumu	8,336	Partly protected in Lake Lanuto'o National Park and Mt Vaea Scenic Reserve. Some conservation effort by MNRE's watershed management section.	Y	Samoan Bush Palm (*Niu vao*), Tooth Billed Pigeon (*Manumea*), Ground Dove (Tuaimeo), Mao (*Maomao*), Samoan Broadbill (*Tolaifatu*), Samoan Flying Fox (*Pea vao*), *Thaumatodon hystricelloides* (*Sisi*)	Invasive species, hunting, development
6	Safata Marine Protected Area	Upolu	Safata	5,870 (marine); 101 (land)	Community Conservation Area	N	Hawksbill and Green Turtles (*Laumei*), Samoan Broadbill (*Tolaifatu*)	Management conflicts, land clearance for new house sites, dumping of rubbish, pollution
7	Central Savaii Rainforest	Savaii	Inland parts of all districts on Savaii	72,699	Partly protected in Mauga Salafai, Lata and Asau-Falelima National Parks	Y	Samoan Bush Palm (*Niu vao*), Drymophleous samoensis (*Maniuniu*), Tooth Billed Pigeon (*Manume*a), Mao (*Maomao*), Samoan Broadbill (*Tolaifatu*), Samoan Flying Fox (*Pea vao*), Samoan Moorhen (*Punae*), Savaii White-Eye (*Mata Papae*)	Invasive species, hunting
8	Falealupo Peninsula	Savaii	Vaisigano West, Falealupo and Alataua West	1,537	Partly protected in a Community Conservation Area	N	Tooth Billed Pigeon (*Manumea*), Samoan Broadbill (*Tolaifatu*), Samoan Flying Fox (*Pea vao*). This site also contains the only known populations of the *Pau* tree (*Manilkara samoensis*), a highly three endemic to Falealupo, not currently on the IUCN Red List.	Invasive species, fire, hunting

Source: CI et al., 2010. *Priority Sites for Conservation in Samoa: Key Biodiversity Areas.* Apia, Samoa.

Map 17: KBAs and ecosystem types in Samoa



Source: CI et al., 2010. *Priority Sites for Conservation in Samoa: Key Biodiversity Areas.* Apia, Samoa.

O le Pupu Pu'e National Park

Table 42: Terrestrial KBA Trigger Species in Samoa (2012 IUCN Red List)						
Species #	**Scientific Name**	**English Name**	**Samoan Name**	**IUCN 2009 Threat Category**	**Threats**	**Population Trend**
I	*Gallinula pacifica*	Samoan Moorhen	Punae	Critically Endangered (Possibly extinct in Samoa)	Hunting, invasive species	Not known
2	*Drymophleus samoensis*	None Known (a palm)	Maniuniu	Critically Endangered	Habitat loss	Not known
3	*Emballonura semicaudata*	Pacific Sheath Tailed Bat	Tagiti	Endangered (Possibly extinct in Samoa)	Habitat loss, invasive species, poisoning?	Decreasing
4	*Clinostigma samoense*	Samoan Bush Palm	Niu vao	Endangered	Habitat loss	Not known
5	*Didunculus strigirostris*	Tooth- Billed Pigeon	Manumea	Endangered	Hunting, habitat loss, invasive species	Decreasing
6	*Gymnomyza samoensis*	Mao	Maomao	Endangered	Hunting, habitat loss, invasive species	Decreasing
7	*Thaumatodon hystricelloides*	None Known (a land snail)	Sisi	Endangered	Habitat loss, invasive species	Not known
8	*Gallicolumba stairii*	Shy Ground Dove	Tuaimeo	Vulnerable	Hunting, habitat loss, invasive species	Decreasing
9	*Intsia bijuga*[104]	Mollucan Ironwood	Ifilele	Vulnerable	Logging for handicrafts and timber	Decreasing (in Samoa)
10	*Myiagra albiventris*	Samoan Broadbill	Tolaifatu	Near Threatened[105]	Habitat loss	Decreasing
11	*Nesofregetta fuliginosa*[90]	Polynesian Storm Petrel	Taio	Vulnerable	Habitat loss, invasive species	Decreasing
12	*Numenius tahitiensis*	Bristle Thighed Curlew	Tuliolovalu	Vulnerable	Invasive species, hunting	Decreasing
13	*Zosterops samoensis*	Samoan White Eye	Mata papae	Vulnerable	Habitat loss, invasive species	Stable
14	*Pteropus samoensis*	Samoan Flying Fox	Pea vao	Near Threatened (Endangered in Samoa)	Hunting, habitat loss, invasive species	Decreasing

[104] *Cited by CI et al 2009, vulnerable in Samoa but not listed in 2012 IUCN Red List*
[105] *Previously Vulnerable (CI, 2009) but reclassified as Near Threatened in 2012 IUCN Red List*

Table 43: Marine KBA Trigger Species in Samoa (2012 IUCN Red List)					
Species #	**Scientific Name**	**English Name**	**Samoan Name**	**IUCN 2009 Threat Category**	**Population Trend**
I	*Eretmochelys imbricate*	Hawksbill Turtle	Laumei	Critically Endangered	Decreasing
2	*Chelonia mydas*[106]	Green Turtle	Laumei	Endangered	Not Known
3	*Cheilinus undulates*	Humphead Wrasse	Malatea	Endangered	Decreasing
4	*Epinephelus lanceolatus*	Giant Grouper	Ata'ata-uli	Vulnerable	Decreasing
5	*Hippocampus histrix*[107]	Seahorse	Pua'a sami	Vulnerable	Not Known
6	*Nebrius ferrugineus*	Nurse Shark	Malie	Vulnerable	Decreasing
7	*Negaprion acutidens*[92]	Lemon Shark	Naiufi	Vulnerable	Decreasing
8	*Rhincodon typus*	Whale Shark	Faaeme	Vulnerable	Decreasing
9	*Rhynchobatus djiddensis*[92]	Guitarfish	No Samoan Name	Vulnerable	Not Known
10	*Sphoeroides pachygaster*[92]	Puffer Fish	Sue	Vulnerable	Not Known
11	*Thunnus obesus*	Big Eye Tuna	Asiasi matalapo'a	Vulnerable	Decreasing
12	*Stegostoma fasciatum*[92]	Zebra Shark	Malie	Vulnerable	Not Known
13	*Bolbometopon muricatum*	Bumphead Parrot Fish	Galo	Vulnerable	Decreasing
14	*Carcharhinus longimanus*	White Tip Shark	Malie Aloalo	Vulnerable	Decreasing
15	*Carcharhinus limbatus*[108]	Black Tip Shark	Malie Aloalo	Vulnerable	Not Known
16	*Plectropomus areolatus*	Polkadot Cod	Ata'ata-utu	Vulnerable	Decreasing
17	*Plectropomus laevis*	Blacksaddled Coral Grouper	Ata'ata-utu	Vulnerable	Decreasing

[106] *Cited by CI et al 2009, but not listed in 2012 IUCN Red List*
[107] *Listed as Hippocampus kuda in CI et al 2009*
[108] *Cited by CI et al 2009 as VU; categorized Near Threatened (NT) in 2012 IUCN Red List*

6.7.2. Overall Assessment

By identifying areas that address the gaps not covered in the then-existing protected area network and target areas, CI et al (2009) has significantly improved the representativeness, at least on paper, of the areas earmarked for conserving Samoa's biodiversity.

Protected Area Health indicators	Low	Medium	High	Trend	Comment
Extent of representativeness of Samoa's protected area network			✓	➔	Terrestrial KBAs cover 12 of 13 terrestrial vegetation communities.
area of KBA with official protection status as a % of total area	✓			Unknown	
% of native forest cover within terrestrial KBA		✓		↓	Definitely decreasing trend in the case of Upolu.
% of KBAs with governance structure in place		✓		Unknown	
% of trigger spp with increasing populations	✓			↓	IUCN 2012 - 20 terrestrial and marine trigger spp are decreasing in population, and 10 are 'unknown' including of 3 species that are already 'critically endangered'.

The extent of protection currently afforded to KBAs varies widely. Some e.g. MPAs are formally designated and have the support of landowning villages with approved management plans being implemented and governance structures in place. Most terrestrial KBAs are only partially protected, with only areas officially designated as national parks having official protection statuses.

The health of many terrestrial KBAs is unclear, especially those on Upolu. Based on MNRE's forest cover assessment, the general dominance of non-native species in Upolu, suggests that KBAs are not as pristine as desired even if not directly impacted by human activities. By the same measure, the Central Savaii Rainforest KBA – described as ' the largest contiguous area of rainforest in tropical Polynesia… and one of the last remaining strongholds for one or more Critically Endangered or Endangered Species…" is in good health with MNRE's forest cover assessment reporting it to be predominantly of native forests.

Information on percentage of KBAs comprising of native and non-native forests respectively are unavailable, but this would have provided an indication of the degree of 'wilderness' in the KBAs.

Overall, a low to medium mark for the 'percentage of native forest cover' is a subjective verdict based on anecdotal information and expert assessment.

6.7.3
General recommendations

1. Secure legal status for all areas proposed as KBA.

2. Develop and implement management plans for KBAs. Take into account current work on developing management plans for designated national parks and, where appropriate, convert these to KBA management plans.

3. Review and update the National Biodiversity and Strategic Action Plan (NBSAP) to reflect new developments and results of recent studies and surveys.

4. Collaborate with other relevant sectors including MAF, tourism, water resources, and affected local communities to promote the integration of designated protected areas with other legitimate land uses, including the interests of affected land owning communities.

5. Develop MNRE's capacity for protected area management and secure financial resources to allow effective implementation of management plans.

6. Cooperate with Forestry Division to find the resources for an aerial photography exercise to update Forestry's forest cover data sets which is useful also for KBA conservation planning and monitoring.

6.8. ATMOSPHERE, WEATHER and CLIMATE

The atmosphere is a global commons. It is also an integral part of Samoa's biophysical environment. Changes to the nature of the atmosphere, often induced by human activities of more developed countries, have dire and direct consequences that are costly and damaging for Samoa, as are for all developing countries and low lying small islands in particular.

Impacts of human induced climate change and climate variability predicted in the 2006 SOE report are now a reality for Samoa. Observed trends include: increased maximum air temperatures, increased frequency in extreme daily rainfall events, sea level rise of 5.2mm a year and maximum hourly sea level rise of between 2.7 – 8.3 mm a year (PCCSP, 2012). Similarly are the predicted increase in the frequency and intensity of cyclones, one of which – Cyclone Evan - hit Samoa with devastating results in 2012.

The emergence of climate change induced extreme events such as cyclones, floods, droughts etc as a major threat to Samoa's economic development has pushed climate change and climate variability into the forefront of Samoa's economic development agenda. Environmental sustainability and disaster reduction constitute one of four Priority Areas of in Samoa's 2012-2016 SDS. It is critical from this perspective that changes taking place in Samoa's climate and atmosphere and the activities of Samoa that contribute directly to these changes are closely monitored and analysed.

For the SOE, the overall questions of interest are - how well is Samoa progressing in limiting if not reducing its vulnerability to climate change and climate vulnerability? Is Samoa making progress in building resilience? Both vulnerability and resilience are not easily measurable. In fact for resilience, an important part of the analysis was conducted under the Rural and Urban Built Environment. For vulnerability, an indirect estimation is derived with the use of indicators that show trends in GHG emissions, CO_2 removals, surface ozone concentrations as well as evidence of effective implementation of priority projects of the NAPA. The last indicator – extent to which NAPA is implemented - is based on the premise that implemented NAPA priority projects in mitigation and adaptation not only reduces Samoa's vulnerability but also strengthen its preparedness and resilience against extreme climate change induced events.

6.8.1 Current Status

Human activities result in pressures on the atmosphere through gaseous pollutants. Of importance to Samoa are emissions of four principal greenhouse gases: carbon dioxide,(CO2), methane (CH4), nitrous oxide (N2O and halocarbons (a group of gases containing fluorine, chlorine and bromine). These gases accumulate in the atmosphere and are the principal drivers of climate change since the beginning of the industrial era.

Available data on GHG emissions and removals are limited and is not disaggregated by different GHGs other than carbon dioxide (CO_2). Surface ozone measurements are somewhat dated. These are presented in the table below.

6.8.1.1 GHG Emissions

A summary of emissions for 1994, 2000 and 2007 are given in Table 45 below –

Table 44 – Summary of Samoa's GHG emissions for 1994, 2000 and 2007

	Gg CO_2-e		
Sector	**1994**	**2000**	**2007**
Energy	102.83	142.74	174.35
Industrial Processes and Product Use	n.a.	4.59	9.51
Agriculture, Forestry and other Land Use (excluding removals)	37.92	86.06	135.37
Waste	24.88	33.09	32.81
Total Emissions	165.63	266.43	352.03
Estimated CO2 Removals			
Agriculture, Forestry and Other Land Use	-658.56	-1150.04	-785.07

Source: MNRE. 2010. Samoa's Second National Communications to the UNFCCC. n.a. = not available

The MNRE report (ibid) found the energy sector to be the main source of GHG emissions, accounting for 50% of the national total in 2007, followed by the agriculture, forestry and "other land use' sector, which accounted for 38% of emissions. Emissions from Waste and Industrial Processes and Product Use (PPU) sectors make up 9% and 3% of total CO_2-e emissions respectively (ibid.).

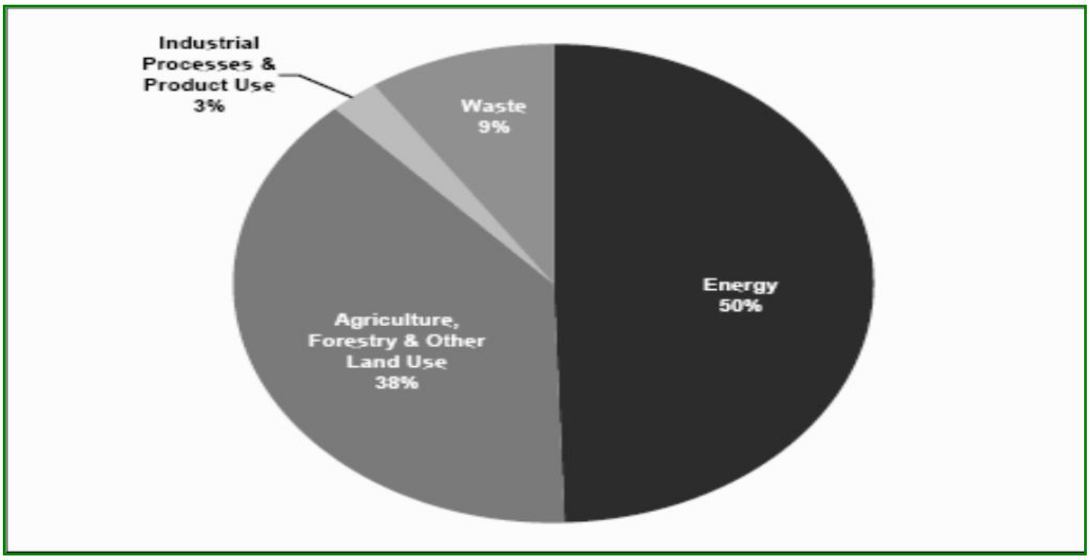
In terms of activities, emissions from different activities are given in Table 41. Of significance for abatement planning purposes, 95% of all GHG emissions come from just six sources with road transport and livestock farming constituting over 50%.

Table 45 – Top six sources of GHG emissions in Samoa (2007)

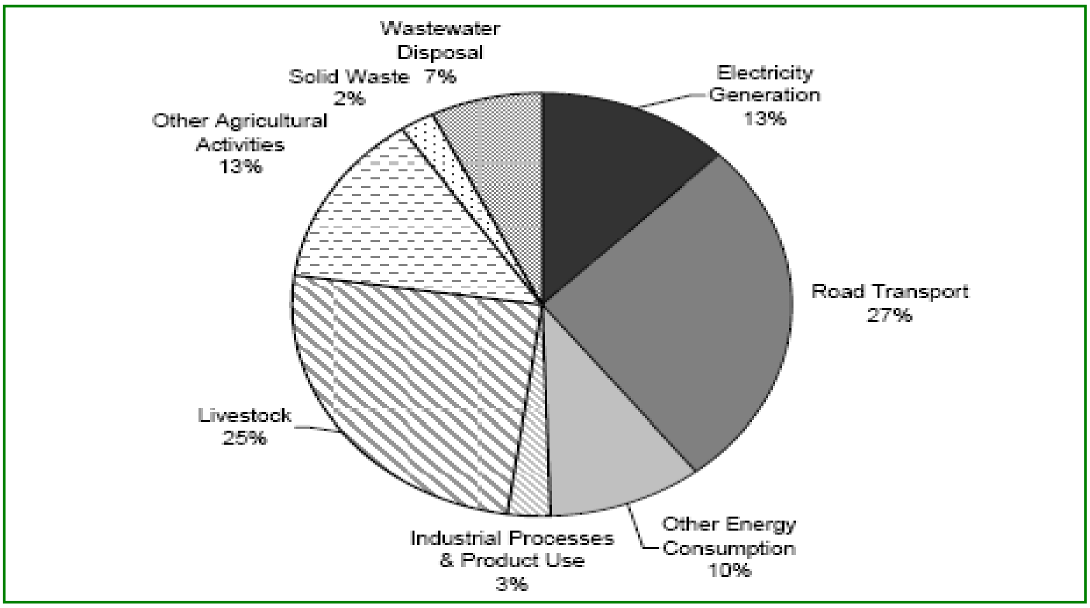
Rank	Source	Emissions (Gg CO_2-e)	% of total emissions
1	Road transport	95.11	27%
2	Livestock farming	88.36	25%
3	N_2O from agricultural soils	47.01	13%
4	Electricity generation	44.21	13%
5	Other energy consumption	31.14	10%
6	Wastewater	25.44	7%
2.2.1.2	**TOTAL**	**335.15**	**95%**

Source: MNRE (2010) ibid.

Graph 16: Sectoral breakdown in Samoa's total GHG emissions (2007)



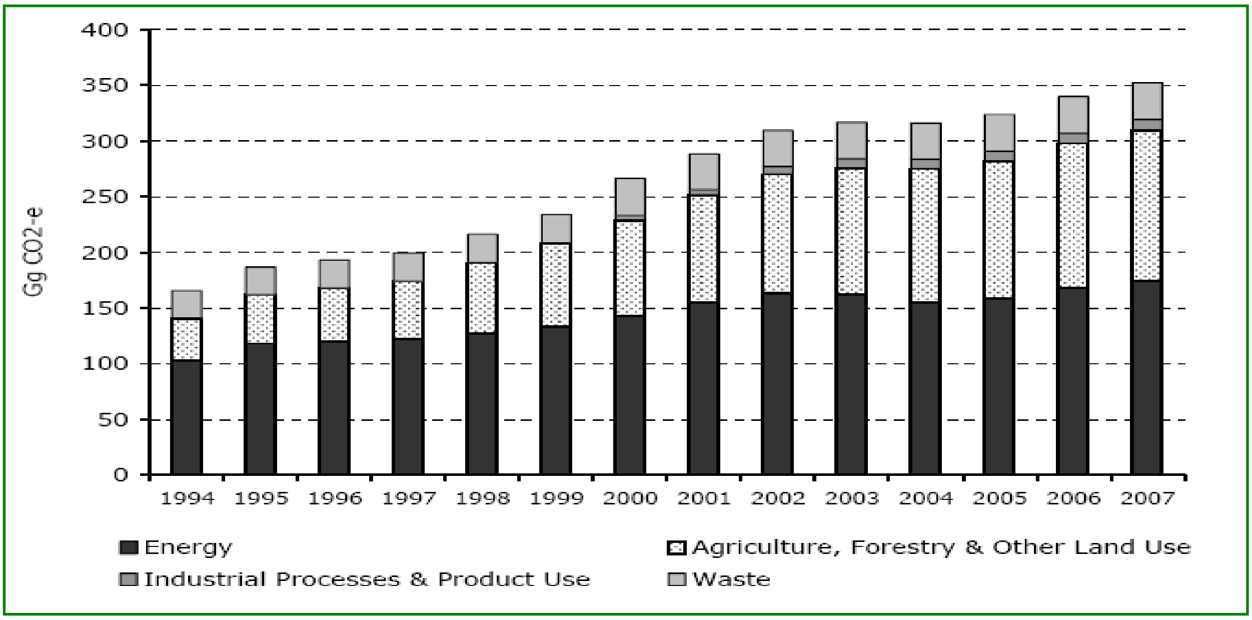
Graph 17: Detailed breakdown in Samoa's total GHG emissions (2007)



Source: Government of Samoa. 2010. Samoa's Second National Communication to the UN FCCC.

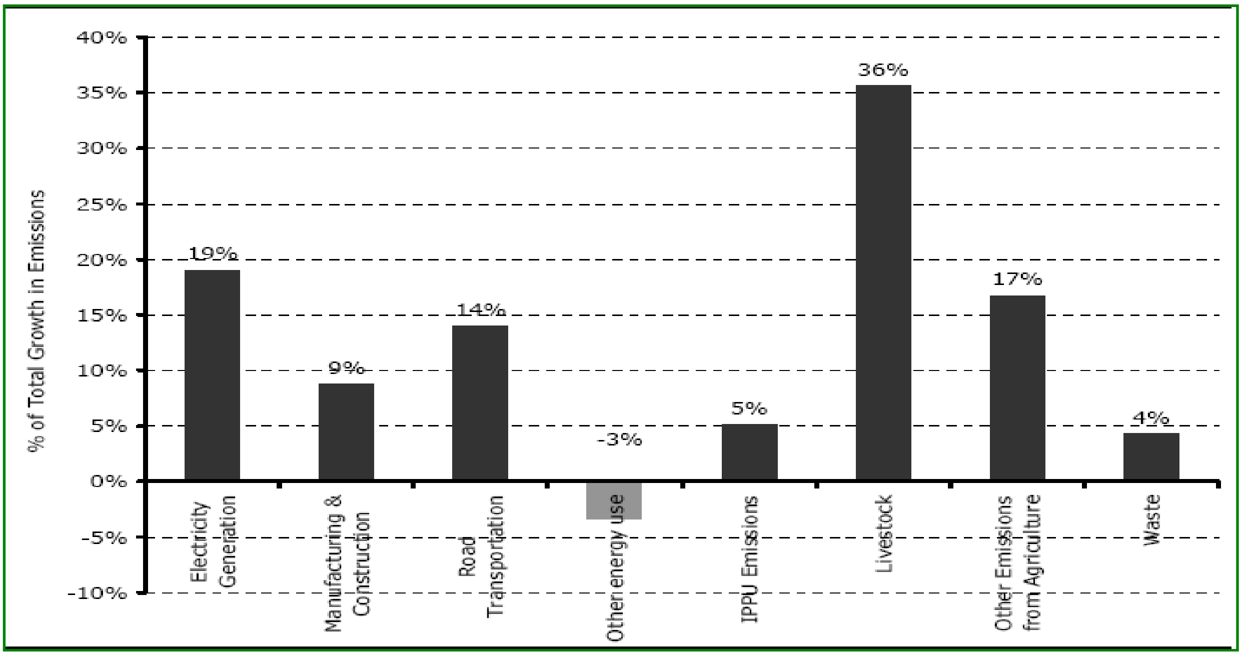
MNRE (2010) reported that Samoa's GHG emissions have increased steadily since 1994 (based year) at an average growth rate of 16% per annum, with the 2007 emission showing a 113% increase over the 1994 based year i.e. from 165.63 Gg CO_2-e to 352.03 Gg CO_2-e (Graph 18). The fastest rate of growth is occurring in Agriculture, Fisheries and Other Land Use (AFOLU) sector. Livestock and electricity generation contributed the most to emission growth accounting for 36% and 19% respectively.

Graph 18: Trend in Samoa's GHG emission 1994-2007



Source: MNRE (2010): Samoa's Second National Communications to the UNFCCC.

Graph 19: Total growth in emissions by activity



6.8.1.2 CO_2 Removals

CO_2 removals from the atmosphere provide a counterbalance to local emissions. Tables 39 and 40 below give estimates of CO2 removals from forests and crops.

Table 46:
Net CO2 removals from forests (Gg CO2, 2000-2007)

Sources/Sink of CO2	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Biomass growth (removal)	-805.43	-805.3	-805.3	805.3	-805.3	-805.3	-805.3	-805.3
Logging (emissions)	71.74	85.40	87.65	56.23	49.23	61.46	13.20	13.20
Fuelwood (emissions)	28.43	27.12	24.88	22.83	20.94	19.21	16.09	14.76
Net removals	**-705.27**	**-692.91**	**-692.90**	**-726.38**	**-735.26**	**-724.76**	**-776.14**	**-777.47**

Source: MNRE (2010). Samoa's Second National Communications to the UNFCCC

Table 47:
Net CO2 removals from croplands (Gg CO2, 2000-2007)

Sources/Sink of CO2	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Clearance of coconut and cocoa (emissions)	400.10	400.10	400.10	338.62	305.04	372.20	338.62	338.62
Biomass growth of coconut and cocoa (removals)	-844.87	-764.85	-684.83	-617.11	-556.10	-481.66	-413.94	-346.22
Net CO2 removals	**-444.78**	**-364.76**	**-284.74**	**-278.49**	**-251.07**	**-109.46**	**-75.32**	**-7.6**

Source: MNRE (2010). Samoa's Second National Communications to the UNFCCC

6.8.1.3 Ozone

Measurements of surface and tropospheric ozone are reported by Shultz et al (1999) for four Pacific Island countries including Samoa. This is presented in Table 48 below.

Table 48:
Surface Ozone in Fiji, Samoa, Tahiti and Galapagos

Site	**Minimum (ppbv)**	**Maximum (ppbv)**	**Average for period 1997 - 2003**
Fiji	2.0	34.0	16.7
Samoa	0.0	37.0	13.4
Tahiti	2.0	32.0	12.8
Galapagos	0.0	28.0	12.3

Source: Shutlz et al, 1999[109]

Shultz (ibid) noted that there are distinct variations between summer (Jan – Mar) and winter June – August). The summer minimum is due to higher sunshine hours when photochemical breakdown is highest.

Table 49: Tropospheric Ozone in Samoa

Year	**Range (DU)**	**MAM Mean (DU)**	**SON Mean (DU)**
1997	9 – 50	16.1	27.3
1998	8 – 39	19.9	24.6
1999	7 – 31	13.3	22.8
2000	10 – 30	16.9	23.5
2001	14 – 29	-	24.6
2002	11 – 30	14.9	22.5
2003	10 – 35	13.3	24.1
Total Average	7 - 50	15.7	24.2

Source: Shultz et al, 1999.
MAM – March April May
SON – September October November
Note: Maximum ozone during spring (SON) and minimum during fall (MAM)
DU – Dobson Units (unit for measuring ozone)

[109] *Cited by UNEP. 2011. Pacific Environment and Climate Change Outlook. Draft Report. Pp.167.*

6.8.1.4 ODS Consumption

The use of ozone depleting substances in Samoa is limited to CFCs, hydro-fluorocarbons (for refrigeration and air conditioning) and methyl bromide (a fumigant in quarantine and pre-shipment applications). Samoa's consumption of ODS was initially relatively low according to figures for 2000 – 2002. After 2002, Samoa's consumption was reduced to zero metric tons following a targeted program of ODS replacement and reduction that was implemented to comply with Samoa's commitment to the Montreal Protocol.

Table 50:
Consumption of ODS in Samoa relative to Oceania

Region/Country	2000	2001	2002	2003	2004	2005	2006	2007
Oceania	635	486	490	346	254	238	124	144
Samoa	1	2	3	0	0	0	0	0

Source: World Resources Institute. http://www.wri.org. Cited by UNEP. 2011.

6.8.1.5 Ecosystem-based adaptation – NAPA Implementation

This assessment of the extent to which NAPA has been implemented is to gauge the extent of preparedness as an indicator of resilience. The assumption is that NAPA projects are those assessed to be priority for mitigation and adaptation against the impacts of climate change and climate variability.

Tables 51 and 52 below summarized all initiatives being implemented or planned that contribute to climate change mitigation and adaptation. The list of donor funded projects is given in Appendix 11.

Table 51: Summary of existing measures that have contributed to climate change mitigation in Samoa

Initiative	Description	GHG Savings
Hydroelectric power	Samoa has an extensive network of hydropower plants. Over the period 1994 - 2006, an average of approximately 45.79 GWh of hydroelectricity was produced annually, saving approximately 13,468 kl of diesel each year. This diesel would otherwise have been used to produce electricity. It is important to note that the proportion of electricity generated from hydropower versus diesel has declined over recent years. In 1994, approximately 89% of Samoa's electricity was generated by hydro. By 2006, however, hydro provided only 47% of Samoa's total electricity requirements. This is because growing demand has not been matched by investment in new hydro plants.	Approx. 36,335t cf pa
Solar power initiatives	The most recent experience with solar photovoltaics (PV) was on Apolima, where a 13-kWp photovoltaic system was installed in 2006, providing households with twenty-four-hour electricity supply. A separate 1 kWp PV system was also installed at the same time to provide electricity for Apolima's church. Before the PV system was installed, electricity needs were met by a small and unreliable diesel generator. It is estimated that the Apolima PV system produces approximately 9.2 MWh of electricity per annum, reducing diesel consumption by approximately 2.7 kl annually. As well, an increasing number of households and businesses have installed solar hot-water heaters and a number of recently installed Government meteorology facilities (seismic stations, tide gauges and automatic weather stations) are now all powered by solar. The vast majority of households, however, do not have any plumbed hot-water system. Other Government buildings now partly using solar are the MNRE Meteorology Division which recently installed 15kW photovoltaic system at its Mulinuu office to supply 40% of power consumption, and the new MESC headquarters at Malifa which has a photovoltaic system installed.	Approx. 7.2 t CO2-e pa Not assessed Not assessed
Biofuels	EPC has trialled a biofuel made from coconuts in several of its diesel generators. The "coco-diesel" was blended with regular diesel at levels of 5-20%. This was only a trial, which means there were no	Not assessed

	ongoing GHG savings. EPC has indicated that the trial was successful and is currently exploring options for using "coco-diesel" on a permanent basis. There is also small-scale use of coconut oil in vehicles. 13 vehicles are running on B10 biodiesel produced by SROS under the IUCN MNRE Greenhouse Gas Abatement in the Land Transport Sector through Energy Efficiency and Biofuel Applications Project. The B10 is constituted of 10% coconut biodiesel and 90% petroleum diesel and the B10 will be improved to increase the amount of biodiesel when capacity becomes available. Jatropha is also being researched under this project for biofuel applications	Not assessed
Biomass	Biogas through anaerobic digestion is estimated to produce 1-3m^3 of methane per household daily depending on the number people in the household. 5 biogas digesters exist in Samoa, two of which are farm scaled systems which can produce 5-10m^3 of biogas (methane) per day. One of these, the YWAM campus in Falelauniu, with an average population of about 40, generates all its cooking gas and 20% of its electricity from biogas digester.	Not assessed
Energy efficiency and energy conservation	IUCN MNRE Greenhouse Gas Abatement in the Land Transport Sector through Energy Efficiency and Biofuel Applications Project is looking into improving the efficiency of vehicles. MNRE is coordinating the ADB Promoting Energy Efficiency in the Pacific Project which is implementing energy efficiency technology and energy conservation measure in the infrastructure and households.	Not assessed Not assessed
Solid waste management	Solid waste management in Samoa has improved significantly over the last decade, particularly after the introduction of the nation-wide roadside collection service and the establishment of properly designed landfill sites. Whilst these were not specifically designed as mitigation activities, improvements in waste management have helped to reduce emissions by promoting a shift away from backyard waste incineration which surveys showed to have decreased in recent years. With financial support from the Japanese government, Samoa's two landfill sites have been converted to semi-aerobic systems. Emissions from semi-aerobic systems are approximately 60% lower than from standard landfill sites.	Annual emissions from backyard burning declined by approx. 35% over the period 2000-2007. Upgrade of the landfill sites saves approx. 4,300 t CO_2-e annually (based on 2007 levels).
Forestry initiatives	**National Parks** In December 2007, the Government proclaimed three new terrestrial national parks, bringing the total number in Samoa to five. It should, however, be noted that more detailed analysis is required to confirm the extent to which these reserves have aided GHG abatement. **Ban on Commercial Logging** In 2007, Cabinet announced a ban on all commercial logging in Samoa. **Reforestation Programme** During the 1970s and 1980s Samoa had an extensive reforestation programme, which was financially supported by the Government of New Zealand (Outlook Study). Cyclones Ofa (1989) and Val (1990) destroyed approximately 75% of the plantations that had been established through this programme. Today, the Forestry Division of MNRE continues to manage a national reforestation programme, but this is limited to approximately 100 ha per annum. **Community Forestry Programme**	Not assessed.

	The Community Forestry Programme, co-ordinated by the Forestry Division, has replanted approximately 190 ha (Outlook Study). The programme provides participating farmers with 200 seedlings each, made up of a mixture of native and exotic species. Some of the species are designed for short rotation plantings, and are intended to provide a sustainable source of timber for construction. Commercial species, including mahogany, are also planted as part of this programme, with the view to providing an additional revenue stream for farmers. The Community Forestry Programme also includes an agro-forestry component, whereby farmers are encouraged to plant trees within existing crop and grazing lands.	

Source: MNRE.2010. Samoa's Second National Communications to the UN FCCC.

Table 52: Summary of Adaptation Measures in Samoa

Sector	**Description of adaptation measures**	**Adaptation options**
Water	Over time, Samoa has witnessed great variability in climatic patterns that affect water resources. This has led to some positive adaptation methods, for instance the significant improvement to water storage systems. Adaptation measures can be implemented both nationally and communally. Community measures, though often simple and small-scale, are critical in providing a foundation for current and future responses. Since the Water Resources Division (WRD) was established within the MNRE in 2006, new legislation has been formulated to address watershed management and the sustainable abstraction of water. The WRD has also implemented reforestation programmes to rehabilitate degraded watersheds and provide hydrological and limited hydro geological monitoring services. Hydrological monitoring networks have been established (mainly in Upolu) to monitor water levels, which is especially important during dry periods to help ensure that scarce water resources are managed properly. A new hydro geological monitoring network is also currently being established, with new observation boreholes planned to allow abstraction of groundwater and the monitoring of groundwater quality. Furthermore, a Water Abstraction Licensing Scheme has been established to ensure the abstraction of groundwater resources within sustainable limits.	• rationing programmes during water shortages • metering and pricing • water storage facilities and tanks • rehabilitation of coastal springs • exploring new fresh water sources • water treatment and testing • upgrading and maintaining water infrastructure • relocating water infrastructures • public awareness and media campaigns • leakage control • rain water harvesting • catchments management. • Monitoring of salinisation levels • Enforcement of the Water Abstraction Licensing Scheme
Health	The National Health Services (NHS) is responsible for delivering clinical services, while the Ministry of Health (MoH) has a regulatory and monitoring role for the total sector. The MoH has developed a Health Sector Plan 2008-2018 in response to priority health challenges identified in its 2006 Health Sector Situational Analysis Report. The report posited six key strategies to address these challenges. Strategies include improvements to health care services, health promotion and prevention services as well as better financial management within the sector.	National level –- (ICCRAHS to be inserted) • further developing the national filariasis eradication programme • awareness programmes and campaigns through available media outlets

	Climate change is not explicitly mentioned in this plan, but the strategies developed to deal with the identified health challenges will have flow-on benefits.	• developing food safety standards • developing a new Public Health Bill and national water standards. • expanding the reach of current immunisation programmes • formulating a draft of the National Avian Influenza Plan[110] • rebuilding four district health centres around Samoa Community level – • distributing free mosquito nets to positive filariasis cases • spraying households to safeguard against dengue transmission • inspecting sanitary conditions in villages. • spraying mosquito breeding areas • conducting complaints-based inspections of piggery farms and sties.
Agriculture	The MAF has implemented numerous adaptation projects, strategies and training programmes. The Strategic Integrated Pest Management Systems (SIPMS) funded by the Food and Agricultural Organization (FAO), focus on applying fungicides and improving plantation sanitation to boost crop yields. The project lifted production slightly in 1995, although farmers found the more intensive management systems unsustainable. The Taro Improvement, Taro Revitalization and Taro Multiplication projects introduced in the late 1990s helped introduce taro varieties resistant to blight. The FAO has trained farmers in improved farm management techniques and set up cost-effective micro-propagation schemes. The Agriculture Sector Plan 2011-2015 emphasises the building of farmer resilience to climate change as essential to its food security goal and sustainable trade in agricultural products and produce. Matching science-based climate change prediction information needs to farmer needs by taking into account traditional practises incorporating local knowledge and experience is considered crucial. Likewise, strengthening the capacity of farmers and producers to manage their resources is considered equally important (MAF, 2011).	• (ICCRAHS to be inserted) • training farmers in improved farm management techniques • planting windbreak and legume trees • cultivating crops resistant to extreme events • training future farmers through class-based education and workshops • livestock protection.
Fisheries	The fisheries sector has relied heavily on support from numerous regional and international institutions to develop and implement	• harvesting, developing and managing fisheries

[110] This has since been completed and approved by Cabinet in Dec 2008

	fisheries policies. Currently, there exist neither formal adaptation mechanisms nor plans-of-action to combat the consequences of climate change. This is somewhat understandable in the case of the offshore tuna resource. According to predictions of the impact of climate change on the tuna resource in Samoa's EEZ, the overall impact is not adverse. Rather, tuna migration within the Pacific SIDS EEZ is projected to favour Polynesian countries including Samoa. Much more vulnerable to climate change is the inshore fisheries resource including coral reefs where increases in sea temperatures already experienced are showing adverse impacts of coral health. The sector does, however, take a proactive role in times of natural disaster. Local communities and commercial fisherman also have their own approaches to managing climate-related risks. Given the potentially disastrous consequences of climate change for the sector, fisheries should consider amending the 1988 Fisheries Act to include adaptation measures for climate change.	sustainably • sustaining the fish export industry • developing the aquaculture sector.
Infrastructure	Climate change poses many threats to Samoa's infrastructure. Already, national and community-level adaptation measures have been implemented to help combat climate stresses. The Coastal Infrastructure Management (CIM) Plans have been developed for all districts and villages under the World Bank funded SIAM II Project. CIM Plans identify and prioritize key adaptation measures to strengthen resilience against climate change, particularly for communities and infrastructure facilities in flood and erosion prone areas. Measure include relocation of communities and in the long term, infrastructure to higher grounds, soft solutions such as tree planting, replanting and conservation of mangroves and hard solutions including construction of seawalls. Many of these measures have already been implemented throughout coastal communities of Samoa.	• implementing CIMs, the Planning and Urban Management Act, EIA, development consent and climate proofing • formulating appropriate legislation, policies, building codes and guidelines; • building traditional, inexpensive tourist accommodation, such as Samoan fale
Disaster risk management	Community disaster risk management programs – to strengthen safety and resilience at local or village level; Risk assessments to determine exposure and measures to minimize risk such as Risk Assessment at Mt. Vaea and surrounding areas Disaster planning at national level (response agencies, business community, NGOs, schools) Strengthening disaster risk management governance.....	• Preparation of village disaster response plans to enable them to respond to a disaster event examples of villages Moataa, Leauvaa etc.; • Risk assessment identifies risk reduction measures to be implemented to reduce risk of being affected and possibly prevent such risks from occurring such as rock walls to prevent landslide which may result from heavy rainfall, increased deforestation, seismic activities such as earthquakes e.g. Mt. Vaea Risk Assessment Study • Disaster plans for response agencies, business communities, schools etc to enable them to respond to a

		disaster event and increase their awareness of disasters

Source: MNRE.2010. Samoa's Second National Communications to the UN FCCC.

6.8.2 Overall Assessment
Is Samoa more vulnerable to the impacts of climate change and climate variability? Have we made progress in strengthening our resilience to these impacts?

The second GHG inventory found Samoa to be a net CO_2 sink, removing more CO_2 from the atmosphere than it releases (MNRE, 2010). The same report also found that the level of GHG emissions have been increasing steadily since 1994 (based year) at an average rate of 16% per annum. There are some concerns about the robustness of the methodologies used but these remain the most recent data on Samoa's emissions and removals communicated to the IPCC in Samoa's Second National Communications.

Samoa has also made good progress in terms of eliminating its consumption of HCFC which achieved the zero targets in 2003.

The impact of both local milestones on global climate change patterns is infinitely small and not likely to reduce our vulnerability in the short term. If anything, with the predicted changes in climate change already a reality, Samoa's vulnerability to climate events such as cyclones and floods is extreme and poses the biggest immediate threat to its socio-economic development.

Measuring resilience is complicated and more likely to be subjective and imperfect. In this report, reviewing progress in the implementation of NAPA is used to give us a general estimation of preparedness as an indirect measure of resilience.

Regarding NAPA implementation, the level of Government commitment and investment is outstanding and consistent with the high priority placed in the SDS for addressing Samoa's economic and environmental vulnerability to climate change induced extreme events. A wide range of mitigation and adaptation projects have been completed, others are being implemented with several in the pipeline in all priority vulnerable sectors. Coastal infrastructure has been a major target for climate proofing with both soft and hard solutions heavily invested in. Work is in progress for climate proofing in agriculture, forestry and tourism. In addition, resilience to climate change impacts is a recurring theme in all key sectors and those particularly vulnerable to climate change. The 20% RE target by 2030 is actively pursued through the development of a range of RE options including new small scale hydropower stations, biomass utilisation technology, biofuels, solar and wind power. The carbon neutral goal set for 2030 reflects a steely determination to contribute to global efforts and this commitment was evident in the One-Million-Tree Planting initiative that was declared achieved in November 2012. Several other sectors are currently undertaking initiatives in climate-proofing.

Overall, Samoa's vulnerability may be difficult to abate given the global nature of factors and forces influencing climate patterns. But Samoa is making a net positive contribution to the global reduction of GHGs with a decreasing carbon footprint based on the 2006 GHG inventory results. A similar positive contribution to ozone depletion has been achieved. The level of progress thus far achieved with the implementation of NAPA priorities also shows that Samoa is better prepared to deal with the impacts of climate change and climate variability today than reported in the last SOE. This high level of preparedness is the closest to an indicator of resilience that can be derived using the available information.

Atmosphere Weather, Climate and Geo-science Indicators	Low	Medium	High	Trend	Comment
Level of GHG emissions				↑	There are methodological issues to be sorted out before this assessment is confirmed.
Level of CO_2 removals				↑	Same comment above on methodologies applies.
% of ozone removed relative to estimated total output			✓	↑	HCFCs have been removed completed.
# of NAPA and other CC related projects implemented (insert indicators)		✓		↑	Subjective assessment

6.8.3 General Recommendations

1. MNRE must address issues of methodology surrounding results of NAPA 6 GHG inventory to produce reliable and unambiguous results and projections.
2. Training of MNRE's staff in GHG inventory methodologies and analyses is necessary.
3. NAPA6 needs updating to review old priorities, taking into account progress in implementation to date and to address any new developments and issues that may have arisen.
4. NAPA implementation must be maintained and if possible, accelerated.

Ozone Day awareness 2010 with the Transport Sector and APTC students

Awareness programmes with schools

7. CONCLUSIONS

The 2012 SOE report is based on the IEA framework and uses the DPSIR analytical model for examining the causes and effects of environmental changes in Samoa's environment. The specific examination and assessment of states used a habitat-based approach to organize and divide the biophysical environment into ecological components that were then examined and assessed using a range of indicators for environmental health.

Several constraints and drawbacks were faced with respect the use of these approaches but the overriding constraint is the lack of up-to-date quality data and information. This affected the overall completeness of the assessments, the nature of indicators selected and used. Many indicators that were considered appropriate had to be culled and others reviewed and amended to be 'assessable' with the available information. In many cases, 'assessability' means the use of subjective expert opinions and judgement where no quantifiable data exists. It is not as scientifically robust but its a practical approach to the limitations and constraints in information that was confronted. The final assessments therefore need to be read with these limitations in mind.

It is worth noting from the outset that these problems were inevitable with the adoption of a new approach with its own specific requirements for quantitative information - after all, information that is 'out there' is not organized and ready-made for this purpose. It requires a well thought out and properly designed environmental monitoring program and several years of consistent application to generate data tailor-made for the indicators and metrics selected. And this is an important lesson for future SOE – a concerted multi-agency effort to agree on indicators and metrics, and to commit to an on-going monitoring, data gathering and information management program to ensure the right information is available and readily accessible for the next SOE. A start has been made with this report in terms of indicators and metrics, which can be added to and refined as better information becomes available. Similarly the habitat-types defined should be retained and be subjected to an on-going and scientifically designed program of environmental monitoring.

In the context of these limitations, the State of Environment (SOE) of Samoa is examined and assessed based on the following habitat-types –

- Upland habitats and cloud forests
- Lowland habitats
- Coastal habitats
- Inshore and offshore marine habitats
- Rural and Urban Built environment
- Rivers and Streams
- Protected areas,Sanctuaries and KBAs and
- Atmosphere, Climate and Weather

In a nutshell, the health of key habitats are summarized below –

Upland Habitats and Cloud Forests

1. Samoa's upland habitats are largely intact with a high percentage of forest cover (99%) for both Upolu and Savaii. The nature and quality of forests in the uplands of the two islands, are now significantly different. For Savaii, 91% of the upland forest area is dominated by native species. For Upolu, non-natives dominate 99% of the upland area. The impact of the invasive vine *Merremia* is the main threat.

   Due to the rare ecosystems, the threatened terrestrial species in the upland and its natural values the upland area above 800 m elevation should be given some form of official protection and for the forests to be managed sustainably in a way that puts conservation as a priority. In addition to conserving the upland forests, emphasis should also be placed on the conservation of adjacent lowland forests, especially for birds and flying foxes which make daily and seasonal movements between the two areas following the flowering and fruiting of different trees. Although the upland area is remote and infrequently visited, the construction of the Mata o le Afi road shows how threats from invasive species, logging and habitat degradation can escalate very rapidly.

Lowland habitats

2. There are two main lowland habitats – cultivated areas and lowland forests. The total lowland area of Samoa is 218,520 ha, of which cultivated areas comprises 80,589 ha and lowland mixed forests 137,931 _ha. Cultivated areas are largely of small sized holdings and with some exceptions, use composting and are largely of mixed cropping systems. The smaller sizes of holdings and the mixing of trees and crops within holdings enhances ecological stability, making these plots less vulnerable to outbreaks of pest and diseases. Having said this, invasive species are also widespread including *Merremia* vines, African snails and Taro Leaf Blight.

3. The remaining forests in the lowland areas are predominantly of non-native species of *tamaligi, pata, pulu vao, faapasi*, and a host of other light demanding and fast growing species that invade open spaces created

by cyclones, windthrows and abandoned agricultural sites. These forests are less dense, of lower species diversity and don't offer the range of habitats to a diversity of native fauna species as would native forests. Ecologically they are less stable. These forests however will dominate Samoa's lowland, possibly in perpetuity, if the process of natural regeneration is regularly set back before climaxing by cyclones and man-made disturbances. The higher frequency and intensity of cyclones predicted as a result of climate change is thus likely to assist in perpetuating the dominance and continuing spread of non-native species.

Coastal habitats

4. Of coastal habitats, mangroves are generally in good condition with a high number of viable populations for the two main species *Rhizophora* and *Bruguiera spp*, despite losses in some areas due to harvesting for firewood, land reclamation and waste disposal. The third species – *Xylocarpus mollucensis* - consists of only one small population (about 2.5 acres) in Siutu, Salailua. This species is urgently in need of conservation action. A second population needs to be established in a different location to avert the possibility of local extinction.

5. The health of beaches is indeterminable due to the lack of information. But there is on-going exploitation in the form of sand mining for construction purposes, which MNRE is trying to manage using a licensing system tied to environmental assessment. In the absence of spatial data on sand distribution and migration dynamics, it is unclear how sustainability is being monitored.

Inshore & Offshore Marine habitats

6. Within the marine/offshore habitats, the health of corals and coral reefs vary throughout Samoa. The most healthy reefs and coral assemblages are found along the coast of northwestern Savaii. The least healthy of coral reefs are found along the northern coast of Upolu from the Manono/Apolima strait right across to the Fagaloa coast. Similarly reef fish is more abundant in the same general areas with northern Savaii having the highest level of abundance, and the northern coast of Upolu the least. There are however more variety of fish species in the northern coast of Upolu, despite lower coral abundance, than northwestern Savaii. The higher diversity of fish in northern Upolu is important for conservation purposes because it suggests the presence of unique coral assemblages not found elsewhere in the country.

7. Tuna stocks are fundamentally healthy especially for Albacore, which is the mainstay of Samoa's tuna import industry. There is some overharvesting of larger and older tuna but the overall biomass is being exploited and harvested within the maximum sustainable yield level. The level of exploitation and fishing prescribed in the Samoa Tuna Management and Development Plan 2011-2015 is sustainable.

Rural and Urban Built Environment

8. Samoa's built environment is the highly modified artificial world of human settlements and its supporting physical infrastructure, amenities and services that in itself functions as an organism that consumes resources and generates waste while at the same time, constantly modifying itself in ways that put pressure on its biophysical surroundings. The key indicators for its sustainability examined in this report are population, waste, sanitation, energy, and environmental safeguards. Several other possible indicators were not used due to the lack of data.

9. Samoa's population has been growing at a declining rate in large part due to a high level of outmigration. This trend is predicted to continue and, based on growth rates over the last 20 years, an annual growth rate of between 0.5% and 1.5% is expected. SBS (op cit) considers an annual growth rate of 1.0% to be within sustainable range. The current annual rate of 0.64% per year suggests this predicted growth rate is well within the realms of possibility.

10. Waste is an area of concern. There are conflicting signs. The average amount of waste generated per person per year is declining, and there is less burning of household wastes. Yet a significant percentage of waste generated is not getting to the landfills despite an expansive public-funded nation-wide collection system and the presence of well managed land fills in both Upolu and Savaii. There are possible explanations one of which is the possibility of illegal dumping of waste in unapproved sites by contractors. Of the waste that is collected and disposed of in the landfills, over 50% are compostable and recyclable, meaning the effective lifespan of the landfills is not optimized.

11. But significant improvements have been made in other aspects of waste management including the collection of sewage in the Apia urban area with the pressure sewer line connecting over 150 commercial users and the treatment facility in Sogi. Sludge treatment facilities are also in operation at both Tafaigata and Vaiaata.

12. A legal regulatory framework (PUMA Act 2004 and PUMA (EIA) Regulation 2008) for screening new development proposals for environmental sustainability is in place and working. Available data shows an increasing trend in the number of applications received and reviewed since 2007, indicating increased public acceptance and compliance. Complementing the PUMA framework are similar permitting systems for sand mining and coastal reclamations, and for regulating imported chemicals and pesticides.

13. Samoa will continue to depend on imported petroleum products in the immediate future for its energy needs, as demand from a growing transport sector increases and preference shifts from biomass to LPG and electricity for household cooking energy. With world energy prices highly fluctuating and generally increasing, Samoa's dependence on imported fossil fuel continues to be a major source of economic vulnerability. A determined and concerted effort to reduce this vulnerability is being implemented with the Government officially targeting a 20% Renewable Energy target by 2030. Building more hydropower schemes appears to be the main option in the immediate future but other RE sources including solar, biomass gasification, biofuels are also being investigated. Bio-gasification and hydropower development can adversely affect the environment hence its important for project designs to be properly screened.

Rivers and Streams

14. Regular monitoring of rivers and streams for physical parameters including flow rates, temperature, turbidity, pH and dissolved oxygen (DO) is on-going under the Water Resources Division of MNRE. Available processed data indicates that river flow rates are highly dependent on seasonal fluctuations in precipitation making it highly vulnerable to climate change and climate variability. Already, there is an emerging declining trend in river flow rates in the main rivers of Samoa. This has far reaching economic implications particular for agriculture, drinking water, hydropower generation and biodiversity conservation.

15. Rivers and stream water quality is not a major issue based on indicators of turbidity, pH and dissolved oxygen but reported incidences of high *E.coli* counts in several villages water springs is a reminder of the impacts of land use, sanitation and waste management practises on underground water sources.

Protected Areas, Sanctuaries and KBAs -

16. Samoa effectively redefined its protected area network following collaborative work between MNRE and several international conservation organizations which reassessed Samoa's entire biodiversity based on conservation planning criteria of vulnerability and irreplaceability. The result is a network of 8 terrestrial and 7 marine Key Biodiversity Areas (KBAs) that incorporates the essential components of the existing parks and reserves network. The 8 terrestrial KBAs cover an area of $940km^2$ or 33% of Samoa's total land area, capturing within it 12 representations of the 13 native vegetation communities in the country. This terrestrial area also constitutes 33% of Samoa's total land area, more than double Samoa's SBSAP commitment of 15%. The marine KBAs cover approximately $173km^2$ or 23% of Samoa's total inshore reef area. Currently, 6 of the 8 terrestrial KBAs and 3 of the 7 marine KBAs have been completely or partially established as conservation areas by the Government of Samoa or by local villages.

17. One KBA is singled out as having the highest priority for terrestrial conservation investment and this is the Central Savaii Rainforest KBA. It is the largest contiguous area of rainforest in tropical Polynesia and a site identified internationally[111] as one of the last remaining strongholds for one or more Critically Endangered or Endangered species.

18. The conventional national parks and reserves system which is now encompassed within the KBA network, was recently expanded with the addition of the Lata National Park, bringing the total of officially designated national parks to two in Upolu (Le Pupu Pue NP and Lake Lanoto'o NP) and three in Savaii (Mauga o Salafai NP, Asau-Falelima NP and Lata NP).

Atmosphere, Weather and Climate

19. The changes in climate and climate variability predicted in the previous SOE 2006 are now a reality. These include: increased maximum air temperatures, increased frequency in extreme daily rainfall events, sea level rise of between 2.7 – 8.3 mm a year (PCCSP, 2012)Tropical Cyclone Heta 2004 and Evans 2012 proves prediction of higher frequency and duration of cyclones with greater intensities, as well as of extreme events such as floods, example the 2012 worst ever Samoa Flood associated with TC Evans.

20. Samoa is actively implementing adaptation and mitigation strategies to reduce its vulnerability and strengthen its resilience. Measures to enhance environmental sustainability and disaster reduction are incorporated into all levels of planning and implementation, particularly for vulnerable sectors including water, health and agriculture. A mix of hard (engineering) and soft solutions are being implemented to protect coastal infrastructure and community assets from natural hazards of coastal erosion, flooding, coastal wave surges and wind damage.

21. Samoa has also been monitoring and measuring its GHG emissions as part of its reporting obligations to the UNFCCC, monitoring and control of Ozone Depleting Substances (ODS) under the Montreal Protocol, and promoting strategies for reducing its carbon footprint. Monitoring results from the second GHG inventory carried out in connection with its Second National Communications to the UNFCCC, suggests Samoa is a net CO_2 sink with less CO_2 emitted and more CO_2 removed, although this figure is treated with caution due to

[111] Alliance of Zero Extinction (AZE), a consortium of over 60 conservation organizations worldwide.

some methodological concerns. In terms of ODS, Samoa has achieved zero CFC consumption target and currently phasing-out HCFC targeting total phase-out by 2040.

22. Samoa has also been monitoring local and regional seismic (earthquakes) activities and tsunamis for safety of lives and properties since 1890. Update in the network stations depicts increasing active occurrences of seismic activity and the Indonesian earthquake generated tsunami of 2004, Samoa earthquake –tsunami of 2009 and more recent destructive New Zealand, Christchurch earthquake of 2010. Parallel is the geo-technical investigations of soils and rock structures for building codes standards to withstand these seismic tremors

Overall, Samoa's biophysical environment is continually changing as a result of a complex combination of drivers and pressures from natural and man-made sources. Underlying drivers include a wide range of economic development activities (such as development in infrastructure, agriculture, tourism, fisheries), population growth, changing consumption patterns and lifestyles, traditional institutional arrangements governing access to and use of resources, and climate change and climate variability as a result of global warming. These underlying influences give rise to more direct pressure sources such as invasive species, overharvesting of resources, poorly designed development activities, proliferation of non-biodegradable wastes, natural disasters, poor sanitation systems and other factors. They operate singly and collectively, often times synergistically with the presence of one or more triggering others.

The main threats to Samoa's biophysical environment are associated with climate change and climate variability. Changes in climate and weather patterns predicted in the previous SOE are now a reality. Of the greatest concern in the immediate term are extreme events such as cyclones and flooding that not only inflict physical damage to the built environment of physical infrastructure, homes, and livelihood sources but also cause severe degradation to natural habitats and decimation of species populations.

On the other hand, the level of preparedness indicated by the range of NAPA prescribed activities being implemented and planned in all vulnerable sectors is quite advanced. Drivers such as economic development, changing consumption patterns and lifestyles, climate change and climate variability, and others will continue to present challenging situations for environmental sustainability. But there is a heightened level of awareness amongst policy makers and planners, and the public at large, of the seriousness of our vulnerability and of the ecological limits of our biophysical environment that are implied in a broad range of policies and strategies currently being pursued. There is also a clear sense of urgency in dealing with our ecological and economic vulnerabilities that is evident in the bold but achievable policies for achieving carbon neutrality and reducing fossil fuel dependence. Collectively, this heightened awareness, the plans now in place, the actions taken and achievements made in all habitats of the environment, is the closest estimation of Samoa's resilience and ability to bounce back that can be estimated from the information available for this report.

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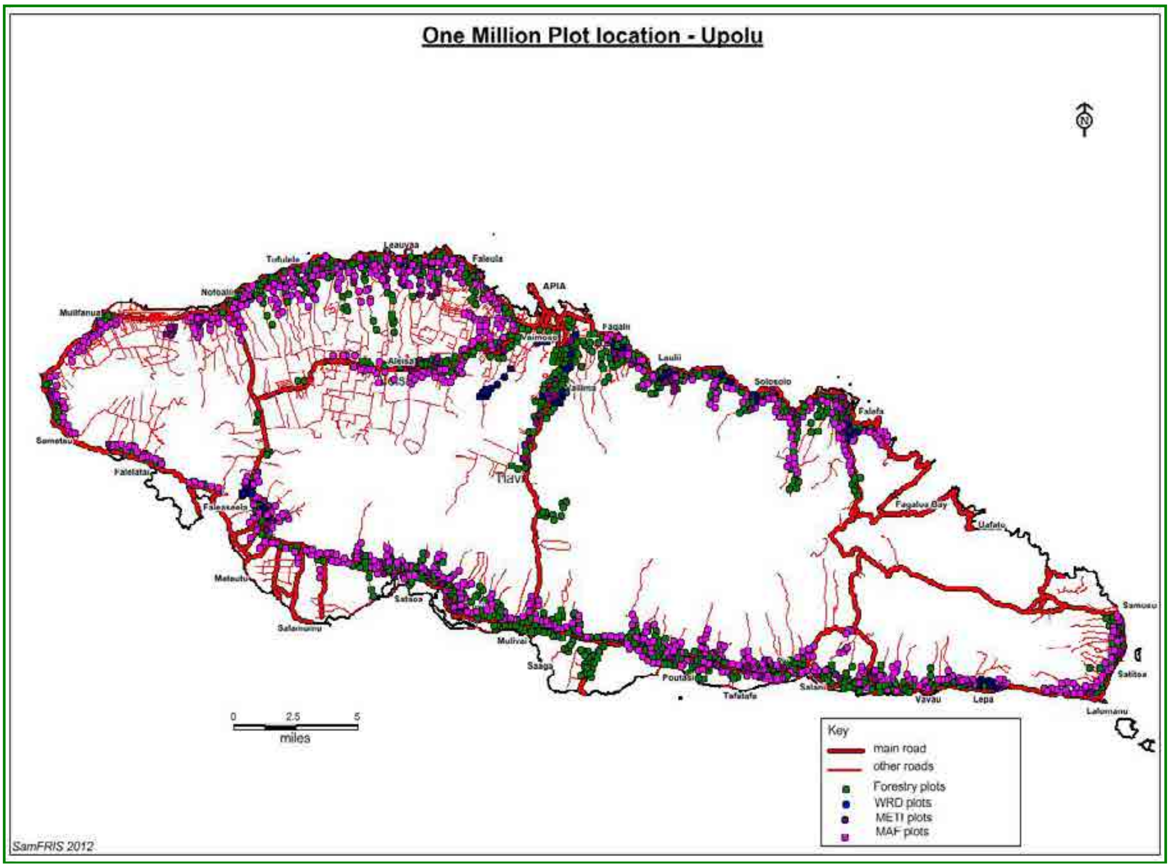
Appendix 2: IUCN Redlist of Threatened Marine Species in Samoa

Genus	Species	English Name	Status	Trend
Eretmochelys	imbricata	Hawksbill Turtle	CR	decreasing
Acropora	rudis	Staghorn Coral	EN	decreasing
Cheilinus	undulatus	Humphead Wrasse	EN	decreasing
Chelonia	mydas	Green Turtle	EN	decreasing
Carcharhinus	longimanus	Oceanic Whitetip Shark	VU	decreasing
Physeter	macrocephalus	Sperm Whale	VU	unknown
Heliopora	coerulea	Blue Coral	VU	decreasing
Isurus	oxyrinchus	Shortfin Mako	VU	decreasing
Millepora	foveolata	Fire Coral	VU	decreasing
Nebrius	ferrugineus	Tawny Nurse Shark	VU	decreasing
Rhincodon	typus	Whale Shark	VU	decreasing
Bolbometopon	muricatum	Bumphead Parrotfish	VU	decreasing
Plectropomus	areolatus	Polkadot Cod	VU	decreasing
Plectropomus	laevis	Blacksaddled Coral Grouper	VU	decreasing
Thunnus	obesus	Bigeye Tuna	VU	unknown
Himantura	gerrardi	Whitespotted Whipray	VU	unknown
Acanthastrea	brevis	Starry cup coral	VU	unknown
Acanthastrea	hemprichii	Starry cup coral	VU	unknown
Acanthastrea	ishigakiensis	Starry cup coral	VU	unknown
Acropora	aculeus	Staghorn Coral	VU	decreasing
Acropora	acuminata	Staghorn Coral	VU	decreasing
Acropora	aspera	Staghorn Coral	VU	decreasing
Acropora	dendrum	Staghorn Coral	VU	decreasing
Acropora	donei	Staghorn Coral	VU	decreasing
Acropora	globiceps	Staghorn Coral	VU	decreasing
Acropora	horrida	Staghorn Coral	VU	decreasing
Acropora	jacquelineae	Staghorn Coral	VU	decreasing
Acropora	listeri	Staghorn Coral	VU	decreasing
Acropora	lokani	Staghorn Coral	VU	decreasing
Acropora	microclados	Staghorn Coral	VU	decreasing
Acropora	palmerae	Staghorn Coral	VU	decreasing
Acropora	paniculata	Staghorn Coral	VU	decreasing
Acropora	pharaonis	Staghorn Coral	VU	decreasing

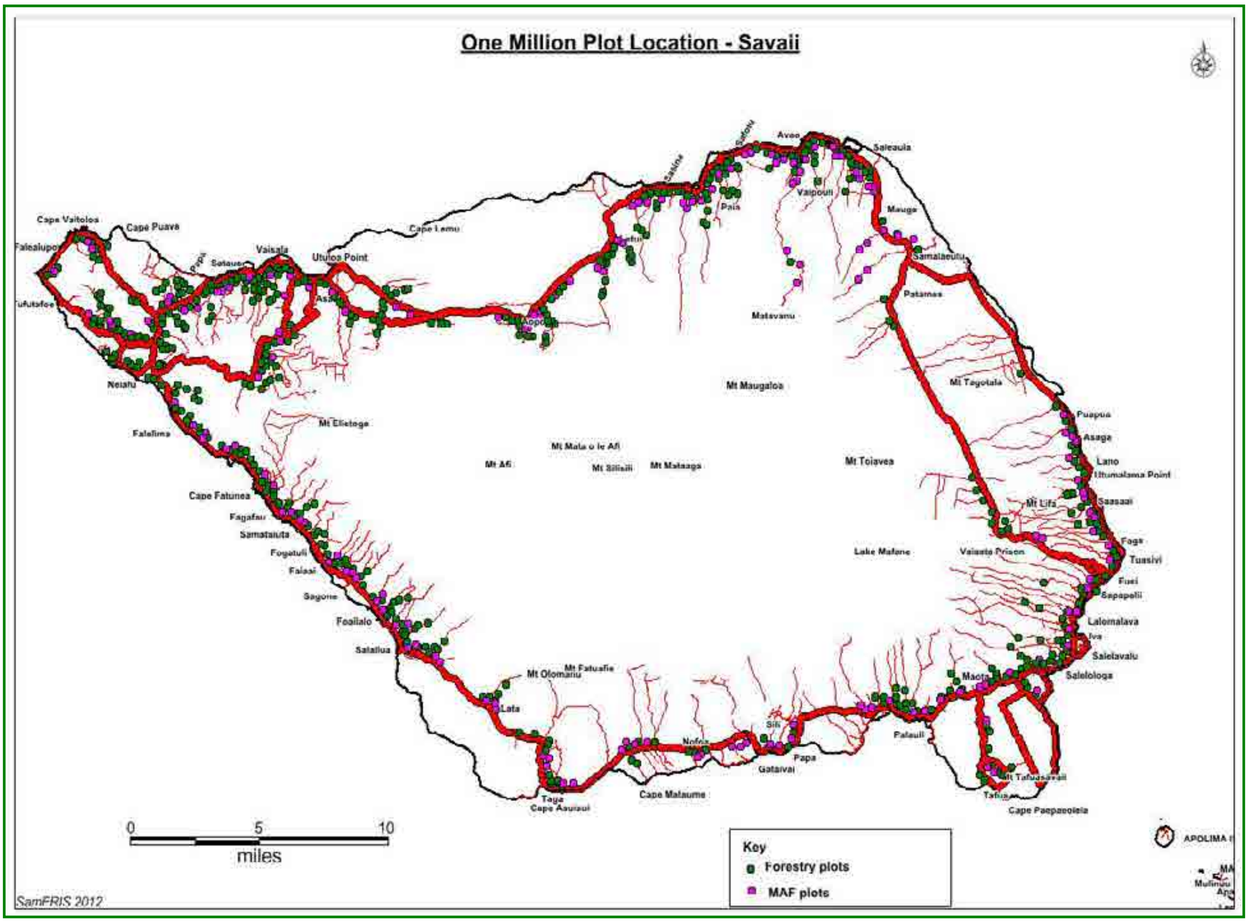
Genus	Species	English Name	Status	Trend
Acropora	polystoma	Staghorn Coral	VU	decreasing
Acropora	retusa	Staghorn Coral	VU	decreasing
Acropora	speciosa	Staghorn Coral	VU	decreasing
Acropora	vaughani	Staghorn Coral	VU	decreasing
Acropora	verweyi	Staghorn Coral	VU	decreasing
Alveopora	allingi	Alveopora coral	VU	unknown
Alveopora	verrilliana	Alveopora coral	VU	unknown
Astreopora	cucullata	Astreopora coral	VU	decreasing
Caulastrea	echinulata	Caulastrea coral	VU	decreasing
Euphyllia	cristata	Stony coral	VU	stable
Euphyllia	paradivisa	Stony coral	VU	unknown
Galaxea	astreata	Galaxea coral	VU	unknown
Isopora	crateriformis	Coral	VU	decreasing
Isopora	cuneata	Coral	VU	decreasing
Leptoseris	incrustans	Encrusting coral	VU	unknown
Leptoseris	yabei	Encrusting coral	VU	unknown
Montipora	angulata	Montipora coral	VU	decreasing
Montipora	australiensis	Montipora coral	VU	decreasing
Montipora	calcarea	Montipora coral	VU	decreasing
Montipora	caliculata	Montipora coral	VU	decreasing
Montipora	lobulata	Montipora coral	VU	decreasing
Pachyseris	rugosa	Pachyseris coral	VU	unknown
Pavona	bipartita	Pavona coral	VU	unknown
Pavona	cactus	Pavona coral	VU	unknown
Pavona	decussata	Cactus Coral	VU	unknown
Pocillopora	elegans	Cauliflower coral	VU	unknown
Porites	horizontalata	Stony coral	VU	unknown
Porites	nigrescens	Stony coral	VU	unknown
Turbinaria	mesenterina	Turbinaria coral	VU	unknown
Turbinaria	peltata	Bowl coral	VU	unknown
Turbinaria	reniformis	Yellow scroll coral	VU	unknown
Turbinaria	stellulata	Turbinaria coral	VU	unknown

IUCN Red List Status abbreviations: (CR) Critically Endangered; (EN) Endangered; (VU) Vulnerable

Appendix 3: Distribution of Trees under the One Million Tree Program for Upolu



Appendix 4: Distribution of Trees under the One Million Tree Program for Savaii



Appendix 5: List of Protected Areas (MNRE. 2009. Samoa's Fourth National Report to the CBD).

	Terrestrial reserves	Year established	Area (ha)
1	Apia Central recreational reserve	2000	2.42
2	Vaigaga Reserve	2000	0.4
3	Maagiagi Reserve	1999	0.2
4	Vaimoso Reserve	1999	0.1
5	Fuluasou Botanical Garden	1999	8.1
6	Samoa National Botanical Garden Vailima	1978	12.1
7	Togitogiga Recreational Reserve	1978	12.1
8	Robert Louis Stevenson Historic Reserve	1978	0.4
9	Mt Vaea Scenic Reserve	1958	89
10	Sinave Reserve	2006	0.1
11	Lotoosamasoni Reserve	2007	0.2
12	Mulinuu Mangrove Reserve	2003	2.42
13	Matautu Tai reserve	2002	0.1
14	Ao-ole-Malo Reserve	2001	8.1
15	Faavae I le Atua Reserve	2001	0.81
16	Taumesina Reserve	2000	2.4
17	Vaitele East and West Reserve	2000	0.81
18	Falealupo Forest	1989	1,215
19	Laulii Conservation Area	2000	400.0
20	Uafato Conservation Area	1997	1,161
22	Saanapu-Satalo Mangrove Forest Conservation Area	1997	52.9
	Total Area of Reserves and Conservation Areas		**2,957.4**
	National Parks		
1	O Le Pupu Pue NP	1978	2,800
2	Lake Lanoto'o NP	2003	1,050
3	Mauga o Salafai NP	2003	6,944
	Total Parks Area		**10,794**

Appendix 6: Terrestrial and Marine Key Biodivesrity Areas (KBAs)

#	Site Name	Island	Faipule District	Approximate Area (ha)	Current protection status
1	Aleipata Marine Protected Area	Upolu	Aleipata	4,842 (marine) 156 (land	Community Conservation Area Active marine protected area
2	Eastern Upolu Craters	Upolu	Aleipata and Lepa	4,759	None
3	Uafato-Tiavea Coastal Forest	Upolu	Vaa-o-Fonoti	2,316	Inactive community conservation area
4	O le Pupu Pue National Park	Upolu	Safata and Falealili	4,228	Active National Park
5	Apia Catchments	Upolu	Vaimauga West, Faleata and Siumu	8,336	Partly protected in Lake Lanotoo NP and Mt Scenic Reserve. Some conservation effort by MNRE's watershed management section.
6	Safata Marine Protected Area	Upolu	Safata	5,870 (marine) 101 (land)	Community Conservation Area Active protected area
7	Central Savaii Rainforest	Upolu	Inland parts of all districts on Savaii	72,699	Partly protected in Mauga Salafai, Lata and Asau-Falelima National Parks
8	Falealupo Peninsula	Savaii	Vaisigano West, Falealupo and Alataua West	1,537	Partly protected in a Community Conservation Area

Source: Conservation International et al. 2010.

#	Site Name	Island	Faipule District	Approximate Area (ha)	Current protection status
1	Aleipata Marine Protected Area	Upolu	Aleipata	4,842 (marine) 156 (land	Active marine protected area
2	Apolima	Apolima	Aiga ile Tai	2,129	None
3	Vaisigano	Savaii	Vaisigano	2,270	None
4	Safata	Upolu	Safata	5,870 (marine) 101 (land)	Active Marine Protected Area
5	Five Mile Reef	offshore	None	1,303	None
6	Vaotupua	Savaii	Falealupo	893	None
8	Palolo Deep	Upolu	Vaimauga West	33	Active Marine Reserve

Annex 7: Preliminary List of Indicators from MNRE SOE Consultation Workshop

Preliminary List of Indicators for SOE Report					
Habitat	**Indicator**	**Priority**	**Measurement (2006 SOE assessment as baseline wherever possible)**	**Data source**	**Location**
Cloud Forest & Upland	Forest Cover	x	% change in area coverage relative to SOE 2006 as baseline;	SamFRIS	MNRE Forestry
	Key Species	x	% change in abundance of key spp, since 2006	Biological Surveys	DEC
	Invasive Species	x	Area or abundance change	Biological Surveys	DEC
	Lakes	x	changes in water level; trends?	Water Level reports	Water Resources Division
Lowland	Forest cover	x	% area coverage trend; % change since 2006	SamFRIS	MNRE Forestry
	Key species	x	% change in abundance since 2006; trends	Biological surveys	DEC
	biodiversity	x	diversity & abundance; % change in abundance of key spp	Biological Surveys	DEC
	invasive species	x	diversity of spp; % change in area affected; % change in abundance	Biological Surveys	DEC
	Development	x	urban footprint change (roads, settlement);	PUMA Reports	PUMA
	Agriculture	x	% change in agricultural footprint	No data	Ministry of Agriculture and Forestry
Coastal Strand	Forest cover	x	% area coverage change	SamFRIS	MNRE Forestry
	Key Species (turtles)	x	Abundance change	Surveys, Quarantine(?), turtle data	DEC, Quarantine, turtle project
	Invasive species	x	Area or abundance change	Surveys, Quarantine(?), turtle data	Disaster Management
	Coastal Springs and boreholes	x	Bacteria WQ and salinity, and borehole abandonment	Water Quality Reports	WRD
	Seawall	x	Linear seawall increase rate	Seawall coverage, Shoreline reports	SPREP
	Mangrove	x	Area change/condition	Mescal	MNRE
	Population		Population Trend	Census 2008	Census
	Development		Change in developed area	PUMA Report	PUMA Office
	Natural Disasters		% Area Affected	Disaster Management Reports	Disaster Management Office
	Sand Mining		% change in # of application for permits; trends in volume mined	No data	
	Reclamation		% change in # of application for permits; % change in area reclaimed	MNRE reports	
	Flash floods and landslides		# of events, trends in frequency of occurrences	Reports tbc	
	Water use		Change in water use	Water use reports	Water Resources Division, Samoa Water Authority

Nearshore Marine	Coral Health	x	% area with Coral Cover	NOAA Biogeography Report	NOAA
	Coral biodiversity	x	Number of Coral species observed	NOAA Biogeography Report	NOAA
	Coral Recruitment		Coral Recruitment		
	Fisheries health	x	Fish biomass	NOAA Biogeography Report	NOAA
	Fish species Richness	x	Number of Fish Species observed	NOAA Biogeography Report	NOAA
	Fish recruitment		Fish recruitment		
	Turbidity		Turbidity	Water Resources Division	MNRE
	Sediment load		Sediment load at tributary	Water Resources Division	MNRE
	Crown of Thorns	x	COT Abundance; trends in frequency of outbreaks	Data to be collected	MNRE - DEC
	Seagrass		Seagrass Coverage, health		
	Macroalgae		Algal Coverage		
	Key inverteberate species		Species Richness?		
Offshore Marine	Tuna Fishery Health	x	Change in Landings, Stock Assessment	Observers/outlook report	MNRE/MAF
	Bycatch	x	Turtle, shark, cetation bycatch trends	Obervers data	MAF/MNRE
	Pelagic Fish		Abundance trends		
	Benthic Fish		Abundance trends		
	Dolphins		Abundance trends		
	Turtles		Abundance trends		
	Seabirds		Abundance trends		
	Deep Benthic Invertebrates		Abundance trends		
Rivers and Streams	Water Quality	x	N,P,DO,Solids,NH4,pH, bacteria, parasites	Water Resources Division	
	Species Richness	x	Trends in freshwater fish species richness	Biodiversity survey	MNRE
	Key species	x	maomao,fish, prawns,eels, abundance and trends	Biodiversity survey	DEC
	Riparian Cover	x	trend in forest buffer %		MNRE
	Water Quantity	x	water and groundwater levels, river flow	Water resource reports	

APPENDIX 8: Priority invasive or potentially invasive plant and animal species in Samoa					
Terrestrial Plant List:					
Source: SNITT Working Group and Samoa Invasives Prioritization and Management Planning Workshop, Apia, August 2007					
Scientific Name	**Family**	**Habit**	**Samoan Name**	**Common Name**	**Invasive Category**
Albizia chinensis	Fabaceae	Tree	Tamaligi uliuli	Silk tree	Transformer
Albizia falcataria	Fabaceae	Tree	Tamaligi pa'epa'e	Albizia	Transformer
Antigonon leptopus	Polygonaceae	Vine		Chain of Love	Potentional Transformer
Ardisia elliptica	myrsinaceae	Shrub	Togo vao	Shoebutton ardisia	Potentional Transformer
Arundo donax	Poacaea	Grass	Fiso palagi	Giant reed	Transformer
Asparagus densiflours	Liliaceae	Herb		Asparagus fern	Potentional Transformer
Brachiaria mutica	Poaceae	Grass		Para grass	Transformer
Calamus casius	Palmae	Tree	Rattan	Rattan Palm	Potentional Transformer
Canna indica	Cannaceae	Herb	Fanamanu	Canna lily	Potentional Transformer
Castilla elastica	Moraceae	Tree	Pulu Mamoe	Panama Rubber Tree	Transformer
Casuarina equisetifolia	Casuarinaceae	Tree	Toa	Australian Pine	Potentional Transformer
Cedrela odorata	Meliaceae	Tree	Sita	Barbados/Spanish cedar	Transformer
Cestrum noctumum	Solanaceae	Shrub	Alii/Teine o le po	Night Cestrum	Transformer
Cinnamomum verum	Lauraceae	Tree	Tinamoni	Cinnamon	Transformer
Clerodendrum chinense	Verbenaceae	Shrub	Losa Honolulu/Fiti	Honolulu rose	Transformer
Clidemiahirta	Melastomataceae	Shrub	laau lau mamoe	Koster's curse	Transformer
Coccinia grandis	Curcurbitaceae	Vine		Ivy gourd, Scarlet-fruited gourd	Transformer
Cordia alliodora	Boraginaceae	Tree	Kotia	Ecuador laurel	Potentional Transformer
Cyperus rotundus	Cyperceae	Sedge	Mumuta	Nut Sedge	Transformer
Dieffenbachia seguine	Araceae	Herb		Dumb cane	Potentional Transformer
Dissotis rotundifolia	Melastomataceae	Herb		Spanish shawl	Potentional Transformer
Eichhomia crassipes	Pontederiaceae/ Liliales	Aquatic Herb		Water hyacinth	Transformer
Elaeocarpus grandis	Elaeocarpaceae	Tree	Siapatua	Blue marble tree	Transformer
Funtumia elastica	Apocynaceae	Tree	Pulu vao	African rubber tree	Transformer
Grevellia robusta	Proteaceae	Tree		Silky Oak	Potentional Transformer
Hevea brasiliensis	Euphorbiaceae	Tree		Brazilian Rubber tree	Transformer
Hedychium flavescens	Zingiberaceae	Herb	Teuila samasama	Yellow ginger	Transformer
Hedychium coronarium	Zingiberaceae	Herb	Teuila paepae	White ginger	Transformer
Hemigraphis alternata	Acanthaceae	Herb	Suipi	Metal leaf, cemetry plant	Potentional Transformer
Hyptis pectinata	Lamiaceae	Herb	Vao mini	Mint weed	Potentional Transformer
Ipomoea aquatica	Convolvulaceae	Aquatic Herb	Lili vai	aquatic morning glory	Potentional Transformer
Kyllinga polyphyla	Cyperceae	Sedge	Tuise tele, tuise fiti	Navua Sedge	Potentional Transformer
Lantana camara	Verbenaceae	Shrub	Latana	Lantana	Potentional Transformer

Scientific Name	Family	Habit	Samoan Name	Common Name	Invasive Category
Leucaena leucocephala	Fabaceae	Tree	Fua pepe/ Lusina	Leucaena, Wild tamarind	Transformer
Ligustrum robustrum	Oleaceae	Shrub/ Small Tree		Privet	Potentional Transformer
Ligustrum sinense	Oleaceae	Shrub/ Small Tree		Privet	Potentional Transformer
Merremia tuberosa	Convolvulaceae	Vine		Wood rose/ yellow Morning glory	Transformer
Merremia peltata	Convolvulaceae	Vine	Fue lautetele	Merremia	Transformer
Mikania micrantha	Asteraceae	Vine	Fue saina	Mile-a-minute	Transformer
*Mimosa diplotricha syn:invisa**	Fabaceae	Shrub	Vao fefe palagi	Giant sensitive plant	Potentional Transformer
Mimosa pudica	Fabaceae	Herb	Vao fefe Samoa	Sensitive plant	Potentional Transformer
Odontonema tubaeforme	Acanthaceae	Shrub	Totoe	Fire spike	Potentional Transformer
Pennisetum purpureum	Poaceae	Grass	Vao Povi	Napier Grass/ Elephant Grass	Potentional Transformer
Piper auritum	Pipercaea	Shrub	Ava tonga	Ava Tonga	Potentional Transformer
Psidium guajava	Myrtaceae	Tree		Strawberry guava	Potentional Transformer
Pueraria Montana var. lobata	Myrtaceae	Tree	Kuava	Lemon Kuava	Potentional Transformer
Scindapsus aureus	Araceae	Vine		Money Plant	Potentional Transformer
Sesbania grandiflora	Fabaceae	Tree	Sepania	Sesbania	Potentional Transformer
Solanum torvum	Solanaceae	Shrub	Vao lapiti	Prickly Solanum, Devils fig	Potentional Transformer
Spathodea campanulata	Bignoniaceae	Tree	Fa'apasi	African Tulip tree	Transformer
Sphagneticola trilobata	Asteraceae	Herb		Wedelia, Creeping ox-eye	Potentional Transformer
Stachytarpheta urticifolia	Verbenaceae	Herb	Mautofu tai, mautofu vao, mautofu fualanumoana	Blue rats tail	Potentional Transformer
Tibouchina urvilleana	Melastomataceae	Shrub		Glorybush	Potentional Transformer
Tepphrosia candida	Fabaceae	Shrub	Ava sa	White tephrosia	Potentional Transformer
Urochloa maxima (Panicum maximum)	Poaceae	Grass	Vao kini	Guinea grass, Buffalo grass	Potentional Transformer

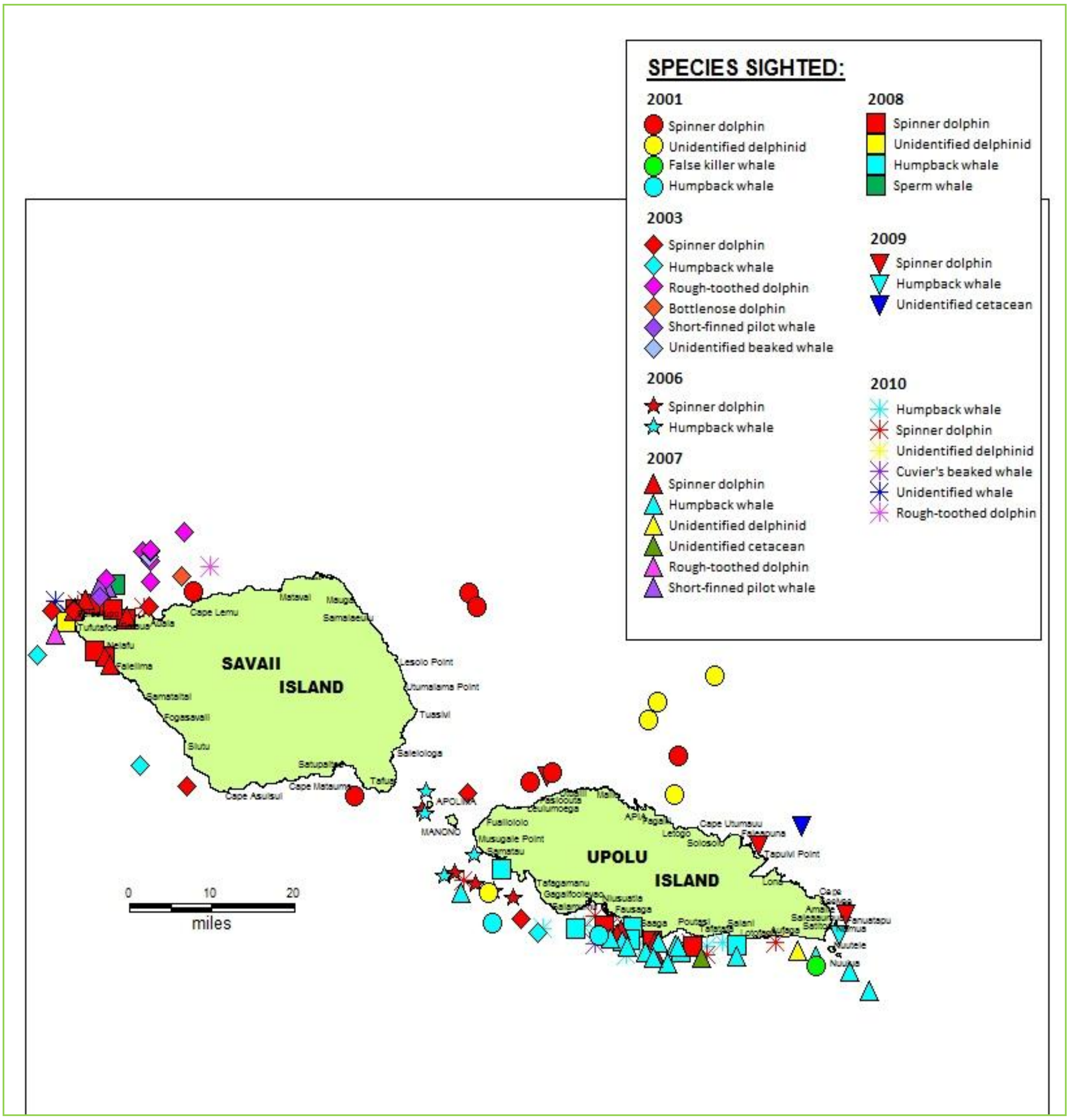
** Species which transform or potentially transform the environments into which they are introduced pose the greatest threat to ecosystems and should be a priority for management.*

Appendix 9: List of Samoa Plants in Coastal Habitats (A.Whistler, 1992)

	TREES	*Vernacular or Local name*			HERBS	*Vernacular or local name*	
1	Acacia simplex	*tatagia*	X	1	Achyranthes splendens		R
2	Barringtonia asiatica	*futu*	X	2	Achyranthes velutina		X
3	Bruguiera gymnorrhiza	*togo*	X	3	Boherhavia glabrata		R
4	Calophyllum inophyllum	*fetau*	X	4	Boherhavia repens	*ufi'atuli*	X
5	Casuarina equisetifolia	*toa*	X	5	Boherhavia tetranda		X
6	Cerbera manghas	*leva*	X	6	Chamaesyce atoto	*pulu tai*	X
7	Cerbera odollam	*leva*	X	7	Hedyotis biflora		X
8	Cocos nucifera	*niu*	X	8	Hedyotis foetida		X
9	Cordia subcordata	*tauanave*	X	9	Hedyotis romanzoffiensis		X
10	Erythrina fusca	*gatae palagi*	X	10	Portulaca lutea	*tamole*	X
11	Erythrina variegata	*gatae*	X	11	Portulaca samoensis	*tamole*	X
12	Guettarda speciosa	*puapua*	X	12	Sesuvium portulacastrum		X
13	Heritiera littoralis		R	13	Tacca leontopetaloides	*masoa*	X
14	Hernandia nymphaeifolia	*pu'a*	X	14	Tephrosia purpurea	*avasa*	X
15	Hibiscus tiliaceus	*fau*	X	15	Triumfetta procumbens		X
16	Neisosperma oppositifolium	*fao*	X	16	Wollastonia biflora	*ateate*	X
17	Pandanus tectorius	*fala*	X				
18	Pisonia grandis	*pu'a vai*	X		**VINES**		
19	Rhizophora mangle	*togo*	X	1	Abrus precatorius	*matamoso*	X
20	Terminalia catappa	*talie*	X	2	Canavalia cathartica		X
21	Terminalia samoensis	*talie*	X	3	Canavalia rosea	*fue fai va'a*	X
22	Thespesia populnea	*milo*	X	4	Canavalia sericea		X
23	Tournefortia argentea	*tausuni*	X	5	Cassytha filiformis	*fetai*	X
24	Xylocarpus moluccensis	*le'ile'i*	X	6	Derris trifoliata	*fue 'o'ona*	X
				7	Entada phaseoloides	*fue inu*	X
	SHRUBS			8	Ipomoea littoralis	*palulu*	X
1	Caesalpinia bonduc	*anaoso*	X	9	Ipomoea macrantha		X
2	Capparis cordifolia		X	10	Ipomoea pes-caprae	*fue moa*	X
3	Clerodendrum inerme	*aloalo tai*	X	11	Mucuna gigantea	*tupe*	X
4	Colubrina asiatica	*fisoa*	X	12	Vigna marina	*fue sina*	X
5	Dendrolobium umbellatum	*lala*	X				
6	Eugenia reinwardtiana	*unuoi*	X		**GRASSES & SEDGES**		
7	Ficus scabra	*mati*	X	1	Cenchrus calyculatus		X
8	Gossypium hirsutum	*vavae*	X	2	Cyperus stoloniferus	*mumuta*	X
9	Pemphis acidula		X	3	Fimbristylis cymosa		X
10	Premna serratifolia	*aloalo*	X	4	Ischaemum byrone		R
11	Scaevola taccada	*to'ito'i*	X	5	Lepturus repens		X
12	Sophora tomentosa		X	6	Mariscus javanicus	*selesele*	X
13	Suriana maritima		X	7	Paspalum vaginatum		I
14	Vitev trifolia	*namulega*	X	8	Stenotaphrum micranthum		X
15	Ximenia americana	*moli tai*	X	9	Thuarea involuta		X

X - Native species or ancient introduction. R - Absent, but a related littoral species present. I - Introduced and naturalized in recent times.

Appendix 10: Locations of sightings of whales and dolphins in Samoa's waters 2001-2012.



Appendix 11: List of donor funded projects addressing climate change

Project Title	Duration	Source of Fund	Project Award	Status
Vaitele Urban Governance	2008 - 2012	UNDP TRAC - PUMA	400,000	Ongoing
Sustainable Land Management (SLM)	2005 - 2011	GEF - LMD	500,000	Completed
Terminal Phase Out - Ozone project	2008 - 2011	GEF - Meteorology	75,000	Completed
NAPA1 ICCRAHSS	2009 - 2013	GEF -LDCF -Meteorology	2,100,000	Ongoing
Early Recovery in Samoa	2009 - 2011	GEF	600,000	Completed
NAPA 3 ICCRIFS	2010 - 2015	GEF - LDCF - Forestry Division	2,400,000	Ongoing
NAPA2 PACC - Pacific Adaptation to Climate Change	2008 - 2014	GEF - SCCF - LMD	750,000	Ongoing
PIGGAREP	2006 - 2012	GEF - RE		Ongoing
ICCRAHS - Integrated Climate Change Risks into Health & Agriculture Projects (NAPA 1)	2009 - 2013	GEF - LDCF	USD 2,000,000	
IWRM		GEF/IUCN - WRD		
NAPA4 (Tourism, Forest Fire - FESA, Water, Meteorology, PUMA	2010 - 2015	Samoa Australia Government Partnership	2,500,000	Ongoing
National Comptetency Self Assessment (NCSA)	2005 - 2008	GEF - CSD	500,000	Completed
CBDAMPIC	2002 - 2005	CIDA/SPREP - PUMA	500,000	Completed
National Adaptation Program of Action (NAPA)	2003 - 2006	GEF - Enabling Activity	400,000	Completed
NBSAP		GEF CBD		
Second National Communication	2006 - 2009	GEF - EA - Meteorology	500,000	Completed
National Action Programme (NAP)	2004 - 2006	GEF UNCCD - LMD	USD 10,000	Completed
POPs	2010 - 2012	GEF - UNDP	USD 160,000	complete
SAICM project	2008 - 2013	UNEP	USD 250,000	complete
Invasive Species	2011 - 2013	GEF PAS - DEC	USD 250,000	ongoing
NAPA 4 - Integrated Climate Change Riks into Meteorology, Water Resources, Forest Fires, Tourism & Capacity Building	2010 - 2015	Samoa-Australian Partnership	AUD 15 M	Ongoing
SMSMCL - Strenthening Mulit Sector Management of Critical Landscapes	2013 - 2016	GEF - LMD	5,300,000	approved
NAPA 5 ICCRITS	2012 - 2014	GEF - LDCF - STA	2,400,00	approved
Samoa Enhancing Resilience	2012 - 2015	Adaptation Fund - PUMA	8,500,000	ongoing
Cross Cutting Capacity Development Strategy (C CCD) - NCSA+	2012 - 2015	GEF - Enabling Activity - CSD	500,000	Pipeline
Samoa Agroforestry and Tree Farming Project (SATFP)	2012 - 2016	AusAID	2,300,000 (A$)	In progress
LDCF - Economy wide Intehration of Climate Change Adapatation and DRM/DRR to reduce climate variability of communities in samoa	2014 - 2019	USD	14 M	In progress
Adaptation Fund - Enhancing resilience of coastal communities to climate change	2012 - 2016	GEF/UNDP	USD 8,732,351	In progress
ICCRITS - NAPA 5	2013 - 2016	GEF - LDCF	USD 2 M	In progress

Project Title	Duration	Source of Fund	Project Award	Status
JICA Weather Forecasting & Early Warning System	2010 - 2012	JICA	SAT 21 M	complete
Samoa China Digital Seismic Network	2009 - 2012	Government of China	6 M SAT (10 M RMB)	complete
Forest Preservation Programme	2012 - 2014	Government of Japan	USD2.5 M	ongoing
Forestry and Protected Areas management (FPAM)	2012 - 2016	GEF - FAO	USD 1.4 M	ongoing
MESCAL	2011 - 2013	IUCN	USD 220,0000	ongoing
Global Climate Change Alliance	2013 - 2016	EU	Euro 3 M	ongoing
GIZ SPC				
Pilot Project for Climate Change	2013 - 2015	WB	USD 400,000	ongoing
Forest and Protected Area Management	2011 - 2013	Goevrnment of Japan	USD 2.5 M	ongoing
NBSAP	2013	UNEP	USD 220,000	current
Two Samoa Initiatives	2013 - 2015	NOAA	USD 200,000	pipeline
Marine Cetaceans Survey	2012 - 2013	Australia Oceanscape Programme	USD 40,000	ongoing

Appendix 11: Legal framework for NESP - National environmental legislation, regulations policies and International agreements

Acts and Bills

1. The Building Alignment Ordinance 1932
2. The Stevenson Memorial Reserve and Mount Vaea Scenic Reserve Ordinance 1958
3. Constitution of the Independent State of Samoa 1960
4. Taking of Land Act 1964
5. Alienation of Customary Land Act 1965
6. Land Titles Investigation Act 1966
7. Alienation of Freehold Land Act 1972
8. National Parks and Reserves Act 1974
9. Lands Surveys and Environment Act 1989
10. Land for Foreign Purposes Act 1992/1993
11. Planning and Urban Management Act 2004
12. Public Service Act 2004
13. Disaster and Emergency Management Act 2007
14. Land Titles Registration Act 2008
15. Water Resources Management Act 2008
16. Unit Titles Act 2009
17. Waste Management Act 2010
18. Survey Act 2010
19. Land Valuation Act 2010
20. Spatial Information Agency Act 2010
21. Stamp Duty Amendment Act 2010
22. Forestry Management Act 2011
23. Environment Management & Conservation Bill (drafting); and
24. Natural Resource Management Bill (drafting)

Regulations

1. Protection of Wildlife Regulation 2004
2. Protection of the Ozone Layer Awareness Regulation 2006
3. Plastic Bags Prohibition on Importation Regulation 2006
4. Marine Protected Areas (MPA) Bylaws 2007
5. Marine Wildlife Protection Regulation 2009
6. Planning and Urban Management (Environmental Impact Assessment) Regulation 2007
7. Planning and Urban Management (Development Consent Application and Fees) Regulation 2008
8. Land Title Registration Regulation 2010
9. Aufaga Water Resources Bylaws 2011
10. Survey Regulation 2011
11. Water Licensing Regulation 2011
12. Tafitoala Water Resources Bylaws 2012

Multilateral Environmental Agreements

1. United Nations Convention on the Law of the Sea (UNCLOS) 1982
2. Montreal Protocol on Substances that deplete the Ozone Layer 1992
3. Vienna Convention for the protection of the Ozone Layer 1992
4. United Nations Convention on Biological Diversity (CBD) 1994
5. World Forest Charter (WFC) 1994
6. UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks 1996
7. United Nations Framework Convention on Climate Change (UNFCCC) 1994

8. United Nations Convention to Combat Desertification (UNCCD) 1998
9. Kyoto Protocol Framework Convention on Climate Change (KP) 2000
10. World Heritage Convention on Cultural and Natural Heritage Sites (World Heritage Convention) 2001
11. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 2002
12. Cartagena Protocol on Biosafety (CPB) 2002
13. International Convention for the Protection of Pollution from Ships (ICPPS) 2002
14. Convention on the Prior Informed Consent Procedures for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) 2002
15. Convention on Persistent Organic Pollutants (Stockholm Convention) 2002
16. Ramsar Convention on Wetlands 2004
17. Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) 2005
18. United National Framework on Forestry 2003
19. Convention on the Conservation of Migratory Species of Wild Animals 2005
20. International Civil Aviation Chicago Convention 2003
21. International Renewable Energy Agency (IRENA) 2010