National Integrated Water and Coastal Management Plan, Vava'u, Kingdom of Tonga

Australian Aid/SPC - IWCM Project, Vava'u, Kingdom of Tonga

GLOSSARY

ADB	Asian Development Bank
AusAid	Australian Government Aid Agency
CBO	Community Based Organisation
CMC	Coastal Management Committee
CSO	Civil Society Organisation
EbA	Ecosystem Based Adaptation
EbM	Ecosystem Based Management
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organisation
FFA	Forum Fisheries Agency
IUCN	International Union of Conservation Networks
IWCM	Integrated Water and Coastal Management
IWCMP	Integrated Water and Coastal Management Plan
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JNAP	Joint National Action Plan on Climate Change
MAFF	Ministry of Agriculture, Forests and Foods
MLSNR	Ministry of Lands, Survey and Natural Resources
MMEIDECC	Ministry of Meteorology, Energy, Information, Disaster Risk, Environment, Climate Change and Communication
MoF	Ministry of Fisheries
MoH	Ministry of Health
MoI	Ministry of Infrastructure (including Marine and Ports)
MoLC	Ministry of Labour and Commerce
MoT	Ministry of Tourism
NBSAP	National Biodiversity Strategic Action Plan
NEMC	National Emergency Management Committee
NEMO	National Emergency Management Office
NGO	Non Governmental Organisation

NSPF	National Strategic Planning Framework
NZAID	New Zealand Government Aid Agency
PACC	Pacific Adaptation to Climate Change
PUMA	Planning and Urban Management Agency
SIDS	Small Island Developing State
SMA	Special Managed Area
SOPAC	South Pacific Applied Geoscience Commision
SPC	Secretariat of the Pacific Communities
SPCZ	South Pacific Convergence Zone
SPREP	Secretariat of the Pacific Regional Environmental Programme
SWMP	Solid Waste Management Project
TEPB	Tonga Electric Power Board
TERM	Tonga Renewable Energy Road Map
TSDF	Tongan Strategic Development Framework
TWB	Tonga Water Board
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention of Climate Change
USAID	United States Government Aid Agency
VEPA	Vava'u Environmental Protection Association
WHO	World Health Organisation
WQM	Water Quality Monitoring
WSM	Water Safety Monitoring
WSP	Water Safety Planning

INTRODUCTION

The Integrated Water and Coastal Management Plan for Vava'u archipelago in the Kingdom of Tonga has involved consultations with multi-level and multi-discipline stakeholders including local, provincial and national institutions, civil societies, private institutions and communities.

The Integrated Water and Coastal Management (IWCM) project was initiated in 2013 as a continuation of the very successful Integrated Water Resource Management Project in Vava'u from 2010 - 2012.

ACKNOWLEDGEMENT

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The support from the Governor of Vava'u, His Lordship Lord Fulivai, throughout the whole project provided great assistance to the success of the consultations and information delivery to district and town officers.

The IWCM Project Management Unit, Ministry of Meteorology, Energy, Information, Disaster Risk, Environment, Climate Change and Communication Vava'u, the Ministry of Lands, Survey and Natural Resources Vava'u, Ministry of Tourism Vava'u and both the Ministry of Fisheries and Ministry of Agriculture, Forests and Foods Vava'u also provided great support and assistance to this project.

We also wish to express our gratitude to the community participants for the vital information on the state of natural resources in Vava'u given during the surveys. Finally, a huge thank you to the staff and team at VEPA for the hard work throughout the project.

EXECUTIVE SUMMARY

The Integrated Water and Coastal Management Plan (IWCMP) has been prepared with information gathered through consultations with varying stakeholders including local, provincial and national institutions, civil societies, private institutions and communities.

Coastal areas include some of the most biologically diverse ecosystems that support a multitude of services to human livelihoods including food sources and raw materials.

Coastal areas worldwide are exploited for their natural resources. Habitat degradation, exploitation of resources, unregulated coastal developments, increased populations along coastal areas and climate variability and change are all playing a critical role in the demise of coastal areas.

Integrated Water and Coastal Management Plans are being adopted worldwide to develop a comprehensive and participatory approach to managing sectoral activities along coastal areas that impact upon coastal resources, these sectoral activities include economic and social activities as well as environmental and ecological issues.

In Small Island Developing States, such as Tonga, the management of coastal resources is paramount to sustainable resource use, economic growth and development.

The Government of Tonga is a signatory to the United Nations Millennium Development Goals and the recent Sustainable Development goals both of which emphasise the need for improved resource management for watersheds and coastal areas. The Government of Tonga is committed to improving resource management however it is under resourced technically to carry out all of the required management practices.

A lack of co-ordination between ministries as well as multiple ministries working to attain coastal management means that replication and misinformation are leading to a lack of recognition by communities on successful and sustainable practices.

There is currently little enforcement of current legislations that are linked to coastal management including the Fisheries Conservation Regulations 2010 and Environmental Impact Assessment Act 2003, both of which are critical in resource management and sustainable development.

Current policies from varying Ministries need to be undertaken and incorporated within IWCM and inter department co-operation will be paramount to the success of the IWCMP.

The following policy interventions and strengthening work is recommended to be undertaken during the five year implementation plan:

- Develop a spatial plan for Vava'u under the National Spatial Planning and Management Act 2012 making provision for population and development trends, current policy framework, land tenure, water catchments and drainage, provision of infrastructure, coastal low-lying areas, climate change or other hazards, environmental capacity including land capability, heritage and carrying capacity and footprint capacity (future proofing surveys).

- Use the Vava'u spatial plan to develop an integrated coastal zone plan for sustainable development.

- Create a body for integrated management of coastal areas "Vava'u Coastal Development Authority" to act as a focal point for all coastal development planning/coordination/enquiries/permitting.
    - Development of a forward policy agenda and work plan for committee
    - Integrate NGOs, tourism and community representatives

- Introduce institutional mechanisms for information sharing and stakeholder participation – an information repository.

- Review, improve and enforce environmental legislation.

- Increase public awareness on environmental policy, legislation and development requirements (for business, government and community)

- Promote participatory approaches to encourage participation of local communities for sustainable development of coastal resources

- Formalise meaningful public consultation process for major coastal development. To be integrated with EIA Act.

- Create a 'one stop shop' for coastal developers:
    - Capacity development needed within government departments to raise awareness of other agency mandates in the coastal area
    - Create integrated check list for legal requirement for permitting – formalise sequential process for all legal conditions to be met and integrate to ensure compliance within all government departments.
    - Produce information pack for developers to include all legal requirements, process and permits necessary for undertaking development and provide order of sequence for these permits to be applied for.

Strengthening coastal resources is a large area of work for coastal managers to ensure that ecological processes, productivity for economic benefits and resilience to climatic and human activities. At present resource management is limited within Vava'u and this would be strengthened through co-operative and participatory techniques to better utilise surrounding stakeholders including resource users.

Current coastal marine resource management centers around two community Special Managed Areas (SMA's) in Ovaka and Taunga under a climate change adaptation fund for fisheries. There are currently five more SMA's in process to be established in 2016. There is little available ecological data to support the success of the SMA's, however the community committee commitment shown especially from Ovaka, proves that community managed resources are a viable and valuable integrated management scheme.

Vava'u faces many land based resource issues including land based erosion from poorly designed road infrastructure and coastal land clearing are exacerbating coral reef and marine ecosystem demise through eutrophication (run off) and pollutants entering the water. Over exploited marine resources are weakening vital coral reef ecosystems and reducing the provisioning services that coastal communities require for subsistence living.

The following mission for the five year implementation plan of the IWCMP was devised to incorporate participatory management for improved coastal resources.

"To promote integrated water and coastal area management practices and support sustainable and balanced use and socio-economic development of the coastal areas and natural resources of the Vava'u archipelago, Kingdom of Tonga."

This mission will be achieved through the following five year planned activities::

Objective: Develop a coastal eco-tourism plan and implement activities that incorporates sustainable development and resource use, utilising coastal communities as hosts for alternative income generation

Proposed Actions

- Conduct a feasibility study on the installation and maintenance of yacht moorings being run as a community micro business outside of the Vava'u harbour.
- Hold training workshops on correct construction, placement and maintenance of moorings for communities.
- Conduct survey of all island resorts/hotels to inspect current waste water management processes and develop a standardised method to be used by resort developers.
- Investigate potential for properly designed and marked community managed coastal hiking trails for tours. Hold workshop on methods and standards of making trails.
- Hold tour guide training course targeted to nature hikes and local cultural highlights i.e Puono Park

Objective: To introduce and implement organic certification for food produce grown in Vava'u and reduce agrochemical runoff in coastal communities.

Proposed actions

- Workshop on organic methods including the use of natural plant based pesticides
- Collaborate with Department of Agriculture on the current surveys conducted to map agrochemical uses.
- Identify current organic farmers and provide support to improve on the domestic food market for economic growth
- Establish community organic gardens in coastal communities that support alternative income generation programs
- Design monitoring and evaluation parameters for project management
- Establish organic certification scheme for integrated water and coastal management program

Objective: To undertake stock taking and socio-economic evaluation of coastal fisheries resources in The Vava'u archipelago

Proposed actions

- Develop a socio-economic study that can be conducted at community level

- Set up Catch-per-Unit-Effort monitoring systems in 2 coastal communities outside of the special management area programs as a pilot project

- Develop a sustainable fish guide for restaurants and tourists that helps support sustainable fisheries practices

Objective: To establish aquaculture as an improved industry for income generation for coastal communities

Currently aquaculture remains a small scale domestic based industry that is restricted by access to technical and infrastructure resources.

- Identify alternative aquaculture opportunities that could economically and ecologically benefit Vava'u

- Identify pilot communities to trial aquaculture programs for improved food security such as 'paka' mud crabs

- Monitor and evaluate pilot activities and prepare a development plan for coastal communities.

Objective: To establish pilot coastal conservation areas within each district for improved conservation of ecological resources and biodiversity

Biodiversity is the key to coastal areas that provide ecosystem services, management of critical biodiversity areas within coastal communities is paramount to improved food security and raw material production.

- Evaluate the effectiveness of coastal conservation areas and how they might lead to improved biodiversity

- Identify important biodiversity areas of both terrestrial and marine values

- Design and implement community conservation areas in line with previous community managed areas such as the fisheries SMA at Ovaka

- Monitor and evaluate pilot activities for future implementation

Objective: To establish rainwater harvesting facilities for livestock in coastal farming areas for improved animal husbandry and health of artisanal livestock farmers

Communities are reliant on farm animals such as pigs, cows, horses and sheep for cultural traits and food resources, current farming activities are for "free-range" animals to cope on their own without constant sources of water. When frequent water is introduced to animals, productivity and health of the animal rises and their destructive patterns such as damage to water pipes would be reduced leading to better water management.

- Conduct a feasibility study to survey a rainwater harvesting opportunities for farm animals within a co-operative farm area.

- Implement pilot activity of a rainwater harvesting plant for animals that would include troughs and monitored water supply.

- Monitor and evaluate the effectiveness of the pilot activities and the impacts upon the animals.

Objective: To establish a large rain water harvesting plant for low rain periods to reduce the pressure on town water and over-pumping of water wells.

Drought and lower than average rainfall periods have become more regular in the last few years and badly implemented and managed rainwater catchment systems are common throughout Vava'u. Implementing larger rainwater harvesting plants could bring refuge to small households in times of lower rain periods and reduce the over-pumping on water wells.

- Identify community areas of fragile water resource status and design and implement a rainwater harvesting station
- Set up community water harvesting plan and committee
- Implement the water harvesting facility within a coastal community including gauges and metering systems for improved management.
- Monitor the effectiveness of community managed rain water resource stations for future implementation

Objective: To identify potential coastal flooding hazards and areas of poor coastal protection and design effective environmentally friendly infrastructure

- Identify and map areas at high risk of coastal flooding and areas with low natural protection from storm surge and heavy rains.
- Design and implement a coastal protection system in one pilot community to reduce the impacts of storm surges, coastal inundation and flooding.
- Monitor and evaluate the impacts, changes in shoreline and coastal vegetation and prepare a coastal rehabilitation plan which can be replicated in other areas.

Objective: To raise awareness and build capacity of resource user groups and stakeholders and to improve upon participatory approaches to coastal resource management.

Proposed actions

- Identify resource needs through a gap analysis on government departments, institutions and NGO's/civil societies
- Run workshops on information gathered from gap analysis to improve upon technical and resource capacity at governance level
- Design and deliver workshops and resources on coastal areas to community groups, youth groups and schools
- Run consistent radio programs and talk back shows on the coastal areas and management programs and activities

The following field activities are recommended to be undertaken or continued during the five year implementation plan:

Development of a spat hatchery in Vava'u for the Pearl Aquaculture industry and strengthening of current aquaculture.

Coastal Flora and Mangrove Forestry to implement growing of coastal flora including mangroves by communities to re-establish coastal areas and to reduce the harmful effects of run-off from deforestation.

Coastal Water Monitoring which should be continued for the coastal waters of the Neiafu Port of Refuge and Neiafu Tahi "Old Harbour", this established baseline is vital for monitoring the related works to reduce pollution entering coastal waters.

The IWCMP will be achieved with the support of the Governor of Vava'u, Lord Fulivai who will oversee the renewed and strengthened Coastal Management Committee (CMC), that would revolve around the integrated participatory approach to coastal area management. It is envisioned that the core CMC members would act as the focal point for IWCM implementation, however feeding into the CMC would be input from a variety of stakeholder groups.

The core CMC itself would comprise of individuals from varying sectors with regular responsibility over natural resource management and community engagement. It would be responsible for implementing the annual action plan and/or pilot projects as approved by the wider CMC stakeholder group. It would also be used as a focal point for the evaluation of coastal issues that arise and to utilise a wide range of local and international knowledge, experience and human resources to effectively create an improved, effective and productive coastal zone for the Vava'u archipelago.

CHAPTER – 1 INTRODUCTION & BACKGROUND

1. Regional and National Context

On a global scale, productive and wealthy coastal areas are densely populated which has led to heavily developed human activity, sometime with very few controls. This has made such areas vulnerable. Not surprisingly, there is a sharp conflict between needs for immediate consumption or use of coastal resources and the needs to ensure the long term supply of those resources. This is especially true in the Pacific island region where the phenomenon is heightened by the occurrence of many island states. With this heightened vulnerability, the protection of coastal areas of Pacific island nations is fundamental to their sustained economic development. Damage to the coastal environment

of island nations has a negative effect on economic development, public health, biodiversity, the lifestyle of island communities and cultural practices.

In 1994, pacific leaders from across the region met to discuss the issues that each nation faced in relation to their coastal environments. From these meetings came an understanding that there were specific needs which had to be addressed regionally in order for coastal protection to be successful. These needs included: mapping and data collection, IWCM, education and public awareness, regulatory regimes, social and cultural practices, alternatives to coastal derived sand and gravel, consideration of economic values and coastal engineering (SOPAC, 1994).

In specific terms of IWCM, the governance processes that have been developed consists of the legal and institutional framework necessary to ensure that development and management plans for coastal zones are integrated with social and environmental goals and are made with the participation of those affected. IWCM uses a participatory approach to ensure that any management plans developed are based on a comprehensive, multi-sectoral approach to the planning and management of coastal areas. It encompasses a process of assessment, planning and management for sustainable development, multiple-use and conservation of coastal areas, resources and ecosystems (SOPAC, 1994). This type of management has provided a proven resilience to coastal damage over the past 20 years in the region. It has already been implemented in current programs in the Pacific and has led to the development of long term solutions that are appropriate to local issues.

Within Tonga, environmental changes in the coastal zones include land loss, shoreline retreat, reduced beach vegetation (including mangroves) which would otherwise act as buffers against the impacts of climate change. Much of the infrastructure and socio-economic activities in Tonga are located on or near the coast which makes them highly vulnerable to the effects of climate change and sea level rise. Inundation and flooding hazards generated by extreme sea states are among the common threats facing Tonga's coastal towns and villages in the low lying areas of Tongatapu and Ha'apai.

The government of Tonga has recognised coastal erosion as being a significant environmental issue facing Tonga (JNAP, 2010), partially as a result of sea level rise. Other contributing factors have been identified as the low altitude of some island groups, the increased denudation of mangrove and coastal trees, live coral removal, illegal mining of beach sands and off shore sand dredging. The JNAP (2010) report has observed that a noticeable result of these activities has been a loss of land and infrastructure along the coast. Recommendations made by Government Ministries/Department and Non-Governmental Organisations as part of the JNAP (2010) consultations have highlighted the need to formulate coastal management plans as an adaptive strategy for coastal areas.

2. The Vava'u Context

The island group of Vava'u, specifically the main town of Neiafu, is about 300km north east of the main city Nuku'alofa in Tongatapu. Vava'u itself is comprised of one large main island measuring 90km² and over 40 outer islands. The Vava'u group measures 21km from east to west and 25km from north to south. It has a coastline measuring 362km covering a geographic land area of 138km².

The coastline is a combination of raised limestone cliffs in the north and an irregular coastline towards the south that opens into a complex network of channels, bays and islands forming one of the best protected natural harbours in the Pacific. On the south side of the island group, there are many small waterways and islands. The largest of these is a channel called 'Ava Pulepulekai which extends 11km inland from the harbour of Neiafu.

The coastal areas of Vava'u can be classified into six water based resource ecosystems: mangrove forest, coral reefs, seagrass beds, deep water, non-coral reef flats and beaches. Supra tidal habitats on the rocky areas above the tidal influence and scattered littoral forest areas are found on the exterior barriers of the scattered communities along the coastal area. Each of these ecosystems provides important socio-economic benefits to the local communities, all of whom live within 2.5km of the coast. As well as providing a livelihood for communities, the coastal areas and waterways of Vava'u also provides habitat for a wide variety of marine flora and fauna many of which also form the basis of the island groups' tourism industry.

The need for ecosystem based coastal resource management has become apparent over recent years with the instances of climate induced impacts and over-exploitation of natural resources increasing, leading to increases in the vulnerability of the coastline habitats and associated ecosystem services.

One of the key differences between the coastal resources in the Kingdom of Tonga and the majority of other Pacific island nations is all of the coastal land is managed by the government and does not belong to individual communities or villages, unlike the coastal tenure system in many of the other countries. The benefit of this system is that any management plans that are implemented within Vava'u can be done through a central body, with the participation of the communities, and managed as a single connected entity.

3. Current Status of IWCM in Vava'u:

The Government of the Kingdom of Tonga has been committed towards the development of an IWCM plan since the development of the IWRM National Water Plan in 20XXXX

Under the United Nations Millennium Development Goals, the United Nations Sustainable Development Goals and the Convention on Biological Diversity Aichi Targets, Tonga has made strong commitments towards the importance of biodiversity and environmental security. The National Biodiversity Strategic Actions Plans and management plans implemented by the Ministry of Meteorology, Energy, Information, Disaster Risk, Environment, Climate Change and Communication (MMEIDEC) outline the commitments and progress made towards these goals and the Ministry of Lands, Survey and Natural Resources have made parallel commitments to coastal resources through both the IWRM and IWCM programs.

Tonga is a signatory to multiple multilateral treaties that include a focus on environmental issues within the coastal areas. Under these treaties Tonga has made commitments to improve upon social welfare, economic development and environmental security alongside climate variability and change.

The Government of Tonga is acutely aware of its vulnerability in the coastal area to the impacts of climate change and disaster risks. It is susceptible primarily due to its geographical, geological and socio-economic characteristics. The government's National Strategic Planning Framework 2011 – 2014 (NSPF) highlights the relationship between the sustainable development of the country and the detrimental impacts of climate change and considers them as high priorities in the NSPF. One of the nine commitments made in the framework is for "cultural awareness, environmental sustainability, disaster risk management and climate change adaptation, integrated into all planning and implementation of programs" (TSDF, 2011).

To help achieve this commitment, the TSDF has developed a strategy to implement the Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management (JNAP) to reduce vulnerability and risks; and to enhance resilience to the impacts of climate change and natural hazards.

In the coastal environment, the government has recognised, through the TSDF and JNAP that year-to-year climate vulnerability, such as El Nino and extreme events, e.g. droughts and storms, will continue to pose significant challenges to key economic sectors including agriculture, fisheries, tourism, public health and safety, climate-sensitive resources such as beaches and coral reef, vulnerable coasts and critical water resources (TSDF, 2011)

The MAFF, MoF, MMEIDECC and MoI have responsibilities in implementing the commitments made by the Government of Tonga to improving the coastal areas through these programs. While there is limited communication between the ministries, within the Fisheries and Environment Ministries, there appears to be a high level of integration between their individual programs and the strategies set out in TSDF and JNAP. The Ministry of Infrastructure appears to have integration within the plans in Nuku'alofa and Ha'apai, however, the infrastructure works taking place in the coastal catchment areas of Vava'u appear to lack coordination and planning to ensure their compliance with the commitments set out in the JNAP. Improved alignment between the implementation of the plans and the ministry communications with their outer island groups is essential to ensure that the objectives for improving resilience in the coastal areas are met.

At the project level, there have been a number of initiatives in the island groups which are in alignment with the JNAP and with the principles of IWCM. Projects such as Ridge to Reef, coastal reinforcement in Tongatapu, coastline fortifications in Ha'apai, SMA development, EbA coastal erosion management in Talihau etc.all demonstrate the ability to implement significant coastal management projects in line with the frameworks and policies developed.

Room does exist for improvement in the implementation at the project level in terms of communications between ministries, between island groups and between major project funders. This will ensure that the projects being implemented are coordinated in their outputs and that Tonga is able to gain maximum benefit from the initiatives being undertaken in her islands. Additionally, in the context of Vava'u, there is a need to improve the distribution of project efforts and to ensure that the more vulnerable remote communities benefit from adaptation initiatives as much as the urban cen-

tre of Neiafu.

4. Need of IWCM Plan:

Due to the geological attributes of the Vava'u archipelago and the unequivocal pressure placed on the coastal resources, ecosystems and watershed, a strong working coastal management plan is required to improve and sustain the coastal resources for improved ecological and economical benefit.

5. Principles of IWCM:

The principles of IWCM are similar to those of IWRM with the key concepts of integration, decentralisation, participation and economic and financial sustainability (World Bank Institute 2006). IWCM plans are designed to be uniquely suited for the local coastal area and the level of governance both nationally and municipally. The concepts also account for local cultures and traditions, current and future economic conditions and potential development areas.

The main principles of IWCM programs are:

- Strengthening provisional sectoral management through increased training, strengthening current legislation and human resources.
- Preserving and protecting biodiversity and ecological processes of coastal ecosystems, through reducing and preventing habitat destruction, pollution and over exploitation of resources.
- Promotes national and municipal development and allows for sustainable uses of coastal resources.

These principles are achieved through program characteristics that include:

- The ability to move beyond national approaches which can dampen progress through being too focused on a single factor. IWCM principles aim to manage the coastal areas as a whole zone using ecosystem based management wherever appropriate.
- Allows for a continuous adaptive management process of administering the development, use and conservation of the coastal area and its resources towards agreed objectives from varying stakeholders.

CHAPTER – 2 COASTAL RESOURCES

1. Physical Environment:

The Kingdom of Tonga lies between 15° and 23°30' South and 173° and 177° West in the Central South Pacific Ocean. Tonga has a combined land and sea area of 720,000 $km^{2.}$ and a total of 172 islands divided into four main island groups Tongatapu and Eua, Ha'apai, Vava'u and the Niuas.

Along the western side of the Kingdom of Tonga runs a line of islands of volcanic origin, steeper in topography and of higher elevation than the islands to the east which are generally lower-lying limestone and mixed geomorphology islands. The Tongan Trench stretches along the eastern side of the Tongan archipelago from the north of New Zealand to south western Samoa and is the second deepest trench in the world with maximum depth's reaching 10,882 metres (35,702 feet).

The coastal zone in Tonga is stipulated by the declared exclusive economic zone (EEZ) of 200 nautical miles from the oceanic facing land points. The contiguous zone of the Kingdom of Tonga is deemed under the Maritimes Zone Act, 2009 as "the area of sea between the territorial sea and a line every point of which is at a distance of 24 nautical miles from the nearest point of the baselines". The territorial seas are depicted as 12 nautical miles from baselines (closest land points).

The Vava'u archipelago is situated between 18.65000 °S and 173.9833° W in the northern Kingdom, Vava'u has over 40 predominantly raised limestone islands with the exception of two volcanic islands: Fonualei and Late, situated to the north west and south west respectively.

Vava'u lies upon a submarine trench area with continental shelves situated to the west and east of the archipelago.

1.1 Geomorphology

The Tongan archipelago is situated on the Tonga-Kermadec Ridge, an active fore-arc laying to the West of the Tongan Trench and east of the Lau Basin that separates two tectonic plates, the Indo-Australian Plate and the Pacific Plate. The Ridge is formed by the downward movement of the Pacific Plate under the eastern edge of the Indo-Australian Plate.

To the west of the Vava'u group and a smaller scale depression (1,800m below sea level), the Tofua Trough, lies the volcanic origin islands of Late and Fonualei and the islands to the east of the Tofua Trough are of low lying coral limestone. (Fry and Falkland, 2011). The eastern islands are older than the volcanic islands to the west.

The main Vava'u group, consists of emerged and tilted limestone islands from the Pliocene (5.2 to 1.64 million years ago) and Quaternary age (1,640,000 years ago and present day) (Roy 1990) with higher elevated limestone cliffs to the northern end and a down-tilted shift to the south. The highest elevations on Uta Vava'u are recorded at 210 meters above sea level.

The northern cliffs are open to the ocean and show signs of long-term marine erosion due to the scalloped plan-form, whereas the southern margin is highly irregular with a fragmented appearance.

1.2 Climate

The climate of Vava'u is semi-tropical with two predominant seasons of summer (November to April) and winter (May to October) and experiences the south-east trade winds that average between 12-15 knots though wind speeds increase during the winter months with averages of 18-22 knots.

Average rainfall in Vava'u is 2150 mm per annum with March and April trending as the wetter months. The drier winter season seas average temperatures of 25℃ and summer time average temperatures of 28℃ with 85% humidity as shown in Figure 1 below.

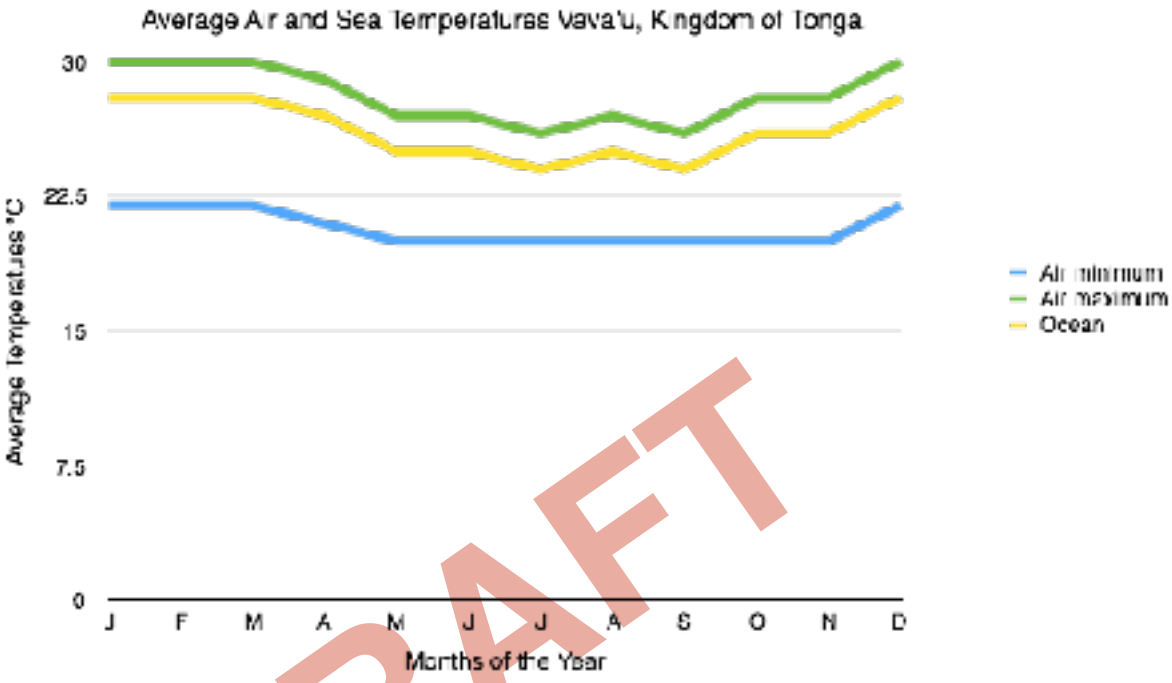


Figure 1. Graph showing the average monthly minimum and maximum air temperatures and the expected sea temperatures for Vava'u.

1.3 Natural Hazards and Occurrences

Natural hazards impact upon ecosystems. Even though they are not directly related to climate variability and change, these natural hazards play a role upon the coastlines and ecological processes.

1.3.1 Volcanoes

Tonga is situated on the "Ring of Fire", a volatile and active area of underwater and terrestrial volcanoes as well as ocean and mountain trenches and hydrothermal vents. Approximately 90% of all earthquakes occur along the Ring of Fire and it contains over 75% of all the active volcanoes on Earth.

Tonga recorded 115 earthquakes in the last 12 month period , 51 of those located near Neiafu, with a magnitude of 1.5 or greater.

Volcanoes release greenhouse gasses into the air during active periods, covering large areas of oceans and land with ash that may limit flora growth and damage local crops; however they also

benefit some ecosystems and in the longer terms can provide the land with rich soil. When sulphur (S) is predominantly emitted local temperature may cool and when carbon dioxide (CO_2) is emitted local temperatures may warm for short periods of time.

Volcanic ash impacts on the ocean and can be beneficial in the eutrophic zone found within the first 200m's of ocean water, however an increase in nutrients similar to those from run off can also trigger Harmful Algae Blooms.

Earthquakes can damage the water bores in Vava'u and is an indicated cause of the 50% of water bores currently not functioning (pers. comm. Manager of the TWB, Vava'u).

1.3.2 Tsunamis

Tsunamis can occur directly after an earthquake, volcanic eruption, landslide, or meteor strike and when the pressure of over 6.75 on the Richter scale has been exerted. Abrupt shifting of tectonic plates cause increased activity in earthquakes and volcanoes. A tsunami is a series of waves that travel fast through the ocean in a series of directions, when the wave approaches a shallow sloping coastal area it becomes a set of large waves that crash against the shore.

Tsunamis have the power to devastate shorelines and coastal communities as well as having large impacts on all coastal ecosystems. The impacts can be felt through a multitude of industries including tourism, aquaculture and low-lying agriculture plots.

The threat of tsunamis for the Vava'u Islands is not as direct as other low-lying coastal areas in Tonga. Vava'u has deep water surrounding most of the islands and higher cliff faces to the North and East.

During the 2009 Samoa earthquake the impacts from the tsunami were devastating to the two islands north of Vava'u known as the Niua's, where loss of life was experienced. In Vava'u the impacts were felt on the Eastern community of Holeva, where the tsunami washed away cars that were parked along the coastal area. Some houses were also moved by the waves which lifted them off their foundation supports. People also experienced rushing waters through buildings. In the main commercial harbour, rapid tidal exchanges occurred, with water rushing in and out of the harbour every 2 minutes.

These extreme tidal exchanges can still have impacts on coastal communities in Vava'u and can cause damage to property such as vessels and houses. The tidal exchanges can also impact and damage coastal ecosystems such as coral reefs and seagrass beds. Aquaculture infrastructure, due to its locality in shallow waters, faces large potential impacts from fast flowing tidal exchanges such as those witnessed previously in Vava'u.

1.3.3 Harmful Algae Blooms

Harmful algal blooms, which are commonly referred to as "Red Tides", occur when there is an increase in nutrients to the surface of the waters resulting in an abundance of phytoplankton leading to a significant algal bloom that can potentially impact human health and marine life due to toxins contained within the algae.

Marine life, especially sessile animals such as corals and benthic marine life such as marine invertebrates are equally impacted from the algal bloom. These impacts often stem from the algae's process of stripping oxygen from the water column causing hypoxic environments and mortality of marine life. Toxins from harmful algae can cause long term impacts on mollusks with the toxin remaining inside the mollusk for extended periods of time.

1.3.4 Tropical Cyclones and Severe Storms

Tropical cyclones are low pressure weather systems that form over tropical waters with surface temperatures higher than 26.5℃ (80℉) and gale force winds with sustained speeds 63km/h and gusts in excess of 100km/h near the centre.

The tropical cyclone season for Tonga is between November and April with an estimated average of one tropical cyclone affecting the island groups per year. This estimation changes with El Niño years in which the frequency of cyclones increases with estimations of two to three cyclones that may affect the Kingdom.

The effects of cyclones can be devastating to coastal ecosystems and resources and can hamper economic development and livelihoods. Storm surge during cyclone activity threatens coastal communities in low lying areas as well as the increased rainfall associated with cyclone systems. Fresh water supplies are at risk of becoming contaminated with salt water intrusion and excessive run off.

1.3.5 El Niño and La Niña

The El Niño-Southern Oscillation (ENSO) occurs naturally every 2 - 7 years as an ocean-atmospheric interaction in the tropical Pacific. El Niño cycles impact upon trade winds, ocean temperatures and cloud and precipitation patterns.

During El Niño cycles Vava'u experiences cooler dry seasons (May to November) and drier wet seasons (December to April). Due to the increased ocean surface temperatures during El Niño, cyclones are likely to be more frequent with estimates of 2 or more cyclones and of higher intensity than La Niña or neutral seasons.

La Niña is referred to as the "cold cycle" of the ENSO bringing warmer than average trade winds (May to November) and heavier rainfall at times that may cause flooding and increased eutrophication.

2. Land Use:

Of Vava'us 40 smaller islands, 11 contain a total of 17 villages spread amongst them. The main island of Great Vava'u ('Uta Vava'u) has 23 villages with the greatest concentration of people living in the urban areas of Neiafu district.

The Government owns the rights to the coastal access lands to 15 meters above the high tide mark, this land may be leased from the Ministry of Lands for water access.

Within the Neiafu harbour, significant infrastructure developments have occurred and include slip-ways, commercial wharfs, smaller jetties and wharfs, land reclamation and hotel development. This development has occurred along the shoreline of Neiafu town itself and the rest of the harbour area remains relatively undeveloped with only a few private jetties being constructed. Outside of the main harbour, the majority of coastal developments consist of small wharfs and jetties associated with coastal villages or tourist resorts. A slipway has been constructed in the Vaipua area of Neiafu district for hauling pleasure craft and there are several bridges and causeways that have been constructed to link nearby islands to the main island.

As each male born in Tonga is entitled to an allotment of land to farm for food, the main land use in Vava'u is agricultural. In addition to this, in previous years there was an obligation of all land holders to plant at least 200 coconut trees on their newly allocated land. This has resulted in a significant amount of the land being dominated by coconut plantations with mixed agriculture plantations. There are still some areas of woodland left on the main island, however these are found in small pockets as the demand for agricultural land continues to grow as newly eligible males make their land claims.

Significant areas of mangrove exist in the northern areas of the island group in shallow estuary type habitats. In some areas, these mangroves have begun to encroach of the everyday life of villages as a result of increased sediment build up directly resulting from the design of the linking causeways. In these areas, the expansion of the mangrove forests has restricted traditional access to the local fishing grounds and greater effort is now required to fish in these areas.

In the smaller islands, coconut plantations are a dominant feature wherever there are villages. Smaller areas have been cleared for agriculture purpose close to villages; however, the uninhabited islands are often covered in woodland or scrubland. The coastal areas of these villages are commonly characterised by shallow fringing reefs or reef flats before steeply descending into deeper waters.

3. Biodiversity (Ecosystem, Habitats and Species diversity):

Vava'u has seven dominant coastal ecosystem types spanning both marine and terrestrial areas with a limited and degrading biodiversity due to the interaction with human activities. There are currently no protected areas or sanctuary's at the present date, though five conservation areas are currently awaiting approval from Cabinet.

Due to the isolated nature of the archipelago of Tonga, species diversity is lower in the Kingdom of Tonga than other Pacific Island Regions such as Papua New Guinea and the Coral Triangle area, this is due in part to the large oceanic spaces between island groups and regional island nations.

Terrestrial ecosystems have been described as seven plant communities 1) Littoral stand; 2) Coastal Marsh; 3) Mangrove Forest; 4) Lowland Forest; 5) Managed Lands; 6) Successful Vegetation and 7) Secondary Forest.

Within Vava'u there is little uninterrupted lowland forest due to the management of the Land Act under the Government of Tonga

The floral community of Vava'u is estimated as 262 native vascular plant species (Whistler, A. 2014) including 188 dicots, 39 monocots, 2 gymnosperms, 30 ferns and 3 fern allies.

Herpetofauna includes 417 terrestrial reptiles of which 11 species are lizards. Four species of marine sea turtles are indicated in Vava'u with Green Turtles and Hawksbill turtles known to nest on the outer island beaches (Vava'u Turtle Monitoring Program, 2014)

3.1 Micro Organisms:

Microorganisms comprise of Bacteria, Algae, Fungi and Protozoa that all play a critical role in biological processes along the coastal areas and surrounding pelagic waters. Though the actual species number is unknown for Tonga.

There are a large number of underwater vents in the deep-waters surrounding the Tongan Trench to the East of Vava'u the deep water pelagic zones that are littered with organic matter (dead animals, algae and other microbes) and bacteria, an important factor in the carbon-cycle of the oceans.

3.2.1 Benthic Community:

Benthic communities involve organisms that inhabit the ocean floor including lobsters, crabs, worms, clams, sponges and stony corals. Benthic animals are highly abundant and important in shallow coastal waters acting both ecologically and economically.

In Vava'u, the "Beche-de-mer" industry has been highly over exploited and a current five year moratorium has been put in place by the Ministry of Fisheries in 2014 to allow for stocks to recover Other ecologically and economically important benthic species such as giant clams are also being over exploited with unsuccessful attempts to develop aquaculture of clams within the SMA's (pers. communication Ministry of Fisheries).

Benthic communities within and adjacent to the mangrove areas are of vital importance due to the movement of detrital matter (decomposed plant litter) to the littoral zone through wave action and detritus feeders such as shrimp, fin fish species.

3.2.2 Pelagic Community:

The pelagic community consists of predatory species that have fast locomotion and are primarily carnivorous in dietary functions, such as tuna, mahimahi, billfish species, barracudas, sharks and cetacean species. The pelagic community also includes the migratory South Pacific Humpback Whale,

Megaptera novaeangliae and reptiles species of marine turtles and sea crates. Juvenile fish species develop and interact within mangrove and coral reef areas.

The pelagic community also includes the economically important Deepwater Snapper species which is a large domestic and exported food fish species.

3.2.3 Supra Tidal Community:

The supra tidal is the dry habitat area above tidal influence and includes flora that requires very little fresh water known as xerophytic flora. Species such as 'fau' (*Hibiscus tillaceus*)dominate supra tidal areas. Species diversity within supra tidal communities in Vava'u consists of rodent species *Rattus rattus*, *Rattus expeluns* and reptilian species of skink and geckos. Avifauna along the supra tidal consists of both marine and terrestrial species including the Kingfishers, White Rumpled Swiftlet, Pacific Heron, Noddies, Boobies and Terns which will nest in the trees on the cliffs. The Tongan Fruit Bat, *Pteropus tonganus* can often be found along coastal areas in the Pandanas trees.

4. Fisheries and Aquaculture:

The fisheries and aquaculture industries in Vava'u are small in relation to economic return, with coastal fishery activities predominantly for subsistence and domestic markets. .

Fishery activities conducted along the coastal areas and near-shore coral reefs involve spear fishing (both night and day), placement of gill nets along near-shore coral reefs or line and hook. Fishing boats are generally small in size of less than 10 metres in length and run with outboard engines.

The deep water snapper fishery in Vava'u has only two licensed vessels that fish the deep waters off the north and western coastline of the archipelago. The fishery of a drop line fishery that targets multiples species from the families of Lutjanidae (snappers), Lethrinidae (emperors and Serranidae (groupers) and is based primarily on the seamounts. Historically six targeted species however with changes in species composition other species are currently associated with the deep water fishery, these species are shown in Table XXXXX below

Species Name	Common Name	Tongan Name
Aphareus rutilans	Rusty Jobfish	palu polosi
Aprion virescens	Green Jobfish	utu
Carangidae	Trevallies and jacks	lupo
Etilis carbunculus	Short-tailed red snapper	palu malau
Etilis coruscans	Long-tail Snapper	palu tavake
Epinethelus morrhua	Comet grouer	ngatala pusi

Epinephelus octofasciatus/ septemfasciatus	Eight bar/Convict grouper	mohuafi
Pristipomoides filamentosus	Crimson jobfish	paluhina
Pristipomoides flavipinnis	Golden eye jobfish	palu sio'ata
Pristipomoides argyrogrammi-cus	Ornate jobfish	
Lethrinus chrysostomus	Sweetlip emperorfish	manga
Paracaesio kusakarii	Saddleback snapper	palu mutumutu
Gymnocranius radiosus	Silver snapper	palu hina

Since the development of the fishing industry in the 1980's there has been a sharp decline in participating licensed vessels with only 14 participating vessels in 2012 for the Kingdom. The decline in vessels is in part from over exploitation of the resource and an increase in overheads to participate. (Fisheries Division, 2013)

Juvenile fish species and non-exportable species such as the palu malu are sold in the domestic market.

Aquaculture is comprised of two main industries: Mabe pearl farming and the seaweed farming for export. The Mabe pearl were introduced as an aquaculture programme to Tonga in the 1980's and are currently harvested and sold in the local markets in Vava'u to visitors.

The seaweed aquaculture is predominately for export to Fiji and Asian markets. Vava'u first started seaweed aquaculture in the 1990's but was soon halted due to the loss of economic demand for the seaweed species.

Though aquaculture is deemed a highly important activity to Vava'u, progress to expand remains slow and limiting to small and domestic markets. Increasing aquaculture products to include desirable edible species such as the mud crab "paka" may create an internal demand for improved resource management and improve current management and ecological role of mangrove species.

4.1 Non Conventional Resources:

There are very few marine resources that are not utilized in Vava'u, with many marine species being over exploited through fishing practices and under resourced management.

Coastal fisheries in Vava'u are primarily based on reef and inter tidal species including reef fish species of groupers, snappers, emperor fish and many others and reef invertebrate species of lobster, crabs, sea cucumbers and mollusks including giant clams. There is over

370 targeted species of fin fish recognised for Vava'u (BioRap 2014). Due to the nature of spear fishing in Vava'u, non conventional resources such as damselfish, pufferfish and other smaller fish species are also caught.

Gleaning activities that take place on the inter-tidal mud flats also target many species of mollusca and invertebrates that are not conventionally fished including "muli'one" the Blunt Edged Sea Hare (*Dolabella aricularia*).

Sea weed is produced for the export market through aquaculture and other species of sea weed such as "Limu" (*Caulerpa racemosa*) are eaten regularly at meals and cultural feasts.

4.2 Infra-Structure:

In terms of the physical infrastructure in the coastal zone, the Halaevalu Wharf, commonly regarded as the Fisheries Wharf, was constructed to provide docking and working space to the domestic fishing industry. The Ministry of Fisheries Vava'u office is located on the wharf behind a small fish processing factory. Connected to the Halaevalu Wharf is a larger container ship and passenger ferry wharf.

Alongside the Halaevalu Wharf a slipway was constructed in 2011 to provide an entry and exit point for the local vessels. This project was funded by European Union under the MAFFF-STABEX project and also incorporated new quarantine facilities on Halaevalu Wharf to assist farmers in the export of watermelon and other produce. The open storage facilities behind the slipway have been leased to mechanical businesses that assist the fishermen.

In 2014, the fisheries processing facilities and fisheries wharf was signed over for management to the Vava'u Fisheries Council to try and further development of fisheries. The VFC is aimed to improve and expand upon the seaweed aquaculture and to provide fishers with infrastructure to be able to safely store and sell fish products domestically. At present there have been issues with the ice making facilities and a percentage of fishers are still selling fish and crustaceans from cooler bins alongside the main wharf.

The building previously operated by Alatini Fisheries and located adjacent to the 'Utukalongalu Market, was taken over by Tavake Fisheries for the domestic sale and export preparation of deep-water snapper species.

The Department of Fisheries building behind the fish processing plants hosts three fisheries officers and one financial officer. Aquaculture development is a large alternative income driver for Vava'u with the export seaweed market and pearls however due to a lack of infrastructure and resources for easy restocking and spat development programs in Vava'u, growth of the aquaculture industry remains slow.

4.3 Measures for Avoiding Over-exploitation of Fisheries Resources:

Marine fish and invertebrate resources are being overexploited in Vava'u that has lead to depleted stocks of lucrative species such as lobster, sea-cucumber and fin fish species of grouper, snapper and emperor fish and migratory pelagic species of tuna and billfish.

Broad scale awareness and knowledge exchange programs need to be implemented to ensure the success of marine resource management programs and sustainable fishing practices to establish improved understanding and conformity to current Fisheries Conservation Regulations. Grants and micro-financing can help support fishers transitions to improved catch methods and fishing gear.

Improving catch methods and equipment that allow for selective fishing, such as enforcing the ban on the spearing of lobster species and introducing an alternative catch method, would allow for improved monitoring and compliance on size limits and the releasing of females with roe as per the Fisheries Conservation Management Regulations 2010.

Improved data management of catch per unit effort (CPUE) surveys to fishers can help monitor and manage fish stocks. Community lead management and co-operative monitoring programs ensure that all participants and resource user groups conduct effective and sustainable practices and have a larger stake in the ecosystems future.

Large marine managed and marine protected areas need to be implemented with community support and management assistance including spawning grounds and important biogeographical regions for larger predatory fish species need to be identified and incorporated into marine managed and "no-take areas". This allows for better regeneration for species that move distances and habitats within the coral reef ecosystem.

The commercial domestic fisheries need to be strengthened and reduce the number of licences given to foreign fishing vessels, ensuring that employment and market support is beneficial to all. Fisheries monitoring officers need to be placed on all vessels at the cost of the vessel for ensured compliance to incensing and regulations. These officers/monitors can be trained from coastal communities.

5.0 Water Resources:

Freshwater resources in Vava'u are either groundwater from freshwater lenses or rainwater catchment. Water resources are predominantly used at the household level and annually by tourism resorts and restaurant facilities.

In limestone islands caverns, sinkholes and fissures found at sea level produce areas where due to a lower density freshwater sits on top of saltwater, these are known as freshwater lenses. The upper surface of a freshwater lens is referred to as the water table (IWRM, 2013)

The freshwater lenses are bored from the surface and water is pumped and piped by the TWB to nearby communities of Neiafu, Makave and Toula regions, with 16 boreholes/wells in July 2015, of which 8 of those boreholes have suffered collapse and no longer operate. Other communities have their own wells which also pump water to the local households.

Salinity in freshwater is increasing due to over pumping of bores and increased seal levels from climate variability and change. The TWB places chlorine into groundwater supplies to reduce the inference of chemicals and bacteria from surrounding agriculture and household sewage.

There is an excessive loss of up to 71% in the Neiafu water supply area (Fry and Falkland, 2011). These losses primarily occur due to malfunctioning and broken pipes that are often undetected. Reports of broken pipes come from voluntary sources.

Rainwater catchment is the preferred water resource due to convenience, quality and cost. In surveys conducted in 2013 under the IWRM, two thirds of households in Neiafu rely on rainwater for all activities and only one third rely on groundwater. Groundwater is used as a backup during drier periods.

Vava'u has one internal brackish lake, Lake Ano, located in the Hihifo district near Longomapu. This lake provides no water resource for local communities.

6.0 Non-renewable (non-living) natural resources

To the east of Vava'u lies the Tongan Ridge, a parallel line of active volcanoes and lying between Vava'u and the Ridge is the Tonga Trough. Within these areas are known to be mineral deposits containing copper, zinc, gold and silver (Natuilus 2010). Deep sea exploration permits have been issued to two mining companies within Tongan territorial waters following the confirmation of Seafloor Massive Sulphide (SMS) deposits (SOPAC, 2013). In anticipation of deep sea mining activities, the Tongan government in 2014 passed the Sea Bed Minerals Act that regulates mineral exploration and potential mining within the Kingdom.

6.1 Tourism

6.1.1 Present Status

Tourism in Tonga has been identified by successive governments, the private sector and many communities in Tonga, as the major economic development opportunity for the country. Tonga is currently ranked ninth out of fifteen South Pacific countries in terms of visitor arrivals (TTSR 2013).

Tourism is now ranked as the government's highest revenue earner (5.6% GDP (WTTC, 2013)) and currently, the main driver for tourism within Vava'u is the Humpback whale swimming industry, which accounts for the majority of visitor nights within the island group. The dominant tourism market within Vava'u is from July to October and is linked to the breeding season of the humpback whales. Secondary tourism markets are the sailing industry, both from charter and cruising yachts and there also exists a small amount of business traveler tourism arising from the many donor funded projects in the island group.

6.1.2 Vava'us share in regional and national tourism

Compared to Tonga's closest neighbours (Fiji, Samoa, Vanuatu and the Cook Islands), Tonga receives the lowest number of visitors with approximately 45,000 annually compared with close to, or more than, 100,000 per annum for each of the other countries.

Of the holiday-maker tourist that come to Tonga, the majority visit Vava'u during the whale swimming season between July and October, and of these, approximately 70-80% undertakes a whale

watch trip during their stay. It is estimated that of these tourists, approximately 8% will choose to undertake their whale swimming trips outside of the Vava'u island group (O'Connor, 2008).

Growth in the Tongan tourism industry has been steadily increasing since 1996. Within Vava'u, it is estimated that growth in whale watch tourism (total number of tourist excursions being undertaken) has been steadily increasing at a rate of 20% annually since the industry was established in 1998. This compares favourably against the annual average growth rate of visitor arrivals into Tonga (by air) of 4.05% between 2000 and 2005. It is important to note that the strong growth rate within the whale watch industry is, in part, generated by tourists undertaking multiple excursions during their stay in Vava'u. It is also estimated that the whale watch tourism currently generates approximately US$1.9million annually through direct and indirect spending. (O'Connor, 2008)

6.1.3 Potential in coastal areas

Vava'u is formed of many islands that provide extended areas of coastline and coastal habitats. In the northern islands, most of the coast is dominated by cliffs or rocky shores. As you move further south through the island group, sandy beaches on small coral islands become more numerous. The northern end of the island group also boasts some large mangrove forests and inland delta-type environments.

Water based activities form a significant part of the tourist experience in Vava'u with many people choosing to paying to take part in whale swimming, sport fishing, sailing or diving activities. There are a small number of land based tourist activities that are available but these do not form part of the driving force for tourist choosing to visit Vava'u.

While Vava'u has a number of water based activities, there is still much potential for increasing tourism revenue through a wider variety of water sports. The formation of the islands and the protection afforded by extended reef systems provide ideal environments for increased levels of all types of water sports and boating activities.

In addition to this, there already exist a number of established anchorages for visiting and chartered yachts within Vava'u and potential exists within in this industry to both strengthen environmental protection and increase economic potential by installing, maintaining and renting mooring balls within these anchorages.

6.1.4 Policy recommendations

The Ministry of Tourism has produced and extensive list of new legislations to be written and enacted to enable the advancement of the tourism industry in Tonga. The proposed list of legislations would provide a very robust framework for the development of the tourism industry, however, the process of developing and enacting these acts would be a costly and lengthy process. In the interim, the Tourism Act provides a framework for most tourism development with support of several other acts such as the Whale Watching Act which, if properly en-

forced would provide an excellent basis for the further development of the industry.

7.0 Urbanisation and Settlement

7.1 Demographic and Social Aspects

A 2011 national population census showed a total population of 103,036 for the whole kingdom, with a population of 14,922 with 2,828 households declared for Vava'u. The population in Tonga generally stays consistent due to the high level of emigration which tends to offset natural increases (UNICEF, 2006). Within the Kingdom, Tongatapu is the only island group to demonstrate an increase in population levels (0.7%) while Vava'u has shown a population decrease of -3.8% between the 2006 and 2011 census (Statistics Department, 2011). At the district level in Vava'u, all districts except Motu have shown a population decrease. The entire population of Vava'u can be classified as living within the coastal zone due to the small land area and all villages can be found within at least 1.5 miles of the coastline.

The 2011 census shows that there are 7,670 people within the working age population (15-59 years of age) with 5,485 people considered to be employed in Vava'u. Of these employed people, 3,201 are subsistence workers who are unpaid but rely on fishing, farming or traditional skills such as handicrafts to provide them with an income. Within the labour force population of Vava'u, there is 0.8% unemployment; however this increases to 43.5% unemployment when only paid employment is considered.

Fishermen in Vava'u work all year round but tend to operate at the subsistence level. There are some small fishing companies who offer commercial fishing services and sell their fish at the local markets; however this is only a small part of the fishing economy in Vava'u. This is also typical of the farming industry in Vava'u. Typically, each family has an area of bush land that they farm or raise livestock on to feed their family. Some of these families have taken agriculture to a larger scale and sell their produce at the local markets, or in some cases, export their produce to Tongatapu for resale. Handicrafts sold in Vava'u are dominated by wood/bone carvings and traditional weaving skills which are used to make baskets, bowls, mats and traditional dress. Tapa cloth making and decorating also forms part of the handicraft market, although this is to a lesser extent than the weaving. In the main, carving is a craft dominated by male artisans, while the women dominate in the weaving and tapa cloth making market sectors. All materials for these crafts are locally sourced.

7.2 Migration to other parts of Tonga

Almost two thirds of the population lives on the main island of Tongatapu and of these residents only 75% were born there. The majority of these are concentrated in the urban areas of Nuku'alofa. According to the 2006 census, approximately 19% of the Tongan population indicated that their birth place was different to their place of residence within Tonga (TSD, 2006). Vava'u lost more people that it gained as many people moved to Tongatapu in search of better economic opportunities. In the 2001-2006 period, Tongatapu had a net gain of 636 people from Vava'u.

7.3 Status of Women

Within Tonga, the traditional social order always allocates a higher rank to daughters than sons (UNICEF, 2006), however, they do not have any authority over their brothers so this ranking traditionally only relates to respect, while women remain subordinate to men as regards authority and inherited rights such as land ownership. The constitution of Tonga only allows for land to be gifted to or inherited by men.

Education is compulsory and free of charge for all Tongans between the age of 6 to 14 (JICA, 2010) and the literacy levels for both genders is in the region of 99%, the net enrolment rate for girls in primary education is slightly lower than for boys however statistics are placed above 90%. Secondary school net enrolment is statistically higher for girls than boys with a lower drop out rate for girls. Tertiary level enrolment for women is 7% over 4% for males, however the majority of female graduates remain close to the family home.

Economic development and increasing exposure to different cultures and values are impacting on traditional roles and responsibilities. As Tongan women take advantage of opportunities for higher levels of education, increasing numbers of women are participating in paid employment with some participating at a senior and professional level. As the status of women in the working environment is elevated, the role of modern Tongan women in the home has been seen to be rising with many of these women having a greater role in decision making at home and managing the family income.

The role of women in Tonga is also improving at a governmental level with more female candidates involved in the 2014 parliamentary elections than in any previous year (16 out of 106 candidates). In addition to this, 2014 also saw the first Women's Practice Parliament being held in an effort to encourage more women to become involved in politics in the run up to the 2014 elections.

8.0 Government and Community Facilities

8.1 Education

The standard of education in Tonga is considered to be high among the other islands of the Pacific. Adult and youth literacy rates are 99% (WDI, 2015) and access to education is free and compulsory for all children up to the age of 14. While the availability of free and compulsory primary education is not unique within the Pacific region, Tonga has had great success in enforcing the legislation and providing a high level of importance on education within the community structure (UNICEF, 2006)

In Vava'u education is provided by 30 government schools at primary level and one government and five non-governmental church schools at the secondary level. All of the outer island villages have a primary school within easy access, with many of the children moving to the main island of Vava'u during the week to complete their secondary education.

8.2 Health

Tonga enjoys a relatively high standard of healthcare, compared to neighbouring counties, with an estimated 100% of the population having access to free health care at a hospital or health care centres within one hours travel (WPRO, 2004). There is still considerable knowledge and use of traditional Tongan medicines, however most Tongans have accepted and widely use modern medical facilities. The main challenge facing the health care system in Tonga revolve around the reduction in prevalence of non-communicable diseases (TSDF, 2011)

The health care system is divided into four districts, each covering the main island groups. Vava'u has a central hospital located in Neiafu with an estimated 61 beds. A new dental clinic was recently constructed within the hospital grounds providing free dental care to residents of Tonga. External assistance in the form of donor funding is vital to the Tongan health care system, contributing to health capital and running costs, training, technical assistance and medical evacuations to New Zealand (Central Planning Department, 2006: 101-102).

8.3 Water Supply, Sanitation and Electricity

Freshwater supply in Vava'u is either via rainwater harvesting, of extracted from a thin freshwater lens within the highly porous limestone substrate. The Tonga Water Board manages the water supply that is pumped from a series of bores to the main urban areas in Neiafu. Outside of the main urban areas, some of the larger villages have installed their own reticulated water system pumped from bores within their villages. For homes which are not connected to a central water system, collection of rain water in concrete or plastic water tanks is the only source of freshwater. Many of the homes on the central water supply also have rainwater harvesting systems on their properties to provide freshwater for drinking and cooking.

Vava'u has no central reticulated wastewater system and relies, instead, on the individual household management of all grey and black water. A common method of disposal in residential areas with plumbed running water is via septic tanks, which are usually inadequate single chamber systems. There have been problems recorded in Vava'u with this system due to the lack of a reliable pump out truck (SOPAC, 2007). Under the IWRM project, a septic truck was purchased in 2010 and is currently managed and maintained by the MMEIDECC. When pump outs are available, the waste materials are disposed of in stabilisation ponds in the municipal dump, however, these ponds are close to the shoreline and have been observed being infiltrated by tidal sea water. In outer islands and areas where no piped water is available, waste water is either diverted directly into a soak-away system, or, in the case of human waste, traditional pit latrines are commonly used. Pilot projects have installed composting toilets in some urban areas of Vava'u with varying levels of success and ongoing support is needed to ensure that facilities remain in good order.

There are a number of issues that have been identified with this type of household based wastewater management, namely contamination of groundwater and marine pollution, human health complications, improper raw sewage disposal and animal waste mismanagement (SOPAC 2008).

The electricity supply in Vava'u is managed by Tonga Power and is generated by a combination of diesel generators and a photovoltaic array. The solar farm was commissioned in 2013 and its 500kW array can provide Vava'u with 70% of its energy demands at noon. Batteries store part of the energy generated during the day and discharge during the peak in the evening.

Electricity is reliably supplied throughout the urban areas of Neiafu and into several of the surrounding villages with a little over 3,000 homes connected to the power supply (Tonga Power, 2013). Homes which aren't connected to the main electricity supply often rely on a diesel powered system, either for individual households or for community areas such as churches and community halls. A project funded by the Government of Japan and commissioned in 2013 saw 500 small solar home systems being installed in homes on 11 outer islands in Vava'u as part of the Tonga Energy Roadmap.

9.0 Current – Institutional and Legislative Arrangements

9.1 National Organisations

In Vava'u there are representative branches from the Ministries in Nuku'alofa, each of the departments is managed by an "Officer in Charge" whose work and directive comes from Nuku'alofa. Table 1 below shows the Ministerial branches and objective.

Table 1: Information showing the Ministry title and correlating departments with Ministerial objectives that were found on documentation and websites to show how each one plays a role with coastal resources.

Ministry/ Public Enterprises	Department	Objectives
Governor's Office		• Deputy Minister of Lands for Vava'u • To oversee the ministry departments in Vava'u • To oversee district and town officers
MEIDECC	Environment and Climate Change	• To effectively monitor and sustainably manage lands, natural resources and environment to increase resilience to climate change and geo hazard impacts in Tonga
MoH		• To support and improve the health of the nation by providing quality, effective and sustainable health services and being accountable for the health outcomes of the people of the Kingdom of Tonga
	Marine and Ports	• Safe and secure ships and ports, clean seas and a viable maritime industry

MoI	Infrastructure	• To provide well-planned and maintained infrastructure that improves the everyday lives of the people and lowers the cost of business • Cultural awareness, environmental sustainability, disaster risk management and climate change adaptation, integrated into all planning and implementation of programs
MCTL		• Encouraging a dynamic, sustainable and competitive business environment • Advance a business environment that is conducive to growth yet at the same time mitigate inefficiencies, which may threaten the livelihood and wellbeing of the general public
MAFFF	Agriculture	• To provide leadership and support to agriculture and the citizens of Tonga by conducting regulatory, service, research and educational activities that assure private sector confidence, protect the environment and promote agriculture
	Forests	• To promote balanced land use considering the importance of trees for soil and water conservation, wood production and shelter • To promote optimal use of senile coconut timber resources • To encourage private sector investment in reforestation • To encourage woodlot planting for industrial and fuel wood purposes
	Foods	• To ensure food security and a safe food supply to enhance, promote and facilitate public health safety and the economic development of the food sector in Tonga • To initiate research and development in value-adding and agro-processing of local produce • To develop national food standards, comply with legal requirements and to promote healthier eating standards
	Fisheries	• Conservation, management, development and sustainable utilization of the Kingdom's aquatic resources to ensure food security and improve the social and economic well-being of the people of Tonga

MLSNR	Lands, survey and natural resources.	• Managing lands, mineral resources and energy for the benefit of all its stakeholders and developing and implementing programmes for the environment
Tonga Water Board		• Utility supplier of well water
Tonga Forest Products Ltd		• Lead forestry development in the Kingdom of Tonga and from Tonga's sustainable forest resources, provide optimal production, marketing and selling of quality logs and wood products to the people of Tonga • Increase forestry development within the Kingdom of Tonga to provide economic, social and environmental benefits to the people
Tonga Waste Authority		• Sustainable and efficient waste manager delivering quality services to the community and ensuring all play their part to enable Tonga to be the most clean, green and healthy island nation in the Pacific
Tonga Power Ltd		• Provide safe, reliable and affordable power to the Kingdom of Tonga

9.2 Governors Office

As set out in the constitution, the role of Governor of Vava'u is awarded to the selected Governor by the King of Tonga based on the recommendations of the Prime Minister. The primary function of the Governor is provide a voice for the people of Vava'u and represent their concerns or needs to higher levels of government and royalty. The Governor's office provides the setting for Town and District Officer meetings, acts as the facilitator for public consultations and provides oversight to development activities within the island groups. While the Governors office does not issue permits or make decisions at a governmental level, it is able to act as a facilitator and conduit to the appropriate government department for these processes.

The Governor of Vava'u also holds the position of Deputy Minister of Lands and with this role, is able to assist with the implementation of the Lands Act in Vava'u.

Community development projects are always undertaken in consultation with the Governor of Vava'u in his role as representative of the people and caretaker of the islands. The office is able to

provide a coordination point for all major projects to ensure that the needs and wishes of the people of Vava'u are in alignment with any development or protection measures.

9.3 Local Councils

Vava'u is one of four districts of the Kingdom of Tonga, that is overseen by a Governor who is appointed by the Prime Minister.The lands of Vava'u are divided into five districts that incorporate Neiafu District (Central) , Leimatu'a District (North), Hihifo District (West), Hahake District (East) and Motu (outer islands). Each of these districts has an officer that is elected by popular vote within the district. Each district will have a number of communities within their region of which each has a town office appointed again by the popular vote.

The town and district officers work under the Governor's office and attend regular meetings to receive updates from the Governor on current activities and upcoming events. Monthly meetings are held in communities by the Town Officers.

9.4 Non Governmental Organisation

There are a number of registered civil societies within Vava'u, shown in Table 2 below, with women's groups being the predominant share. Major organisations within Tonga such as the Red Cross and Tonga Trust have small designated branches in Vava'u that focus on social issues and humanitarian efforts. The Vava'u Environmental Protection Association is the only registered civil society in Vava'u focused solely on environmental issues and natural resource protection.

Table 2: A list of registered and operational non governmental and community based organisations that are stakeholders within coastal management.

Society	About
Tongan Red Cross	Prevent and alleviate human suffering in Tonga, focusing on disaster management, persons with disabilities, health promotion and humanitarian laws/ values.
Tonga Youth Council	The Tonga National Youth Congress provides youth in the Kingdom of Tonga with skills, knowledge and opportunities to help them develop into highly capable citizens. Through the council's volunteer program many youth have acquired skills and moved into full time employment in various services around the Kingdom of Tonga.
Tonga Community Development Trust	The Tonga Community Development Trust (TCDT) is an indigenous, non-governmental development organization operating in the Kingdom of Tonga. TCDT's focus is on capacity building with special attention on the less developed, more disadvantaged communities of Tonga including the poorest of the poor.

Society	About
Laione Development Association (Vava'u Lahi Lion's Club)	TO EMPOWER volunteers to serve the Island of Vava'u in the Kingdom of Tonga, meet humanitarian needs, encourage peace and promote international understanding.
Tonga Health Promotion Foundation	An independent body to act as a link between the community, NGOs, and the Government to promote health by fighting Non-Communicable Diseases (NCDs). This is the government's initiative to address the NCDs crisis in Tonga.
Tonga Family Health Association	The Tonga Family Health Association (TFHA) provides family planning, maternal and child health support, fertility and counselling assistance through 20 service points: 2 permanent clinics and 15 community-based distributors/ community-based service (CBDs/CBS) outlets.
Catholic Women's League	To bring together the women to help nurture their social, spiritual, intellectual, physical and emotional growth. Through this, the women may be empowered with the knowledge, awareness and skills to cope with the threats to the welfare of the individual and family and challenges of a rapidly changing world.
Vava'u Environmental Protection Association (VEPA)	VEPA is the only environmental conservation NGO in Tonga, having been founded in 2009. VEPA is dedicated to the conservation of Vava'us natural beauty through educational awareness, sustainable development and collaboration.
Women and Children Crisis Center Tonga	The Women and Children Crisis Centre (the Centre, WCCC) is committed to the elimination of violence against women and children who are victims/survivors of domestic violence, rape, sexual harassment and all forms of child abuse – and will work towards the elimination of all forms of violence in Tonga.

CHAPTER – 3 THREATS TO VAVA'U COASTAL ECOSYSTEM

1. Introduction:

Vava'u coastal ecosystems are subject to a variety of anthropological and climate variability and change induced threats. Coastal areas are heavily populated worldwide placing often already fragile resources under increased pressure for intrinsic and economic values.

1.1 Population Growth:

Vava'u has a censored population of 14,922 (Census, 2011) shown overall and by provincial district in Table 3 below, the population appears to fluctuate with varying degrees potentially due to seasonal overseas workers being away from the Vava'u group during census.

Table 3: Information taken from the National Census of Tonga, 2011 that shows the populations per district for the years 1996, 2006 and 2011.

Division/District	2011	2006	1996
Vava'u	14,922	15,505	15,715
Neiafu	5,774	5,787	5,650
Pangaimotu	1,325	1,412	1,298
Hahake	2,297	2,422	2,291
Leimatu'a	2,436	2,742	2,753
Hihifo	2,105	2,267	2,375
Motu (outer island)	985	875	688

1.2 Fresh Water Availability and Salinity:

The main sources of freshwater for Vava'u are either rainwater harvesting or through water lenses (groundwater) that are situated within the limestone islands which are highly porous in nature.

Poor management, lack of financial resources and poorly designed infrastructure hampers the rain-water harvesting to individual households, government offices and community halls. Broken pipes and limited guttering, restricted sometimes to only one side of the roof, reduces the ability to max-imise rainwater harvesting and improve on long term storage facilities for drought periods.

The ground water is often infiltrated with saline water from both over-pumping during low rain and drought periods to salt intrusion from rising seal levels and higher than average water levels during peaks on King tides. Chlorine is added to the groundwater by the Tongan Water Board to reduce the salt water tastes and eliminate bacterial content from leakage of sewage from nearby toilet facilities

1.3 Over Exploitation of Natural Resources by Coastal Communities:

Coastal and natural resources are overexploited for subsistence, commercial and cultural activities. The lack of adequate management or enforcement exponentially decreases the recovery ability of habitats and biodiversity.

Mangrove species are overexploited due to the desire for inhabitation directly upon waterfront properties, areas of mangroves are removed to build and reclaim coastal areas for buildings, wharves and private jetties. Smaller areas of mangroves are harvested for firewood by individual households.

Mangrove species are also unsustainably harvested through ring barking where a strip of bark for cultural activities including handicrafts and medicine is removed from the trunk. When mangrove trees are exposed in such a way, disease and intrusion by saltwater harms and kills the mangrove.

The mangrove species deemed important for medicinal purposes, Lekileki, (Xylocarpus sp.) has been declared as endangered by MMEIDECC, (MESCAL, 2012).

Coastal fisheries are over exploited due to fishing pressures and low management and monitoring of sustainable fishing practices and ecologically important predatory species.

Sand mining heavily impacts upon coastal resources, removing critical biodiversity, habitats and coastal protection offered from the beaches. Sand mining is conducted for construction materials such as the pouring of concrete and repairing of roads. Licences are to be obtained from the Governor's office, however unregulated and unlicensed mining still occurs.

1.4 Marine and industrial pollution due to urbanisation and industrialisation

Neiafu is Vava'u's main town with a population of about 6,000 people. It is an urban centre surrounded by several large residential areas which feed into Neiafu and such it is the most significant source of coastal marine pollution within the island group. The geography of the main island of Vava'u means that most marine pollution or run off originating in Neiafu enters the water either in the main Port of Refuge harbour, or in the Neiafu Tahi harbour area. There are no significant industries on the coast of Vava'u, therefore most pollution originates as a result urban and commercial waste water management and storm water run-off.

Due to the lack of central sewage systems in Tonga, all waste water is managed by on-site systems, with supervision from the Ministry of Health (when resources permit). In this respect, waste water management is in the hands of the community or the individual business and poorly constructed facilities can lead to pathogens and nutrients being released into the surrounding environment. In Nuku'alofa, excess nutrient loads appear to be impacting the near shore reefs in the area and the lagoon in general. Algal growth can be seen in these areas and there are concerns over the potential contamination of shellfish (IWRM, 2013). As part of the IWRM project completed in 2014, permanent water quality testing stations were established around the coastal areas of Neiafu to enable the Ministry of Health to track the pathogen and nutrient loading levels in the marine environments associated with the urban centre.

A further source of industrialised marine pollution in the Neiafu catchment area is that of repair works on small fishing and recreational craft within the Port of Refuge Harbour. Currently 3 slipways with tracks are operational within Neiafu and are used to lift boats out of the water temporarily while repair work is carried out. There are no environmental management strategies in place for the waste generated by these works and much of the material is washed into the marine environment.

There is also one new haul out facility in the Vaipua estuary area which is designed for long term hard stand storage of boats. This facility has been subject to a government approved Environmental Impact Assessment and have measures in place to handle polluting materials at the site. Long term monitoring of the site is part of the environmental permit to evaluate the success of their preventative measures.

Outside of Neiafu, pollution enters the marine environment in coastal areas where land clearing has occurred either for development or agriculture where pesticides and fertilizers are used abundantly (pers comm., Min of Ag). The maritime industry is also a contributing factor to marine pollution with no effective regulation of waste dumped from visiting commercial or recreational vessels.

There is also concern over lack of proper waste water management at island resorts that are developed within vulnerable low lying environments with no effective regulation of the works that take place in these remote areas.

Marine pollution in Tonga is regulated through the Maritime Pollution Prevention Act 2002 however, the enforcement of these regulations is lacking in Vava'u.

1.5 Lack of uniform legislation and coordination

Inter-departmental and inter-island group communication is lacking at the government level in Vava'u. Key opportunities to build capacity within Vava'u are often missed due to lack of coordination of government training efforts and lack of resources to send staff between island groups for trainings. The emphasis for most project level work is in Tongatapu and lack of communications often means that offices in Vava'u are not aware of opportunities or developments within their own ministries.

Four Ministries have responsibilities over the coastal area (Fisheries, Environment, Ports and Lands), however, a strategic plan for coastal management which encompasses all of these ministries is lacking. This has led to instances of ministries acting within the project area of other ministries with no advance notice or planning, effectively undermining the work that had been done to date (XXX need to reword this XXX). It is also common to see infrastructure development works in Vava'u undertaken without consultation with other ministries and outside of development frameworks.

Comprehensive environmental and development legislation does exist in Tonga to facilitate cooperation and integration between government departments in the implementation of coastal management projects, however lack of effective communication at every level is the greatest barrier to success.

1.6 Use of Destructive and Unsustainable Fishing Practices:

Unsustainable and destructive fishing practices are common throughout Pacific Island states. In Tonga, the "open access" of marine resources under the Lands Act 1988, hampers fisheries management practices in implementing, developing and enforcing protected and managed areas.

Destructive fishing practices including the use of the “Feo” tree, a native associate mangrove species that contains a compound similar to cyanide, is crushed into a powder and used to stun or kill marine species.

Despite, the Fisheries Act 1998, declaring all fishing activities on SCUBA as illegal, there are numerous cases of harvesting on SCUBA especially surrounding the Beche-de-mer industry (personn. comms Ministry of Fisheries). The use of SCUBA allows for divers to reach deeper habitats and exploit the marine resources further.

Unregulated fishing practices are widespread, with little to no data collection on coastal fishery production outside of the single functioning SMA at Ovaka. There is little to no enforcement of current fisheries regulations.

1.7 Lack of Education & Awareness among People, Government & NGO/CBOs:

Common knowledge and awareness on the benefits and sustainable use of natural resources is lacking in Vava'u, this is not only limited to coastal communities but also amongst policy makers, social leaders and civil societies and institutions.

General awareness on specific projects is raised during the project timeframe to the direct benefactors that leaves a large knowledge gap to persons outside of the project and remote demographic areas. Human resource development within government ministries needs improvement and training to further disseminate information and knowledge to important coastal sectors such as fisheries, aquaculture and infrastructure.

Vava’u has no institutions that conducts training on the marine environment and fisheries sectors and regular training to coastal communities would be beneficial to the sustainable use and management of coastal resources.

1.8 Unplanned development along the coast

All major development projects which are externally funded by donors go through a comprehensive planning and environmental assessment stage as deemed necessary by the conditions set by the funder. However, for locally or privately funded projects there is little planning or coordination when it comes to coastal development.

Vava’u is lacking a Spatial Development Plan and therefore, development proceeds without an overarching plan in mind or without proper consideration to the coastal environment, its uses and vulnerability. In addition to this, many developments happen without the proper environmental or building code approval process being followed. Legislation exists to ensure that every coastal development must follow the regulations set out by the Environmental Impact Assessment Act 2003, however, limited resources in the Vava’u Ministry of Environment office means that this is rarely enforced. It is often the case that pubic (such as road building) and as well as private (resorts, houses,

jetties) developments happen on the coastline without any approval from or communications with the Environmental Assessment Committee within the Ministry of Environment.

Unplanned and uncoordinated development along the coast may have major environmental implications for sustainable management of marine coastal resources. Without the correct permits and approvals in place, there is no way of tracking or monitoring the developments that are occurring in Vava'us outer islands and the ministries are reliant on the residents of Vava'u to report to them any development that are giving rise to concern. With unchecked and unplanned development comes the increased risk of damage to the coastline, thereby further reducing the ecosystems natural resilience to change.

As the EIA Act becomes better known and the environmental implications of certain types of developments are highlighted to the communities, the instances of EIA involvement is growing. However, in Vava'u, this is still very much dependent on the developer themselves to come forward and proactively start the EIA process.

1.9 Port Operations

Vava'us commercial port is located in the main harbour of Neiafu. Entrance is through a long, narrow and deep channel. Annual reports are published by the Ports Authority in Nuku'alofa documenting the level of commercial shipping in each port. On average, there are 150 cargo vessels and cruise ships that visit Nuku'alofa each year. Numbers for Vava'u and Ha'apai are significantly lower and include the inter-island ferry ships (which are excluded in the Nuku'alofa figures) but vary between 10-12 visits per month in Ha'apai and between 13-15 visits per month to Vava'u.

'No anchoring' areas are defined in Nuku'alofa and Vava'u, which will allow a certain level of protection for the narrow near shore band of reef within the harbour. The Ports Authority in Nuku'alofa has raised the possibility of future dredging in the shipping entrance to the Neiafu harbour. However, it is important to note that these have been long discussed plans which are not yet scheduled and which do not appear in the Ministry of Infrastructures Investment Plan 2013-2023.

1.10 Enforcement capabilities

The capacity to enforce the current legislation and regulations is one of the most significant obstacles facing all of the relevant authorities with jurisdiction over the coastal areas and zones. The Vava'u government and law enforcement offices are poorly equipped to deal with infringements occurring in any location off the main island of Vava'u. Many of these departments do not have access to boats or lack sufficient resources to charter vessels when enforcement activities are necessary. The Vava'u offices of the ministries involved in the coastal areas have shown capability and willingness to enforce their regulations; however the financial and human resources are not made available to them to expand these efforts into the marine and offshore environments. Active monitoring or patrols of coastal environments are not possible under their current resource level and they are heavily reliant on citizens or other organisations to report infringements.

Within the community managed SMA's enforcement committees have been set up to enable to villages communities to police their own areas and this has been met with some success in SMAs where the resources and willingness allow.

CHAPTER – 4 IWCM PLAN DEVELOPMENT

1. Business as Usual:

In developing an ICZM plan for Vava'u, we must consider the 'business as usual' approach. In other words, what would be the result of no intervention on coastal management and allowing the system to continue as it is. Characterising this process is not as straightforward as simple projections from the current state because, realistically, the biophysical and socio-economic systems in the zone are not likely to be static (Salomons, 2012), changing and adapting as the climatic and socio-economic environments change.

Having said that, projecting the current trends with a 'no IWCM' strategy over the next twenty years would likely result in declining conditions for natural resources, environmental health and socio-economic opportunities. Current trends have seen the over harvesting of coastal resources, such as bêche-de-mer, increasing and having a detrimental impact on the natural balance within their niche environments. In the terrestrial coastal environment, instances of unplanned coastal development are starting to increase as the tourism industry grows and are leading to increased pollution and nutrient loading, disruptions to natural coastal processes, and increased instances of coastal erosion. Agricultural, industrial and urban development is also leading to increased opportunities for land based pollution to enter the coastal marine environment and this will continue to increase over time without the introduction of an IWCM plan.

The option of 'business as usual' is not an appropriate direction to take in islands such as those in Vava'u where the coastal area and the services it provides is fundamental to the environmental and socio-economic well-being and development of the communities.

2. Purpose of Consultative Meetings:

The IWCM project implemented a consultative process to assist in the development of the integrated water and coastal management plan through a stakeholder consultation plan (appendices XXXXX).

The purpose of the consultation meetings was to gather together policy makers, government representatives, civil society organisations, district and town officers and resource users to gather and deliver information on coastal management processes, ecological benefits of coastal resources and varying implementation methods for the design of the integrated coastal management plan.

The consultative meetings were held in three parts with the first as an introductory consultation with government officers, district and town officers. This consultation was designed to gather information

from leaders in Vava'u and to disseminate the objectives and design of the surveys for resource user stakeholders.

The second part engaged civil societies, resource users including fishers, tourism business operators and community members. Two questionnaires were delivered during these stakeholder meetings that gathered information on ecosystem services and how the resource users identified the services that each coastal resources delivers to them; the second questionnaire asked resource users and stakeholders to rate the impacts of pre -identified issues on the coastal areas. These identified issues were rated both for socio-economic and environmental/ecological impacts through both over-exploitation and potential impacts from climate variability.

During this stage in-depth interviews were also conducted with resource managers of the TWB and officer in charge representatives from Ministries both directly and indirectly involved with coastal management.

A follow up consultation was conducted with government officers, town and district officers, resource user groups and civil societies to disseminate the results and to offer a range of actions and solutions that will be recommended, modified and undertaken within the coastal management plan.

3. Issues Identification & Prioritization:

For the successful design and preparation of the IWCMP, the following actions and priority actions in Table 4 below were used as guidelines:

Table 4: Steps and priority actions guidelines that were adapted to fit with the Vava'u IWCM Source: Adapted from GESAMP, 1996 and Olsen et al. 1997.

Steps	Priority Actions
Step 1. Issue identification and assessment	• Identify and assess environmental, social and governance issues and implications; • Identify major stakeholder groups and relative interests; • Define the goals of the integrated management program; • Select and invite response on the issues and implications the management plan will focus around

Step 2. Preparation of the plan	• Document baseline conditions • Conduct a public education and stakeholder planning process • Develop the integrated management plan and institutional framework for implementation • Develop recommendations for institutional capacity and project staffing • Implement and test management strategies and activities at pilot scale
Step 3. Formal adoption and funding	• Obtain formal endorsement of integrated management plan and Ministries necessary for implementation • Obtain the finding required for program implementation
Step 4. Implementation	• Promote compliance with program policies • Strengthen institutional capacity frameworks and management authorities • Implement strategies for interagency coordination • Capacity build program staff's technical and administration skills • Engage stakeholders into policies and implementation
Step 5. Evaluation	• Assess the program's impacts on the management issues and frameworks • Adapt and monitor the program it local social and environmental conditions • Conduct external evaluations at regular intervals and major implementations within the programs development

CHAPTER – 5 INTEGRATED WATER and COASTAL MANAGEMENT STRATEGY

1. Strategic Approach and Guiding Principles

The coastal area and inclusive water based habitats are extremely important socio-economic and cultural based assets. Due to the fragile nature of water based ecosystems, high impact areas from urbanisation and unsustainable utilisation, any further attempts to utilise coastal resources may inhibit current and future economic developments and reduce the efficiency and productivity of the coastline to livelihoods.

Under integrated ecosystem based management policies and practices over an extended period of time, coastal marine resources are able to increase in productivity providing beneficial increases in intrinsic and economic value but also resilience to climate variability and change and coastal protection.

1.1 Goal:

To promote integrated water and coastal area management practices and support sustainable and balanced use and socio-economic development of the coastal areas and natural resources of the Vava'u archipelago, Kingdom of Tonga.

1.2 Objectives:

The following present the over-arching objectives of the Integrated Water and Coastal Management strategy for Vava'u:

- To advocate for policy change in improved and sustainable integrated management practices for watershed and coastal resource management through:
    1. adapting current policies into integrated management activities and working policies
    2. adopting new policies for improved integrated balance coastal resource management
- To improve on current solid waste management programs and to implement sewage treatment programs through composting toilet integration
- To improve upon and facilitate sustainable management programs including aquaculture industry; community managed reef's and marine conservation areas and species management
- To facilitate coastal development in a sustainable and economically beneficial manner
- To promote the fair and equitable sharing of the coastal resources
- To facilitate work towards the prevention, reduction and management of marine pollution

1.3 Recommended Interventions

1.3.1 Policy Level Interventions

Coastal development in Vava'u is currently lacking integration with all necessary governing agencies. Development has a tendency to be ad hoc and often occurs without any consultation or notification.

This is the case for both private and government developments. The implementation and enforcement of the existing legislation in Vava'u is of prime importance. Effective communication and coordination between ministries is needed to ensure that coastal and marine legislation is implemented.

In developing a management plan for IWCM, sectoral departments such as water management, environment, fisheries, tourism, revenue, public health and infrastructure should contribute towards the plan. Provision is made within the National Spatial Planning and Management Act 2012 for plans governing specific areas to be developed and submitted for approval. A fully participatory approach is needed in developing a IWCM plan for Vava'u under the framework of this act and incorporating requirements from all other Acts with coastal mandates.

It is important to consider three levels when developing a plan for managing coastal resources – these are environmental, economic and social. By taking each of these levels into account through a participatory approach, the necessary public and institutional support for the plan will be secured and will ease the implementation of the integrated management actions.

Suggestions for policy level interventions to allow for the effective management of IWCM would be as follows:

- Develop a spatial plan for Vava'u under the National Spatial Planning and Management Act 2012 making provision for population and development trends, current policy framework, land tenure, water catchments and drainage, provision of infrastructure, coastal low-lying areas, climate change or other hazards, environmental capacity including land capability, heritage and carrying capacity and footprint capacity (future proofing surveys).

- Use the Vava'u spatial plan to develop an integrated coastal zone plan for sustainable development.

- Create a body for integrated management of coastal areas "Vava'u Coastal Development Authority" to act as a focal point for all coastal development planning/coordination/enquiries/permitting.
  - Development of a forward policy agenda and work plan for committee
  - Integrate NGOs, tourism and community representatives

- Introduce institutional mechanisms for information sharing and stakeholder participation – an information repository.

- Review, improve and enforce environmental legislation.

- Increase public awareness on environmental policy, legislation and development requirements (for business, government and community)

- Promote participatory approaches to encourage participation of local communities for sustainable development of coastal resources

- Formalise meaningful public consultation process for major coastal development. To be integrated with EIA Act.

- Create a 'one stop shop' for coastal developers:
  - Capacity development needed within government departments to raise awareness of other agency mandates in the coastal area
  - Create integrated check list for legal requirement for permitting – formalise sequential process for all legal conditions to be met and integrate to ensure compliance within all government departments.
  - Produce information pack for developers to include all legal requirements, process and permits necessary for undertaking development and provide order of sequence for these permits to be applied for.

1.4.1 Mangrove and Coastal Vegetation Plantation:

Mangrove replantation programs have been completed with varying success within Vava'u and a "Mangrove Rehabilitation Manual" documents the best practices. In general most mangrove areas remain healthy despite unmanaged harvesting for cultural activities including wood, handicraft production and tree removal for coastal developments of small private jetties and wharves.

In order for mangroves to work efficiently and effectively as a coastal species, there is a need to protect and enhance the supra tidal zone around depleted coastal areas within Vava'u. This would aim to reduce the sedimentation from coastal run off to mangrove areas. The supra tidal area incorporates minor and associate mangrove species and helps to emphasise natural mangrove habitats and increase mangrove habitat productivity.

Mangrove areas are also inundated with excess sediments due to lack of tidal flow with poorly designed and managed causeway systems. Several near shore areas are being taken over by mangrove encroachment due to this resulting sediment build up (Annex 3). These mangrove areas need rehabilitation works conducted to restore the water flow within the habitat and increase marine resource productivity for surrounding areas.

Community managed nursery areas can provide consistent and improved rehabilitation services to programs as well as supporting other alternative income generating programs such as sandalwood (Ahi) and Pandanas tree planting for weaving.

1.4.2 Coastal Aquaculture and Sustainable Fisheries:

The aquaculture industry within Vava'u is slowly developing as an alternative livelihood program for domestic and commercial export of products such as pearls and seaweed. Expanded aquaculture programs can also be designed and implemented along coral reef and inter tidal ecosystems to assist in reducing unsustainable practices of certain species within these habitats.

Current aquaculture development in Vava'u is hindered by a lack of resources and technical support. Often implementation is hindered by awaiting spats, seedlings and technical support from Nuku'alofa.

1.4.3 Coastal Protection and Flood Control:

Coastal erosion occurs in foreshore areas due primarily to land based erosion and run off from cleared lands and poorly designed infrastructure with no flood control or drainage alongside roads.In areas where there is drainage infrastructure in place, there is often no maintenance and the drains are clogged with debris and rubbish which if passes through the drains ends up in the Port of Refuge Harbour..

Changes in longshore sediment movement have been identified from satellite imagery over the 3 year period 2008 - 2012. Communities on lower lying beach areas on outer islands experience frequent movements in sand often attributing this to climate variability, instead of to natural occurrences exasperated by human activities such as poorly designed and placed jetties/wharves.

Islands whose low lying beach areas face the south-east trade winds will notice more sand shifts between May and November.

King tide periods that occur on the equinox moons bring higher than average tides which can impact upon reclaimed and low-lying coastal lands below the 10m land contour line as shown on the vulnerability maps produced for communities. Storm surge during high tide periods can cause increased erosion to low lying coastal areas and expose greater amounts of sandstone on beach areas.

Coastal protection measures can be in two phases with ecosystem based management looking to enhance and restore coastal habitats of mangroves and beaches and infrastructure developments such as foreshores and improved causeways/bridges that will reduce coastal and land based erosion. Infrastructure developments need to be in line with and support ecosystem management works and enhance rather than impact upon current coastal ecosystems.

1.5 Pollution Prevention Interventions

1.5.1 Sewage, Drainage, and Solid Waste Management

The SOPAC/GEF National Integrated Water Management Plan outlines the Government of Tonga's strategy for improvement of integrated freshwater resource management which includes recommendations for the management of pollution causing water related to sewage, drainage and solid waste. The linkage between freshwater and coastal water resources is well established and the pre-

vention of a large contributor of marine pollution is through effective land based water resource management.

Preventative recommendations made in the NIWMP, and endorsed by this IWCM report are as follows:

- Incorporation of contamination (including salination) risk/vulnerability assessment and mitigation measures into sub-regional and local environment and natural resource plans.
- Septic surveys in villages throughout Vava'u.
- Implementation of septic system management aspects of household water safety planning throughout villages in Vava'u.
- Continue urban drainage management initiatives undertaken in Neiafu.
- Close management of the use of fertilisers, herbicides, pesticides, particularly in areas close to bore-fields or wellheads.
- Monitoring and management of potential hydrocarbon contamination from petrol stations and other storage facilities.
- Better monitoring and management of groundwater and near shore water contamination from rubbish disposals and landfills.
- Incorporation of standard conditions on quarrying activities to avoid impacts on groundwater quantity and quality.
- Development and implementation of a plan to limit bacteriological contamination of coastal and harbour waters from yachts and ships.

In addition to the recognised need for the management of freshwater resources to prevent coastal prevention, the Maritime Pollution Prevention Act 2002 is the responsibility of the Marine and Ports division of the Ministry of Infrastructure and is aligned with the Convention for the Prevention of Pollution from Ships (MARPOL). It regulates direct pollution into the marine environment from vessels. The Act also stipulates the requirements of marine repair facilities and legislates against pollution entering the waterways from paints or other marine repair works. Within Neiafu there is a need for the enforcement of this act as several marine repair slipways and facilities are operational within the main harbour with no environmental management plans to prevent direct pollution into the coastal waters. Environmental controls have been imposed by the government on a boatyard and repair facility in the Vaipua area of Neiafu, but this also should be addressed within the main harbour.

1.6 Water Management Interventions:

Rain water harvesting is a popular yet under resourced management strategy in Vava'u and must be strengthened to reduce the pressure on the water wells.

Improved management and monitoring of the fresh water bores as outlined in the IWRM National Water Management Plan would help facilitate the management actions and improve the facilitation of the Tongan Water Board and Community Water Committees.

Reserve rain water storage areas can be implemented within coastal communities for drought periods and climate related occurrences such as cyclones. Committee support for maintaining current

rain water harvesting facilities should be prioritised to ensure maximum capacity and capture of rain is established on community halls, schools and churches which are often used as reserve water facilities for community members.

1.7 Coastal livelihood/Micro-enterprise development initiatives

The Asian Development Bank and the World Bank have rated the quality of Tonga's policies and institutions as 'weak', averaging 3 points on their scale of 6. The assessment rates the policies covering economic management, policies for social inclusion and public sector management and institutions (TSDF, 2011). In terms of ease of doing business, Tonga has a relatively good rating, with the World Bank listing it as 52nd out of 183 countries placing it in the top third of countries included in the index.

In an effort to improve the situation of the macro economy in Tonga, the government is focused on providing improved access to micro-enterprise activity at the community level. The government has committed to focusing on the development of micro-finance and financial inclusion, targeting those who are presently not well served by the existing financial system (TSDF, 2011).

1.7.1 Eco-tourism

Micro-enterprise opportunities for coastal eco-tourism do exist in Vava'u. The coastline of the island group is varied through its geographic range including cliffs, mangrove forests, sandy shallows, coral reef, fringing beaches and protected waterways. Within these environments there exists a number of opportunities for small scale tourist enterprises which have the potential to be successful at the community level.

Opportunities exist for activities such as nature tours through the large mangrove areas in Vava'u. Feasibility studies have been conducted by the Vava'u Environmental Protection Association for the construction of mangrove board walks to enable access for tours. Alternatively, small boat or kayak tours through mangrove areas are particularly popular in other SIDS, areas such as the extensive mangroves in Holeva and Koloa villages, among others, create an ideal environment for mangrove kayak tours. During certain time of year, Vava'u boasts extensive sea bird nesting populations on the small outer islands, some of which are ideally suited to small scale low impact nature tours. There are land based hikes around the coastal area which also provide a great opportunity for nature tours and trails. To target the visiting yachts, many of the outer island village would benefit from installing good quality yacht mooring for overnight rental, this would both provide an income and help to minimise damage to the coral reefs. The coastal environment of Vava'u is rich and complex and there are many opportunities to be realised.

Moving away from the coast, opportunities also exist for local women to start their own tourist initiatives, the local handicraft economy could be expanded by running classes on how to weave baskets, make tapa cloth, etc. In the same vain, cookery classes for traditional Tongan foods can also be run at the micro-enterprise level.

1.7.2 Setup Micro-credit Facilities

Micro credit facilities exist in Tonga through established organisations such as South Pacific Business Development (SPBD) which is a network of micro-finance organisations working in Fiji, Samoa, Tonga and the Solomon Islands.

Experience shows that micro-finance can help the poor to increase income, build viable enterprises, generate job opportunities and reduce their vulnerability to external shocks. It can also be a powerful instrument for self-empowerment by enabling the poor, especially women, to become agents of change (Kinivuwai, Fiji). In micro-finance programs all over the world, the clientele are primarily women who are proven to be more reliable than men in meeting loan obligations. This is reiterated by the SPDB who focus their micro-finance activities around women in Tonga.

In addition to organisations like SPBD, the Tonga Development Bank (TDB) launched a micro-finance loan scheme in 2014 funded by the Asian Development Bank under the Japan for Poverty Reduction Grant Assistance Project. The stated purpose of this scheme is to empower the vulnerable in Tonga especially women in the outer islands and disadvantaged communities in Tonga with previously limited access to micro-finance services. The TDB scheme focuses on income generating activities and provides incentives to change behaviours of target groups such as saving habits, financial and business planning and entrepreneurship for income generation and welfare improvement.

1.8 Advocacy and Education Interventions:

1.8.1 Awareness Raising and Capacity Building:

Capacity building needs to be enhanced at the government department level to all officers that work directly with coastal habitats, lands and resources. Capacity building needs to include an improvement in interdepartmental co-operation for integrated resource management techniques.

NGO's and other civil societies also need to have cross-over training to assist both government departments and communities in their roles in the IWCMP.

Awareness programs need to be run at community level and within the secondary and primary schools on the functions and services of the coastal areas and how improved integrated and participatory management techniques can be beneficial for socio-economic and livelihoods as well as strengthening ecological process and biodiversity.

1.9 Community Level Use Zoning

Community level use zoning is a participatory approach to establishing management areas and public policies within the coastline. In Vava'u, this could be conducted in each district with communities agreeing to abide by and support the management recommendations and policy implementations.

Developing visual topographical models of habitats and ecosystems can emphasise the need for improved management and infrastructure. Decision making through land use and resource use planning can be enhanced through the provision of maps and spatial planning data.

CHAPTER – 6 FIVE YEAR IMPLEMENTATION PLAN

1. Management Actions:

Objective: To advocate for policy interventions that support integrated water and coastal management techniques for Vava'u

Effective legislation is the backbone to successful strategies and projects. Current legislation needs to be advocated to resource users and stakeholders and enforced for improved resource management and coastal protection. Tonga is a signatory to many international and regional protocols and treaties that coastal projects need to ensure are aiding and implementing national and global strategies.

Proposed actions:

- Design a environmental legislation handbook in English and Tongan that covers all the current legislations that mandate the coastal area and resources
- Workshop with Government officers, District and Town officers on raising awareness of current legislations and acts for improved knowledge in stakeholder groups
- The coastal management committee with improved knowledge, resources and structure will advocate for improved policies and national working plans for watershed and coastal resource management

Objective: To achieve integration of the proper EIA approval process within all relevant government departments for coastal developments within Vava'u.

Proposed Actions

- Survey/consult with all ministry departments involved with development permitting to gauge understanding and current adherence to legal EIA process and assess their current permitting processes
- Based on consultations design process for integrating EIA permitting process into permitting process of other ministries/departments
- Consultations with international funding agencies to gauge understanding of their institutional EIA compliance policies and develop process to integrate with Tongan EIA process
- Produce information 'package' on permitting processes for distribution in outlets where foreign investors can benefit.
- Implement program of development inspections for EIA legislation compliance.
- Secure support for application of legal EIA process for major donor funded developments with at the CEO level within government ministries.

Objective: Develop a coastal eco-tourism plan and implement activities that incorporates sustainable development and resource use, utilising coastal communities as hosts for alternative income generation

Proposed Actions

- Conduct a feasibility study on the installation and maintenance of yacht moorings being run as a community micro business outside of the Vava'u harbour.
- Hold training workshops on correct construction, placement and maintenance of moorings for communities.
- Conduct survey of all island resorts/hotels to inspect current waste water management processes and develop a standardised method to be used by resort developers.
- Investigate potential for properly designed and marked community managed coastal hiking trails for tours. Hold workshop on methods and standards of making trails.
- Hold tour guide training course targeted to nature hikes and local cultural highlights i.e Puono Park

Objective: To introduce and implement organic certification for food produce grown in Vava'u and reduce agrochemical runoff in coastal communities.

Proposed actions

- Workshop on organic methods including the use of natural plant based pesticides
- Collaborate with Department of Agriculture on the current surveys conducted to map agrochemical uses.
- Identify current organic farmers and provide support to improve on the domestic food market for economic growth
- Establish community organic gardens in coastal communities that support alternative income generation programs
- Design monitoring and evaluation parameters for project management
- Establish organic certification scheme for integrated water and coastal management program

Objective: To undertake stock taking and socio-economic evaluation of coastal fisheries resources in The Vava'u archipelago

Proposed actions

- Develop a socio-economic study that can be conducted at community level
- Set up Catch-per-Unit-Effort monitoring systems in 2 coastal communities outside of the special management area programs as a pilot project
- Develop a sustainable fish guide for restaurants and tourists that helps support sustainable fisheries practices

Objective: To establish aquaculture as an improved industry for income generation for coastal communities

Currently aquaculture remains a small scale domestic based industry that is restricted by access to technical and infrastructure resources.

- Identify alternative aquaculture opportunities that could economically and ecologically benefit Vava'u
- Identify pilot communities to trial aquaculture programs for improved food security such as 'paka' mud crabs
- Monitor and evaluate pilot activities and prepare a development plan for coastal communities.

Objective: To establish pilot coastal conservation areas within each district for improved conservation of ecological resources and biodiversity

Biodiversity is the key to coastal areas that provide ecosystem services, management of critical biodiversity areas within coastal communities is paramount to improved food security and raw material production.

- Evaluate the effectiveness of coastal conservation areas and how they might lead to improved biodiversity
- Identify important biodiversity areas of both terrestrial and marine values
- Design and implement community conservation areas in line with previous community managed areas such as the fisheries SMA at Ovaka
- Monitor and evaluate pilot activities for future implementation

Objective: To establish rainwater harvesting facilities for livestock in coastal farming areas for improved animal husbandry and health of artisanal livestock farmers

Communities are reliant on farm animals such as pigs, cows, horses and sheep for cultural traits and food resources, current farming activities are for "free-range" animals to cope on their own without constant sources of water. When frequent water is introduced to animals, productivity and health of the animal rises and their destructive patterns such as damage to water pipes would be reduced leading to better water management.

- Conduct a feasibility study to survey a rainwater harvesting opportunities for farm animals within a co-operative farm area.
- Implement pilot activity of a rainwater harvesting plant for animals that would include troughs and monitored water supply.
- Monitor and evaluate the effectiveness of the pilot activities and the impacts upon the animals.

Objective: To establish a large rain water harvesting plant for low rain periods to reduce the pressure on town water and over-pumping of water wells.

Drought and lower than average rainfall periods have become more regular in the last few years and badly implemented and managed rainwater catchment systems are common throughout Vava'u. Implementing larger rainwater harvesting plants could bring refuge to small households in times of lower rain periods and reduce the over-pumping on water wells.

- Identify community areas of fragile water resource status and design and implement a rain-water harvesting station
- Set up community water harvesting plan and committee
- Implement the water harvesting facility within a coastal community including gauges and metering systems for improved management.
- Monitor the effectiveness of community managed rain water resource stations for future implementation

Objective: To identify potential coastal flooding hazards and areas of poor coastal protection and design effective environmentally friendly infrastructure

- Identify and map areas at high risk of coastal flooding and areas with low natural protection from storm surge and heavy rains.
- Design and implement a coastal protection system in one pilot community to reduce the impacts of storm surges, coastal inundation and flooding.
- Monitor and evaluate the impacts, changes in shoreline and coastal vegetation and prepare a coastal rehabilitation plan which can be replicated in other areas.

Objective: To raise awareness and build capacity of resource user groups and stakeholders and to improve upon participatory approaches to coastal resource management.

Proposed actions

- Identify resource needs through a gap analysis on government departments, institutions and NGO's/civil societies
- Run workshops on information gathered from gap analysis to improve upon technical and resource capacity at governance level
- Design and deliver workshops and resources on coastal areas to community groups, youth groups and schools
- Run consistent radio programs and talk back shows on the coastal areas and management programs and activities

2. Monitoring and Evaluation:

Monitoring and evaluation are integral parts of project successes and both carry unique characteristics in design and production that feed into reporting and enable the tracking of the execution and performance throughout the project and ensuring that each section and activity is progressing as per the plan in terms of timeframes, finances and physical targets. Monitoring and evaluation also allows for mid-course corrections to be made through revising resource and financial allocations and altering human resources to more effective and prioritised areas.

The following areas are recommended to be included in the Monitoring and Evaluation Plan devised alongside the confirmed action plan:

- Data acquisition
- Data management
- Information generation
- Information distribution
- Information use

There are three types of indicators within a CMP that are important:

1. Governance indicators: the performance of the program concepts and the progress and quality of interventions alongside the governance of the IWCMP itself;
2. Ecological/Environmental Indicators: Monitoring of the coastal resources enables the project to reflect trends in the state of coastal habitats and resources. The indicators are then used as performance indicators once they compare to targeted ecological conditions i.e improvement of coastal fisheries through reduction in over-fishing;
3. Socio-economic indicators: these indicators reflect the state of the human and developmental components of the IWCMP and the relationship to the coastal area and ecosystems. These indicators enable the monitoring of human pressures in relation to the coastal areas in that they relate to not only improved ecological benefits but improved socio-economic and sustainable development.

3. Field Activities:

Implementing field activities is a key element of integrated management principles, participatory approaches are easily established and reinforced during consistent field activities where ownership and information to encourage informed decisions is shared. A range of demonstration and pilot projects are recommended below. These field activities incorporate a ridge to reef approach whereby existing and potential impacts on ecosystem health (??) are reduced and mitigated across a range

of ecosystems . This integrated approach would have the benefit of reducing the spill-over effect that over exploitation of resources and increased climate variability has upon resources, ecosystems and biodiversity.

The following field activities and studies are recommended to be undertaken and implemented through continued and pilot activities as some of the recommended IWCMP approaches.

3.1 Pearl Farming:

The current pearl culture industry in Vava'u has become stagnant due to a low viability of spats, harvesting spats from coastal resources has seriously depleted natural populations and there is a strong need to rehabilitate natural populations, whilst supporting and advancing the aquaculture product, demand and industry.

Pteria penguin, commonly known as Mabe pearls are the primary species of pearl harvested and cultured in Vava'u, *P. margaritifera* were trialed in 1997 and despite being an economically effective species, spat trials were unsuccessful (Chand et al. 2011).

Developing a spat hatchery in Vava'u, would create easier access for aquaculture programs and could be potentially housed and introduced to coastal communities as an alternative method and livelihood to natural populations. Technical workshops can be hosted through the project management unit to advance the current human knowledge resources.

Pearl culture can also be used as an ecotourism incentive for island and coastal communities, where visitors can see the process of pearl culture from the seeding, through the development stage and then the final process at which time purchases can provide direct income to the culture unit.

3.2 Sustainable Coastal Flora and Mangrove Forestry:

Public awareness on the importance of mangrove species and mangrove ecosystems need to be raised to ensure that a common understanding of the coastal habitat is understood. Mangrove ecosystems have unique and differing functions around the Vava'u coastal area and each habitat can have management plans and actions created for sustainable forestry systems.

The development of nursery plots within coastal communities will provide rehabilitation benefits to the supra tidal and mangrove forests. Species of high cultural demand and species required for coastal protection and increased ecological benefit can be raised as seedling by community groups and improve on coastal processes and reduce land based erosion and eutrophication to coastal waters. Leki leki, (Xylocarpus sp.), which is prized for medicinal qualities and henceforth has been over harvested has been successfully propagated under the Integrated Water and Coastal Management

Project.

Reducing the unsustainable harvesting of mangroves from ring barking and implementing strip barking harvesting will protect mature mangrove species that are essential in coastal protection and ecological processes and they provide the necessary size and maturity.

The use of mangrove boardwalks can be implemented in coastal areas to reduce the removal of mangroves for access, mangrove boardwalks also enhance mangrove habitats for ecotourism development and nature walks and provide access to aquaculture and fishing ground areas.

Monitoring and evaluation are essential to the success of the sustainable coastal flora and mangrove forestry and should include multi-lateral partners to ensure success and sustainability through cross training.

3.3 Coastal Water Monitoring

Water pollution is an ever increasing threat to coastal resources; eutrophication from agrochemicals can increase the occurrences of Harmful Algal Blooms, such as the bloom that occurred in December 2014. Regular water monitoring has previously been carried out under the IWCM project and these activities should be continued for consistency.

Coastal water quality in Neiafu Tahi, exceeded the World Health Organisations, safe swimming levels for sewage on several occasions after heavy rains had occurred. Water testing should include fecal bacteria testing, nitrate and phosphates as well as temperature, P.H levels and dissolved oxygen tests.

Testing should be conducted every 3 months after heavy rainfall and at high tide periods. Extensive testing may be required should environmental conditions change.

4.1 Project Staff:

The following is the recommended project staff for a five-year implementation plan

Project Manager: Will organise and manage the entire project including reporting, finances and field activities. The project manager needs to be able to conduct themselves visually for participatory management and should be actively public in raising awareness and confidence in the program.

Project Assistant: The project assistant will organise, manage and run the awareness programs and community meetings and support the role of the project manager.

Procurement/Financial Officer: A procurement office is paramount to the success in ensuring that financial capacity is performed to a high standard and on time.

Field Assistants: Two field assistants would be necessary for monitoring and implementation of activities, the field assistants would also with training be able to be vessel captain's should the project require a vessel for outer island activities.

4.2 External Consultants:

External consultants may be required during the plan to assist in technical knowledge to implement fields and management actions. The following is a list of international and national experts that the project might need for success and monitoring and evaluation programs.

Aquaculture specialist - International

Pollution control specialist: International

Environmental Impact Assessors: Vava'u Based

Marine biodiversity specialists: Vava'u Based

Resource economist: International

Marine Infrastructure: Vava'u based

4.3 Equipment:

The following table 5 shows the minimum requirements for the five-year implementation plan, for the management activities pertaining to pilot activities, the following are estimates for equipment and will be further analysed through the recommended feasibility studies as indicated above:

Table 5 shows the predicted equipment needed for the five year implementation project including staffing for the management unit.

Action/Management Strategy	Equipment
Project Management	Office space that is accessible and open to public Desktop computers for office staff x 3 Printer and scanner Filing cabinets x 2 3 Desks
Field activities/monitoring (General)	Vehicle Clipboards Waterproof Paper GPS

Pearl Culture (Spat Rearing Facility)	Fibreglass/Concrete tanks (4-6) Water pumps (2) Lift Pump for salt water (2)
Rain Water Catchment Systems	Fibreglass/concrete tanks 10,000 litre (4/6 per site) Water Pumps Water Meter (for monitoring distribution) Water troughs for livestock (3 per site) Float and toilet valve (for trough filling) Solar panels for water pumps Roofing for catchment and shade

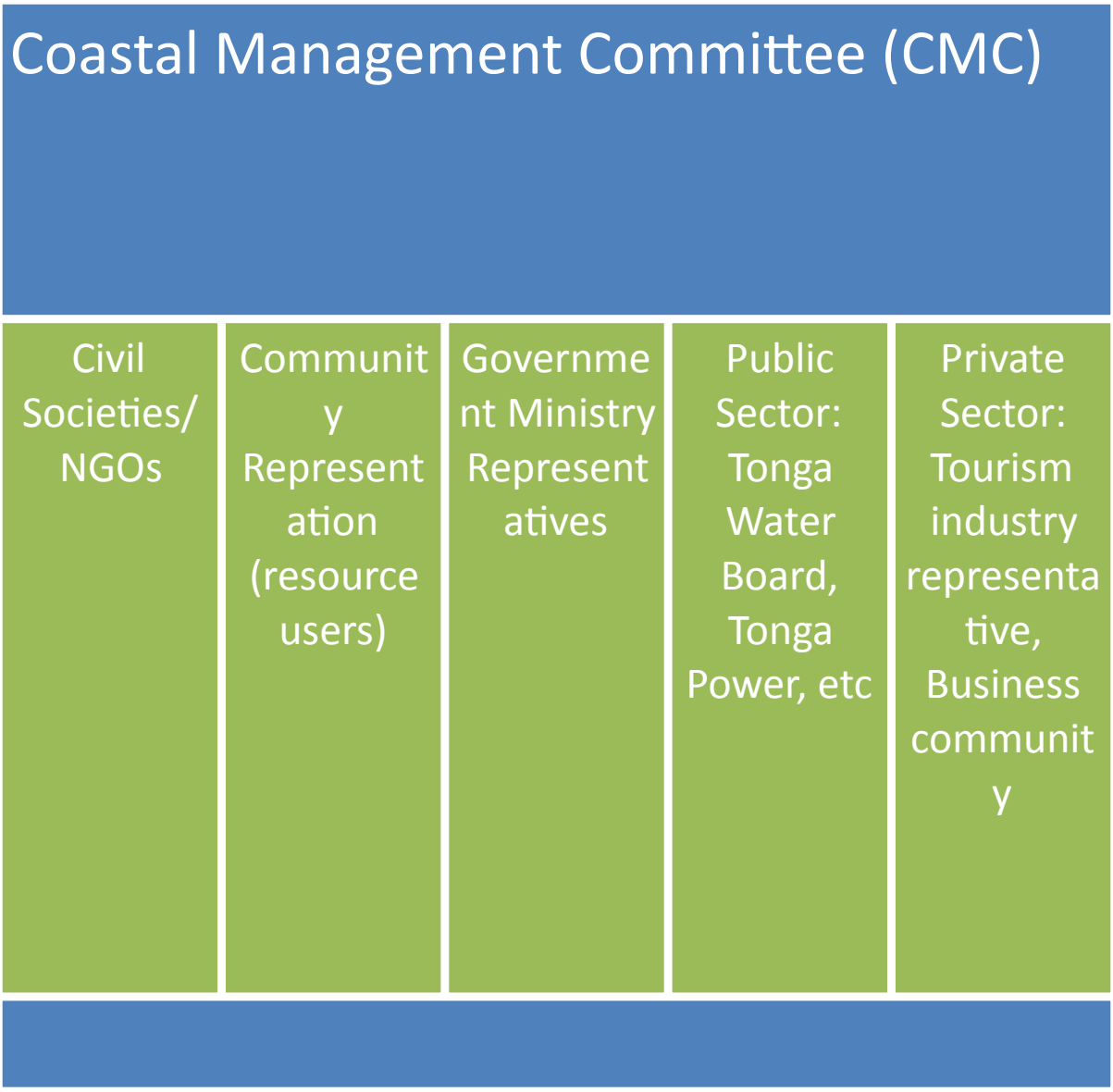
5.0 Institutional Framework for IWCM Coastal Ecosystems

An ICWM plan will need to be presented to the public for consultation and once endorsed by communities and the Governor of Vava'u, it will need to be presented to and endorsed by the ministerial departments who have jurisdiction over the coastal zone. Endorsement of the IWCM plan at the regional and national level will then allow for implementation at the regional level using the proposed institutional framework presented in this chapter.

5.1 Coastal Management Committee Framework

The current legislations and relevant ministerial jurisdictions have been discussed earlier in this report. In this section, a proposed framework is outlined to enable effective implementation of an endorsed IWCM plan for Vava'u.

It is proposed that a Coastal Management Committee (CMC) be established within Vava'u which would revolve around the integrated participatory approach to coastal area management. It is envisioned that the core CMC members would act as the focal point for IWCM implementation, however feeding into the CMC would be input from a variety of stakeholder groups. The following diagram illustrates the proposed structure.



The core CMC itself would comprise of individuals from varying sectors with regular responsibility over natural resource management and community engagement. It would be responsible for implementing the annual action plan and/or pilot projects as approved by the wider CMC stakeholder group. It would also be used as a focal point for the evaluation of coastal issues that arise and to utilize a wide range of local and international knowledge, experience and human resources to effectively create an improved and effective coastal zone.

It is proposed that, once the IWCM is approved and the core CMC is established, meetings are held with the wider coastal stakeholder group to discuss and approve the annual action plan. This plan should include (but not be limited to) proposed pilot projects for the upcoming year, proposed surveys that may be required by communities and an outreach and education program for the year. It would then be appropriate to meet with the larger stakeholder group during the mid-year point to update on the implementation of the annual plan and update/review it as necessary.

Within the core CMC, the implementation of the annual action plan would be broken down into manageable tasks with an associated timeframe and responsibilities. Meetings for the CMC would then be held every two months to update each of the core CMC team on progress and compare this

to commitments in the annual plan. Following completion of the year, a meeting would be held with the wider stakeholder group to advise on progress through the year and to propose the action plan for the following year. Within this process, the Governor of Vava'u should be invited to act as the chairman for the stakeholder wide meeting and his office would be regularly updated on activities and issues as they arise.

The overall objective of the CMC would be to monitor changes to coastal resources through effective data collection and knowledge exchange of projects, impacts and management proposals. A portal would be established by the CMC for effective data sharing with both local and national counterparts.

Proposed Core CMC Structure
To ensure that all institutions are represented within the core CMC team, the following membership is proposed:

- Governor's Office
- VEPA representative (NGO)
- OIC Department of Agriculture
- OIC Department of Fisheries
- OIC Department of Environment
- OIC Department of Land
- OIC Department of Infrastructure
- OIC Department of Tourism

These core members would be responsible for implementing the annual action plan derived from the IWCM plan and endorsed by the wider stakeholder group meetings.

5.2 Coordination

As highlighted throughout this report, coordination and communication between the different departments with jurisdiction over the coastal zone needs improvement. In addition to this, central control over Vava'u projects from the Nuku'alofa offices can lead to logistical and financial burdens that may not be necessary with careful coordination and the implementation of the proposed CMC structure.

Once the IWCM has been endorsed by the relevant ministries in Nuku'alofa, the coordination of the plan's implementation would be driven by the CMC with significant input from the stakeholder groups and with regular reporting to and consultation with the relevant government departments in Nuku'alofa. Overall governance of the IWCM would reside with the central departments; however this should maintain involvement at the strategic level, being mainly concerned with the initial plan development, the strategic vision for coastal development and the annual review of the IWCM plan implementation. The implementation level of the IWCM should reside in Vava'u and the CMC with the full participation of the communities and government departmental offices.

Effective annual planning by the CMC will be critical to ensuring that the IWCM can be successfully implemented and coordinated. The annual plan, which will be informed by the 5 year IWCM plan will be the main instrument by which the years activities are set out and will form the basis for the annual reporting. It is suggested that VEPA take on the role of secretary within the CMC for meeting organisation and record keeping, along with other traditional committee secretary roles.

5.3 Legislative and Contractual Requirements

No change in the legislation is envisaged at present in order to implement this plan for sustainable management. Most of the government organisations have the legislative jurisdiction over the coastal areas of Vava'u and all of these organisations will be represented in the CMC at the departmental level. These organisations already have the authority and the duty to conserve the national resources.

5.4 List of Actions needed for Adoption of the Plan

- Formalisation of CMC structure, processes and responsibilities
- Endorsement of the IWCM plan by the Vava'u stakeholders and then by NUK authorities
- Identify funding stream for implementation

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MAPS / SATELLITE IMAGERIES

Annexure-I: Community Consultation Questionnaire

Integrated Water and Coastal Management

Interview Questions

Name

Title

Please briefly describe your position and duties.

What do you believe are the biggest climate change issues faced by Tonga?

Do you believe communities are aware of these impacts and issues? Why or why not?

Is there adequate intergovernmental department cooperation on policies and projects for climate change adaptation?

Does your department have any current climate change projects in Vava'u?

Project Name	**Objective**	**Location in Vava'u**

In your opinion, do current policies and legislation adequately reflect an understanding of climate change impacts and appropriate mitigation methods?

How could policies and legislation be adapted effectively respond to issues from climate change?

Under the NECC (National Emergency Coordination Center), how effective is the process in assessing climate change impacts and providing mitigating strategies?

Who are the key stakeholders facing the major issues caused by climate change?

What is your vision for the coastal environment within the next 10 years? Both in terms of the effects of climate change as well as efforts to mitigate those effects.

Are there any other points not covered in this questionnaire that you believe should be discussed?

Thank you very much for your time in answering these questions.

Area	Threats/Impacts	1 no im-pact	2 small im pact	3 medium im-pact	4 large im-pact	5 very large im-pact
	Collapse or damage of more than 2/3 of the Neiafu bore-fields.					
	Poor configuration of pumping bores in Neiafu borefield, re-sulting in unsustainable local pumping rates and significant risk of groundwater salination.					

Fresh Water Supply	Unacceptable water losses in the Neiafu water supply. Estimated 38% of the water pumped if lost between pumps and storage and 33% loss in distribution between tanks and meters or plumbing					
	Climate change and drought					
	Lack of coordinated approach to development of emergency and drought rainwater supplies from community buildings					
Fresh Water Quality	Septic systems in the water supply capture zones					
	Inappropriate/potentially contaminating land uses in water supply capture zones.					
	Local over pumping causing salination					
	Poor design and maintenance of rainwater harvesting infrastructure					
Coastal Process and Hazards	Construction of causeways, groynes and sea walls					
	Dredging					
	Sand Mining					
	Reclamation of land					
	Natural hazards cyclones, storm surges and tsunamis					
	Urban storm water drainage					

Coastal Water Resource and Sediment Quality	Septic systems within the foreshore zone					
	Near shore/foreshore construction					
	Waste disposal close to foreshore					
	Yacht and shipping waste					
	Agricultural chemical run off (potential)					
	Fuel storage (potential)					
Near shore natural resources	Mangrove removal					
	Seagrass removal					
	Reef damage from anchors					
	Unsustainable fishing, removal of shell fish					
	Potential sea level rises and increase in sea temperature					

Ecosystems	**Provisioning**	**Regulating**	**Cultural**	**Supporting**
Mangrove Wetlands				
Tidal Flats				
Seagrass Beds				
Coral Reefs				
Beaches				
Cliff Ecosys-tems				
Forests				

Annexure -II-A: Combined Data Analysis of Social Issues

Annexure-II-B: Combined Data Analysis of Environmental Issues

Annexure-II-C: Combined Data Analysis of Economic Issues

Photographs:

Annexure-III: Proposed Composition of the Steering Committee

The steering committee would be overseen by His Lordship, Governor of Vava'u.

Chairperson	Chief Justice Vava'u
Secretary	VEPA
Member	OIC Ministry of Fisheries
Member	OIC Department of Environment
Member	OIC Ministry of Agriculture
Member	OIC Ministry of Tourism
Member	OIC Ministry of Forestry
Member	OIC Ministry of Lands
Member	TWB
Member	OIC Ministry of Infrastructure
Member	District Officer Leimatu'a
Member	District Officer Hihifo
Member	District Officer Hahake
Member	District Officer Neiafu
Member	District Officer Motu
Member	Tonga Red Cross
Member	Vava'u Youth Council
Member	Tonga Trust