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Island Diagnostic Analysis Report for the

Kingdom of Tonga

December 2021

Pacific R2R Ridge to Reef

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Island Diagnostic Analysis Report for the **Kingdom of Tonga**

December 2021

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Cover Photo: Island Diagnostic Analysis Workshop- 21/07/2021.The Island Diagnostic Analysis (IDA) provides a framework for identifying and examining local and national environmental and social impacts within a Ridge to Reef process .IDA focuses on areas that includes all environments and resource uses as well as wider social and cultural impacts to prioritize local and policy actions for strengthening management activities and streamlining events between Ministries and projects. Representatives from line ministries, NGOs, Civil Society, Member of Parliament and communities participating on the IDA Workshop.

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Abbreviations

FAO	Food and Agriculture Organization of the United Nations
FHR	Fish Habitat Reserve
GEF	Global Environment Facility
GEM	Geoscience, Energy and Maritime Division
IDA	Island Diagnostic Analysis
IWCM	Integrated Water and Coastal Management
MAFF	Ministry of Agriculture, Forests and Foods
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communication
MET	Ministry of Education and Training
MIA	Ministry of Internal Affairs
MLNR	Ministry of Lands and Natural Resources
MoF	Ministry of Fisheries
MoT	Ministry of Tourism
MP	Members of Parliament
NGO	Non-governmental organisation
PMO	Prime Minister's Office, Tonga
PMU	Project management unit
RPCU	Regional Programme Coordination Unit
SMA	Special Management Area
SoE	State of Environment Report
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environmental Programme
UNDP	United Nations Development Programme
VEPA	Vava'u Environmental Protection Association

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The Tonga IWR2R demonstration project is implemented through the Ministry of Lands and Natural Resources (MLNR) and administered by a dedicated project management unit. The support and dedication of the project management unit, Silia Leger, Kilistina Moala, Angelic Pale, Heidi Muller and Lutolofi Tauisila was extremely important in the organisation and flow of the stakeholder workshops as well as the ongoing support for technical development of the diagnostic analysis. The support from the Chief Executive Officer, Rosamond Bing, brought great advice and assistance to the policy and planning for the IWR2R.

The Tonga IWR2R project technical support team was instrumental in the development of the diagnostic analysis report, and included Sesimani Lokotui (Civil Society), Amanda Le'ota (Ministry of Fisheries), Tu'amelie Fusimalohi (Department of Environment, MEIDECC), Nikolasi Heni (Ministry of Lands and Natural Resources).

Lastly, the participation, knowledge and contribution of the all the participants at the diagnostic analysis workshops in Tongatapu and Vava'u is greatly appreciated and was essential in enabling the drafting and presentation of this information. to the participation, knowledge, and support from all the participants of the diagnostic analysis workshops in Tongatapu and Vava'u, it is greatly appreciated and acknowledged the importance of the information to the drafting and presentation of this information.

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Diver from Tonga Department of Environment conducting Rapid Coastal Assessment coral reef survey. Photo by Tonga IW R2R Project

Executive Summary

The Regional International Waters Ridge to Reef project is funded by the Global Environment Facility and implemented by UNDP and with Pacific Community (SPC) as the executing agency. The regional project co-ordination unit is housed at the Geoscience Division of SPC in Suva. The Regional IWR2R project is implemented in fourteen (14) countries including Tonga. and implemented nationally through the project management unit under Ministry of Lands and Natural Resources.

Through the IWR2R project, activities are implemented to benefit environmentally and socially through ecosystem-based adaptation, climate resilient and integrated approaches to strengthen the ecosystem services relied upon. The objectives of the R2R Island Diagnostic analysis are to provide stakeholder approaches to identify adaptation and intervention measures needed for addressing the priority environmental issues. This work is conducted through workshops with representatives from government ministries, civil society groups, community representatives and public sector.

Tonga is a sovereign island nation in the South Pacific, that is facing increasing challenges environmentally and socially through decreasing biodiversity and habitat health and increasing threats from overharvesting, pollution, development, and climate change. These issues are challenged further by a small economy that relies heavily on financial support through grants, loans, and remittances from family overseas.

Economic, subsistence and cultural activities rely heavily upon the natural resources in Tonga with most communities living in very close proximity to the coastal areas, waste management, water quality and exploitation of resources (marine) where the three identified national priority issues identified during the IDA workshops.

To address these at national level, immediate, underlying and root causes were identified to provide ways forward to address and strengthen community-based initiatives, governance and management mechanisms and policy reform.

Realigning national frameworks such as the Tonga Strategic Development Framework towards adaptation of objectives through ridge to reef and ecosystem-based approaches will aid in streamlining the process to government representatives and community leaders. Secondly to add core training for all civil servants on the current environmental issues and ongoing impacts will ensure that higher level communication is strengthened for a whole of island approach.

Community led and driven approaches have been implemented through the development of the Hihifo youth council under the R2R programme. These initiatives have provided training and financial opportunities through grant applications for youth programme. Providing further mechanisms such as management resources and training for identifying and monitoring R2R processes would strengthen two-way communication between community and government. These initiatives can be further supported by civil societies and national NGOs.

Community management programmes are being implemented through single sector programmes such as the Special Management Areas, Ministry of Fisheries. These programmes have given legal recognition to communities for the coastal fishery resources, similarly the water committees in rural communities manage the water bores. Both initiative frameworks can be utilized and expanded to incorporate further R2R management, which in turn assist in the identification of connected environmental issues such as pollution from liquid and solid waste.

Legislation and regulations need to take into consideration and adapt R2R approaches including the environmental impact assessment (EIAs). The EIAs are important considerations for both domestic funded and development aid programmes. Building codes and infrastructure requirements need to adapt and mitigate better towards R2R frameworks and work cohesively with other Ministries and sector programmes.

Similarly, landuse best practices and planning activities should be undertaken at a district level with support from responsible agencies in government and civil society. For instance, the use of GIS and modelling tools are important to identify and map issues, uses and threats and to further holistic approaches to reduce immediate and underlying environmental and social impacts.

Further domestic economic activities should be identified to reduce the reliance of imported products that local manufacturing could initiate and further reduce consumption demand on cheaper, poorer quality items. These initiatives would relate directly to reducing solid and liquid waste items such as single-use plastics and move activities towards a circular domestic economy.

This report details the inputs and outcomes from previous surveys and national reports as well as the information shared during the workshops help between July and August 2021.

All projects, studies and interventions under the R2R Regional project are gender and socially inclusive to ensure the meaningful participation of all sectors of targeted communities. The participation of women, youth and other vulnerable groups is ensured in community consultations, in project planning exercises, capacity building and awareness work and all other activities conducted.

Gender and social inclusion has been considered under all components of the Island Diagnostic Report and the roles of women, youth, and other vulnerable members of communities in resource use had been considered.

In conclusion, the R2R island diagnostic analyses in the Kingdom documented three priority environmental threats impacting coastal areas - waste management, water quality and exploitation of resources (marine). The report outlines the root causes of these problems and recommended several priority and practical actions and reforms that can be considered in future R2R investments.

Tonga International Waters R2R Project Rapid Coastal Assessment team comprised of technical staff from different Ministries conducting surveys.
Photo by Tonga IW R2R Project

1 Introduction

The Regional International Waters Ridge to Reef project is funded by the Global Environment Facility and implemented by UNDP and executed by the Pacific Community (SPC). The Regional Project Coordination Unit (RPCU) is housed at SPC's Geoscience Division in Suva and serves the 14 participating Pacific Island countries. The IWR2R Tonga project is implemented through the Ministry of Lands and Natural Resources (MLNR) with a dedicated project management unit (PMU).

The core focus of the IWR2R project is to provide climate resilient and integrated approaches to land, water, forests, and coastal management through the prioritisation of strategic planning, capacity building and pilot programmes that support sustainable livelihoods and conserve the ecosystem services provided by natural habitats and biodiversity resources of the island.

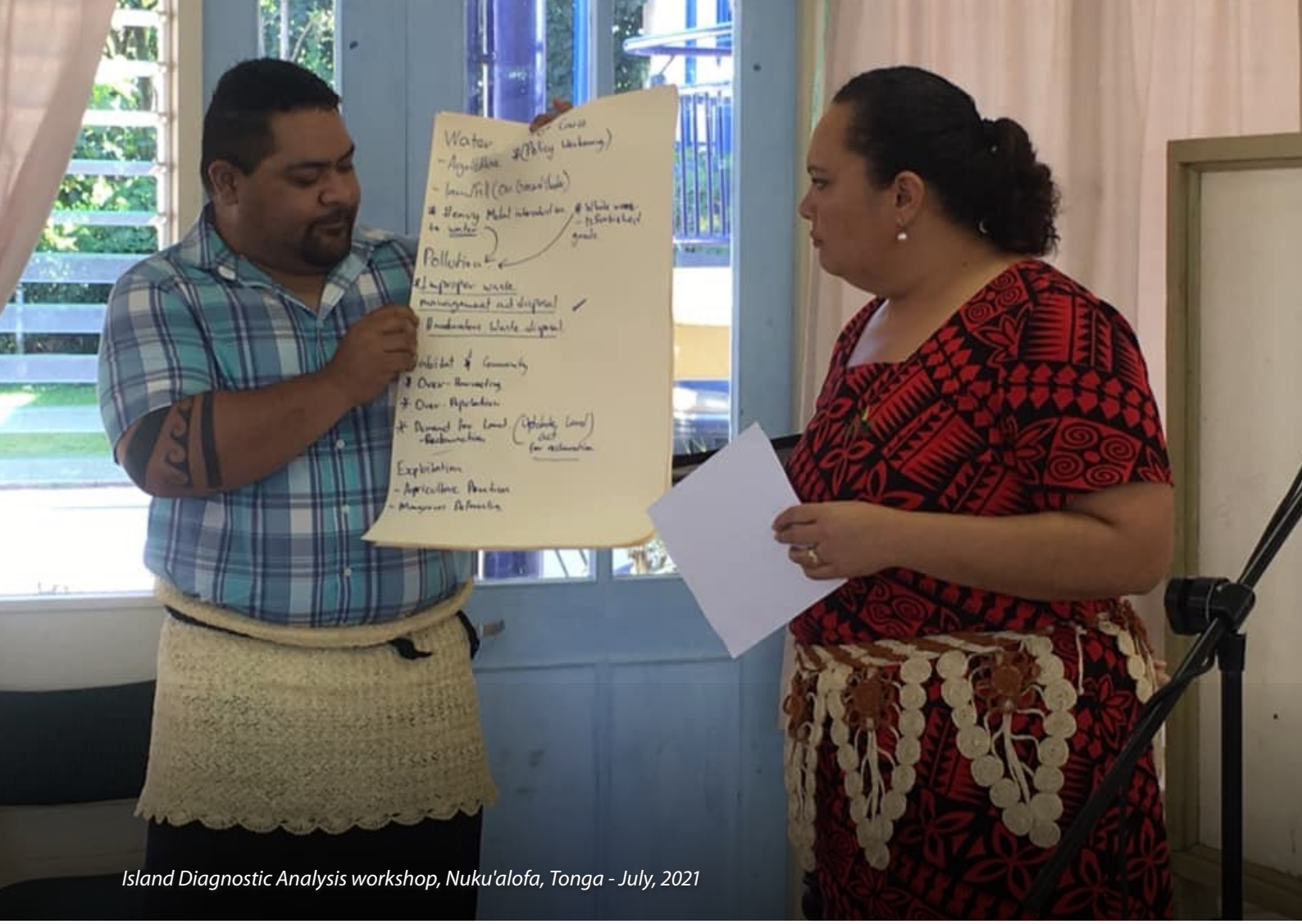
Social and environmental frameworks and sustainability are important to support the long-term objectives and needs of large ocean states such as Tonga. The broad environmental issues are well documented in national and regional reports such as the State of Environment report (Government of Tonga 2018). Scientific research has shown the negative trends in marine species and resources (Smallhorn-West et al. 2020) and there are ongoing land based issues that affect the coastal habitats (Stone et al. 2021).

Social and economic pressure on land, resources, health and sanitation, climate change and community resilience, and governance and resource management at household and community level have been outlined in reports (Kara 2021). However, further discussion and reflection is needed to identify, manage, and adapt ongoing social risk. This is possible through open and frank discussion at stakeholder consultations on priority issues and range of short- and long-term policy actions and interventions, addressing underlying issues and root cause level. These consultations need to be gender and socially inclusive with the participation of women and other vulnerable members of the community.

The Island Diagnostic Analysis (IDA) has been developed to suit the broader ecosystem approach to the Ridge to Reef (R2R) programme, including terrestrial and marine ecosystems and hydrological systems. An IDA takes a highly collaborative approach to identify, quantify, and set out environmental problems from a multi-sectoral or ridge to reef approach.

The purpose of this Tonga National IDA is to identify and document priority environmental issues and the root causes to inform policy discussion on the most appropriate and practical actions and reforms needed to address the problems. The diagnostic analyses also provide a factual and accountable process for developing the State of Coast (SoC) Report and the Strategic Action Framework (SAF). These technical and policy frameworks are the basis for mainstreaming and integrating R2R into domestic polices and legislations relative to natural resources governance and climate resilience.

As required under the R2R Regional Programme, all activities of the IDA process have a gender and social inclusion component. This ensures meaningful participation of men, women, youth, and all sectors of community in all initiatives undertaken including consultations, research, training activities and workshops.



Island Diagnostic Analysis workshop, Nuku'alofa, Tonga - July, 2021

2 Methodology

The following outlines the consultation process for developing the Tonga R2R island diagnostic analysis. through a series of workshops facilitated by a dedicated diagnostic analysis working team and broader stakeholder consultation.

Preparation and distribution of the workshop materials was organised using the guidelines for conducting an island diagnostic analysis provided by the RPCU (Pacific R2R 2018) and in coordination with the core working team shown in Appendix 1.

There were four (4) main diagnostic stakeholder workshop activities, which aimed to:

- Identify and agree on the scope, objectives and responsibilities pertaining to the focus area under investigation.
- Identify and analyse the issues, problems, and impacts (and the environmental and associated socio-economic impacts) using problem-tree and causal-link analyses.
- Prioritise the issues using risk assessment and problem-tree analysis.
- Develop priority systems and plans for actions and interventions.

Data from the workshops was entered into a Microsoft Excel sheet to evaluate the scoring process for identifying priority needs and areas for reform as outlined in the documentation from the RPCU. These workshops were gender and socially inclusive considering the different needs of all sectors of communities.

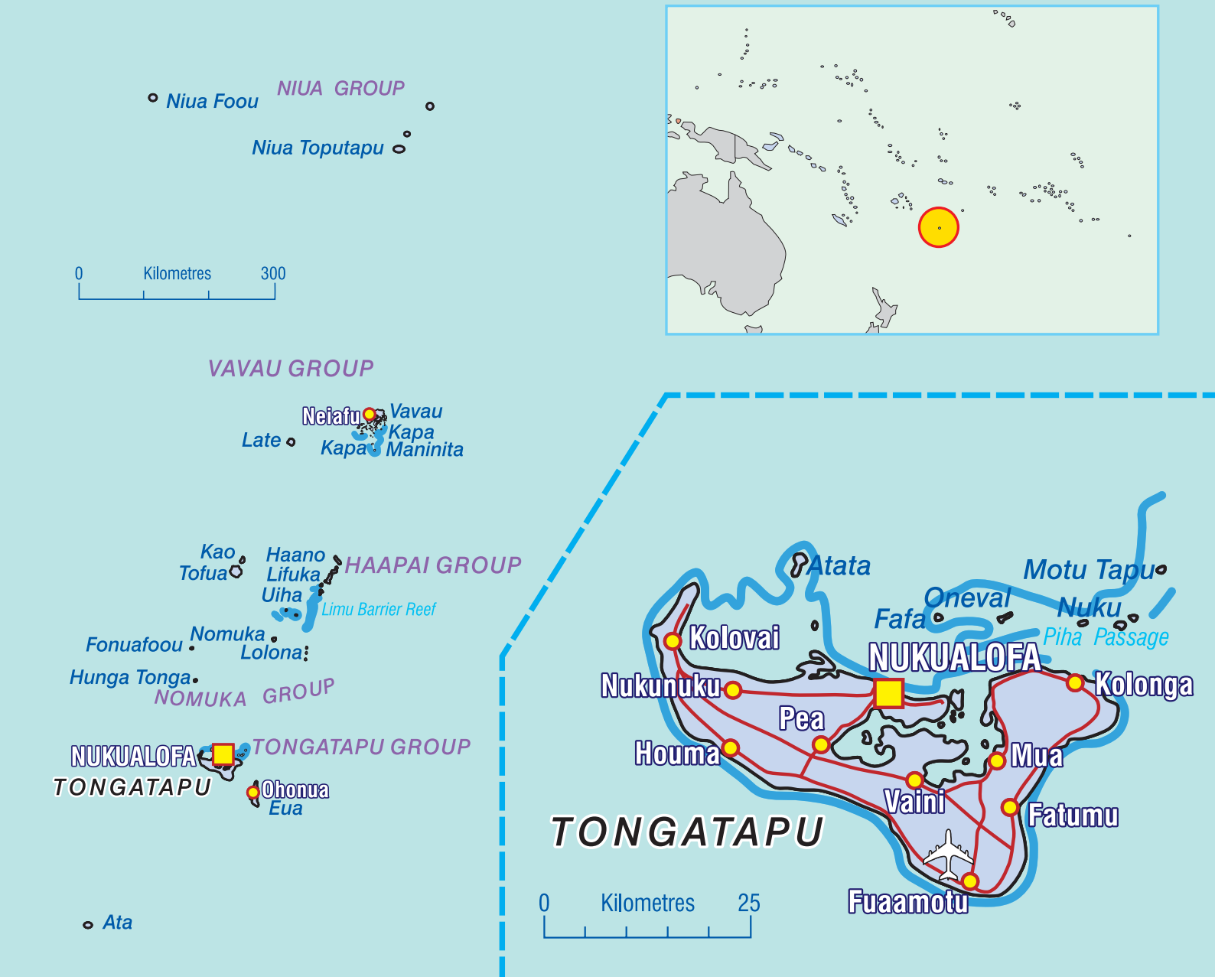


Figure 1 Map showing the island districts of Tonga including Niuatoputapu and Niuafo'ou at the top of the map, Vava'u, Ha'apai, Tongatapu and 'Eua at the south of the chain.

3 Description of Kingdom of Tonga

The population in 2016 was 100,651 persons with 70% of the population living in Tongatapu where the capital Nuku'alofa lies. Male population and female population are both at about 50,000 and there is not much gender disparity in population composition (Sem 2019).

Tonga is a constitutional monarchy established in 1875 and currently ruled by King 'Aho'eitu Tupou VI since 2015, with a parliamentary democracy since 2010 after public outcry and rioting caused constitutional changes to the government and monarchical ruling and allowed for generally elected members of parliament to be the majority in the house (17 of 26 seats). Prior to 2010, the majority of seats were for hereditary nobles (Takau 2019). Within the parliamentary democracy, the generally elected members of parliament create the majority (17) with the nobility holding the remaining 9 seats. Elected representatives consist of members from the outer island districts ('Eua – 1, Ha'apai – 2, Vava'u – 3, Ongo Niua (Niuatoputapu and Niuafo'ou) – 1) and 10 representatives in Tongatapu.

The ruling monarch is supported by the Privy Council and retains power over the Military (Army and Navy), while the Judiciary is independent. There is no provision for local government mechanisms, however, in some villages, councils have been established to discuss matters of priority and to assist the town and district officers in the development of village life.

3.1 Physical and Geographic Characteristics

The archipelago of Tonga lies on the Tonga-Kermadec Ridge in a north-northeast to south-southwest trend. It was formed through the subduction zone of the Pacific plate sliding under the Indo-Australian plate with the Tongan Trench stretching along the eastern side of Tonga (Spennemann 2004).

The islands of Tongatapu, Ha'apai and Vava'u are raised limestone coral reefs on top of older volcanic rocks, that are exposed on the islands of Nomuka (Ha'apai) and 'Eua. These rocks date back to the Eocene period. The western ridge of Tonga contains the volcanic chain of Tofua, Kao, Hunga Ha'apai, Late, Fonualei and the Niua's.

The island groups are elevated on a rise from the deeper continental shelf and provide fringing coral reef habitats and deeper coastal water directly off the islands of Eua and Niua's (Ceccarelli et al. 2017).

3.2 Socio-economic situation

Tonga's economic activities rely on the export of goods from primary sectors such as agriculture and fisheries, with secondary resource-based activities such as tourism providing only 15% of the estimated GDP (as at 2013) (Trip Consultants 2013).

Employment within Tonga is recorded in a labour force survey from 2018 as 28,598 or approximately 45% of the available working age population (63,189). Of this workforce, 56.5% are men and 43.5% women with the largest employment sector being manufacturing (20.4%), followed by agriculture, forestry, and fishing (19.8%), administration (9%) and construction (8.6%).

The unemployment rate in 2018 was 3.1% or 1959 persons. The informal employment sector has the greatest human engagement with 49,224 persons engaged. The informal sector is defined as small enterprises without business structure that work irregular hours and do not have secure income – in Tonga, the informal sector also includes small market stalls from agriculture and fisheries, handicrafts and taxis among other small business sectors (Tonga Statistics Department 2018).

Average annual income across all earning sectors was T$32,540, with the higher incomes in urban Tongatapu (T$37,240) and lowest in Niua (T$17,730). Estimated wage and salary income for households varies between urban and rural Tongatapu (T$18,640 and T$15,270 respectively) and is much lower in the outer islands, ranging from T$9,230 in Vava'u to T$6,080 in the Niua's. Subsistence earnings are much higher in the outer island districts (between T$2,500 and T$3,120) in comparison with Tongatapu (T$240 in urban areas and T$1,020 in rural areas). Remittance income from family and friends averaged nationally at T$6,370 per household (Tonga Statistics Department 2016).

Household expenses were highest for food and alcohol, with the outer island districts having slightly greater expenses (T$10,200 to T$11,300). The annual national average household expenditure was T$30,150. Housing and utilities were the second highest household expenditure (T$6,170 average) (Tonga Statistics Department 2016). Electricity costs in Tonga are very high per capita due to the heavy reliance on diesel generators. The government subsidises T$0.0767 per kilowatt hour (kWh) which is T$0.8071/kWh.

Tariff rates are standardized across the four main islands where it was set at 0.8514 Tongan Pa'anga (TOP) per kilowatt hour (kWh). A subsidized "lifeline tariff" of 0.7 TOP for the first 100 kWh of monthly consumption is also applied (United Nations Climate Change Technology Centre and Network, 2018).

Land parcels are for males only and are available upon application from the MLNR for both housing and subsistence agriculture development (land size is not to exceed 3.3387 hectares). If the applicant is residing on hereditary estate (nobility/Tofi'as) then the land parcel is gifted from the noble (Government of Tonga 2002b).

Access to education is very high in Tonga for both males and females, with compulsory primary school education since 1876. Education in Tonga consists of 6 years at primary school, 3 years at high school and 3 years at senior high school. Previously the first 8 years were compulsory. High schools are either provided by the government or are independent church schools, The cost of education according to the 2016 household expenditure report averaged at between T$60 (Niua's) and T$270 (Urban Tongatapu) (Tonga Statistics Department 2016).

Tertiary education is also available within Tonga and scholarships are supported both through the government and development partners (Australia, New Zealand, China, and Japan). Tonga has a high literacy rate (98% approximately) and highest number of doctorates per capita in the world (Toetu 2014).

Health services are free at the hospitals for all Tongan citizens with general medications subsidised by the government. Private doctors are available at additional cost in some of the private pharmacies in Tongatapu and Vava'u.

3.3 Ecological status

The status of the biodiversity of Tonga has been reported for forest, coastal and marine biodiversity as well as related livelihood and economic sectors, including agriculture, commercial fishing, aquaculture, and tourism.

The Rapid Assessment of Biodiversity of the Vava'u Archipelago (BioRAP) featured surveys conducted in 2014 by international and national researchers on terrestrial and marine flora and fauna to provide a rapid overview biodiversity assessment and identification of priority areas for management. The BioRAP showed that the uninhabited islands of Vava'u had higher biodiversity of marine species compared to inshore islands and identified 206 species of hard corals of which 67 species were range extensions. The land based biodiversity is impacted by development, land management and invasive species with very little undisturbed low-land forest (Atherton et al. 2014)

The State of Environment Report 2018, developed by the Government of Tonga in partnership with SPREP, highlights the status of the environment. Natural forest habitats are indicated as degrading and decreasing in natural size due to land development and agricultural uses. The health of coral reefs is indicated as fair with a mixed trend due to exploitation; lagoon health is deteriorating; and biodiversity of marine mammals, threatened and endemic species is deteriorating (Government of Tonga 2018b).

The Rapid Assessment of Priority Coastal Areas (RapCA) conducted in 2020 highlighted the need for improved multi-sectoral and community-led approaches to address the increasing land-based impacts on the coastal and marine areas of Hihifo District in Tongatapu. Mangrove areas are being impacted from poor water quality resulting from high incidence of seepage from liquid waste (Lokotui 2021) and increasing run-off and sediment deposits from poor land management. The mangroves within Hihifo district showed signs of stress with low natural regeneration and very low observations of bird and invertebrate species (Stone et al. 2021).

Houma Blowholes, Tongatapu, Tonga

4 Ridge to Reef Management in Tonga

The application of the ridge to reef concept in managing natural resources has been implemented, adapted, and developed in Tonga for many years. In 2007 the Integrated Water and Resource Management (IWRM) focused on managing water. Its follow up project is the regional IW R2Rproject, which commenced in 2015 and takes a cross-sectoral approach, integrating water, land, forest, and coastal management.

The Tonga IW R2R demonstration project is hosted by the MLNR in collaboration with SPC through a signed memorandum of agreement. These programmes have focused on ecosystem and community-based management of the coastal and freshwater resources and developing sustainable mechanisms for continuing R2R management.

Other R2R management programmes such as the Integrated Land and Agro-ecosystem management systems (ILAMS) funded by GEF and implemented through the Food and Agriculture Organization of the United Nations (FAO) and SPC are also running in Mangia, Vava'u, Pukotala in Ha'apai, Haveluliku in Tongatapu and Ta'anga in 'Eua. The objective is to strengthen the resilience of communities by enhancing the land tenure systems, improving forest management and piloting agro-ecosystem programmes for degraded landscapes. The ILAMS project is implemented in Tonga through MLNR, Ministry of Agriculture, Forests and Foods (MAFF) and the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communication (MEIDECC).

The Fanga'uta Lagoon programme in Tongatapu is implemented through the Department of Environment (MEIDECC) and in partnership with communities to develop an integrated land, water and coastal management approach to protect livelihoods, food production and enhance climate resilience.. The GEF-financed project known as the Integrated Environmental Management of the Fanga'uta Lagoon Catchment was officially launched in February 2015 where project activities focused on the conservation of ecosystem services of the Fanga'uta Lagoon through an integrated land, water and coastal management approach thereby protecting livelihoods and food production and enhancing climate resilience (Rijal 2018).

4.1 Natural resources

The natural resources of Tonga include vast ocean areas with fringing and raised coral reefs, mangroves, seagrass beds, estuaries, and small lagoons such as Fanga'uta lagoon. Deepwater seamounts and hydrothermal vents are situated up the western side of Tonga in the Lau basin and have been identified and explored for deep sea mining by overseas companies through permits from MLNR. Marine species include the Oceania population of humpback whale (Megaptera novaeangliae), which migrates to Tonga annually from the Antarctic as well as migratory species of tuna and billfish, marine turtles and over 500 confirmed species of reef fish and 220 hard coral species (Ceccarelli et al. 2017).

Forest areas are found in small patches, with 'Eua having the largest natural forest area. Terrestrial biodiversity of birds, insects and reptiles have been identified however terrestrial biodiversity has not been surveyed as extensively as marine resources, with the BioRAP having the most insight on the flora and fauna in Vava'u (Atherton, Mckenna and Wheatley 2014).

Fresh water resources are derived from precipitation draining through the porous limestone islands into water lenses, with springs running naturally through the islands to the coastal areas. Niua's and 'Eua have freshwater pools within the islands and Nomuka, Ha'apai and Vava'u have brackish lakes.

4.2 National Protected Areas

Within Tonga there are currently two terrestrial national parks, the largest being the 'Eua National Park that spans approximately 4.51 km^2 of tropical rainforest bordered by sheer cliffs.

There are currently four marine protected areas (MPA) under the Parks and Reserves Act 1988 in Tongatapu however, the MPAs do not have active management and there are no management plans providing structure and regulations to the MPAs (figure 2).

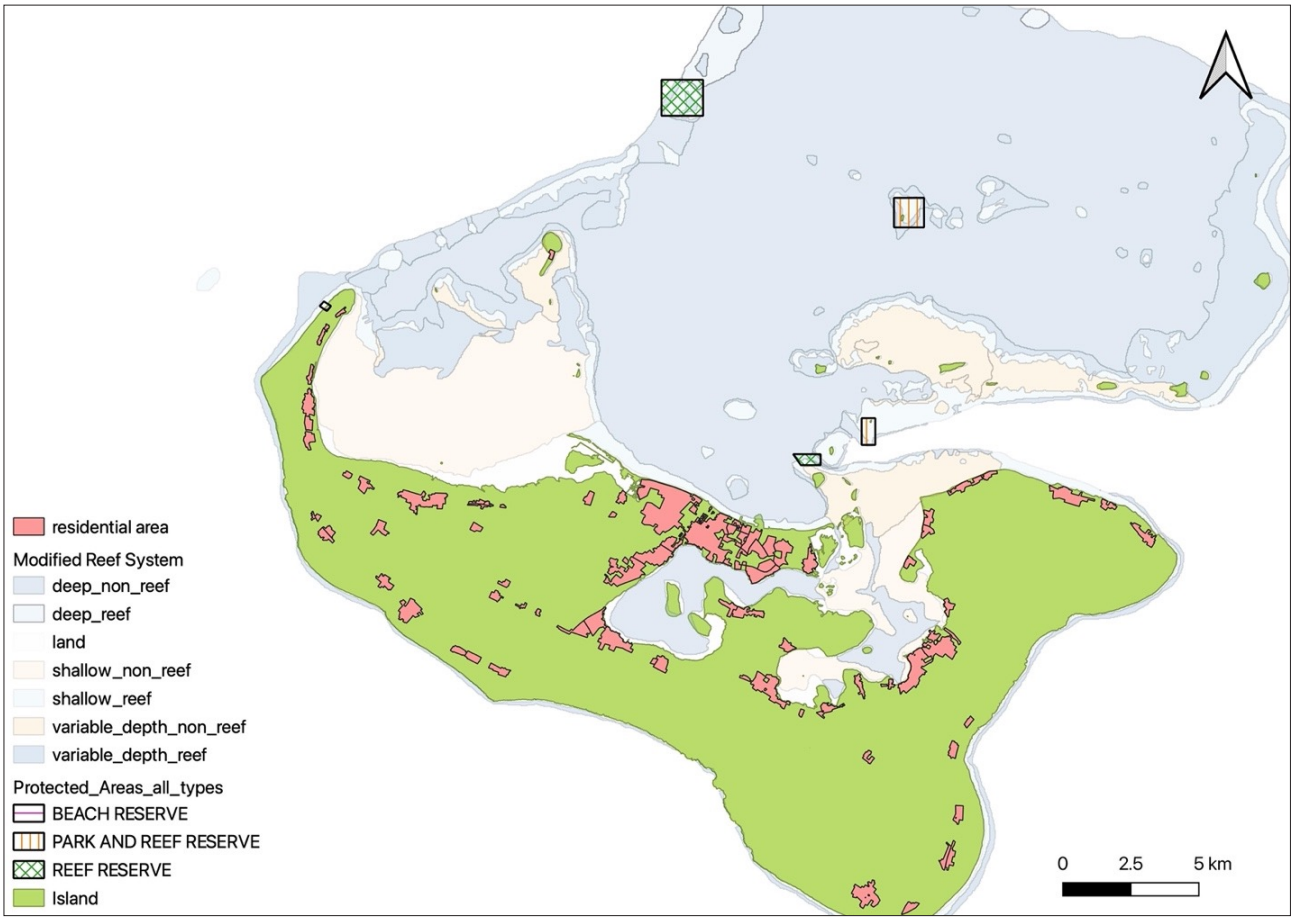


Figure 2 Map created by QGIS software on the protected areas in Tongatapu under the Parks and Reserves Act 1988. *Source Government of Tonga.*

Since 2015, the Government of Tonga has designed and implemented its marine spatial planning to protect and conserve 30% of the economic exclusive zone through a series of ocean management areas, including no-take areas. Tonga's ocean policy was approved by Cabinet in July 2021 and is currently awaiting the legislative process.

4.3 Island Vulnerability

Tonga is highly susceptible to natural and climate hazards, including sea level rise, increasing frequency and strength of tropical cyclones, longer drought periods and increased flash flooding (Government of Tonga 2018a). Based on the Integrated Research on Disaster Risk peril classifications (IRDR 2014), the impacts and rating of natural hazards have been classified as well as the disaster profile from 1900 to 2016 (EM-DAT 2017) shown in Table 1.

Ocean acidification is likely to be impacting the marine calcium carbonate resources in Tonga such as corals, bivalves, and crustaceans, however, currently this is largely not monitored. Initial surveys conducted in 2017 show the need for further studies to be conducted and broadening the knowledge on ocean acidification (Stone et al. 2017).

Agriculture and fisheries are both susceptible to climate and natural hazards as well as unsustainable use and overharvesting especially of marine resources (Smallhorn-West et al. 2019). Food security is a high priority of MAFF and MoF and will be critical in preventing social vulnerability to future shocks such as COVID-19.

Table 1 Natural hazards for Nuku'alofa (*Source: Fakhruddin et al. 2019*)

Family	Main Event	Peril	Natural hazard	Hazard Rating
Geophysical	Earthquake	**Tsunami**	Local landslide causing tsunami	Medium
			Regional tsunami causing inundation	High
			Far-field tsunami of height sufficient to cause inundation	Very low
Geophysical	Earthquake	**Earthquake**	Ground rupture within the site due to earthquake faulting	Low
			Ground level change of the site due to earthquake faulting	Low
			Seismic instability of reclamations and causeways/breakwater due to liquefaction or soft foundation soils (including seabed deposits).	Low to Medium
			Seismic stability of wharf structures	Medium
Geophysical	Mass Movement	**Land Slide**	Small scale shallow instability of hillslopes around the margins of the sites and access roads during large storm events	Low
			Larger scale instability of hillslopes around the margins of the sites and access roads due to cyclonic type storm events	Low
			Larger scale instability of adjacent hillslopes around the margins of the sites and access roads due to major earthquake	Low
			Fill settlements due to long term consolidation	Very Low
Geophysical	Volcanic Activity	**Volcanic**	Ash fall	Medium
Hydrological	Flood	**Flash flood**	Flooding	High
			Sedimentation	Medium
Meteorological	Tropical Cyclone	**Storm Surge**	Extreme wind	High
			Extreme waves	Medium
			Major storm surge coinciding with high tide and rainfall or large waves	Medium
			Catchment flooding	Medium
Meteorological	Extratropical storm	**Storm Surge**	Coastal inundation	Medium- High
			Storm erosion	medium
			Long-term recession	Low
			Sedimentation	Medium
Climatogical	Glacial Lake Outburst	**Sea Level Rise**	Sea level rise increasing inundation hazard	Medium
			Sea level rise causing landward translation of the shore face (recession)	Low
			Changes in storm events	Low
			Changes in sediment supply	Very low

4.4 Institutional Arrangements

Tonga has been a constitutional monarchy since 1875 and became a parliamentary democracy in 2010 following riots in 2006 and the dissatisfaction with monarchical rule (Powles 2014).

Within the parliamentary democracy, the generally elected members of parliament (MPs) create the majority (17) with the nobility holding the remaining 9 seats. Elected representatives consist of members from the outer island districts ('Eua - 1, Ha'apai - 2, Vava'u - 3, Ongo Niua (Niuatoputapu and Niuafo'ou - 1) plus 10 in Tongatapu. General elections are held every four years and registered citizens over the age of 21 may vote within their electoral jurisdiction.

The ruling monarch is supported by the Privy Council and retains power over the Military (Army and Navy); the Judiciary is independent.

The main Government is housed in Nuku'alofa, Tongatapu with smaller office branches in the outer island districts. Ha'apai and Vava'u have Governors that act as advisors to the Minister for Lands and oversee the government department meetings.

District and Town officers are elected by the public every three years and are mandated through the Prime Minister's office and District and Town Officers Act (Government of Tonga 1988). District councils have been established, including in Hihifo, however, are not currently recognised under legislation.

In Tonga, women have traditionally held a high social status. However, in recent centuries, there has been a sociological shift with modernisation and the adoption of Christian values that has resulted in the society becoming more patriarchal. As a result, Tongan women today face various inequalities in legislative matters and work settings (JICA 2010).

Land is primarily owned by the King through Royal estates and the Nobles, each of whom has hereditary ownership across the island groups. Only men have legal rights to inherit land and these rights pass through male heirs. Women are disadvantaged as they do not have independent land rights unless a lease is acquired (Pacific Community 2019).

The Tonga Strategic Development Framework II (2015–2025] (Ministry of Finance and Planning 2015) -provides the overarching mandate for social, cultural, environmental and economic objectives for the Government of Tonga including:

- More inclusive, sustainable, and balanced urban and rural development across island groups;
- More inclusive, sustainable, and empowering human development with gender equality;
- More inclusive, sustainable, and responsive good governance with law and order;
- More inclusive, sustainable, and successful provision and maintenance of infrastructure; and
- More inclusive sustainable and effective land administration, environment management and resilience to climate and risk.

The State of Environment (SoE) provides the framework for current status of coastal, terrestrial and marine habitats and the biodiversity within, and indicates priority broad scale management activities in Government sectors (Government of Tonga 2018b).

Integrated Water Resource and Coastal management (IWCM/IWRM) reports and frameworks have included the national integrated water resource management diagnostic analysis in 2007 funded by the Global Environment Facility and highlighted management and resource needs to strengthen the development of water resources management in Tonga (SOPAC 2007b).

Special Management Areas (SMAs) are coastal/marine initiatives of a community-based fisheries programme led by the Ministry of Fisheries and legislated through the Fisheries Coastal Community Regulations and Fisheries Act. The SMAs include the responsibility of communities taking care of the SMA itself, where fishing is only allowed for registered members of that community, and Fish Habitat Reserve (FHR) where there is a permanent no-fishing zone within each SMA (Smallhorn-West et al. 2020).

The Ministry of Infrastructure, through the relevant regulations, is responsible for building codes in the Kingdom (Government of Tonga 2016a). However, under the Health Act, Ministry of Health may specify the design and placement of septic tanks, including proximity to public or domestic water (Government of Tonga 2016c). Town water supplies for urban areas are managed and designated under the Tonga Water Board and inspections conducted under the Ministry of Lands and Natural Resources (Katoa 2020).

The Environmental Impact Assessment (EIA) Legislation and Regulations are implemented through the Ministry for Environment. These EIA policies and legislations provide best practices and guidelines for determining the potential size and scale of development and infrastructure programmes and to oversee and approve Environment Impact Assessment reports through projects and consultants (Government of Tonga, 2016b).

Currently in draft is a 10-year strategic plan for hydrological resource management through the Ministry of Lands, Survey and Natural Resources. The plan aims to address institutional and human capacity for effective and inclusive water resource and related ecosystem management; operate and strengthen infrastructure for sustainable water resources; facilitate the potential for wastewater treatment and reuse and to improve the efficiency on the use of water resources.

4.5 Public and Stakeholder Participation

Table 2 below outlines the formal and informal ways that communities and wider stakeholders support and communicate on matters to do with social, environmental, and economic activities.

Table 2 Formal and informal communication and support sectors.

Category	Stakeholder	Role
Community	**Town officer**	**Elected official for representing community needs and providing input to the district and government ministries**
	Church	Spiritual support and assistance to the congregation, emergency shelter during cyclones
	Kava Clubs	Social men's gathering, provide support for social and community needs, fundraising activities for families
	Women's groups	Community groups providing economic activities (weaving) and social gathering and support
	Youth groups	Support and programme-based activities for youth between 15–34 years of age
District	**District Officer**	**Oversees needs of communities within the district, liaises with District Council and Government**
	Church	Spiritual and cultural counsel Evacuation centres during cyclones and other natural disasters
	Schools	Education and social support for children, parents, and youth
	District Council	Manages the needs of the communities and presents political engagement through Member of Parliament (not nationally implemented)
	Business	Social and economic engagement, provides some employment benefit
	Civil Society and NGOs	Communication, awareness, and project-based programmes covering economic, social and environment programmes
	Government	Governance, communication, awareness, social and financial support

The 'Fono' is the traditional provincial community and district meeting which is undertaken as part of the elected roles of the District and Town officers. The fono is held quarterly and includes community representatives from women, men, and youth.

Town officers may hold regular meetings within their community depending on the ongoing needs, projects, and upcoming activities. Government, civil society groups and non-governmental organisations, through funded projects, also hold meetings which communities participate in to gain knowledge and provide feedback. Civil society groups and NGOs also provide more open communication platforms for women, youth and people living with disabilities to participate.

5 National Priority Issues

5.1 Introduction

Tonga's environmental and resource priorities are well documented. In the Tonga State of the Environment Report 2018, priorities were reviewed for each sector, focusing marine and terrestrial resource use and management, and social impacts from natural and climate related hazards (Government of Tonga 2018b). The following are further indicators based on local social and economic indicators as well as reviewed reports and recommendation to increase R2R processes into mainstream activities and management strategies.

5.2 National Priority Issue: Pollution

Solid and liquid waste management are ongoing issues with limited land availability for the management of waste. The limited land and the nature of low-lying islands exacerbate the problem with increased potential for seepage of liquid waste through porous limestone and volcanic islands.

The heavy reliance on imported goods that are often received in plastic wrapping or are of lower quality material, means that turnover of products and mass of waste are high per capita with previous estimations of one ton of solid waste per household annually and direct and indirect costs of waste management to Tonga estimated at T$6.5 million per year (Lal & Takau, 2006).

Most of the population in Tonga depends directly on coastal and freshwater resources for protein sources. This also means that levels of pollution can directly and quickly impact on the ecosystem services of these habitats and resources. Littering and illegal dumping in bush and coastal areas are still happening (see details in Figure 3). This not only impacting directly on habitats but also increasing health risk and contamination levels on edible resources living in those habitats.

Figure 3 Plastic bottles and waste discarded in the coastal area are a major source of pollution that is impacting freshwater and marine resources.

5.2.1 Description of the problem and its national importance

The first national priority identified through the stakeholder consultation diagnostic analysis is pollution, which includes solid and liquid waste, run-off (eutrophication), suspended solids and microbiological. The priority issue of pollution is supported by the IWR2R technical working group in the country.

Solid and liquid waste management is a large issue in Tonga due to the high reliance on imported and overseas products for consumption, social and economic activities. These imports are largely of lower manufacturing quality, especially whiteware such as fridges and washing machines so there is a high turnover of such items. Imported cars have increased over the last 15 years since the availability of the Japanese car market; these cars when no longer functional are often left derelict and in bushland with little option to recycle in country.

Tonga Waste Authority manages waste collection on Tongatapu, Ha'apai and Vava'u, while there is community-based waste management in 'Eua. There is little information on waste management in the Niua's. Households and businesses pay a monthly fee, which varies based on the type of business activities. Fees are collected through their electric bill at Tonga Power Ltd or, for extra waste services such as direct take or extra pickups, these are paid directly to the Waste Authority landfill office.

There are currently two managed landfills, one in Tongatapu (Tapuhia) and one in Vava'u (Kalaka). Both landfills are situated close to coastal waters with limited space or ability to manage waste effectively and to reduce potential of seepage into coastal/marine and fresh water sources.

Liquid waste management is an increasing concern for coastal areas. There is potential occurrence of high mortality of marine/freshwater resources from harmful algae blooms resulting from eutrophication. This is largely influenced by increased nitrates and phosphates from agricultural products and increasing numbers of poorly implemented and maintained septic systems. This is not a new problem to Tonga, but finding a suitable long-term option that could be easily implemented at community level in households has been challenging. In the past, there have been small programmes to introduce composting toilets, which have been implemented through the Integrated Water and Coastal Management project (SOPAC 2007a) and the IWR2R programme in Hihifo in 2020.

Secondly, there is nowhere to effectively dispose of other types of liquid waste, including waste oil from cars, heavy machinery and vessels, and the waste oil is often dumped inland or continually reused by other people. The dumping of waste oil on land has the potential to seep into fresh and coastal waters and cause health and environmental issues as well as contaminating soils for agriculture.

Run-off and increasing eutrophication are linked to solid and liquid waste and agricultural management activities. Old and poorly maintained storm and drainage systems in Vava'u and faecal deposits from increasing roaming animals near freshwater systems and along coastal areas are contributing to increased nitrates and phosphates in these ecosystems.

5.2.2 Major environmental impacts and socio-economic consequences

The environmental impacts of solid and liquid waste management are widely observed and reported in Tonga. In a recent study, there was increasing level of pollution and poor quality of coastal water, including in Fanga'uta Lagoon, Hihifo district (Karen et al. 2021).

The landfills are located closed to sensitive mangrove and coastal water habitats, suggesting high possibility of increased and potential spillage and leakage into adjacent coastal waters previously fished by communities in Vava'u and Okoa. The studies conducted by the Department of Environment in 2019 and 2020 showed high levels of phosphate compared to safe levels for aquatic marine life (see details in Figure 4)[1]. Faecal coliforms were also high at Okoa suggesting human and animal wastes contaminating underground and surface waters. The study recommended, amongst others, to request Ministry of Fisheries to evaluate impacts on marine invertebrates.

1 Unpublished raw data from the Department of Environment.

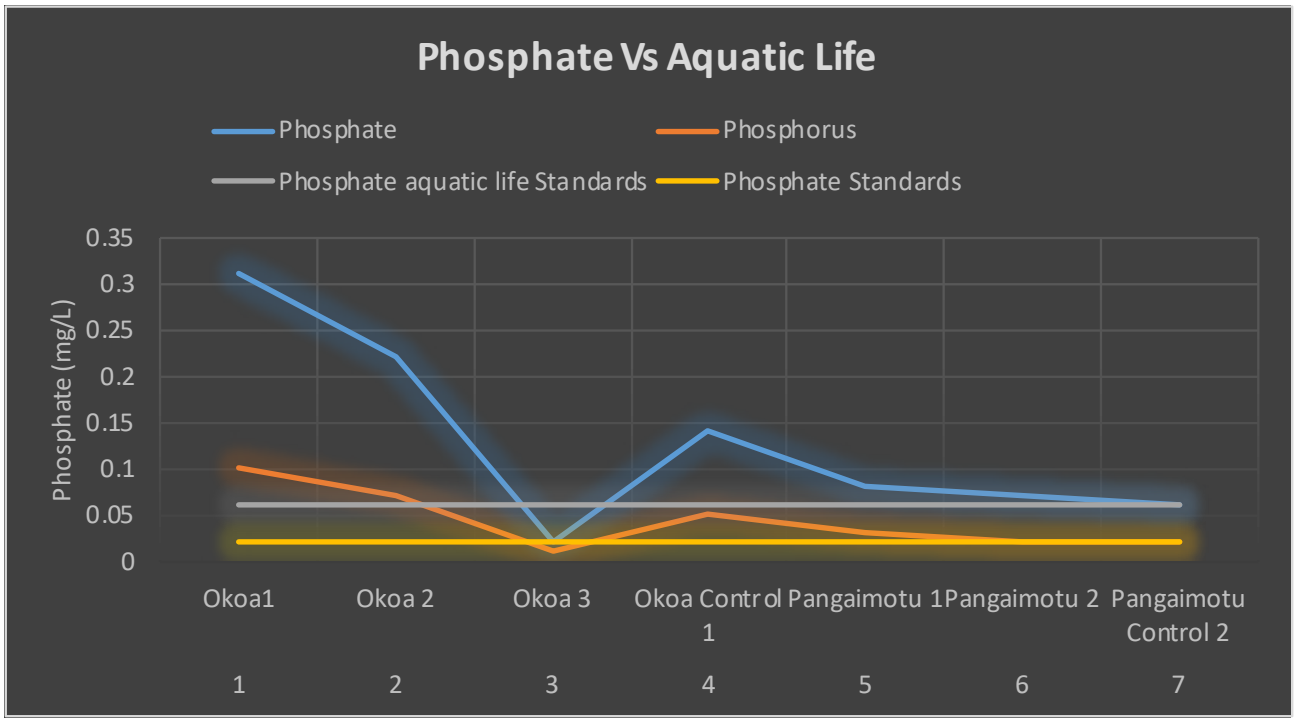


Figure 4 Showing the phosphate versus aquatic life recommendations for Okoa where the landfill is located in Vava'u. *Source Department of Environment 2019 data, unpublished.*

Figure 5 shows the overview of results from the diagnostic analysis workshop for broad identification of environmental and social impacts. Social impacts increase as the health and viability of the environment and its resources decrease.

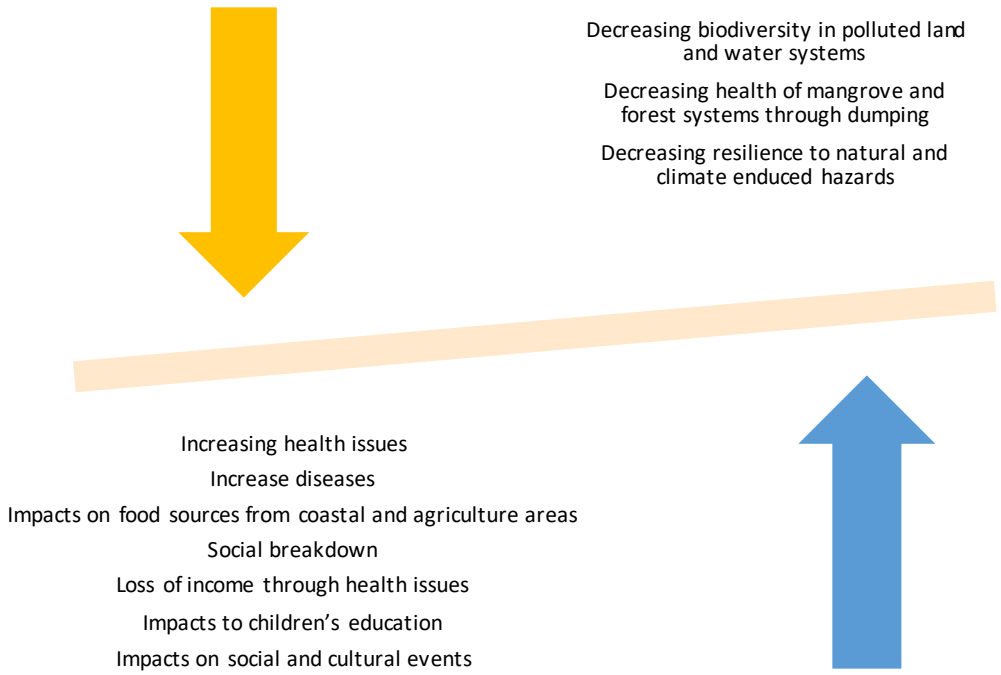


Figure 5 Showing the identified environmental and social issues related to solid and liquid waste management during the stakeholder workshop in July 2021. Environmental issues are shown at the top with increasing social issues underneath.

5.2.3 Linkages with other national problems

Solid and liquid waste management is linked and demonstrably manifested in the quality of habitats and flora and fauna community (biodiversity). Where contamination levels exceed thresholds beyond which some organisms cannot survive, there will be mass mortality, in turn, impacting on the status and health of coastal resources and the communities that rely upon them for consumption.

Increasing negative human health impacts are consistent when wastewater and sanitation are poor. There are three broad categories of water-related conditions that have been identified to be the causes by poor sanitation practices. These include dengue fever, gastrointestinal diseases, and skin infections. Of these, only dengue and gastrointestinal cases are officially reported by the Ministry of Health (Newton 2008).

5.2.4 Immediate, underlying and root causes

Figure 6 shows the immediate, underlying and root causes that were identified by the working groups at the consultation meetings held in Tongatapu and Vava'u for the island diagnostic analysis. Participants at the workshops included government representatives, public enterprises, Members of Parliament, and community leaders (Appendix 1). The consultation concluded that the root causes of the problems are often linked to policy and social activities. These root causes are much harder to address, however, the immediate causes are often best managed at grassroot led community initiatives and underlying causes needing governance and management.

Figure 6 List showing the identified immediate, underlying and root causes solid and liquid waste management during the stakeholder workshop

Despite the development of waste collection programmes in Tongatapu, Vava'u, 'Eua and Ha'apai with Tonga Waste Authority Limited, sufficient resources are not available to support the management of waste collected. This often leads to waste piles and the eventual need to halt the collection programme, which in turn leads to illegal dumping and littering. There are household and government agencies that are unwilling to collaborate in paying for the collection of wastes.

Waste collection charges, through Tonga Power Ltd., have been included as part of the electricity bill at T$50 per month. Small businesses and offices that produce a relatively smaller amount of waste compared to restaurants and bars all pay a fixed fee with no consideration to the relative amount of waste produced.

Despite having external funding support, liquid and solid waste management is not a national priority. Weak policy and regulations do not address illegal dumping and littering. The necessary resources, whether human or financial, are not placed within the relevant agencies to deal with non-compliance and enforcing of regulations put in place.

Reusable or higher quality products would be more accessible through the reduction of import tariffs, which could lead to the reduction of unnecessary waste due to non-reusable and lower quality products. There also needs to be awareness and support for the development of domestic businesses for the manufacturing of products to reduce unnecessary imports. Plastic bag taxes could also be considered to further reduce unnecessary production of plastic waste.

5.2.5 Knowledge gaps

Current information is limited on the changes to solid waste management because of little to no data available from the landfills on waste classification. A study being conducted by the Word Bank and implemented through the Ministry for the Environment (MEIDECC) has surveyed household wastes and waste collected at the landfills and should provide latest results to inform development of policies and legislation to improve waste management in the country. The report was not available at the time of preparing the IDA.

This report encourages integrating waste management solutions such as recycling and reducing single-use plastics, which could be conducted in line with the Ministry of Revenue and Customs (MORC) and Tongan shops and business owners. The outcomes of these initiatives will not only attempt to address the problem but also further identify significant gaps in the environmental and social knowledge collected. MORC controls and regulates the importation of goods through duties and taxes and could assist in discussions to reduce tariffs on better quality and reusable items to help stimulate local waste management solutions.

Community-based and traditional feasts previously used natural biodegradable food wrapping from banana and taro leaves, however, packaging is now predominantly single-use plastics for take-away boxes for food sharing and storing. A feasibility study should be conducted on potential for developing domestic business activities to provide solutions including packaging materials from biodegradable materials instead of continuing the need and reliance on imported items.

Recycling is currently not advantageous nor feasible for current business in Tonga. The shipping of waste products to other countries is costly and needs further development and partnerships from shipping companies, is an example. However, recycling can lead to an effective circular economy by encouraging sustainable development through the minimal wastage of materials through efficient planning in the design and production stage. Recycling also fosters an effective circular economy by providing new opportunities to new innovative businesses which could lead to positive impacts on the environment and society (Di Maio and Rem, 2015).

Focus activities for Tonga can be on the reuse of glass for crushing and developing building materials such as replacing sand currently mined commercially from beaches.

5.2.6 Conclusions and recommendations

Tonga's solid and liquid waste management issues have long been recognised and there have been actions taken such as the development of the Waste Authority Limited to manage solid waste. However, there is still a need for further intervention on the landfills and improving the ability for managing the different types of waste, including potential for separation of whiteware goods for recycling. This separation of waste will help with the management of the landfill between green waste, electronic and whiteware and other types of waste. The separation will aid in analysing the waste amounts and providing data and analysis for developing other interventions.

Recycling has not been advantageous in Tonga, with export and economic markets reducing the feasibility of the companies involved, managing waste at the source may be more beneficial to long-term recycling initiatives especially if the product (crushing glass to aggregate/sand) could be utilised locally and not rely on export and outside market influences. Development of domestic recycling and reusing of single use plastics could be an important activity in developing economic markets and manufacturing – these activities can reduce the impacts of discarded plastics on the marine life and human health.

Developing liquid waste stations at the ports in Nuku'alofa, Ha'apai and Vava'u would be beneficial for ship waste, including yachts and container ships as well as for domestic use to enable waste oil from vehicles to be transported away from the coastal areas and potentially utilised for biogas production. Local initiatives for reusing waste oil such as potential for small biogas systems might be too costly for the amounts of waste oil in Tonga.

Awareness campaigns on littering have been widely implemented by government, private sector, and NGOs, however the focus remains strongly on clean ups and, whilst beneficial to remove the waste from immediate harm to the environment, clean ups do not address long term activities to reduce littering. MEIDECC is proposing a framework for reducing single-use plastics over a 10-year period (personal comms. Director for Environment), however consideration is also needed on how to ensure food safety through other feasible and affordable items that are reusable. This could include reusable plastic containers or introducing the concept of people bringing their own packaging, including biodegradable products. Including all sectors of communities – women, youth, etc – and all stakeholders in awareness campaigns and capacity building will help stimulate creativity in developing innovative waste management solutions in Tonga.

5.3 National Priority Issue: Water Quality

The issue of degradation fresh and coastal water quality is not new to Tonga and has been widely addressed through awareness and intervention programmes (Figure 7). The following provides the diagnostic analysis including stakeholder comments on addressing the issues.

5.3.1 Description of the problem and its national importance

Water is critical for health, economy and environment in Tonga and includes both fresh water and coastal waters. Land uses, unsustainable harvesting, agricultural practices and poorly implemented and maintained infrastructure are all impacting the quality of water.

Groundwater through freshwater lenses is found throughout the island groups. Surface water areas found as springs in 'Eua or high up on the volcanic islands. Many outer islands in Ha'apai and Vava'u rely solely on rainwater harvesting for freshwater (SOPAC 2007a). In the main cities of Nuku'alofa, Pangai (Ha'apai) and Neiafu (Vava'u), the Tonga Water Board manages the fresh water supplies, while further out communities manage their own bores through established water committees (personal comms. Sesimani Lokutui).

Figure 7 Wastewater run-off from community into the mangrove habitats. *Source RapCA*

Roaming animals and leaking poorly implemented and maintained septic tanks are increasing faecal matter contamination of the freshwater lenses and coastal waters (Lal and Takau 2006). This increase in pollution to fresh and coastal waters is impacting the nutrients in the coastal habitats such as mangrove areas and will impact on the health of marine species, especially sessile species such as molluscs, bivalves and other invertebrates (Stone et al. 2021). The issues have been found to be increasing within the Hihifo district on Tongatapu and in Vava'u (Stone et al. 2016).

Nationally, water quality is an increasing issue exacerbated further by the impacts of natural hazards and climate change with predictions showing changes in rainy seasons through longer drought periods and heavier flooding at times. Drier periods with low lying ground water can also increase salt water intrusion when pumping (Government of Tonga 2018a).

5.3.2 Major environmental impacts and socio-economic consequences

Degrading water quality has socio-economic impacts that affect communities, livelihoods, and economic activities such as tourism. Human health is at risk from bacteria and viruses in contaminated water (Figure 8).

Women and children are particularly vulnerable to health impacts from poor water quality. Women are also traditionally, and in rural areas, responsible for providing for household water needs and will have the additional burden of locating safe water sources.

Many households harvest rainwater from tin roofs and guttering into plastic or cement tanks. These need regular maintenance and management – keeping the tanks clean and the roofs rust free – to ensure the water collected if safe to drink.

The links between environmental impacts and health impacts include the rise and increase of bacteria in water supplies and increase in heavy metals and nutrients from liquid and solid waste. Current testing of water supplies however, is limited, thus all the issues and links between water quality and human health in Tonga are yet to be understood and addressed.

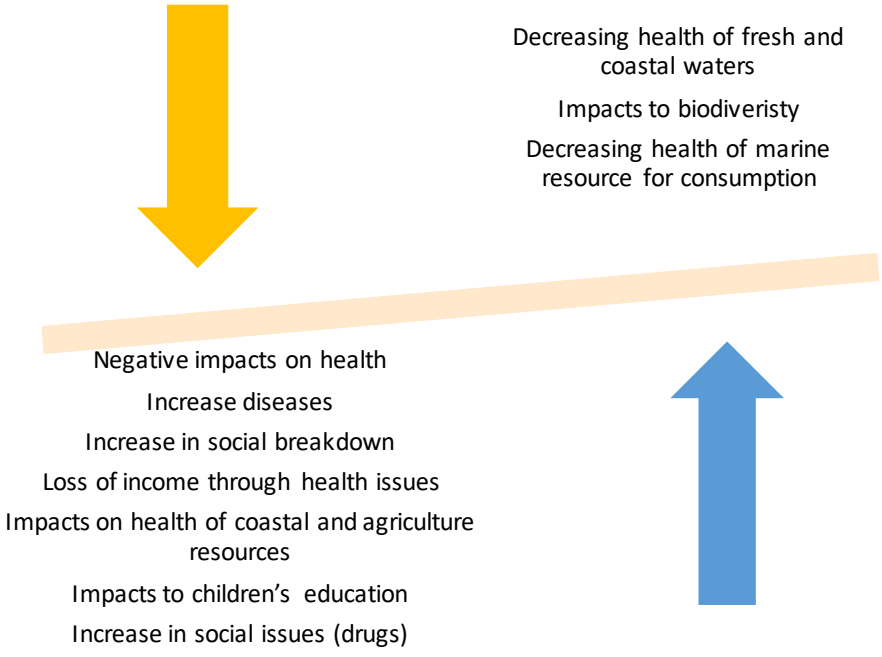


Figure 8 Chart showing the environmental and social issues related to deteriorating water quality identified during the stakeholder workshop in July 2021. Environmental issues are shown in the top with increasing social issues underneath.

Continuing degradation and decline of water quality, both fresh and coastal, increases the social impacts due to the loss of income and ability to provide for the family. Polluted habitats and resources not only affect biodiversity but reduce the efficiency and services of the habitats to humans. Increasing economic and social hardship result in the potential for poor choices to make money and provide for the family, with families and youth turning towards drug use.

5.3.3 Linkages with other national problems

The state of coastal waters and the increase in pollution from liquid waste management also impacts the status and health of coastal and marine habitats and biodiversity, as well as directly impacting the health and socio-economic well-being of communities as discussed above.

Human health is impacted by poor solid and liquid waste management through increases in bacteria in the water as well as from waste that lies discarded on coastal areas, which contributes to increasing flies and potential for diseases in both animals and humans. Waste also gets blown into the coastal waters impacting on the marine biodiversity and affecting management programmes such as SMAs.

5.3.4 Immediate, underlying and root causes

Figure 9 is the information collected from the diagnostic analysis workshop held in June and July 2021 showing the immediate, underlying and root causes identified.

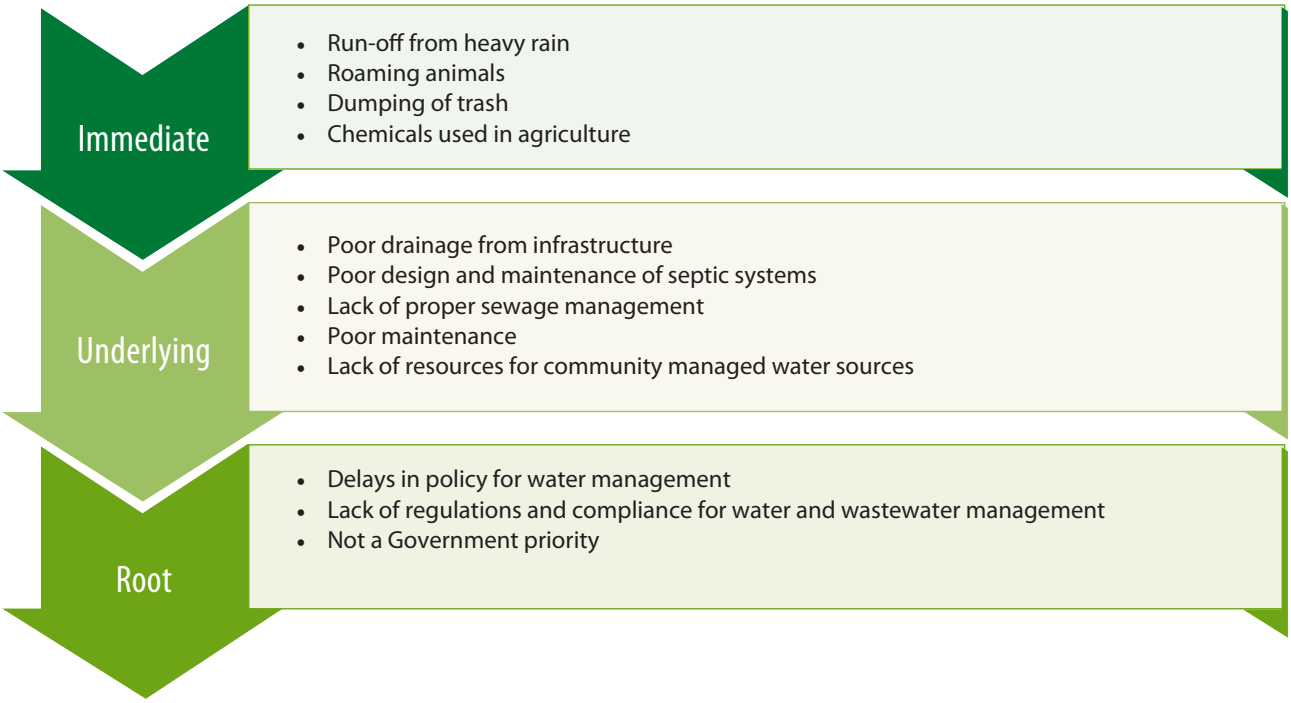


Figure 9 List showing the immediate, underlying and root causes for water quality identified during the stakeholder workshop.

The impacts of heavy rain has been identified as a climate related hazard with heavier rainfalls predicted (Government of Tonga 2018a). This increase in heavy rainfall is impacting upon the land and coastal waters through run-off and transfer of sediments and pollution of freshwater and coastal habitats (IWCM 2013) with sediment and run-off transferring increased nitrates, ammonia and phosphates from the use of agricultural fertilisers, pesticides and fungicides. Nitrates and phosphates are also increased from roaming animals (Lokotui 2021). Underlying issues for flooding and run-off are the poorly maintained drainage systems and improper road repairs that increase tar and bitumen layers with elevation above land topography, thus increasing flood areas.

Community management of water resources has been established for private wells and bores outside the urban areas and the TWB (Tonga Water Board) jurisdiction. These community water committees, which comprise men, women, and youth from communities, have limited resources to properly manage and monitor water quality and freshwater levels. Monitoring of the freshwater supplies is conducted by the Ministry of Lands and Natural Resources and the Ministry of Health for potential disease from bacteria.

Household and commercial sewage and septic systems have limited guidance in design for porous limestone and volcanic islands with the building codes regulations of 2016 showing no recommendations for septic placement and design and are only indicated in the public health act stating "the minister may specify standards for septic tanks, relating to site, size, frequency of emptying, ventilation, control of discharge, proximity to public or domestic water supplies and avoidance or nuisance to injury or health" (Government of Tonga 2016c).

Solid waste management within the coastal areas is an ongoing issue that is linked to immediate issues with illegal dumping and littering occurring through all island groups. This waste breaks down through wear from rain and wind as well as being rooted around in by pigs and dogs. The seepage from rain washing over waste, particularly discarded batteries, and metals, increases the impacts to human health through polluted fresh and coastal waters.

Regulations and legislation are integrated into national plans and development goals, including the Environmental Impact Assessment 2010 (Government of Tonga 2003), to benefit all housing and infrastructure by employing best practices for liquid and solid waste. However, there remains to be challenges in compliance and enforcement. Furthermore, the effectiveness of the legislation would depend on socialising it nationally as a way of improving social and health issues, with priority actions identified and adequately funded.

5.3.5 Knowledge gaps

There is need for data from the hospital to be shared with government ministries, communities and NGOs/CSOs working on water quality to raise awareness on the range of health issues that may be attributed to degrading water quality. Knowing and understanding the range of gastrointestinal (Giardiasis, etc), skin and other direct health issues would help inform awareness campaigns and interventions to directly deal with the issues.

Water quality indicators and evaluations need to be consistent in the timeframes conducted; often one-off results do not show the true extent or relationship between environmental issues. Long term monitoring stations for impact areas and control sites (areas of similar habitat or resources but different in pressure) are important in managing the data. Long-term sites should have some fixed equipment on the coastal areas to monitor coastal water and sediment movements from the land. These sediment gauges and tidal stations can be monitored by community.

Awareness campaigns have been conducted widely through news, radio, and consultations, however, the knowledge has not created ownership of issues or management potential. There is a need to create other avenues for knowledge sharing through non-formal methods, including social media and youth platforms.

5.3.6 Conclusions and recommendations

Water quality issues have long been observed and recorded in Tonga, with varying levels of intervention however, limited human and financial resources at both government and community level means that efforts are stagnated, often replicated, and not monitored or evaluated towards a best practice scenario and balanced better within regulations. The Water Resource Bill 2020 will provide beneficial governance mechanisms, however, needs broad scale consultation and awareness across sectors to be better understood. Single sector development programmes are an ongoing challenge for improving water management holistically, including strengthened and renewed policy for structures and management of liquid waste including septic systems. The water quality issues are too big for any one entity or partner to deal with and need a full multi-focus engagement to plan, implement and monitor changes. Without policy reform and resource alignment, the issues will continue to magnify through the social and economic impacts.

Priorities need to be centred around shared responses to monitoring and management of freshwater resources. This can be done by strengthening the community water committees through provision of resources and training and engaging further with women and youth groups and committees within the community.

Town and District officers are elected officials that are primarily in place for overseeing the community and reporting on issues and impacts that are occurring. With population and development increases, the duties of the town and district officers have become broader than the training provided to them. Environmental, social and health issues are now a large part of the duties, however resources are not there to support them. Engaging with youth and women's groups to monitor and manage some of the issues would be beneficial, however government and partners need to offer support and resources for simplified monitoring and reporting.

SMA committees that are managing the coastal fishery resources can also play an integral part in monitoring the health of the coastal habitats, including the identification of changes associated with water quality issues.

5.4 National Priority Issue: Exploitation of Marine resource

Fishing and coastal marine resources are very important for the subsistence and livelihoods of communities; economic activities such as commercial fishing and tourism; and the social and cultural ties to the ocean. The decline of marine resources has been heavily documented in Tonga, including through the Rapid Assessment of Biodiversity of the Vava'u Archipelago 2014 (Atherton et al 2014) that included the uninhabited islands and identified higher biodiversity areas and analysis of coastal SMA areas for community fisheries (Smallhorn-West et al. 2020).

5.4.1 Description of the problem and its national importance

In 1875 Tonga's constitution as a Monarchy declared that all land and sea belonged to the King and was further reinforced under the Lands Act 1927. Tonga's ocean and coastal areas were deemed open access to all Tongans and any traditional or local control or management authority over fishing areas was to be abolished (Gillett 2017). This open access nature though very in tune with the concept of community sharing, also resulted in increased fishing activity as fishing equipment, methods and populations increased over time. The easily accessed coastal resources declined and fishers had to travel further to find fishing grounds (Smallhorn-West et al. 2019). The need for better fisheries management was raised by communities concerned with other island groups fishing within their local waters. In 2002, the Fisheries Management Act was amended to include community management called Special Management Areas (Government of Tonga 2002a). The Fisheries Coastal Community Regulations were developed in 2009 and have since been amended with each SMA gazette (Government of Tonga 2020).

Marine resources have also been affected by coastal development, especially wharves and jetties, where wave and coastal tidal movements and direct building have changed beaches, coastlines, coral, and seagrass habitats.

5.4.2 Major environmental impacts and socio-economic consequences

Environmental impacts and socio-economic consequences are shown in Figure 8 as identified at the stakeholder workshop held in Tongatapu in July 2021.

The expolitation of marine resources includes coastal fisheries for reef fish, near-shore pelagics and marine invertebrates such as sea cucumbers that are harvested for commercial processing of beche-de-mer. Marine species and habitats are interrelated in providing ecosystem services to humans, including protection from storms and surges, food, and cultural and traditional activities. With the exploitation of marine resources, the ecoystem becomes weakened. This includes algal dominated shifts to coral reefs due to low abundance of herbivores and grazers such as parrot fish, surgeon fish and rabbit fish (Stone et al. 2017).

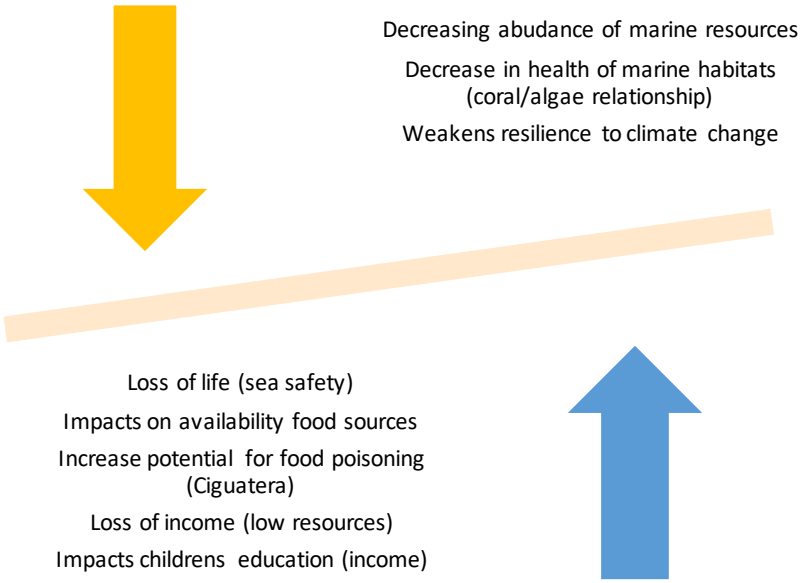


Figure 10 Chart showing the environmental and social issues related to declining marine resources identified during the stakeholder workshop in July 2021. Environmental issues are shown at the top with increasing social issues underneath.

With declining health of coral reefs and the increase of marine algae, the dinoflagellate *Gambierdiscus toxicus* becomes more prevalent. It is consumed by marine fish (grazers and herbivores) such as parrotfish, surgeonfish and rabbitfish. These fish are preyed upon by barracuda and some snappers (*Lutjanus bohar*), which are then consumed by humans. The dinoflagellate, which accumulates in the fish, causes ciguatera poisoning in humans. As the toxin moves up the food chain, it escalates in the impacts to human health (Skinner et al. 2011). Climate change will continue to increase the potential for ciguatera poisoning to occur within Tonga.

Loss of marine species and resources for food and money heavily impacts upon the choices families have for their livelihoods. Declining marine resources ensure that fishers must travel further, often with vessels and equipment not suitable for more open ocean areas. This potential for loss of life and loss of income for families impacts on the social structure, including providing education as well as increasing the potential for social activities to change. Loss of income and livelihoods would therefore impact on both men and women and their roles in food and income security.

5.4.3 Linkages with other national issues

Food security is greatly important in Tonga for providing local produce and domestic economic markets. The impacts of COVID-19 have vastly increased the need for more sustainable locally sourced foods that are not only economically beneficial but also important from a health standpoint. Non-communicable diseases (NCDs) are impacting a large percentage of the population and, according to a report from 2015, NCDs accounted for 74% of human deaths (Government of Tonga et al. 2015).

Improving the abundance and health of the marine habitats and marine species plays a big role in the overall health of the population of Tonga.

5.4.4 Immediate, underlying and root causes

The causes listed in Figure 9 were expanded on at the stakeholder workshops in July and August 2021.

Figure 11 List showing the immediate, underlying and root causes of declining marine resources identified during the stakeholder workshop.

Despite regulations such as the Fisheries Act 2002, destructive fishing practices such as the use of natural form cyanide known as 'aukava, that is derived from a native plant known as kava huhu (Tongilava 1994) are still utilised in the island districts as recorded by the Global Reef Expedition in 2013 (Purkis et al. 2017).

Despite effort and large investment by the Ministry of Fisheries, donor and NGO partners and communities, and despite the importance of fisheries to the social and environmental security of Tonga, the development policies, actions and directives to reduce exploitation is not a national priority. Fisheries policies are not in place that directly address exploitation, and compliance with current legislation is hard to enforce across the communities.

5.4.5 Knowledge gaps

There is a need to increase the feedback to communities and fishers on the surveys and data being collected and look towards the benefits of community knowledge for sharing future pathways for improving the marine resources.

Alternative aquaculture and livelihood activities need to have proper feasibility surveys, including assessing environmental and social impacts with the community for better understanding of the practices and the species to be introduced.

Cross-ministerial training and cooperation needs to happen regularly for an infrastructure development framework to properly address minimising the impacts on coastal resources and implementing wastewater strategies that reduce sedimentation and run-off.

5.4.6 Conclusions and recommendations

There are many coordinated and beneficial programmes being conducted relating to the marine environment, including the Special Management Area programme through Ministry of Fisheries and development of food security and economic aquaculture to relieve the pressure on the marine resources. These programmes need to be supported by R2R projects and activities to reduce the land-based impacts, including waste management, sand mining, land development and water quality that are also impacting the coastal water health.

The dependency of communities on coastal fisheries for subsistence and food security is paramount. Therefore, while supporting the efforts in SMAs, it is equally important that local fishers, including men and women are not deprived of their rights to access and exploit the resources for subsistence use. There are guidelines and measures in the management plans that already provide for the restrictions of sizes, weights and restricted areas in edible marine fish and invertebrates that can be harvested. There also programmes for replanting and rehabilitation of degraded habitats with corals, giant clams and other species that can be used to increase current stocks.

Training and adoption of land use planning at community and district level is an integral part of monitoring and management control that will have positive benefits on coastal fisheries. Exploitation of marine resources is one indicator of an overused ecosystem, however, ecosystems weakened from pollution, sedimentation and eutrophication cannot sustain marine species populations and further extraction of marine species will exacerbate impacts.

RAPCA Principal Investigator Karen Stone conducting training on the 100 meter Transect at the Intertidal area at Fo'ui Village. Photo credit: Pacific R2R Programme

6 Options for Reform and Action

R2R processes are important in an overarching holistic approach to ecosystem-based management that aims to maintain and enhance ecosystem goods and services and improve economic and social well-being while providing pathways for adaptation and mitigation to climate change.

Determining root causes and ensuring that R2R processes are mainstreamed can be done through the Tonga Strategic Development Framework (TSDF). The TSDF is the umbrella framework for Government and filters down to communities and NGOs and CSOs. It provides guiding principles for everyday practices that strengthen the governance and management of Tonga's resources. To move R2R process into mainstream government approaches, the TSDF, which will be revised for 2025, needs to incorporate wording and recommendations on activities and approaches for social and economic development while effectively managing natural resource use.

A key component of the R2R process will be the development and implementation of land use plans through national spatial planning and addressing issues related to land use, agriculture and liquid and solid waste management.

Knowledge exchange and sharing of best principles is essential to the R2R process and can be achieved by engaging with the Public Service Commission that trains and liaises with all civil servants. An environmental component should be introduced into new staff training so all government ministries can benefit from the information and approach of R2R.These training programmes can also include gender and social inclusion awareness to ensure the meaningful participation of women, youth, and all vulnerable members of communities in all project interventions.

There are many policies and legislation already in existence in Tonga that are beneficial to R2R management and principles, however emphasis needs to be on the overlap between Ministries on the same resources and ensure that programmes and legislation are streamlined. Some legislation needs to be updated and amended, one of the main ones being the Building Code (Government of Tonga 2016a) to include best practices for septic and liquid waste management as well as supporting beneficial activities such as composting toilets and sand filtering systems.

Similarly, the Environmental Impact Assessment of 2010 is not widely implemented for domestic, and Government led activities and primarily only when there is private or development funding. Ensuring the principles of an EIA are progressive to the changing environment and development needs for climate change, the EIA regulations need to be better conducted and enforced at a government level.

District and town officers were originally engaged to address the social issues in the communities; however, they have limited resources and training for dealing with the increasing environmental, social, and economic issues. Implementing a broader community committee, such as the Hihifo youth council, could be beneficial for supporting the town and district officers in R2R monitoring and processes. There will be consideration for gender inclusion in these committees to ensure wider community ownership. Funding grants can also be applied for by the youth councils and CSOs/NGOs to support activities.

Reform and action to address immediate and underlying causes can be implemented through a multi-stakeholder engagement process, which includes strengthening community led programmes such as the district and youth councils of Hihifo, through training and knowledge-based programmes on water resources, basic environmental assessments and reporting and financing skills. The potential for smaller effective and inclusive working groups can lead to a better broader implemented R2R programme. A multi-stakeholder engagement process will also ensure the participation of women and marginalised groups in planned community led engagements.

Local employment on projects and development programmes needs to be supported to better provide for inclusive approaches and ensure traditional knowledge and existing leadership approaches are acknowledged and incorporated within international development frameworks. These are also entry points for inclusion of women, youth, and other sectors of the community. Increasing local engagement can also strengthen data management for monitoring and evaluation.

Island Diagnostic Analysis Workshop- 21/07/2021.The Island Diagnostic Analysis (IDA) provides a framework for identifying and examining local and national environmental and social impacts within a Ridge to Reef process.

7 Summary and conclusions

The process of R2R management is currently being implemented through several independent sector programmes. It would be of better value to the holistic ecosystem-based approach if synergies are established between these sector-based programmes and reported under an umbrella committee for consistency and collaboration. The National Environment and Climate Change Committee (NECC) would be best suited for ensuring collaboration on R2R programmes is facilitated and strengthened at a governance level. By incorporating R2R design and objectives through the TSDF and other formal sector plans, the NECC can help facilitate and strengthen governance and implementation of R2R approaches from the foundational stages.

The inclusion of community and civil society/NGO partners is often mentioned throughout sector and formal plans, however the development of partnerships, sharing of information and capacity for strengthening planning and programme objectives needs to be secured in activities. Community engagement is important especially in ensuring the participation of community representatives, men, women, and youth in planned interventions. Work by CSOs and NGO partners is usually gender and socially inclusive, thus development of partnerships and sharing of information with these groups will mean inclusion of all sectors of communities in interventions.

R2R management (integrated management) is a term used in varying and differing ways across projects. Government ministries and partnerships, consistency in reporting and accounting would show a great deal of approaches to R2R principles, however currently it is divided by individual sectors.

Many approaches to new management and programmes are to bring new committees and resources to the project, however this can often lead to increasing duplication of systems, programmes, and recommendations. Streamlining the approach and re-evaluating and re-defining current systems and reporting would be widely beneficial to an on-going multi-partner approach and to ensure that confusion at community level is reduced and inclusive partnerships can be strengthened to increase ecosystem-based management, implement community led initiatives and support governance approaches that benefit biodiversity, social and economic activities.

References

Atherton J., Mckenna S. and Wheatley A. 2014. Rapid Assessment of the Biodiversity of the Vava'u Archipelago. Samoa: SPREP.

Cara P. 2021. Rapid Assessment of Priority Coastal Areas (RapCA) in the Hihifo District Tongatapu. Social and Economic Survey Report.

Ceccarelli D. M., Hans W., Matoto A., Fonua E. and Fernandes L. 2017. Biophysically Special Unique Marine Areas of Tonga. MACBIO (GIZ, IUCN, SPREP), Suva.

EM-DAT. 2017. Disaster Centre for Research on the Epidemiology of Disasters (CRED). https;//www.emdat.be

Fakhruddin B.S., Reinen-Hamill R. and Robertson R. 2019. Extent and evaluation of vulnerability for disaster risk reduction of urban Nuku'alofa, Tonga. Progress in Disaster Science, 2,

Gillett R. 2017. A Review of Special Management Areas in Tonga. FAO Fisher. 54.

Government of Tonga. 1988. District and Town Officers Act, 14.

Government of Tonga. 2002a. Fisheries Management Act 2002, 69.

Government of Tonga. 2002b. Land Act.

Government of Tonga. 2003. Environmental Impact Assessment Act. https://ago.gov.to/cms/images LEGISLATION/PRINCIPAL/2003/2003-0016/EnvironmentalImpactAssessmentAct2003_1.pdf?zoom_ highlight=Environmental+Impact#search=%22Environmental%20Impact%22.

Government of Tonga. 2016a. Building Control and Standards Regulations, 41.

Government of Tonga. 2016b. Environmental Impact Assessment Regulations. https://ago.gov.to/cms/images/ LEGISLATION/SUBORDINATE/4704/4704-0001/EnvironmentalImpactAssessmentRegulations_2.pdf?zoom_ highlight=Environmental+Impact#search=%22Environmental%20Impact%22.

Government of Tonga. 2016c. Public Health Act, 89.

Government of Tonga. 2018a. Joint National Action Plan 2 On Climate Change and Disaster Risk Management 2018-2028. 2.

Government of Tonga. 2018b. Tonga State of Environment Report. SPREP.

Government of Tonga. 2020. Fisheries (Coastal Communities) Regulations, 113.

Government of Tonga, Australian Aid, World Health Organization, and Tonga Health. 2015. National Strategy for Prevention and Control of Non-Communicable Diseases 2015-2020. https://www.dfat.gov.au/sites/default/files/tonga-national-non-communicable-disease-strategy-2015-20.pdf.

IRDR. 2014. Peril classification and hazard glossary (IRDR DATA). Beijing: Integrated Research on Disaster Risk; 2014.

IWCM. 2013. Water Quality and Coastal Monitoring Results.

JICA. 2010. Country Gender Profile: The Kingdom of Tonga. IMG Inc.

Katoa A. E. 2020. Water Resources Bill 2020, 19.

Lal P. N. and Takau L. 2006. Economic Costs of Waste in Tonga. IWP-Pacific Technical Report (International Waters Project), no. 33. Apia, Samoa: SPREP.

Lokotui S. 2021. Coastal Water Quality Assessment Report: Rapid Assessment of Priority Coastal Areas, Hihifo, Tongataou, Kingdom of Tonga.

Di Maio, F. and Rem C. R. 2015. A Robust Indicator for Promoting Circular Economy through Recycling. Journal of Environmental Protection, 6, 1095-1104. http://dx.doi.org/10.4236/jep.2015.610096

Ministry of Finance and Planning, Government of Tonga. 2015. Tonga Strategic Development Framework 2015-2025. http:// www.finance.gov.to/sites/default/files/2018-06/TSDF%20II_English_printed%20to%20LA%20on%2019May2015_0.pdf.

Newton A. F. 2008. Sanitation and Wastewater Management in Tonga, 25.

Pacific Community. 2019. Gender equality: Where do we stand? The Kingdom of Tonga. Ministry of Internal Affairs.

Pacific R2R. 2018. "GEF-R2R - Developing an Island Diagnostic Analysis - Final-3.Pdf." https://www.pacific-r2r.org/.

Powles G. 2014. The Tongan Monarchy and the Constitution: Political Reform in a Traditional Context. Australian National University.

Prescott N., Kaly U., Taufa P., Matoto L., Lepa S. T., Faletau T. and Palaki, A. n.d. Environmental Management Plan for Fanga'uta Lagoon System, 12.

Purkis S., Dempsey A.C., Carlton R.D., Samaniego B., Lubarsky K., and Renaud P. P. 2017. Global Reef Expedition Final Report 8: 60.

Rijal A. (2018). Integrated Environmental Management of the Fanga'uta Lagoon Catchment – Terminal Evaluation Report.

Sem G. 2019. Third National Communication on Climate Change Report: In response to its obligations under the United Nations Framework Convention on Climate Change.

Skinner M. P., Brewer T. D., Johnstone R., Fleming L. E. and Lewis R. J. 2011. Ciguatera Fish Poisoning in the Pacific Islands (1998 to 2008). Edited by Charles H. King. PLoS Neglected Tropical Diseases 5 (12): e1416. https://doi.org/10.1371/journal.pntd.0001416.

Smallhorn-West P. F., Bridge T. C. L., Malimali S., Pressey R. L. and Jones G. P. 2019. Predicting Impact to Assess the Efficacy of Community-Based Marine Reserve Design. Conservation Letters 12 (1): e12602. https://doi.org/10.1111/conl.12602.

Smallhorn-West P. F., Sheehan J., Rodriguez-Troncoso A., Malimali S., Halafihi T., Mailau S., Le'ota A., Ceccarelli D., Stone K., Pressey B. and Jones G. 2020. Kingdom of Tonga Special Management Area Report 2020. 86 p.

SOPAC. 2007a. Sustainable Integrated Water Resources and Wastewater Management, 73.

SOPAC. 2007b. Sustainable Integrated Water Resources and Wastewater Management, 73.

Spennemann D. R. 2004. The June 1847 Eruption of Fonualei Volcano, Tonga. An Historical Analysis. 196. Charles Sturt University. http://csusap.csu.edu.au/%7Edspennem/ReportStore/JCReport196.pdf.

Stone K., Lokotui S., Kara P. and Leger S. 2021. Review of Rapid Coastal Assessment (RapCA) in the Hihifo District, Tongatapu, by George Naboutuiloma, Antoine Y'ert, Samsoni Sauni, John A Carreon, Fononga Vainga Mangisi-Mafileo, Jose Antonio, and Hilda Waqa-Sakiti. Suva, Fiji SPC, 58.

Stone K., Gómez-Buckley M., Stobart B., Buckley R., Halafifi T. and Matoto A. 2017. Project for Development of Conservation Monitoring and Assessments of Coral Growth and Coral Recruitment, Zooplankton Communities, and Cryptobenthic Fishes, in the Vava'u Archipelago, Kingdom of Tonga – March/April 2017., 61.

Stone K., Matoto A., Aleamotua P. and Fekau A. 2016. Marine Ecosystem Health Monitoring Program, Kingdom of Tonga. SPREP.

Stone K., Mengerink K., Estep A., Halafihi T., Malimalii S. and Matoto A. 2017. VOI Interim Marine Expedition Report.

Takau, Yvonne. 2019. "The Development of Planning Processes in Tonga and the Impact of the 2006 Riots," 141.

Toetu, A. 2014. Ki He Lelei Taha: Talanoa Mei He Kaliloa of Successful Tongan Graduates, 346.

Tonga Statistics Department. 2016. Household-Income-and-Expenditure-Survey-Report-20152016.pdf.

Tonga Statistics Department. 2018. Labour Force Survey Report 2018-Labour-Force-Survey-Report.pdf.

Tongilava, S. L. 1994. Traditional Practices and Their Implications for Sustainable Development in Tonga. SPREP Reports and Studies, no. 71. Apia, Western Samoa: South Pacific Regional Environment Programme.

United Nations Climate Technology Centre and Network. 2018. Government of Tonga Energy Efficiency Master Plan. https://www.ctc-n.org/system/files/dossier/3b/deliverable_3.3._final_teemp.pdf

Appendices

Appendix I: List of Participants at the Island Diagnostic Analysis workshop in Tongatapu on the 21st of July 2021

Date: 21-Jul-21

#	Name	Ministry/ Agency	Gender (M/F/O)
1	Siola'a Malimali	Ministry of Fisheries	Male
2	Amanda Le'ota	Ministry of Fisheries	Female
3	Peta Koloamatangi	Department of Environment/MEIDECC	Female
4	Lola Tonga	Waste Authority Limited	Female
5	Eleni Latu'ila	Ministry of Internal Affairs/WAGED	Female
6	Mele Kioa	Ministry of Agriculture, Food, Forestry	Female
7	Emaloni Tongi	Live and Learn Tonga	Male
8	Sione Tokai	Ministry of Finance & National Planning	Male
9	Amelia Sili	Ministry of Lands & Natural Resources	Female
10	Susitina Ta'ai	Ministry of Lands & Natural Resources	Female
11	Karen Stone	Vava'u Environment Protection Association	Female
12	Melesila Weilert	Ha'atafu Community(	Female
13	Sivilaise Manumanu	Ahau Community	Female
14	Sione Manumanu	Hihifo District Officer	Male
15	Siosaia Ma'asi	Hihifo Constituency Council	Male
16	Losaline Ma'asi	Tongatapu 5 Parliament Representitive	Female
17	Samuela Finau	Youth Council - Hihifo	Male
18	Tupou Pinomi	Hihifo Constituency Council	Female
19	Marika Moala	Tonga Red Cross	Female
20	Elisapeti Veikoso	Marine Spatial Plan	Female
21	Maka Matekitonga	PUMA	Male
22	Tu'amelie Fusimalohi	Department of Environment/MEIDECC	Male
23	Sesimani Lokotui	Small Grants Programme, Civil Society	Female
24	Renny Vaiomo'unga	Ministry of Lands & Natural Resources	Male
25	Silia Leger	IWR2R/Ministry of Lands & Natural Resources	Female
26	Kilistina Moala	IWR2R/Ministry of Lands & Natural Resources	Female
27	Angelic Pale	IWR2R/Ministry of Lands & Natural Resources	Female
28	Lutolofi Taunisila	Ministry of Lands & Natural Resources	Male
29	Heidi Muller	R2R, Youth Council TBU 5	Female

Appendices

Appendix II: Participants at the diagnostic analysis and training in Vava'u, July 2021

International Waters, Ridge to Reef Tonga Project

Island Diagnostic Analysis

Date: 27th July 2021 Location: VEPA Office

No	Name	Ministry/Agency/Community	Gender (M/F/O)	Phone
1	KAREN STONE	VEPA	F	7833018
2	Mele Finau	MEIDECC	F	7742542
3	STANELY TAMIFOTE	TOWNOFFICER TAUFAHAU	M	8736108
4	Vetekina Pau	Ministry of Fisheries	F	8620817.
5	Niuia Lolohea	Community	F	7512272
6	Tupou Nonu	USP	F	70-545
7	Maee 'Esau	VEPA	F	8613457
8	Halaniehi 'Asitomani	Community	F	7714171
9	Susana Ika	VEPA	F	7793695.
10	Sesilia Hausia	VEPA	F	8603055
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International Waters, Ridge to Reef Island Diagnostic Analysis