



# State of the Coast Report

## Kingdom of Tonga

February 2022





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# Abbreviations

<b>CBD</b>	United Nations Convention on Biological Diversity
<b>CBO</b>	Community Based Organisation
<b>CSO</b>	Civil Society Organisation
<b>DPSIR</b>	Driver, pressure, state, impact, and response framework
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>GEF</b>	Global Environment Facility
<b>ICM</b>	Integrated Coastal Management
<b>IDA</b>	Island Diagnostic Analysis
<b>IWCM</b>	Integrated Water and Coastal Management
<b>IUCN</b>	International Union for Conservation of Nature
<b>MAFF</b>	Ministry of Agriculture, Forests and Foods
<b>MARPOL</b>	International Convention for the Prevention of Pollution from Ships
<b>MEIDECC</b>	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communication
<b>MET</b>	Ministry of Education and Training
<b>MIA</b>	Ministry of Internal Affairs
<b>MLNR</b>	Ministry of Lands and Natural Resources
<b>MoF</b>	Ministry of Fisheries
<b>MoT</b>	Ministry of Tourism
<b>MPA</b>	Marine Protected Area
<b>NBSAP</b>	National Biodiversity Strategic Action Plan
<b>NGO</b>	Non-governmental organisation
<b>PMU</b>	Project Management Unit The Pacific Community
<b>RPCU</b>	Regional Programme Coordination Unit
<b>SMA</b>	Special Management Area
<b>SoE</b>	State of the Environment Report
<b>SPC</b>	The Pacific Community
<b>SPREP</b>	Secretariat of the Pacific Regional Environmental Programme
<b>TSDf II</b>	Tongan Strategic Development Framework
<b>TWD</b>	Tonga Water Board
<b>UNDP</b>	United Nations Development Program
<b>VEPA</b>	Vava’u Environmental Protection Association

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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 International Waters Ridge to Reef (IWR2R) project is funded by the Global Environment Facility and executed by Pacific Community (SPC) through the Geoscience, Energy and Maritime (GEM) Division in Suva, Fiji and nationally implemented under the Ministry of Lands and Natural Resources, Government of Tonga.

The project is testing innovative technologies and management measures addressing municipal waste pollution and protection of coastal habitats and wetlands and responding to domestic development in the Kingdom. Specifically, the Tonga IWR2R demonstration project aimed to deliver on its environmental stress reduction target (104 TN/kg/yr), which corresponds to conversions of six household sanitation systems to compost toilets. There is also the target of 90 ha of wetland that has been protected and conserved. The construction of household compost toilets and sand filter systems in schools has been successfully completed and the Integrated Coastal Management (ICM) planning is close to completion, jointly prepared with the Ministry of Fisheries.

The livelihoods and economic development of Tonga's communities are focused on the coastal areas; thus, impacting on coastal and marine resources, habitats, and species. In turn, the impacts also affect cultural and social needs of households to fish, farm and gather for subsistence use. Tourism and shipping rely on the coastal lands and seas for development and engaging with people about the beauty of nature and people in Tonga. Often unknown or unseen, are the issues linking the land and sea and renewable and non-renewable sources.

The watershed catchment and coastal habitats of Tonga are important to the environmental, social, and economic wellbeing of the local population. The underground water lenses within the limestone and volcanic rock formations provide an abundance of freshwater, and slowly seeps from land to sea. For instance, surface water found in 'Eua, Niuas and Ha'apai are formed in freshwater craters in volcanic and mixed geology rocks and brackish lakes in Nomuka and Longomapu. Other forms of catchment are from runoff over lands that seep through the rocks or run towards the coastal on sloping elevations of the landscape.

Pollution is a priority concern in the Kingdom and comes in the form of liquid and solid waste with faecal matter derived from roaming animals within the water catchment and coastal areas, as well as poorly maintained and implemented septic systems. This pollution impacts not only the freshwater lenses, but seeps into the coastal areas, trapping excessive nutrients and bacteria in sensitive habitats such as mangroves, seagrass, and coral reefs.

Moreover, climate change and natural disasters put further pressure on social and environmental systems, with changes to families and infrastructure putting greater demand on the use of limited natural resources. Ecosystems and habitats that are polluted or under other threats from human activities can no longer sustain external shocks and increasing anthropogenic impacts.

Resource and environmental management, as well as adaptation programmes need political and stakeholders' support to ensure that effective policy, adequate resourcing, and implementation is conducted through interventions for the priority areas of waste management, water resource quality and exploitation of natural resources. These priority focal areas were identified during the workshops for island diagnostic analysis in June/July 2021.

Management programmes and resource-based projects, which are supported by regional and national donor partners, are undertaken by ministries, NGOs/CSOs and communities. Sharing and implementation of these programmes and activities nationally ensures better understanding as well as progress in growing national capacity. Annual workplans from the relevant line ministries need to support and reflect strategic and cohesive actions with budget support to reduce and mitigate ongoing, immediate, and underlying causes, with political support and acknowledgment of the root causes through environmental and social awareness.

Ongoing capacity building and institutional strengthening needs to build in future R2R investments and ICM planning. Communication, knowledge, and training need to be improved and implemented through existing mechanisms, such as the community committees already implemented for water resources and coastal fisheries. Expanding on these functioning committees with provision for other training can be beneficial from a ridge to reef perspective.

This State of the Coast report outlines the threats and pressures faced through natural and human derived activities. It also provides an analysis of options for strategic priority actions and finding a pathway for improving the ecological and social benefits of the coastal areas.

# Introduction

The International Waters Ridge to Reef (IWR2R) project is funded by the Global Environment Facility and implemented through the regional programme co-ordination unit (RPCU) at the Pacific Community (SPC) through its Geoscience, Energy and Maritime (GEM) Division in Suva, Fiji and nationally implemented under the Ministry of Lands and Natural Resources.

R2R programmes foster sustainability and resilience for island nations through policy reform and intervention, strengthening of institutions, capacity, and coordination for implementing the integration of land, water, and coastal management programmes through evidence-based approaches.

The IWR2R project in Tonga selected the Hihifo district of Tongatapu as the demonstration site. Project activities at the demonstration site include the Rapid Assessment of Priority Coastal Areas (RapCA) and the development of a Special Management Area (SMA) at Kanokupolu, where over 300 hectares of mangroves, seagrass and fringing reefs are being conserved by community led management. The RapCA report documents priority environmental impacts on the coastal biodiversity (marine and terrestrial) at the demonstration site. Further, the IWR2R project developed the Hihifo youth council that is enabling youth led programmes, training, and grant management towards R2R approaches (Pacific R2R 2020).

In 2021, the IWR2R programme implemented the diagnostic analysis, which consisted of a series of stakeholder workshops and participatory consultations. The workshops provide an opportunity for stakeholders (men, women, youth, leaders) to gather cross-sectoral information on environmental and social impacts and set priority focus areas that benefit R2R management for adaptable and implementable activities (Stone, Leger et al. 2021).

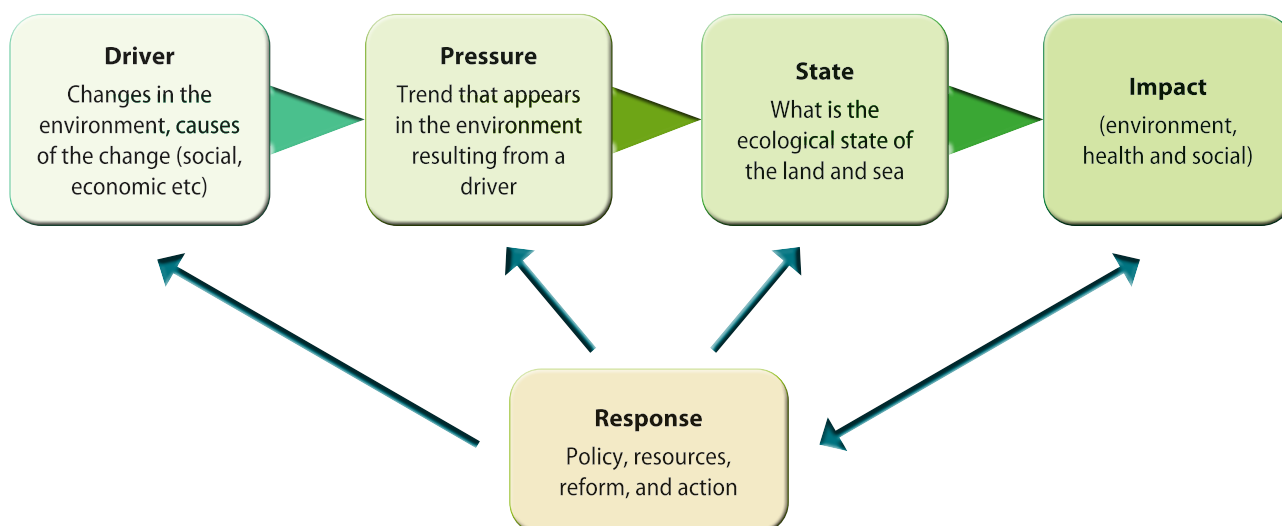
The island diagnostic analysis (IDA) covers issues related to all the Kingdom of Tonga, including the outer island districts Ha'apai, Vava'u, Niuatoputapu and Niufo'ou (the Niuas). A policy and reform workshop was held with national leaders from government, private sector, and community to identify and aid discussions for strengthening and mainstreaming R2R management and practices for the coastal areas of Tonga.

The participants at the diagnostic analysis workshops represented different relevant line ministries of the government, community, and private sector. The diagnostic analysis workshops utilised indicators and logarithmic scales to assess the environmental impacts. The workshop outcomes cover, amongst others, natural and anthropogenic threats and root causes impacting on natural resources and ecosystem goods and services. The detail on these impacts and priority policy interventions are documented in the Island Diagnostic Analysis Report 2021 (Stone, Leger et al. 2021).

The State of the Coast (SoC) report describes the condition of the biophysical, socio-economic, and institutional environments as they relate to Tonga's coastal zone. It describes the current situation as baseline and uses historical information, where available, to assess changes to the coast over time. The Tonga SoC report is designed for natural resource managers, government agencies, civil society, non-governmental organisations, community leaders and donor organisations to provide a framework for addressing the growing environmental and social impacts through a ridge to reef process.

## Indicator Assessment Summary

The indicator assessment was designed by the RPCU technical committee and agreed upon by the IDA technical committee under the project management unit at MLNR. It incorporates the driver, pressure, state, impact, and response (DPSIR) framework as shown in Figure 1.



Utilising the framework for identifying the environmental and social impacts on the coastal areas in Tonga. The DPSIR framework incorporates a continual analysis of the status and provides avenues for developing policy and reform to improve the State of the Coast in Tonga. Image is adapted from materials provided by RPCU (SPC 2020)

Indicators used to determine the drivers for the SoC report replicate those used in the Government’s previous work on developing the state of environment. This will enable continuity of assessments and ease of reporting towards objectives in the future (Government of Tonga 2018).

## Current State of the Environment

The current state of the environment within the coastal areas is dire, impacting heavily on biodiversity, livelihoods, culture, and the welfare of society, which is largely dependent on ecosystem goods and services. As the local population increases, so does the demand for further economic development, which in turn will impact on the limited natural resources, as well as constraining ecosystem services.

The Tonga SoC report identifies the current state of biophysical, socio-economic, and institutional environments, and documents spatio-temporal changes to the coastal zone. It identifies the priority threats and challenges impacting coastal zones in the Kingdom, and what strategic frameworks and plans are in place to address such threats, informs policy decisions and political support for immediate actions.

Trends are used to monitor the activity being implemented towards addressing the environmental and social impacts.

<p><b>Deteriorating</b></p> 	<p>Environmental impacts are not being addressed, increasing levels of impacts broadly affecting society and biodiversity.</p> <p>Environment and social activities are being heavily impacted, no active management, resources are not available.</p>
<p><b>Mixed</b></p> 	<p>Environmental and social impacts are being addressed but not across Tonga; active management is small and fragmented; resources are not available to increase activities. If no action is taken, environmental and social issues will increase.</p>
<p><b>Improving</b></p> 	<p>State of the Coast is being actively managed, environmental, and social issues are being addressed and managed, resources are adequate for sustainable management.</p>

## Data confidence

Some environmental and social impacts have been widely assessed, researched, and monitored within Tonga. However, the attributions for data to be evidenced across environmental and social impacts, national frameworks, and project activities, needs to be established for the whole of Tonga.

<b>Low</b>	No current or recent sources of research, low number of sources to indicate changes, monitoring or information to the environmental impact. Needs evaluation to make determined outcomes.
<b>Medium</b>	Research and monitoring information is available, issues have been identified in several research studies, monitoring and national frameworks.
<b>High</b>	Abundance of research and monitoring, outcomes and issues addressed are similar, high level of attributes towards activities, frameworks, and policy address issues.

The outcome of the trend assessment is shown as a key in the top corner and explained within each section. The outcome of the trend assessment is shown as a key in the top corner and explained within each section. Data confidence summarises the number of reports relating to the topic, identification of shared priority issues and relevant management interventions that have been implemented.

# Pressures (population biodiversity)

The Kingdom of Tonga is an island archipelago with approximately 700,000 km<sup>2</sup> of ocean area and approximately 747 km<sup>2</sup> of land area, which is divided between the four island groups of Tongatapu and 'Eua; Ha'apai; Vava'u; and Niuatoputapu and Niuafu'ou (Niuas) (Salcone et al. 2015).

Within Tonga, identified taxa and biodiversity are spread throughout the island groups. The following sections are adapted from the initial biodiversity stocktake in 2004 for the development of the national biodiversity strategic action plan (NBSAP) (Prescott and Folaumoetu'i 2004), State of Environment (Government of Tonga 2018) and the Rapid Assessment of the Biodiversity of Vava'u (BioRap)(Atherton et al. 2014).

## Trees and Plants (*Flora*)

Native trees, shrubs and plants have been less studied than the root crops and agricultural produce. There is an estimated 338 native flowering plants (angiosperms), two native conifers (gymnosperms, including one endemic species) and 96 fern and fern like species. New endemic records for flora were identified under the BioRap including *Phyllanthus amicornum* and a further two endemics to Vava'u, *Attractocarpus crosbyi* and *Caseari buelowii*. There are 11 species of mangroves identified throughout Tonga.

Root crops and agricultural crops include traditional and native species such as taro, yams, and cassava, with further introduced fruits watermelon, bananas, papaya etc. There is an increase of agricultural crops including citrus and fruit trees imported for food security production.

## Birds (*Aves*)

There are 74 recognised species of terrestrial (22 species) and seabirds (23) with 6 introduced species and 23 migratory species (6 shorebirds, 13 seabirds and 3 land and wetland birds) within Tonga. One species, Hengahenga, Tongan Whistler (*Pachycephala jacquinoti*) is endemic to the Vava'u group, the Malau, Megapode (*Megapodus pritchardii*) has been relocated and re-introduced to Fonualei, Niuafu'ou and Late, however is not considered endemic to Tonga due to the sub-species in Vanuatu.

## Reptiles (*Reptilia*)

Reptiles include the marine turtles, hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*). Of these four species, green and hawksbill nest on the beaches in Vava'u and Ha'apai.

Land reptiles include geckos (9 species) and skinks (9 species) and one iguana (*Brachylophus fasciatus*), which is considered an endangered species. There are three snake species. The Pacific boa (*Candioa bibroni*) has been identified, however, is rarely seen. The two other snake species are the marine sea cretes, banded sea crete (*Laticauda spp*), one being pelagic and one that inhabits the reefs and undersea caves.

## Mammals (*Mammalia*)

There are few native land mammals within Tonga. These include the flying fox (*Pteropus tonganus*), Polynesian rat (*Rattus exulans*) and ocean species that includes 13 species of cetaceans (whales and dolphins), including the humpback whale (*Megaptera novaengliae*).

Introduced land mammals include feral cats, dogs, pigs, cows, sheep, goats, and other livestock animals. Two invasive rat species, Norwegian rat (*Rattus norvegicus*) and the black or shipboard rat (*Rattus rattus*) are found throughout Tonga.

## Fish and Corals

There are 220 known hard coral species (Scleretania) that have been identified and reported on within the islands of Tonga. A total of 1162 reef and near shore fish species (Randall et al. 2004) are predicted for the biodiversity of Tonga, however surveys have shown declines in fish species of grouper, parrotfish and other fish species for consumption.

The International Union for Conservation of Nature (IUCN) Red List of Threatened and Endangered Species provides population trends for species through data analysis and scientific assessment. There are several species listed for Tonga including hawksbill, green and loggerhead turtles (endangered), leatherback turtle (critically endangered), Napoleon or Maori wrasse (endangered), five plant species, two land reptiles and two species of land snails found in Eua.

Threats to biodiversity are increasing through unsustainable land use, land degradation from removal of key tree species, including mangroves; invasive species; pollution; human and social pressures; and natural and climate related hazards.

There are gaps and under-researched taxa for a total assessment of biodiversity, including endemic, endangered, and rare species, with limited analysis and data collection to provide in country reporting on biodiversity through stocktakes, monitoring and evaluations. These taxa include marine and terrestrial invertebrates outside of commercial and subsistence used species, bacteria, plankton, and algae. These taxa are subject to ecological changes that may impact further species from higher orders and threats such as invasive species.

Ensuring collaboration in monitoring biodiversity and key species needs to be strengthened to understand further how social and human impacts locally are affecting biodiversity of the Kingdom.

## Human and social pressures

The human population of Tonga has grown since 1956 from 56,838<sup>1</sup> to 100,651 in the national census of 2016, which gives Tonga a population density of 155 people per km<sup>2</sup> with 35 per cent of the population (35,184 persons) living in Nuku'alofa, the capital, and Parliament of Tonga. 74 per cent of Tonga's total population lives on Tongatapu (Tonga Statistics Department 2017). Fanga'uta lagoon, situated on Tongatapu, has a population of 40,000 people living in communities scattered directly along the catchment area.

Migration overseas for the seasonal workers programme has become an increasing activity for both men and women, meaning that population changes are fluctuating annually. Domestic migration from the outer island districts to Tongatapu also fluctuates depending on a family's situation, participating in schools and employment opportunities.

The significant increase in the local population influences natural resources, particularly on terrestrial, water and coastal management of ecosystem goods and services. For instance, the quality and volume of underground water and aquifers are diminishing fast. The clearance of coastal/marine areas (including land-based activities such as animal or agriculture farms, wetlands like mangroves, seagrass, and coral reefs) for major developments of logging, farms, jetties, or wharves are also impacting on natural resources.

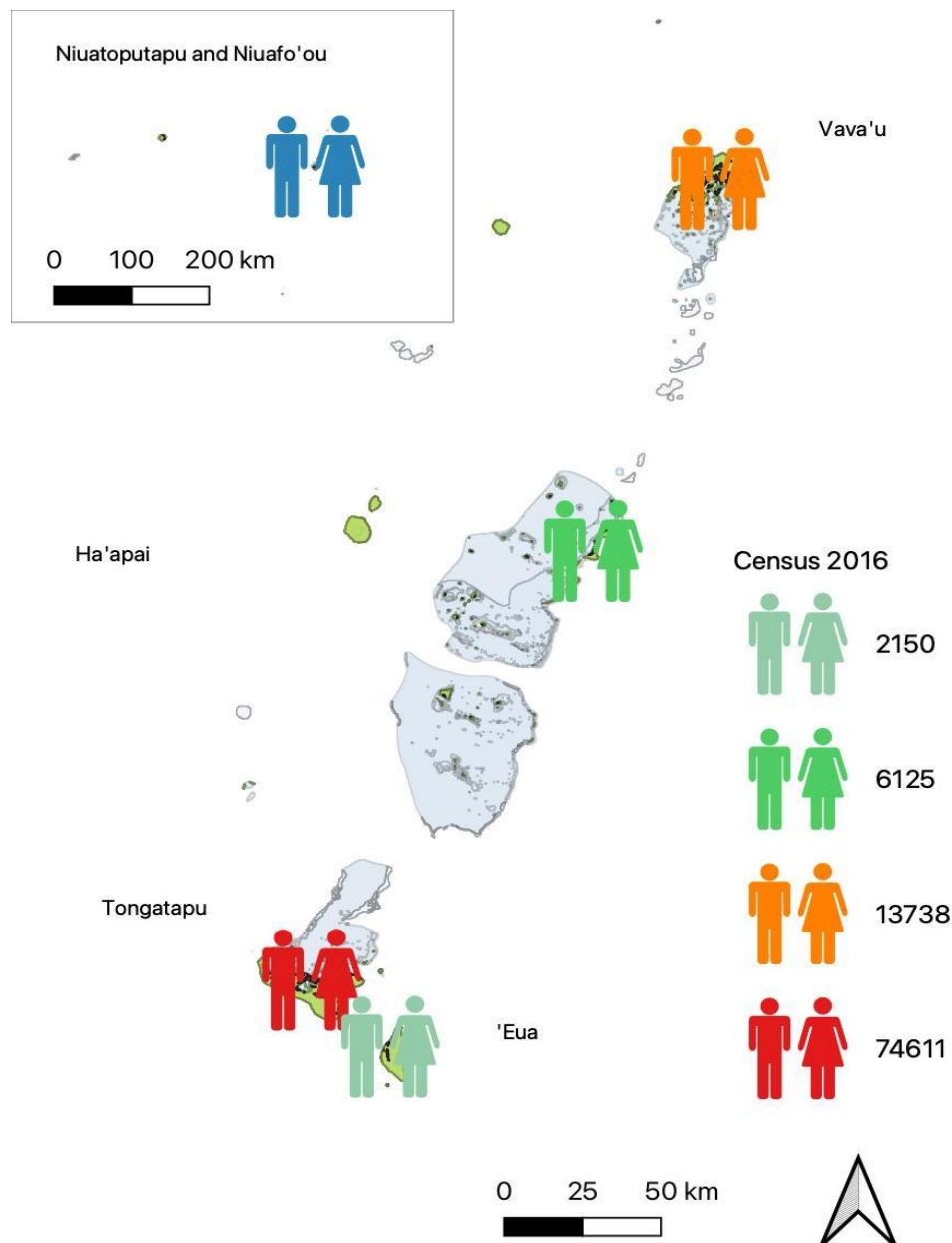
Small land mass and dense populations mean that coastal areas are under heavy pressure with many communities living directly upon or within 1 km of the coastal waters. Subsistence living, including agriculture, is high in Tonga, with 13,944 registered households for agriculture. Of this, 95 per cent or 13,246 households engage in semi-subsistence or subsistence living (Ministry of Agriculture, Food, Forests and Fisheries et al. 2015).

The fishing community is similar however, limited statistics are available for subsistence and coastal vessels, with the 2016 census showing the fishing for subsistence as 1486 people or 65 per cent of the active fishing population of 2301 people (Pacific Community 2018).

Infrastructure of ports and shipping has expanded over the last decade in Tonga, especially in Tongatapu where new domestic ferry terminals and cruise ship wharves have been developed along the Vuna waterfront, Nuku'alofa. Container ships are frequent entrants at Tongatapu international ports, and one container ship arrives directly into Vava'u every month from New Zealand. Domestic ferries carry cargo and passengers between the island groups.

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<sup>1</sup> Historical population statistics: Tonga Statistics Department <https://tongastats.gov.to/statistics/population-statistics/>

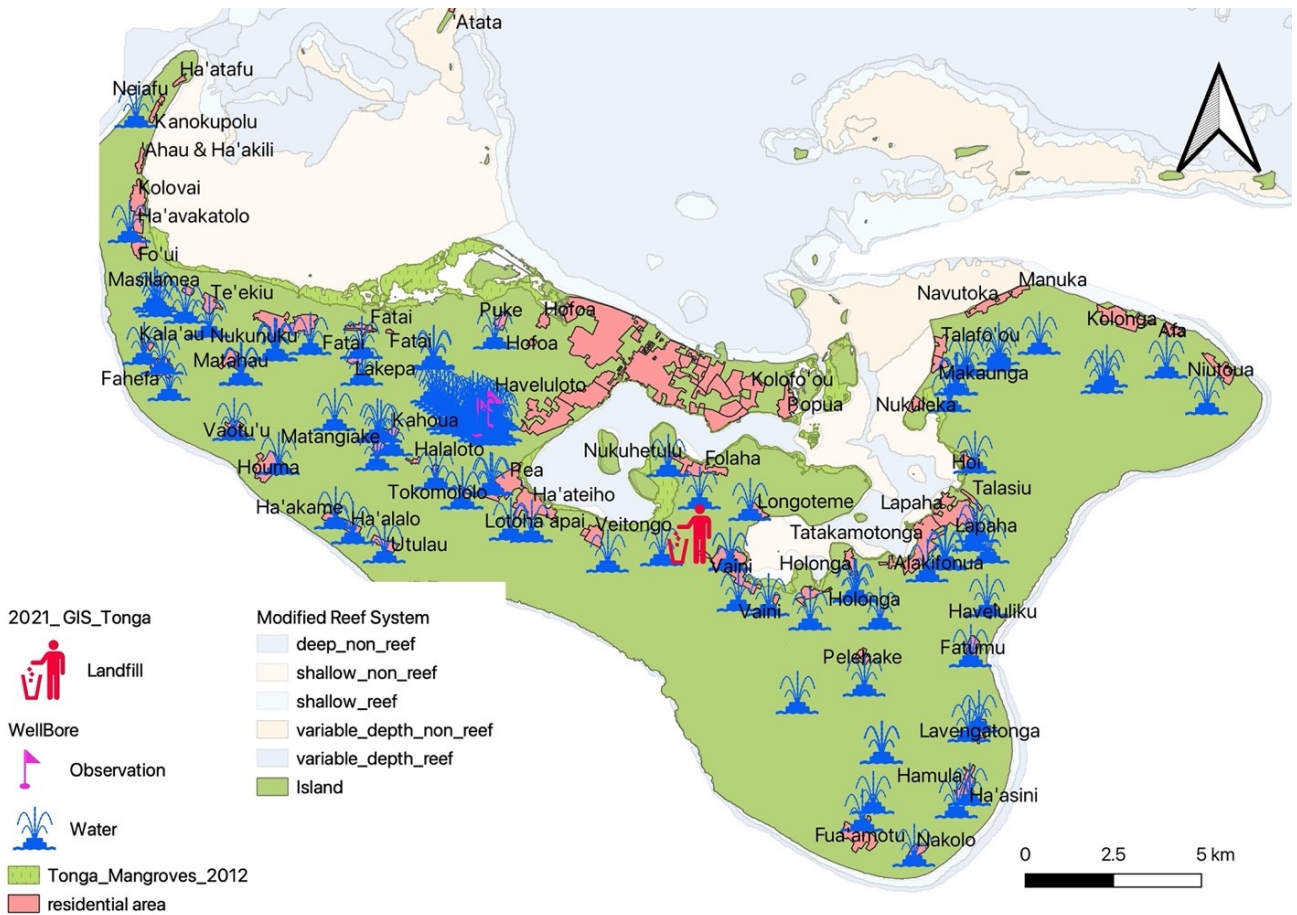


**Figure 1** Map showing the population of Tonga from the national census data (Tonga Statistics Department, 2016). Inset box shows the 'Ongo Niuia (Niuatoputapu and Niuafu'ou) located 300 kilometres north of Vava'u.

Importation of consumables and white ware is common in Tonga. Importation of goods brings increasing demands on waste management and public enterprises to manage their services. Waste generated from the imported goods consists of single-use plastics including food wrappers, shopping bags and plastic made goods, tins and aluminium cans, bottles and larger goods that utilise electricity.

Waste management services are provided by Tonga Waste Authority as a public enterprise that operates in all island groups except for the Niua. The paid collection service has provided improvement to the collection and management of waste, however illegal dumping and littering still occur and impact the coastal areas and habitats.

Waste collected from households and businesses, including old cars, batteries and household waste is taken to landfills which are located within close placement to the coastal areas and lies upon the soils and rocks that allow for seepage and leakage through the permeable rocks. The landfill in Vava'u is located within the mangrove habitat near 'Okoa community and Tapuhia landfill in Nuku'alofa is situated on the small peninsula between the Fanga'uta lagoon area (Figure 2).



**Figure 2** Map showing the island of Tongatapu with the location of the landfill and locations of dug water bores for accessing the freshwater supplies. Water bores are dug by the Tonga Water Board for urban supply or community well for rural water.

Tourism developments are being established across Tongatapu, 'Eua, Ha'apai and Vava'u with primary hotel and resort development on coastal areas both on the mainland and outer islands. An estimated 57,099 tourists in 2019<sup>2</sup> and approximately 700 yachts arrive between May and November annually.

Dominant tourism activities rely upon the biodiversity of the island group with whale watching, SCUBA diving and snorkelling and game fishing the frequent vessel bound and coastal activities.

<sup>2</sup> Tourism statistics <https://www.macrotrends.net/countries/TON/tonga/tourism-statistics>



# Catchment Environment

Land topography in Tonga varies between the island groups, with low lying lands in Tongatapu and Ha'apai while Vava'u, 'Eua and Niua have higher elevation through raised coral reefs, mixed geology and volcanic islands (Sinclair et al. 2014). To the west of Tonga lies the chain of uninhabited volcanic islands that form part of the Pacific Ring of Fire; these volcanic islands include Tofua, Kao both in Ha'apai and Late and Fonualei in Vava'u.

In Tonga, freshwater from precipitation collects in underground lenses lying on top of the seawater within porous limestone or fractured rock aquifers in volcanic rocks and run-in natural streams through the rocks to the coastal habitats, including estuaries and intertidal mud flats (Falkland 1992). Well bores are dug into the water lens to extract the freshwater, which is provided to communities and businesses; the well bores are of varying depths throughout the island groups.

Tongatapu has well bores drilled 62.5 metres into coral limestone with others drilled just a few metres below the surface. Through limestone rocks, water permeates quickly with an estimated 30 per cent of average rainfall reaching and refreshing the underground lenses (Nath et al. n.d.). In Lifuka, Ha'apai, the lens is observed as 9 metres thick, but of limited extent for resource use (Sinclair et al. 2014).

Most of the freshwater lenses are situated underneath or near communities and agricultural lands with limited natural vegetation and protection from the impacts of roaming animals. The groundwater supplies are very hard, containing calcium carbonate from the limestone islands. Most households supplement their drinking water from rain catchment.

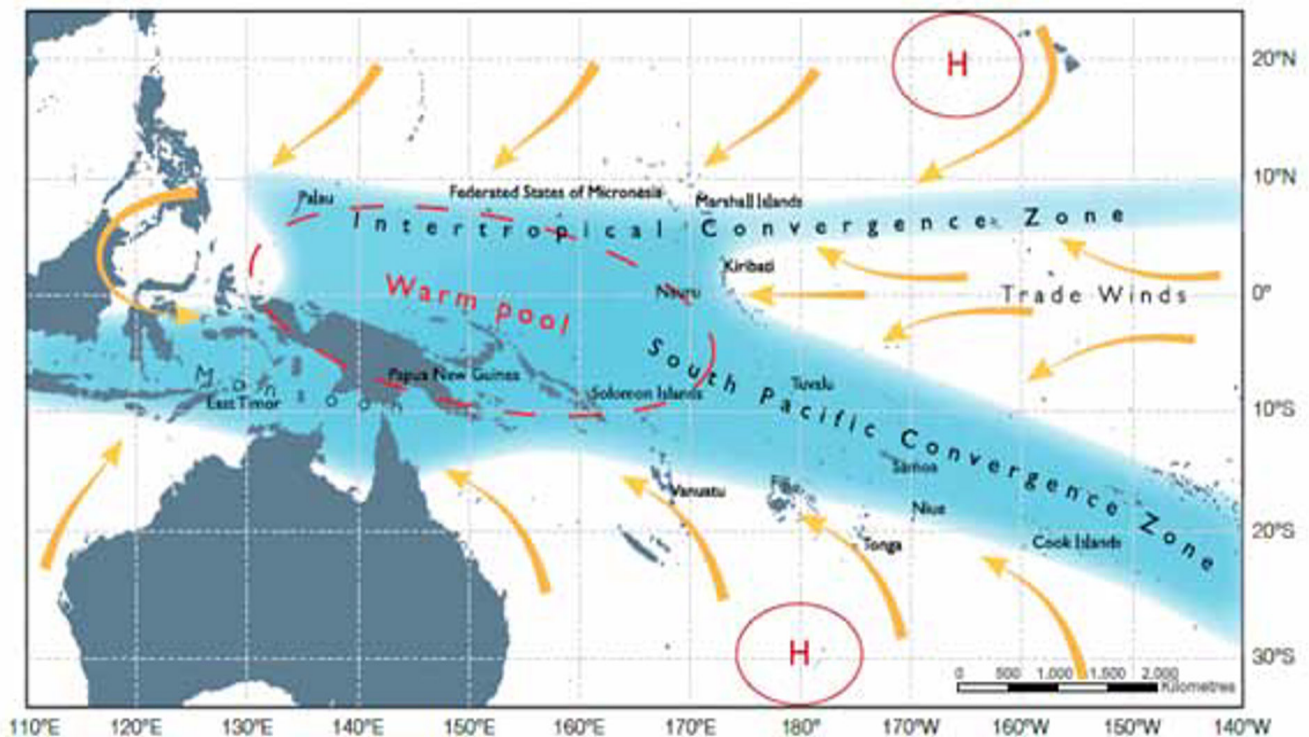
Fanga'uta lagoon, situated on the main island of Tongatapu, hosts an area of 28.35 km<sup>2</sup> and has 54 freshwater streams from the lenses that flow down through the rocks into the lagoon and watershed movements from precipitation feed freshwater runoff from the land. These natural watershed movements are often impeded by the increase of soil sediment and nutrients and can increase unwanted pollutants into coastal catchment areas. Restriction in tidal flow from topographical changes create areas of restricted water flow, increasing the issues and impacts from direct use and activities (Hokafonu et al. 2016).

Surface waters are found in 'Eua, Niuafo'ou and Tofua, Ha'apai. Surface water is found in caves and creates waterfalls and natural springs from the higher elevations in volcanic and mixed geology islands like 'Eua (Falkland, 1992). The surface waters in both 'Eua and Niuafo'ou are used as freshwater sources by communities, however most households predominantly harvest rainwater (91 per cent) through individual household catchment systems with either plastic or cement tanks (Ministry of Lands and Natural Resources 2019). In 'Eua the surface waters are also used in pools by communities and tourists for swimming and bathing.

Nomuka, Ha'apai and Longomapu, Vava'u have brackish water lakes that permeate saltwater through the rocks and low-lying lenses. These lakes collect precipitation, however due to the salinity, are currently not used as water resources.

Tonga has a wet season between November and April and a dry season between May and October. The variation of rainfall is influenced by the South Pacific Convergence Zone (SPCZ); the northern islands receive higher precipitation annually, approximately 2500 mm, whereas the southern islands receive approximately 1700 mm annually (Sinclair et al. 2014) (Figure 3).

Freshwater lenses in low lying islands such as Ha'apai and Tongatapu are subject to the impacts of climate change through saltwater inundation from sea level rise and changes in precipitation necessary to keep the water levels consistent for demand. Drought periods are associated with the El Nino-Southern Oscillation, with El Nino periods bringing increased drought like conditions that affect water catchment areas and increase the salt intrusion when over pumping of the freshwater lens occurs. La Nina periods can bring increased rainfall with heavier flash flooding at times.



**Figure 3** Position of major climate features, including the SPCZ, November to April. Yellow arrows indicate surface winds, and the blue band shows rainfall (convergence zones with relatively low pressure), the red dashed oval indicates the Western Pacific Warm Pool. Source: (Pacific Climate Change Science Program (Australia) 2011)

## Availability of Information

Data collection, research, monitoring and development of management plans have been ongoing in Tonga and information is available from as far back as 1992, when the Tonga Water Supply Master plans were developed, for the Niua (PPK Consultants 1992) and for whole of Tonga (Falkland 1992). Integrated Water Resource Management and Integrated Water and Coastal Management programmes have been implemented in both Tongatapu (SOPAC 2007) and Vava'u (IWCM 2013) through national teams with regional support. with data and planning implemented to reduce the impacts of pollutants to the water catchment area and benefit the supply of fresh water to households.

The datasets available focus mainly on the limitations of the water lenses to provide enough water for household supply and on the water quality. These are sourced primarily from internal monitoring conducted by Ministry of Lands and Natural Resources, Department of Environment (MEIDECC) and the Tonga Water Board. The Ministry of Health has responsibility for making sure the water quality is not harmful to human health, including monitoring for typhoid and other bacterial issues associated with gastro-intestine issues. Resources for the Ministry of Health are extremely low for conducting health tests on water and most of the monitoring programmes focus on common indicators of bacteria primarily E. coli and nutrients such as nitrates, phosphates and ammonia that are reflective of runoff and agricultural uses.

Testing for heavy metals and other impacts of water quality rely on resources not readily available in Tonga; these tests would provide valuable data on the further impacts of human activities, including waste management, to the surrounding catchment and freshwater supplies. An initial survey was conducted in 2003 on Fanga'uta lagoon that included sediment and soil samples, as well as shellfish samples; all samples were taken to an international lab (Morrison and Brown 2003).

A repository for water quality data is not in place yet where cross monitoring could be conducted by the agencies when a situation arises. Standardisation of testing methodology and equipment would also be critical, including ensuring that calibrations are conducted regularly.

Disaster response programmes have also included water quality monitoring, such as the 'Eua report following Cyclone Gita, that monitored fresh and rainwater collection (Ministry of Lands and Natural Resources 2019).

Research programmes have attributed the important relationship between water catchment and biodiversity, through cooperative assessments and impacts on the environmental condition of the coastal areas. These include the Rapid Assessment of Priority Coastal Areas (Stone, Lokotui et al. 2021) and water quality impacts at the same coastal locations (Lokotui 2021). These multipurpose, ridge to reef studies provide great insight into environmental impacts that are linked to the water quality.

Awareness raising sessions with communities on the outcomes of assessments and projects have been conducted through the ministries and NGOs/CSOs, however, general information and awareness campaigns are not regularly conducted on water health and water resource management at community level. Broader scale awareness campaigns would be beneficial outside the project scope.

Despite a lot of information being available, there is significant time lapse between assessments and limited information on activities and management initiatives to address the ongoing issues.

## Biodiversity hotspots

Biodiversity hotspots within the catchment areas and freshwater lenses are less studied than the biodiversity of the coastal and natural forest habitats. Land space within the catchment areas has been divided up for hereditary land titles for agricultural lands for crops and coconut plantations.

Fanga'uta lagoon is a critical area for biodiversity as a catchment providing 80 km<sup>2</sup> of catchment area that slopes downwards into the lagoon, with scattered mangrove stands primarily of the species *Rhizophora stylosa* (tongofeta'u) and *Bruguiera gmnorhiza* (tongota'ane). There is also low occurrence of *Xylocarpus granatum* (lekileki), *Exoecaria agallocha* (feta'anu) and *Bruguiera gmnorhiza* (fa'onelua) (Fa'u et al. 2015).

The depth of the lagoon ranges from 1.2 metres of seawater to 6 metres of seawater depth, with observed high levels of dissolved oxygen that increases the ability for the growth and development of fish.

The brackish water lake in Nomuka and Longomapu (Lake 'Ano) provide a unique biodiversity for fish, invertebrates and terrestrial species and have been identified through cultural knowledge and brief articles (SPC Bulletin 1955) on the breeding of milkfish ('ano 'ava) in Nomuka island, with some fish reaching up to 28 inches. These species and locations are not important for biodiversity, but for supporting livelihoods and resources that will be beneficial in the future.

The freshwater craters of Vai'lahi, Niuafu'ou and Tofua, Ha'apai are priority biodiversity areas for native terrestrial plants and animals, including fish species. Changes to natural biodiversity impact upon the health of the freshwater systems. When tilapia were introduced to the crater lake in Niuafu'ou, the tilapia ate all the freshwater plankton and algae, which were the source of nutrients for the crater's native species (Schabetsberger et al. 2009). The inner walls of the Niuafu'ou crater include humid broad-leaved forests with regenerating forests on the outer crater (BirdLife International 2007).

Niuafu'ou is also important for the protection of the megapode (*Megapodus pritchardii*). Efforts to rehabilitate the bird on Niuafu'ou and Fonualei (uninhabited) were conducted in the 1990's. Similar efforts were conducted with a native species of passerine, the endemic *Aplonis tabunensis nesiotis* (form of Polynesian starling) (Faka'osi et al. 2012).

## State and trends



The overall status and trends of water resources in Tonga is declining due to the continual trend of increasing water pollution, increasing impacts from climate change and low activity and engagement at the national level.

Data availability is high. Research and assessments all indicate similar issues and impacts however, engagement and progress toward solving the issues has not advanced on a national, whole of island approach, so this affects the overall assessment of the progress made.

Freshwater resources are being heavily impacted in Tongatapu and Vava'u through land-based pollution sources, including agricultural run-off and roaming livestock; poorly implemented and maintained infrastructure; and land management practices. The population pressures on the freshwater supplies create increasing impacts on the environmental sustainability of the freshwater lenses.



Across the research conducted, the issues replicate with increasing pollution from sewage, wastewater and agricultural use impacting the water quality of the lenses and streams.

The Rapid Assessment of Priority Coastal Areas (RapCA) identified increasing impacts from pollution to the water supplies in Hihifo, Tongatapu, including the encroachment of wastewater and septic systems to the freshwater and coastal habitats, such as mangrove ecosystems. The RapCA identified pressing areas where future consistent monitoring will be needed to understand the ongoing patterns of water quality impacts and what resources will be required to enable this monitoring.

## Water quality

Freshwater quality is monitored by the Ministry of Lands and Natural Resources, Ministry of Health, community water committees and, in urban areas by the Tongan Water Board (TWB).

Salinity within the lenses is an ongoing issue with increasing threats from climate change and more intensive drought periods. Over-pumping of the freshwater lenses increases the salinity exchanges from the seawater underneath the lenses.

The TWB treats the freshwater supplies with chlorine to address potential issues with bacteria that cause gastrointestinal diseases. The monitoring of chlorine taste and residue is not frequently monitored by the TWB.

The porous geology of the limestone substrate islands increases the ability for pollutants to impact the freshwater lenses and streams.

Faecal coliforms such as *E. coli* bacteria that lives within the intestines of warm- and cold-blooded animals, including humans is monitored regularly. Faecal matter enters the freshwater supplies from seepage of animal faecal matter, which breaks down during rainy periods; or through the breakdown of septic systems within households. Long drop toilets, which are still utilised, also contribute to faecal matter pollution of freshwater. Surveys in Tongatapu, 'Eua and Vava'u have frequently found *E. coli* bacteria in the fresh water supplies.

Heavy metals and contaminants from leaking landfills and illegal dumpsites around the coastal areas will be affecting the water quality of catchment areas and impacting the surrounding benthic and sessile marine organisms that are heavily relied on by communities for subsistence consumption.

During the survey of Fanga'uta lagoon in 2003, results showed magnesium and sodium were present in significant concentrations, with iron, aluminium, and strontium (a natural mineral found in seawater and soils) in elevated amounts. The 2003 study concluded that though trace elements were found, no significant impacts to human health were noticed (Morrison and Brown 2003). However, the area of commercialism and urbanisation have changed dramatically from 2003 and therefore these studies need to be conducted annually to identify changes and potential impacts.

# Coastal environment

The coastal environment of Tonga spans approximately 419 km around 169 raised limestone and volcanic islands of which 36 are inhabited throughout Tongatapu and 'Eua, Ha'apai, Vava'u and Niua's.

Beaches line the islands, especially in Ha'apai, with the southern islands of Vava'u having beaches showing the southern tilt of the islands on the tectonic plate. Beaches are an important ecosystem providing links between the land and the sea and are habitats to marine turtles for the nesting season, crabs, and other species.

The primary habitats included fringing coral reef areas, seagrass beds, intertidal mudflats, small estuarine lagoons, mangroves, beaches, and cliff fronts on sharp limestone and volcanic rises in 'Eua, Vava'u and Niua's.

Mangroves are located throughout the coastal habitats of Tongatapu, Vava'u and the Niua's, covering an estimated 1768 hectares or three per cent of the coastal area as of 2017 (Ma'u et al. 2020). There are 11 confirmed species of mangroves within Tonga. Coastal plants include secondary species of mangroves such as the *Hibiscus tilacea* (fau).

Intertidal mudflats are extensively found in Tongatapu and Vava'u, which are exposed at low tide and create important habitats for gleaning activities that include the collection of invertebrates and molluscs. These intertidal flats also provide habitat for seagrass and macroalgae species. The intertidal areas are also subject to important mixing from freshwater streams and catchment areas.

Tonga's coral reefs are classified as fringing, barrier and submerged lagoon reef types and vary according to the geological characteristics of the island groups. Narrower reef areas in 'Eua, southern Tongatapu and Niua's fall away quickly into deeper coastal waters, whereas Vava'u and Ha'apai have shallow sand banks and flats that extend from the low water tide mark between the islands and fringing reefs.

**Table 1:** Reef types found in the archipelago of Tonga as described in the National Status of Tonga's Reefs (Lovell and Palaki, 2000)

Island Group	Barrier reef	Fringing reef	Lagoon reefs
Niua's	X	X	
Vava'u		X	
Ha'apai	X	X	X
Tongatapu		X	X
'Eua		X	x

The coastal environment is heavily utilised and developed in Tongatapu and Vava'u with increasing coastal development in Ha'apai and 'Eua. The Niua's currently have less development, with smaller populations relying upon the coastal species and resources.

## Availability of Information

Surveys of the coastal areas have been conducted throughout Tonga with an emphasis on Tongatapu, Ha'apai and Vava'u. Comprehensive overviews of marine ecosystems, health and species diversity are covered under the National Biodiversity Strategic Action Framework (Ma'u et al. 2020) and State of Environment (Government of Tonga 2018) that combine collective data and information from ministries and available research.

Further to these national reports, sector surveys are conducted by Department of Environment (MEIDECC) on mangroves, water quality, coral reef monitoring and health; and by Ministry of Fisheries, on the marine habitats for the implementation of SMAs. These reports are internal reports, which are not easily accessible online.

Mangroves have been studied through ministries, NGOs and regional projects for the biodiversity and cover of mangrove species and threats and impacts to mangroves along the shoreline.

Tonga's coral reefs have been surveyed multiple times, including a survey in 1996 by Paul Holthus, which provided a baseline for coral reefs in Vava'u and Tongatapu (Holthus 1996).

The Rapid Assessment of Biodiversity of the Vava'u Archipelago (BioRAP) undertaken by the Government of Tonga, Secretariat of the Pacific Regional Environmental Programme (SPREP) and supported by Waitt Foundation, conducted rapid biodiversity assessments of uninhabited islands in Vava'u. This report includes coral species, reef fish biodiversity and commercial invertebrate species, as well as reef health, turtle nesting and marine mammal species updates.

A study undertaken by a PhD student through the Ministry of Fisheries, provides the most comprehensive outlook on coral habitats from a fishery perspective, compiling data from 2016 and implementing coral and fish data collected independently (Smallhorn-West et al. 2020).

Stock assessments of commercially targeted species, including sea cucumbers, are undertaken by the Ministry of Fisheries (Tonga) and the Fisheries, Aquaculture and Marine Ecosystems (FAME) Division of the Pacific Community.

Surveys conducted through the PROCfish (Pacific Regional Oceanic and Coastal Fisheries Development Programme of the SPC) project alongside the Ministry of Fisheries included catch surveys of fin fish and socio-economic surveys within selected communities in Tongatapu (Friedman 2009). Socio-economic and household surveys also provide important information from community towards the valuation and perception on the health and status of resources.

The Marine and Coastal Biodiversity Management in the Pacific Islands (MACBIO) implemented by the International Union for the Conservation of Nature through the Government produced the Economic Assessment and Valuation of Marine Ecosystem Services of Tonga, that calculated the financial benefit of marine and coastal habitats and species to Tonga (Salcone et al. 2015).

Through the marine spatial planning project, Special and Unique Marine Areas (SUMA), were identified by technical representatives from government, NGOs, fishers, private sector, and community. Similar means of identifying and verifying these areas were undertaken. SUMAs were identified for the whole of Tonga, including the deeper oceanic and offshore waters (Ceccarelli et al. 2017).

## Biodiversity hotspots

Coral reefs around Tonga are biodiversity highlights for reef fish, marine invertebrates and boost critical ecological benefits including protection of the shorelines and communities from storm surges.

The BioRap conducted in 2014 registered 220 species of hard coral in Vava'u. Species diversity surveys have not been conducted throughout the whole of Tonga. The outer and uninhabited islands in Ha'apai and Vava'u host higher biodiversity of fish and marine invertebrates than inhabited islands (Stone et al. 2017), however as SMAs increase, these uninhabited islands are under increasing pressure from fishing (Smallhorn-West et al. 2019) (Figure 4).

All coastal waters are inhabited by resident and migratory species, including marine turtles primarily of the species green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) that nest on the beaches between November and February annually. The humpback whale (*Megaptera novaeangliae*) migrates annually from the feeding grounds in Antarctica to the warm waters of Tonga to breed and birth their calves. Threatened to extinction by overharvesting, both turtles and humpback whales face increasing impacts from climate change, coastal development, and pollution, including plastics.

The mangroves in Tonga provide habitat for juvenile fish and marine invertebrates as well as for land and shore birds. Mangrove species are declining in natural abundance in Tongatapu, with species such as lekileki remaining in Vava'u but needing to be better managed from coastal development. These species are not just ecologically important but also have great medicinal and cultural value.

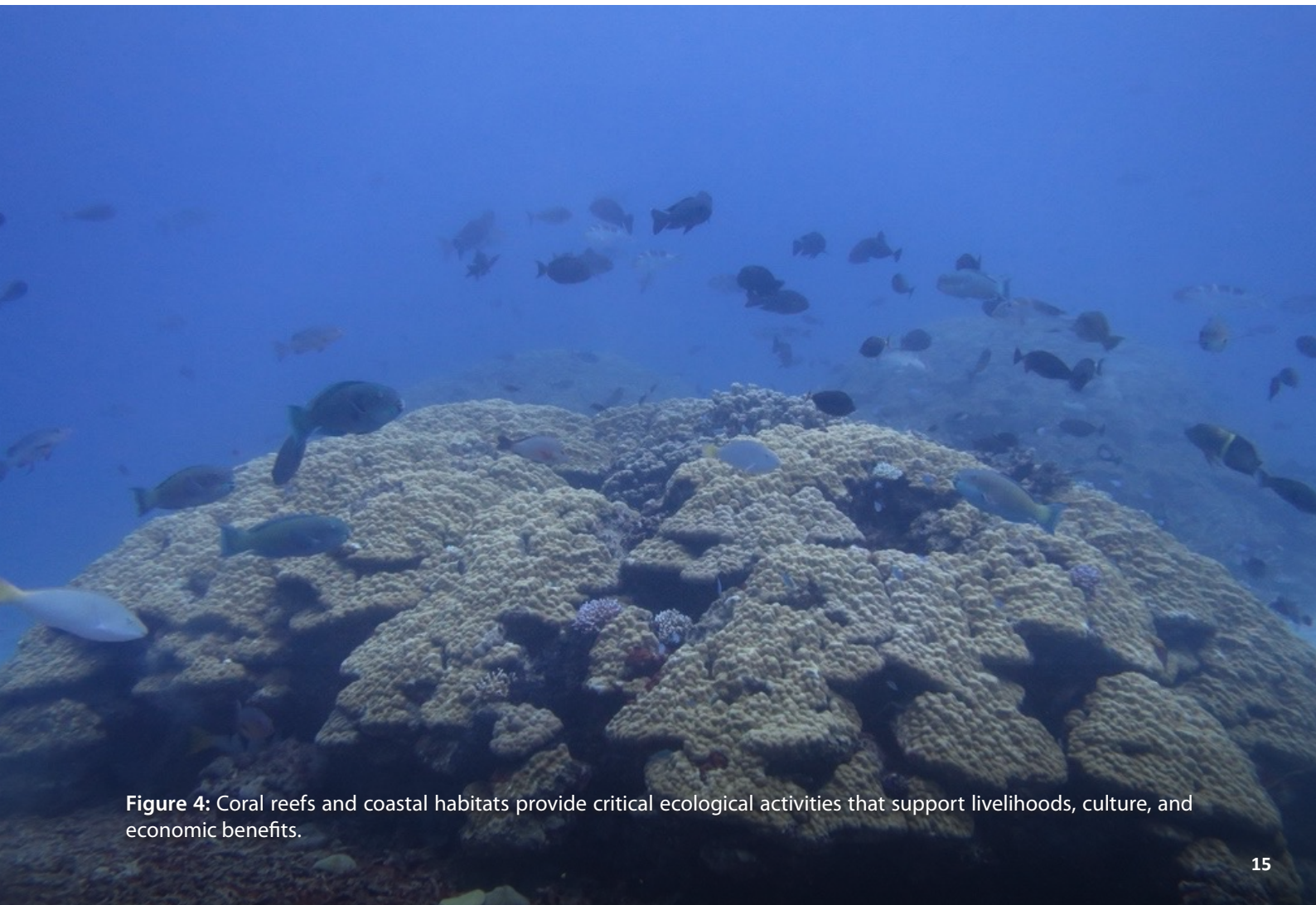


## State and trends

The state and trends of the coastal habitats is mixed across Tonga, with benefits being seen in some instances due to the ongoing implementation of management programmes such as the SMAs. The 2020 SMA report showed that in areas where there was community management and conservation of fishery resources, these areas were benefitting over reef areas without management (Smallhorn-West et al. 2020). However, similar impacts on coastal areas suggest that the environmental impacts are not decreasing and if this current state is not addressed through the whole of Tonga, the environment and social activities will continue to decline.

The coastal habitats have been researched and reports have provided similar assessments on the impacts and biodiversity loss occurring in Tonga, however, there are fewer studies on the seagrass beds and intertidal mudflats that can provide critical information on the linkages and impacts between the land and sea. RapCA, under the International Waters, IWR2R programme, conducted ecological and water quality studies across all the coastal habitats, including mangroves, intertidal mudflats, and fringing reefs. Water quality assessments were also undertaken at the same locations. The results showed that there is correlation between the land-based water and reduction in the health and functions of coastal habitats, however, further consistent monitoring, including of upstream water quality, is required to enable a full analysis of the relationships (Lokotui 2021).

Fanga'uta lagoon (Figure 5 and 6) in Tongatapu has fluctuations of algal blooms from the high levels of nutrients flowing from the land primarily liquid household and agricultural waste. The Fanga'uta survey report in 2015 from the Department of Environment, showed that tidal exchange between the north entrance and lagoon took approximately 29 days for complete exchange in the western section and 9 days in the eastern section (Fa'u et al. 2015). Sedimentation from runoff and lack of tidal exchange can increase the stagnation of water and increasing impact on the health of species and habitats.



**Figure 4:** Coral reefs and coastal habitats provide critical ecological activities that support livelihoods, culture, and economic benefits.



Figure 5: Map showing the location of Fanga’uta lagoon in Tongatapu with the community areas surrounding and the small water channels for tidal exchange.



Figure 6: Image captured flying over Fanga’uta Lagoon in 2017 and showing the ongoing water quality issues and algae blooms with the communities impacted by heavy rain and inundation from King tides.



The impacts on coastal areas throughout Tonga, including from land-based uses and erosion, are increasing threats and pressures to extremely sensitive habitats, whereas in Vava'u, due to increased sedimentation and decreased waterflow, the mangroves cover large areas of previous fishing grounds. In Hihifo, Tongatapu, thick mud patches lie barren and open with very little regeneration of mangroves species (Stone, Lokotui et al. 2021).

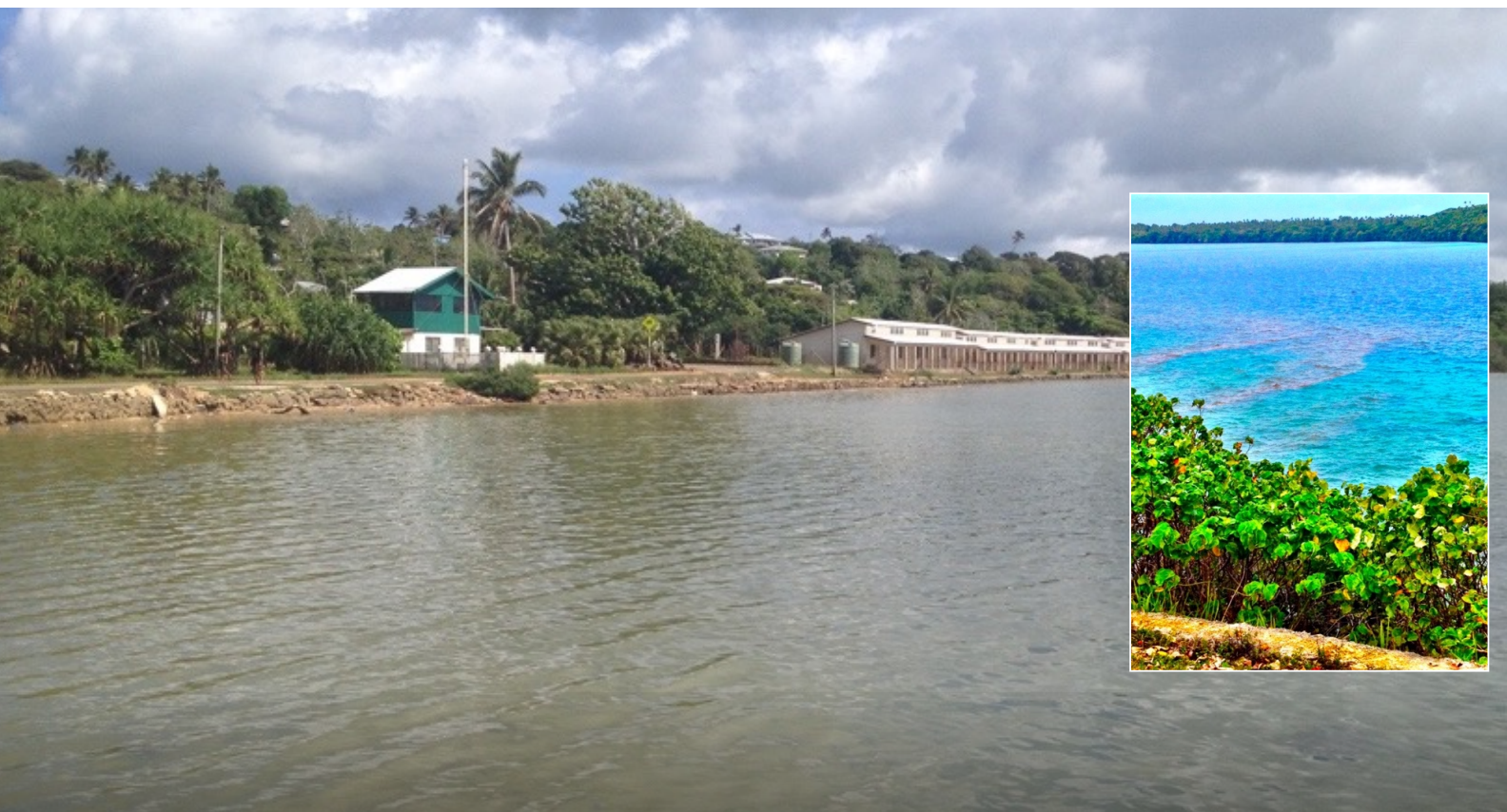
Sand mining is increasing on coastal areas with the increase in demand for aggregate for building. The monitoring and compliance to sand mining lies with the Ministry of Lands and Natural Resources or the Governors of the outer islands. Excessive mining of these resources causes coastal erosion and land instability. Natural sand movement occurs with tidal exchanges and storm surges, often causing big changes to sand cays. These natural movements are being increased by climate change, and impacting on the habitat potential for nesting sea turtles (Walker 2013).

## Water quality

Water quality indicators for nitrates, phosphates and ammonia are used to identify associated issues with runoff from liquid and solid waste or agricultural use of pesticides and herbicides. Plants and algae (photosynthetic eukaryotic organisms) naturally utilise nitrates and phosphates during growth processes, however the rapid increase of nitrates and phosphates above normal levels can stimulate the natural coastal algae into reactions called harmful algae blooms (Figure 6 and 7).

The Department of Environment (MEIDECC) and Ministry of Lands and Natural Resources monitors coastal water quality for the impacts of septic systems and runoff attributes as well as general parameters of status of water and site. NGOs also conduct water quality monitoring and responses to environmental impacts such as algal blooms.

The RapCA survey on biodiversity and ecological impacts identified several issues with coastal water quality from observed impacts on the surrounding habitats. The water quality impacts showed that faecal coliform were present in the coastal waters of the Hihifo district with anomalies on nitrate testing. Wastewater discharge was also seen on the freshwater stream in the mangrove areas (Figure 9).



**Figure 7:** Map showing the population of Tonga from the national census data (Tonga Statistics Department, 2016). Inset box shows the 'Ongo Niua (Niatoputapu and Niuafu'ou) located 300 kilometres north of Vava'u.



**Figure 8:** Flounder found during the algae bloom in Neiafu Tah. Other species impacted included shrimp, moray eels, emperor fish and crabs. Algae blooms heavily impact the livelihoods of coastal communities when they occur. Photo credit: VEPA 2015..



**Figure 9:** Image showing wastewater run-off in the mangrove areas in Hihifo district, Tongatapu. Liquid waste is carried through small streams and runoff areas to the coastal habitats.



**Figure 10:** The two culverts in the causeway at Holeva, Hahake show the difference in water flow and quality of water. Both photos were taken on the same low tide movement with the left photo showing clear water and the second photo showing stagnant water.

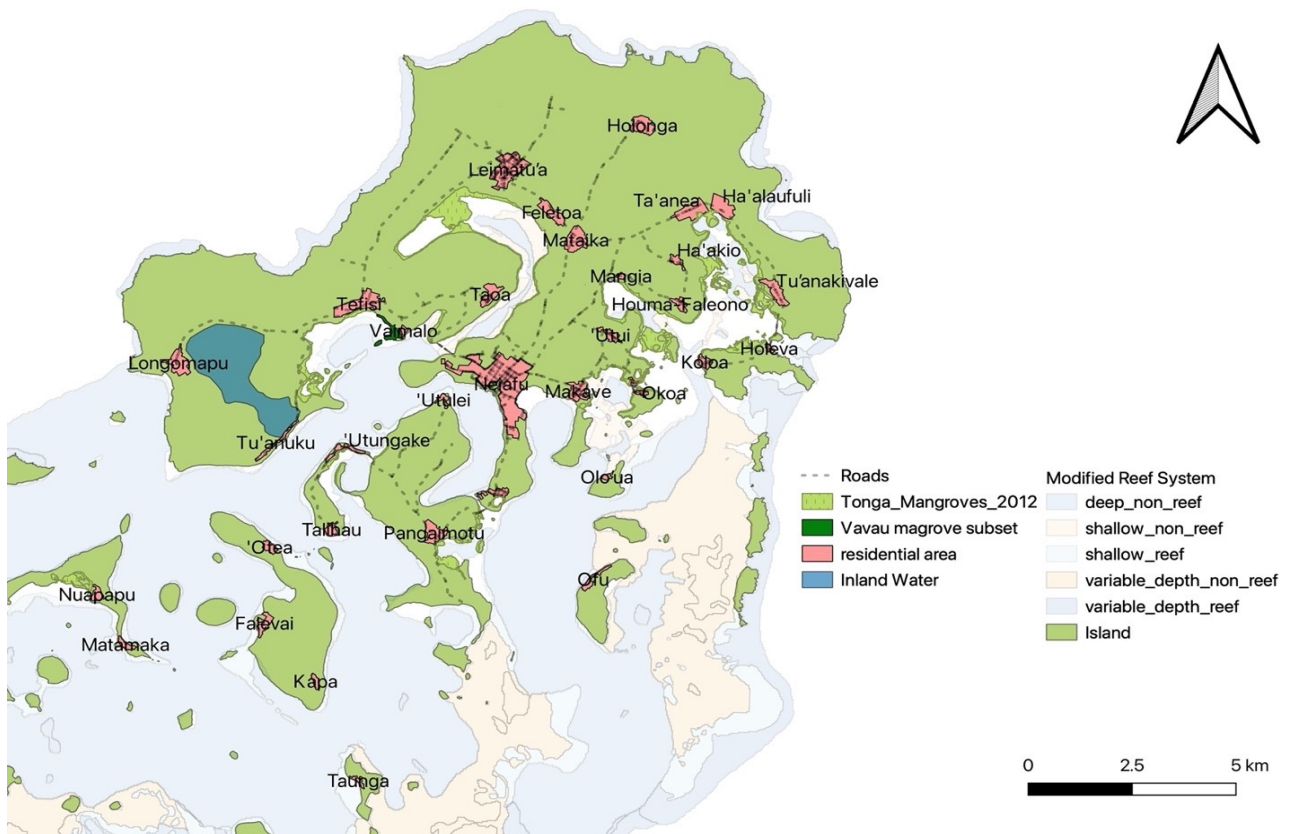


**Figure 11:** Indicators of decreasing coastal marine habitat water quality include roaming livestock, such as pigs grazing in the low tide areas and stagnant water increasing development of algae and cyanobacteria mats reducing community fishing areas.

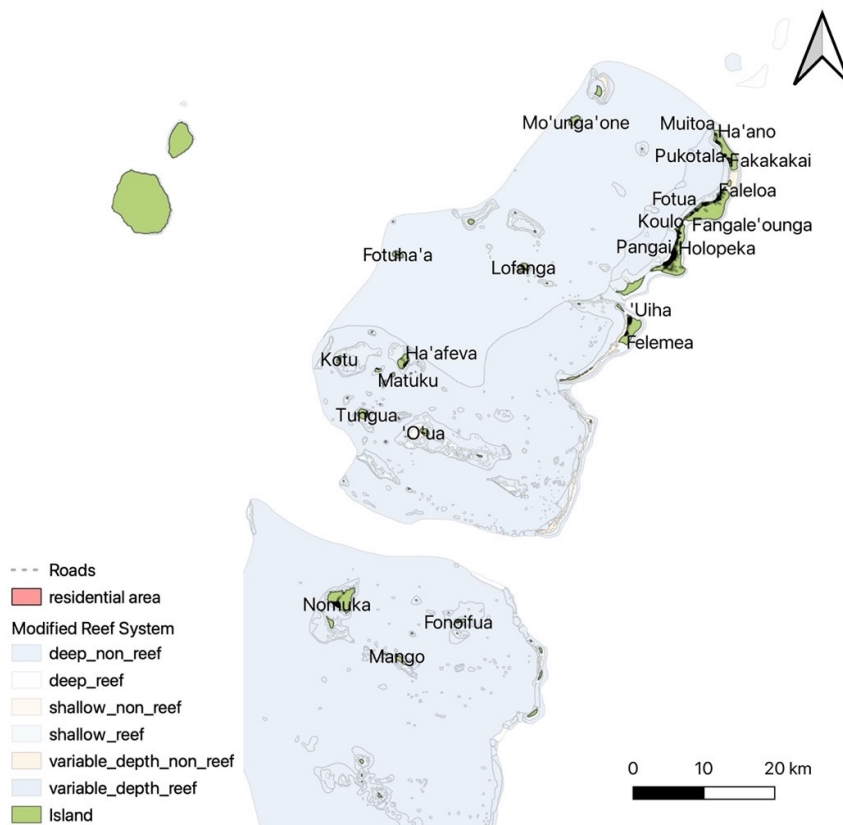
In Vava'u, causeways developed in the 1970s join nearby outer islands to the main island of Uta Vava'u. These causeways are reducing the water flow due to the age of the infrastructure and the increasing sediments are allowing for continuing expansion of mangroves, especially within the eastern district of Hahake (Figure 10). The increase of cyanobacteria mats and nitrates and phosphates can be attributed to roaming animals that freely enter the intertidal and shallow water areas (Figure 11).

Coastal water quality in Ha'apai, 'Eua and Niua's seems to have been less impacted. This can be due to fewer pressures on the environment due to the smaller populations of these communities and increased tidal water flow due to the more open geological setting of the island. However, fewer studies have been conducted on the health of the coastal waters in these island groups.

Figures 12 and 13 show the differences in the topographical and geological settings between Vava'u, Fanga'uta Lagoon (Figure 5) and Ha'apai. They also show how changes in inlets and restricted water flow impact the environment and people's livelihood. Tidal flow is not just critical for water exchanges, but also for the transportation of species larvae. The coral recruitment in Vava'u has been monitored, but needs further investigation to look at the impacts of reduced tidal flow (Stone et al. 2017).



**Figure 12:** Map of the islands of Vava'u focusing on the main island of 'Uta Vava'u and the inlets of seawater. During summertime, temperatures increase in these inlets, and reduced water flow between the inlets and main channels causes stagnant areas increasing the risk of bleaching and pollution. Causeways between the main island and Holeva, 'Utungake, Toul/Pangaimotu and 'Okoa were built in the 1970's and prior to this, these channels were open.



**Figure 13:** Map of the Ha'apai islands showing the open nature of the islands, which can increase tidal and water flow, reducing still water areas that can increase sea temperatures and trap pollutants.

## Risks at coast

Communities and towns are situated on low lying areas near the wharves and docks of Tongatapu, Ha'apai, the outer islands of Vava'u, and 'Eua and Niua's. All coastal areas are facing increasing impacts of natural disasters, climate change related effects such as sea level rise, increasing king tides and storm surges. These impacts affect biodiversity, habitat function, culture, livelihood, and economic activities.

The social risks at the coast have been well documented in the previous five years following the impacts from Tropical Cyclones Ian (Cat 5, 2014), Gita (Cat 5, 2018) and Harold (Cat 5, 2020), which created devastating infrastructure damage in Ha'apai, Tongatapu and on 'Eua, with storm surges causing buildings, roads and community wharves to be swept away.

Infrastructure can be beneficial to adapting and creating resilience to these impacts, however, often resources and design are not fully accountable for long term environmental impacts, such as erosion and flooding (changes to natural water flow from infrastructure). Addressing the risks to the coastal areas requires appropriate support from external and national partners outside of the infrastructure project.

Coastal erosion and shoreline stability also threaten communities and livelihoods with increasing examples of impacts to agricultural grounds, infrastructure, fishing grounds and sensitive habitats. Increasing sedimentation from the runoff reduces the ability of certain organisms (seagrass, corals, bivalves, etc) to photosynthesise.

Aside from climate change and natural disasters, habitats, and species (both terrestrial and sea) are at high risk from ongoing and increasing impacts from pollution, solid and liquid waste management, overharvesting and unsustainable practices and infrastructure interventions.

Species of cultural and ecological importance are disappearing because of removal and exploitation; tree and plant species are being replaced by faster growing species that often miss an important ecological function and may not be suitable for the location.

Addressing the threats to coastal communities, habitats and biodiversity need a national, forward planning and cohesive approach to ensure that community knowledge, adaptation and environmental benefits are long term, resilient and create ownership and management opportunities for communities.

# Governance at Coast

Coastal governance of Tonga is carried out through single sector legislation and management plans that align with the Tonga Strategic Development Framework (TSDF) II 2015–2025 as the overarching document, which provides the framework for governance in Tonga. Tonga has commitments to international conventions that are relevant for coastal management:

## Sustainable Development Goals (United Nations)

The 17 SDGs outline the commitments of member governments to ensuring good governance, transparency, and equality for achieving the related goals of environmental and social benefits. Focusing on the five main goals that support the implementation of healthy and sustainable coastal systems can benefit addressing the reduction of poverty and inequality.



**Figure 14** The sustainable development goals that relate directly to benefits of sustainable and inclusive coastal management, with the benefits driven from environmental management and implementation or threat reduction. Source: <https://sdgs.un.org>

## Convention on Biological Diversity

The Convention on Biological Diversity (CBD) mandates the progress towards the Aichi targets for protection of biodiversity and assists in the country development of the National Biodiversity Strategic Action Framework (NBSAF) (Ma'u et al. 2020).

## Marine Pollution Prevention (MARPOL)

MARPOL is an agreement with the International Maritime Organization to manage and reduce the impacts of waste from vessels. Waste products include both liquid and solid waste management with regulations pertaining to how and where types of waste can be disposed. Within the coastal areas no liquid or solid waste may be dumped from ships, wharves, or jetties. Within Tonga, MARPOL is regulated under the Marine and Ports division, Ministry of Infrastructure.

Tonga's coastal areas cover 174 islands spread throughout the four island groups and are managed by national government with outer island ministry offices and officers that align the workplans and goals within their collective areas. The national government is housed in the central business district, Nuku'alofa, Tongatapu and has direct control over all programmes, ministry objectives and finances.

Governance of coastal areas is combined under multiple legislations through single-sector approaches (albeit aligned to the TSDF) and often collide in objectives and clarity of ministry roles and activities. Transparent actions can be realigned and reaffirmed to create collective approaches towards strengthening local and national governance of the coastal areas, including strengthening knowledge-based programmes through community and youth.

# Legislation

Tonga has numerous legislations (Appendix 1) associated with environmental, resource and social management, with some overlapping and competing interests between resources and ministries. Resources to support the ministries creating compliance materials and engagement are widely needed alongside training on how to enforce legislations.

There is no coastal policy framework within Tonga that provides an overarching strategic plan for aligning sector legislation and corporate plans. Information on legislation, regulations and management plans is not broadly communicated within Tonga; the various laws are hosted on the Attorney General's Office website, however this is not easily accessible due to internet connection for all Tongans. An integrated manual that highlights the best practices (do's and don'ts) for laws that are intended to support and benefit coastal management would be beneficial for all stakeholders.

The following laws are essential to improve and sustain the current coastal habitats:

## **Environmental Impact Assessment Act 2010**

This Act is implemented by the Department of Environment, MEIDECC, which determines the need for an EIA according to the project category (major and minor projects) and the size, type, and potential environmental impact of the development activity.

A weakness of the EIA Act is that it does not cover the "scope" of all projects within the coasts and focuses on those with funding or aid development. Domestically implemented infrastructure such as roads, wharves, jetties, and buildings are not always subject to an EIA despite the large scale and potentially impactful nature.

## **Water Resources Management Bill 2020**

Recently passed in 2020, the water resource management bill aims to manage all water resources in Tonga under the Ministry of Lands and Natural Resources. This bill needs regulations to be effective.

## **Waste Management (Littering) Act 2016**

To be implemented by MEIDECC, this Act requires regulations to seek compliance and enforce action on the dumping of waste through large sites or through general littering. The Act currently does not have regulations and is not widely enforced.

## **Building Codes and Standards Regulations 2016**

Under the Ministry of Infrastructure, these regulations control the building codes, including septic systems. The regulations are poorly known and have limited enforcement, with there being need for some discussion on the design and best practices depending on proximity of a household or business to the water lens and/or coastal area.

## **National Spatial Planning and Management Act 2012**

Under MLNR and implemented through the Planning Urban Management Agency, the national spatial planning and management Act has not been widely implemented or utilised. Land use planning is a critical approach to identifying social and environmental risks from activities and planning. District wide and/or community-based plans will be essential in the long-term management of coastal land areas and water resources.

# Traditional Governance

Traditional governance in Tonga changed with the development of the Constitution in 1875, yet, even prior to the Constitution, Tonga's governance was through hierarchical kinships that formed the basis of power within the varying island groups. Land was controlled by descent groups (ha'a) through higher-ranking chiefs, who held smaller population divisions (kainga) (Powles 2014). After the Constitution in 1875, hierarchical chiefs became Nobles and remained as estate holders of private lands; all other lands and ownership of waters (fresh and ocean) was under the Monarchy.

Land may only be owned by Tongans, with land ownership split between King's estates, hereditary estates (Tofia's) of the Nobles and Matapule (spokesperson), Government land and private allotments. Under the Lands Act 2002, every male Tongan may apply for a tax allotment (api) which is subdivided by government or applicable to the hereditary estate where they reside (Government of Tonga 2002a).

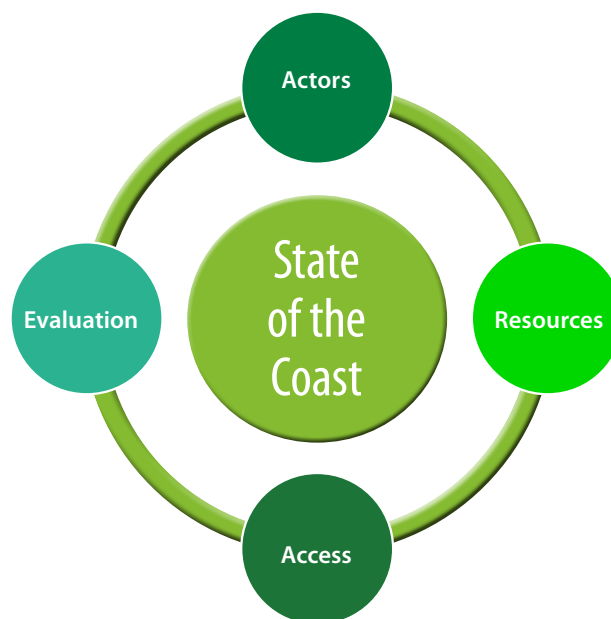
Traditional governance within the community is through elected district and town officers, with overarching governance provided on the estates of Nobles. The district and town officers were originally elected to help the Government communicate and understand social issues affecting communities, however the town and district officers now undertake further duties, including the responsibility for observing of legislation, including waste management, health, and disaster management.

The coastal and ocean areas were, until 2002, seen as open access to all Tongans for fishery resources through both fishing and gleaning activities (Gillett 2017); tabu (prohibited areas or species) were not a common form of village governance that is consistent with chiefly tenure such as in Fiji and Vanuatu. In 2002, the Ministry of Fisheries developed and legalised community management of coastal fisheries through the designation of SMAs (Government of Tonga 2002b), the SMAs grant the community legal rights to manage the fishery activities within a gazetted boundary.

# Coordinating mechanisms

Coordinating mechanisms enable inclusive governance through ensuring that all participants have access to resources (human and financial), information and support to establish and maintain suitable activities to strengthen R2R and state of coasts.

To ensure coordinating mechanisms are implemented and supported, it is critical to identify the different "actors" engaged in coastal areas. These "actors" are both inclusive of and outside of government.



**Figure 15:** Coordinating mechanisms ensure that all stakeholders are engaged and have access to resources and support needed to benefit the environmental and social activities associated with the state of coasts. These coordinating mechanisms can assist in the engagement and development of national frameworks and objectives.



Within the Government, there are line Ministries that have overlapping mandates and areas of responsibility, such as coastal and marine areas, resource use and social and economic development activities. Institutional arrangements and governance may be needed to provide transparent and clear mandates for integrated cross sectoral approaches. Figure 16 shows an example of government line ministries engaged through environment, resource use and socio-economic development. Notably, most Ministries are engaged across the three platforms, which requires further clarity to ensure that cooperation and integration of management and policy can be achieved for R2R processes.

Supporting the adoption of cross-over coordination needs to be better defined in overarching documents, such as the TSDf II that outlines the priorities of government and stakeholders to engage on environmental and social issues and defines the processes for good governance.

### Environment and Resource Management

- » MEIDECC (Department of Environment, Climate Change, Energy, Disaster Risk Management) – mangroves, waste management, protected areas, EIAs, renewable energy, invasive species
- » Ministry of Lands and Natural Resources (MLNR) – hydrological, sand mining monitoring
- » Ministry of Fisheries (MoF) – SMAs, fisheries resource stocks, species management
- » Ministry of Tourism (MoT) – beautification of historical and cultural sites, whale watching
- » Ministry of Agriculture, Forests, and Foods (MAFF) – forest and tree resources
- » Marine and Ports – illegal dumping of liquid and solid waste (MARPOL)

### Resource Use

- » Ministry of Lands and Natural Resources – sand mining, land use, offshore extraction
- » Ministry of Fisheries – coastal fisheries, aquaculture
- » Ministry of Agriculture, Forest, and Food – land use for agriculture
- » Ministry of Tourism – commercial tourism activities, land use for development
- » Marine and Ports – land use for ports, wharves, and jetties

### Social Economic Development

- » Prime Minister's Office – social development, economic planning, Town, and District Officers
- » MLNR – land development, sand mining, land surveying
- » Climate Change (MEIDECC) – climate resilient infrastructure
- » Ministry of Infrastructure – development and infrastructure
- » Ministry of Internal Affairs – youth and women's programs, economic development, community development
- » MTED – economic development formal and informal sectors
- » MoF – domestic and commercial fishing activities
- » Public Enterprise – waste management, urban water supply (TWB)
- » MAFF – agriculture exports
- » Ministry of Finance – domestic funded projects, management of development grants
- » Ministry of Tourism – tourism infrastructure, commercial tourism activities

**Figure 16:** Diagram showing the interests and activities of the various ministries within the coastal areas, including the cross-over between environmental and management efforts, resource use and development activities.

Academic institutions in Tonga could provide further support for training on coastal management through tertiary programmes. Tonga has three academic institutions: University of the South Pacific (Tonga campus), Tonga Tertiary, and the newly announced Tonga National University.

## Management plans

Coastal management plans are a critical component in strengthening the objectives of individual programmes towards transparent and effective management and as stipulated in the management plans, can be monitored, and evaluated. Currently there are a few management plans in place for coastal areas.

There are many sector management plans, including the MoF supported SMAs that provide community management to the coastal fishery resources up to ocean depth of 50 metres or 2500 meters from the high-water mark. Each designated SMA has its own management plan that is implemented by the Coastal Community Management Committee (CCMC). The CCMC cannot manage other coastal resources or environmental impacts under the SMA programme such as sand mining, anchoring of vessels and land use that may be impacting the health of the coastal area (Government of Tonga 2002a).

Protected areas in Tonga have limited management plans for conservation. The marine protected area (MPA) management plans are being developed under the Strengthening Protected Area Management (SPAM) programme through Department of Environment (MEIDECC) and funded by the Italian Ministry for Land, Environment and Sea. These management plans are currently awaiting the gazette of the marine spatial planning project.

A forest management plan was drafted in 2017, which sets out the actions needed to enhance the sustainable management of forests and tree resources (Ministry of Agriculture, Food, Forests and Fisheries and Wilkinson 2017).

A water resource management framework is in progress to map and outline the freshwater resources of Tonga and define the Ministry management activities, ensuring that there is inclusion of programmes and support to CSO/NGOs as well as engagement of community to help strengthen a national plan.

Tonga's ocean plan to implement 30 per cent protected areas within the exclusive economic zone will be gazetted as a full management plan with cooperating legislation and implementation plans.

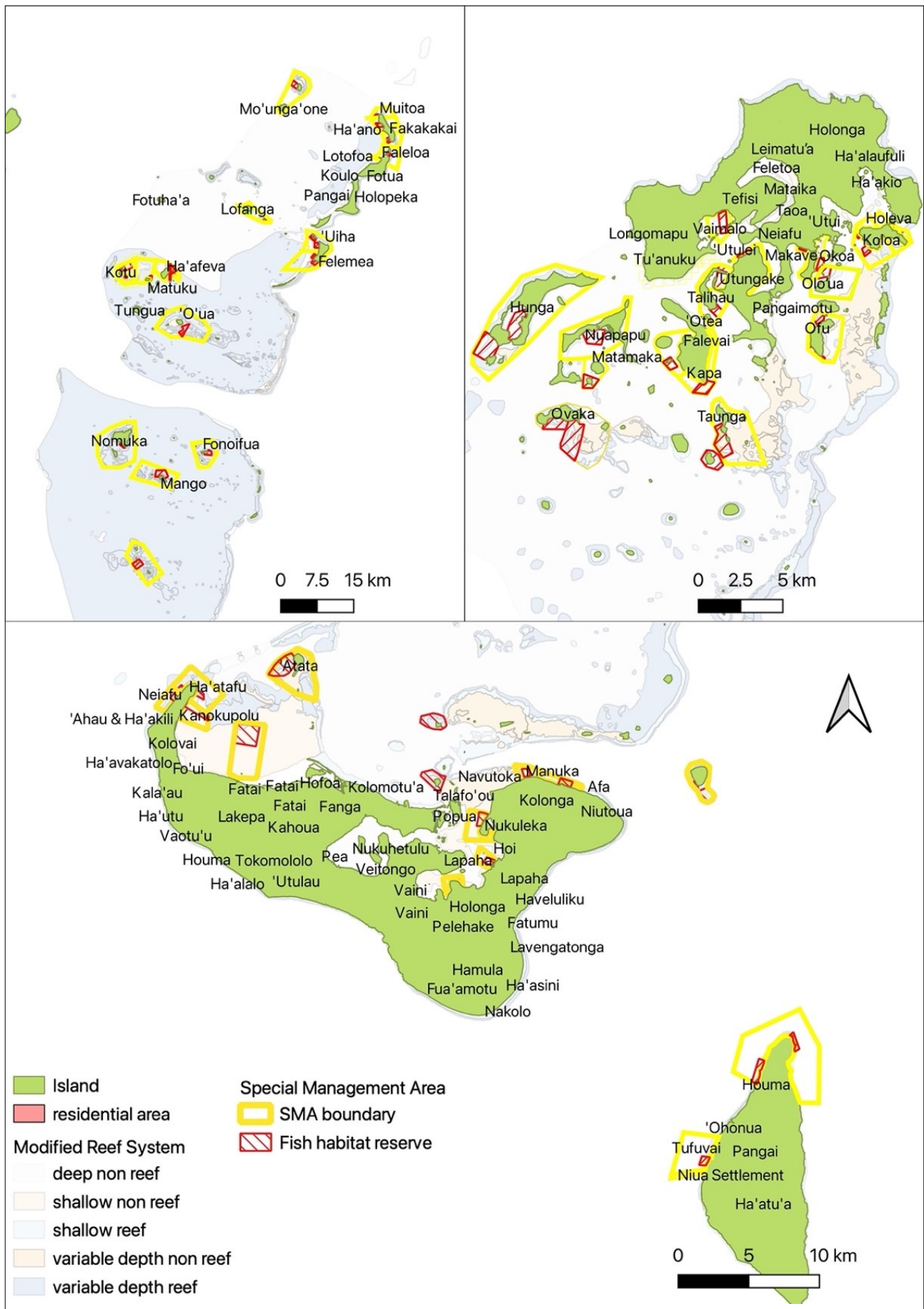
## Active Management

Tonga's coastal area is under single sector or project-based management programmes. Both financial and human resources can slow down the whole of Tonga approach to supporting coastal management.

The Ridge to Reef project demonstration is in Tongatapu, Hihifo district, Fanga'uta lagoon and Neiafu, Vava'u, with other similar projects implemented by other agencies and called nature-based solutions or water catchment programmes. These projects rely on regional support and donor funding.

The SMA programme is led by the Ministry of Fisheries and has the biggest active management of coastal fishery resources. It is supported by various donor and national organisations. The SMA programme engages communities in active management, but also leads to other benefits from gaining donor support. The activities led and managed by the communities are showing success through social engagement and monitoring and evaluation of projects..

CSOs and NGOs are active within the communities and districts covering a range of social, humanitarian, gender rights and environmental activities with many crossovers between social and environmental aspects. Although not widely reported, active management in the field is conducted through invasive species monitoring, reef management (removing crown-of-thorns starfish, *Acanthaster planci*) and aquaculture for livelihoods development. These activities are often carried out with training of community members and ministry staff.



**Figure 17** Map of the islands of Tongatapu and Eua, Ha'apai and Vava'u with the location of Special Management Areas (SMAs) designated as of 2020. SMA boundary is shown in yellow with the fish habitat reserve in red. Data provided by Ministry of Fisheries.

## Monitoring and evaluation

Monitoring and evaluation (M&E) is conducted through project-based activities. Government-led M&E is not currently consistent. Development agencies and funding partners implement M&E on environmental, social, governance and economic activities.

## Stakeholder participation

Regular meetings and consultations are held with communities, outer island ministries and private sector organisations and businesses. These meetings are a combination of project based and government activities and aim to create awareness and knowledge exchanges with stakeholders.

Though participation is high, the effectiveness of these stakeholder engagements and comments is intermittent in terms of strengthening projects and government activities, with traditional and cultural knowledge often not being encouraged nor the people being engaged in the outcomes.

## NGO/CSO and CBO activity

Civil society or non-governmental organisations (CSO/NGO) and community-based organisations (CBOs) are primarily situated in Tongatapu, with the larger CSO/NGOs such as Red Cross, having small subnational offices in the outer islands. A few independent NGOs are situated throughout the island groups of Ha'apai and Vava'u.

The Civil Society Forum of Tonga acts as the umbrella organisation for CSO/NGOs and CBOs in Tonga, with the primary focus on social and governance projects. The Global Environment Facility (GEF) runs the small grants programme through an officer based at the Civil Society Forum.

Outer island organisations that are independent, gain financial support through philanthropic organisations and grants available regionally.

## Knowledge and training

There is immense knowledge in Tonga within the ministries, CSO/NGOs and the CBOs and the communities from which coastal management programmes would benefit.

Training is conducted independently through ministries and CSOs/NGOs. There is a need for conformity of data collection and methodology to ensure that cross analysis can be conducted through data sharing. Ensuring that knowledge is transferred and shared between stakeholders is an integral aspect of the management work implemented through NGO and CSO programmes.

Outcomes from training programmes are evaluated internally by organisations, however, sharing of lessons learned would be beneficial to the overall improvement of communication programmes, especially in ensuring that community voices and knowledge is elevated throughout.

Community based initiatives for water resource and coastal management, including fisheries management, have been implemented by national and regional stakeholders.

Other institutional programmes that can provide support in developing coordinating mechanisms are through hands on management and technical training, including the Skills and Employment for Tongans (SET) project funded by the World Bank and Tonga Skills through the Department of Foreign Affairs and Trade, Australia. These projects can be utilised to strengthen institutional gaps. The provision of scholarships and tertiary training by other donor partners is also providing critical long-term benefits to ministries and agencies.

## Risk Management

Risk management is the process of identifying, monitoring, and managing risks and threats with the aim to minimise the impact on environmental, social, and economic activities.

The coastal areas and coordination mechanisms towards a more cohesive pathway towards sustainable, integrated water resource and coastal management requires a risk management strategy to prioritise activities, stakeholders, and resource availability.

Currently in Tonga, consistent risk management is not conducted at a broad scale but through sectoral approaches and at project level, with limited capacity being transferred between programmes for best practices and implementation. NGOs and CSOs run more risk management programmes particularly as they need to be accountable for project delays and successful outcomes of their donor funded programmes.

Disaster risk management is highly coordinated and supported through a multi-sector approach under the National Emergency Management Office (NEMO), which has gained resources due to the large ongoing social impacts related to cyclones, tsunamis, flooding, and COVID-19. Data from NEMO could be coordinated to identify environmental risk patterns.

Developing a national risk management strategy for coastal areas, habitats, biodiversity, and livelihoods would be an additional benefit to addressing not only risks from disasters but critical risks on the current activity towards managing coastal areas, environmental and livelihood impacts.

Risk management identifies other compatibilities that are needed to maintain and improve environmental and social impacts and provides useful sustainable coastal management activities, including financial and human risk and identifies adaptation and mitigation methods to ensure the continuity of activities.

# Looking Forward

The Kingdom's coastal areas, habitats and resources have been extensively studied with documentations readily available. The studies range across the sectors of fisheries, environment, and natural resource use, with the science and data agreeing on the continuance of impacts affecting ecosystem services and goods and the need for management for the benefit of community and economy.

For change to be substantial and sustainable, policy, planning and innovation are needed to implement national (Tonga wide) strategies for reducing waste (both liquid and solid), improving quality and access to water resources, and reducing exploitation of natural resources.

The next five to ten years are a critical turning point for ensuring the ecological future of biodiversity and resources for Tonga's land and coastal areas; programmes such as the SMAs are integral to reducing fishing pressure in community areas, however, cannot reduce all the threats the coastal ecosystems face. The multifaceted approach must be conveyed as a national priority, with political support from Cabinet members, legislators, and state actors.

Innovation needs to lead to implementation with nature-based solutions, economic markets and outliers supporting both terrestrial and ocean activities. Critical needs are for reducing waste and pollution pressures upon the environment through effective reduction and adaptation methods, including identification of potential secondary use for waste materials, increase management and capacity for e-waste and minimising the importation of single use plastics. Innovation needs to be inclusive and allow for adaptable income markets and development to be supported within communities. These can only be implemented with adequate and appropriate financial and human capacity and should be adaptable to the local demographics of the outer islands and districts of Tonga.

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# Appendices

## Appendix 1: List of current regulations and legislations that cover coastal management

Legislation	Ministry/Sector	Year	Focus/Comments
Agriculture Act	MAFF		Legislation for agriculture and use of pesticides, herbicides, and fungicides
Aquaculture management act	Fisheries	2003	Provisions for commercial and subsistence aquaculture
Birds Prieservation Act	MLNR	2016	Amended from Birds and Fish preservation act 1988.
Protection of mangrove species			
Building Codes and Standards Regulations	Ministry of Infrastructure	2016	Regulation on building standards and codes
Climate Change Policy	MEIDECC	2006	
Constitution of Tonga	Government of Tonga	1988	Overarching establishment for legal grounding in Tonga
Environment Management Act	Environment (MEIDECC)	2010	Overarching legislation for environment management and climate change through the Ministry for Environment
Environmental Impact Assessment and Regulations	Environment (MEIDECC)	2010	Development and Infrastructure adaptation and mitigation procedures environmental, social, and economic benefit
Fisheries Coastal Community Regulations	Fisheries	2009	Special Management Area (community managed near-shore fisheries)
Fisheries Management (Conservation) Regulations	Fisheries	2008	Fisheries and marine resource species regulations including giant clams, turtle, and other bivalves. Mullet is the only fish that has a protected season in Tonga.
Fisheries Management Act	Fisheries	2002	Licensing and regulations for commercial and domestic fishing activities
Forests Act	MAFF	2016	Control on removal of forests
Hazardous Waste and Chemical Act	Climate Change (MEIDECC)	2010	Regulation for reducing hazardous waste, protection of ozone layer
Health Act			
Lands (Removal of Sand) Regulations	MLNR	2016	Regulation and permit for sand mining
Lands Act	Lands (MLNR)	1988	Land ownership, delegation of powers to the Minister
Marine Pollution Prevention Act	Ports and Marine	2016	MARPOL regulations for the disposal of solid and liquid waste at sea
National Spatial Planning and Management Act	MLNR	2012	Land use planning (not implemented widely in Tonga)
Parks and Reserves Act	MLNR	1988	Protected area designation, lacks regulations and management directive
Pesticides Act	MAFF	2002	Control on import and use of pesticides

Legislation	Ministry/Sector	Year	Focus/Comments
Public Enterprise Act	Government of Tonga	2020	Government owned enterprises for waste, water, communication (Tongan Communications Corporation etc)
Public Health Act	Ministry of Health	2016	Monitoring of public health includes water quality
Roads Act	Ministry of Infrastructure	2020	Building and maintenance of public roads, including maintenance and integrity
Town and District Officer	Government of Tonga	1988	Legislation for town and district officers, role of position. Needs amending to status and loading of work required by DO/TO
Waste Management (Littering) Act	Environment (MEIDECC)	2016	Provides for compliance and enforcement on public littering
Water Resource Management Bill	MLNR	2020	Water resource management, resource management, guidance



