TONGA STATE OF ENVIRONMENT REPORT 2018

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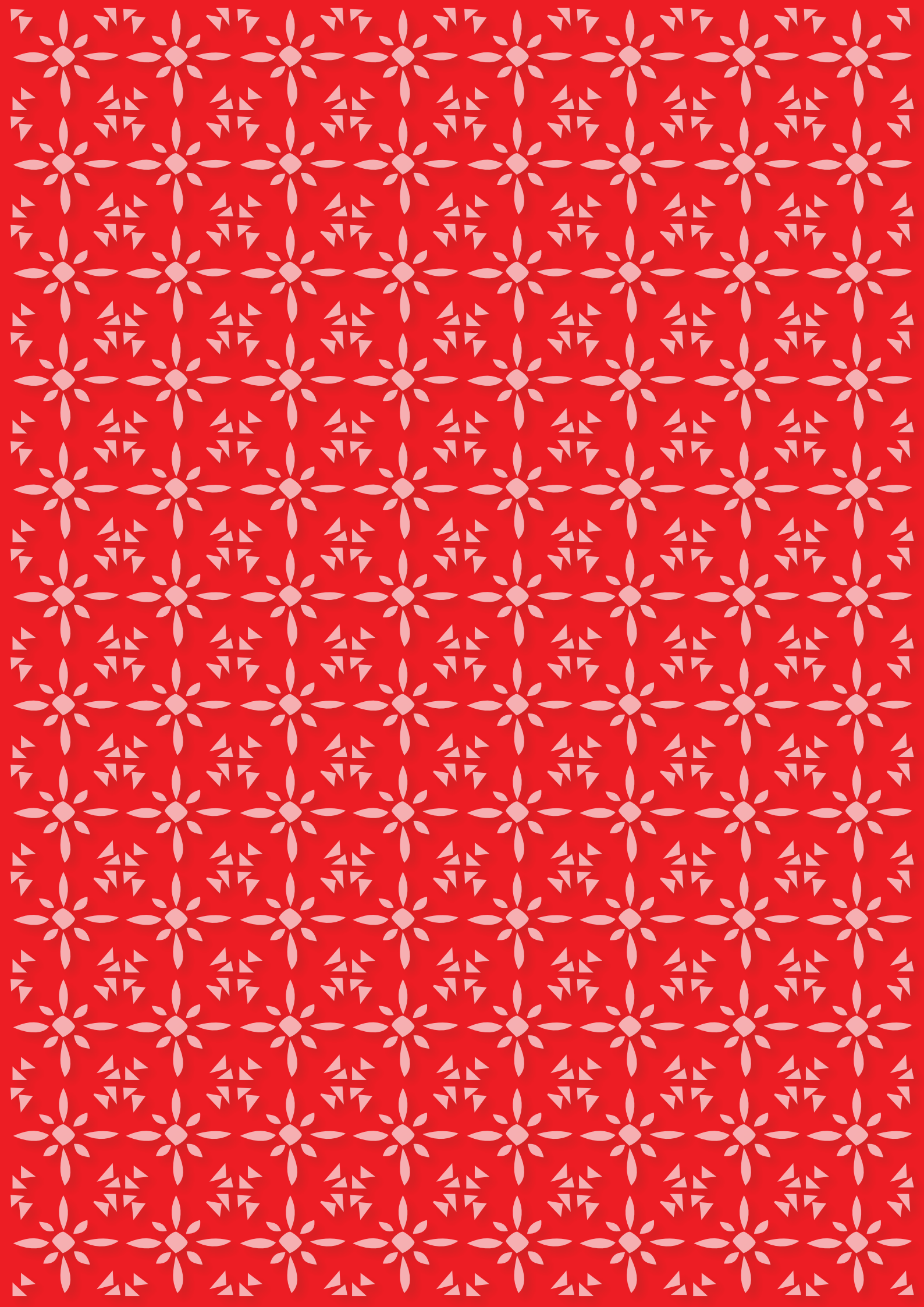

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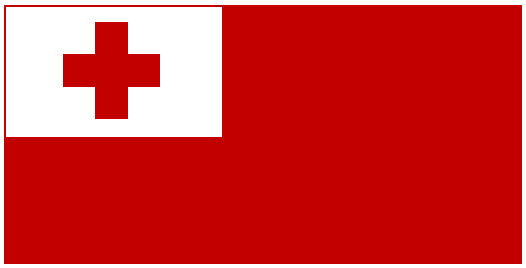

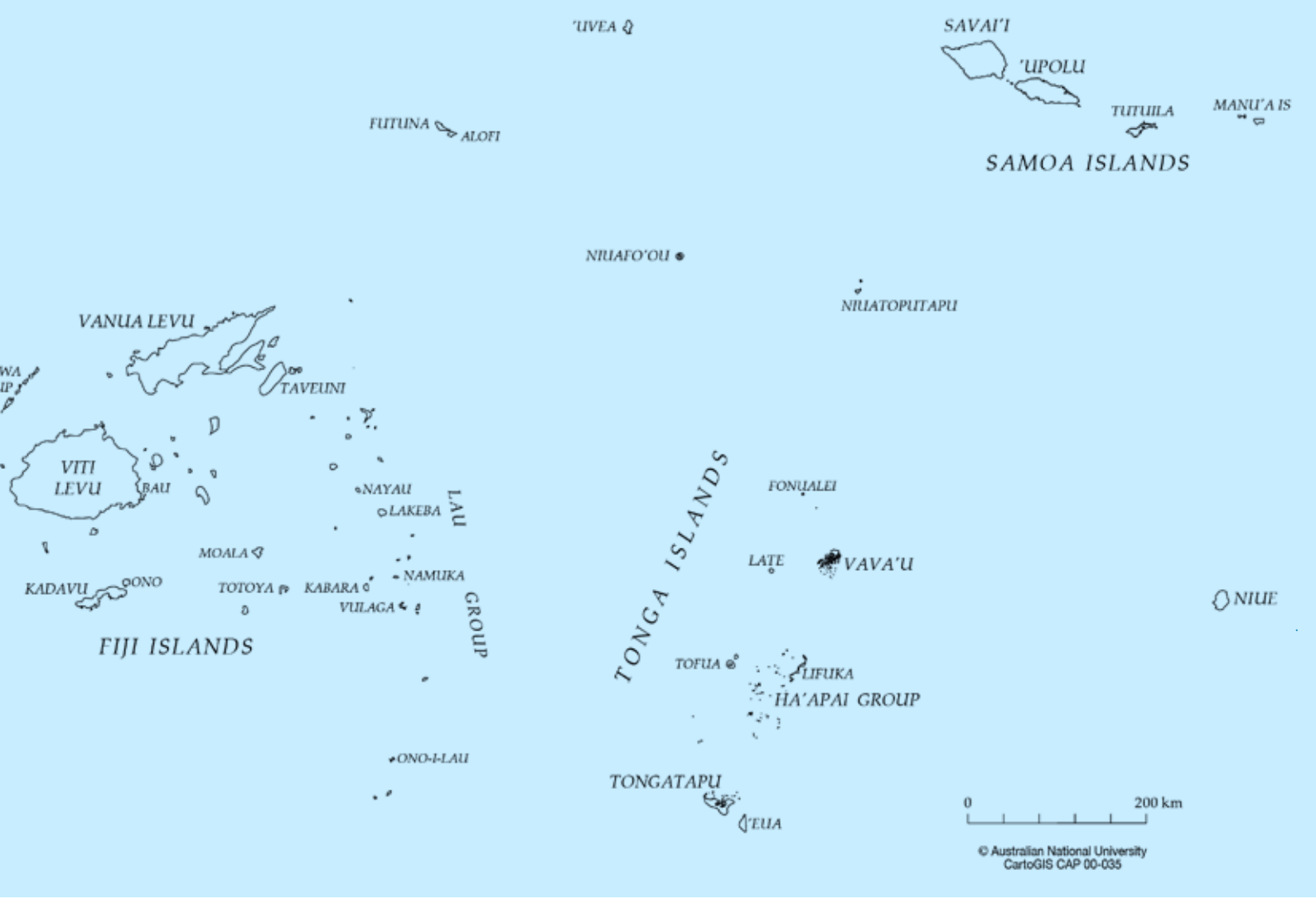

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Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

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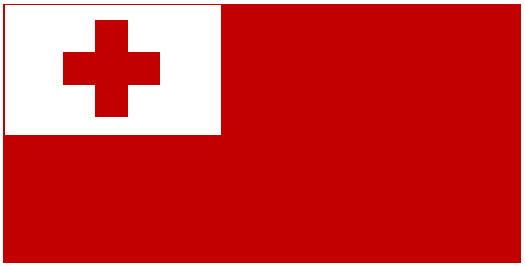

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ACKNOWLEDGEMENTS

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Lastly, this report would not have been completed without the valuable contributions of staff from different agencies of the Government of Tonga and private sector, as shown in the table below.

Fakamalo atu moe hounga'ia mo'oni he ngaue kuo lava 'i hono fa'u e 'Tu'unga 'o e 'Atakai 2018 'o Tonga. 'Ofa ke kei monu'ia ai pee maa'imoa 'a e Fale 'o Tupou mo Hou'eiki.

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ACRONYMS

ADB	Asian Development Bank
AFB	Adaptation Fund Board
CBD	Convention on Biological Diversity
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
COT	Crown of Thorns (starfish)
DO	Dissolved Oxygen
DPSIR	Drivers, Pressures, State, Impact and Response
DRM	Disaster Risk Management
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EbA	Ecosystem-based Adaption
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
INDC	Intended Nationally Determined Contribution
JNAP	Joint National Action Plan
KBA	Key Biodiversity Areas
MAFF	Ministry of Agriculture, Forestry and Food
MAFFF	Ministry of Agriculture, Forestry, Food and Fisheries (*historical*)
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications
MLSNR	Ministry of Lands, Survey and Natural Resources
MMA	Marine-managed Area
MOA	Ministry of Agriculture
MOT	Ministry of Tourism
MSY	Maximum Sustainable Yield
NBSAP	National Biodiversity Strategic Action Plan
NEMS	National Environment Management Strategy
NESAF	National Environment Strategic Action Framework
NGO	Non-governmental Organisation
NH4	Ammonium
NMDI	National Minimum Development Indicator
N20	Nitrous Oxide
NO_3	Nitrate
ODS	Ozone-depleting Substances
OPM	Office of the Prime Minister
PIC	Pacific Island Countries
SMA	Special Management Area
SF6	Sulphur hexafluoride
SDG	Sustainable Development Goal
SoE	State of the Environment
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
SPREP	Secretariat of the Pacific Regional Environment Programme
SST	Sea Surface Temperature
TCTD	Tonga Community Trust Development (TCTD)
TSS	Total Suspended Solids
TWB	Tonga Water Board
WAL	Waste Authority Limited
WT	Water Technology Pty Ltd
WATSAN	Water Waste and Sanitation Unit of ICI
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WWF	World Wildlife Fund

MESSAGE FROM THE MINISTER OF METEOROLOGY, ENERGY, INFORMATION, DISASTER MANAGEMENT, CLIMATE CHANGE AND COMMUNICATIONS (MEIDECC), TONGA

The Tonga State of the Environment 2018 report has been developed to answer three key questions related to the environment of Tonga, and is based on seven thematic areas:

- What is the current condition of the Tongan environment?
- What are the risks the Tongan environment faces and what measures have been put forward to minimise them? This could provide lessons for Tonga.
- Where is the environment of Tonga headed based on the assessed thematic areas?

The report finds that parts of the environment of Tonga and heritage are largely in good and stable or improving condition, and identifies aspects of the environment where the current status is poor or deteriorating. The growing population, social and economic activities, land use changes and climate change produce challenges for the environment including pollution, resource extraction, consumption rate and generation of waste. The approach of the Government of Tonga in managing these challenges will be vital for safeguarding the environment.

The report discusses the key responses adopted by the government and private sector to sustainably manage the environment and reduce the negative impacts on thematic areas. More importantly, it provides key recommendations to be carried out by government agencies to improve the status of the environment.

As this is the first SoE report for Tonga, it will stand as the baseline. Continuous monitoring of key information is important and continuous upskilling of government staff is critical in their ability to safeguard the environment. I recommend the report be endorsed by parliament and be reviewed at an agreed frequency.

I offer my gratitude to the Secretariat of the Pacific Regional Environment Programme and acknowledge their valuable contribution and support, and for providing the financial means to develop this important report. I also acknowledge the work by Water Technology Pty Ltd as the consultant commissioned by SPREP to develop the SoE.

I look forward to the ongoing support and assistance from all stakeholders both regionally and internally in helping us to safeguard our beautiful environment.

As the Minister of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications, I have the honour to present the Tonga State of the Environment 2018 report for government endorsement and implementation.

Hon. Poasi Mataele Tei
Minister of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications (MEIDECC), Tonga

MESSAGE FROM THE DIRECTOR GENERAL OF SPREP

The natural environment has always been part of Pacific island culture. It has shaped and influenced our way of life for centuries and as the primary source providing for our Pacific communities, it has fed, clothed and kept us safe.

Despite its immense value, our environment is under growing pressure due to economic development, tourism expansion and the threat of global climate change. Therefore, it is important that we continue to monitor and maintain the quality of our environment for future generations.

The SoE 2018 report assesses and reports on seven thematic areas as well as the baseline information for new and emerging environmental challenges.

This report emphasises data-based conclusions and presents supporting evidence for all indicators.

This new baseline can help Tonga with national, regional and international reporting obligations, including multi-lateral environmental agreements (MEA) and sustainable development goals (SDG). This report has already informed environmental planning and decision-making and has guided the development of the National Environment Management Strategy (NEMS).

SPREP is pleased to have partnered with the Ministry of Environment in developing this document, as well as the many other agencies and civil society organisations that contributed to the consultative process. I acknowledge the financial support from the EU ACP/MEA Capacity Building Project Phase 2 and the UNEP Inform Project. These two projects are executed by SPREP.

I would like to sincerely thank the individuals and all the government ministries and departments for their contributions. It is important that regular updates to this SoE Report are conducted to assess Tonga's environmental conditions. I encourage you all to use this report to help track, manage, plan and report on natural resources and the environment.

Kosi Latu
Director General
Secretariat of the Pacific Regional Environment Programme

EXECUTIVE SUMMARY

The Tonga State of the Environment 2018 Report aims to give Tonga the best and clearest status of its environment by answering the following key questions:

- What is the current condition of the Tongan environment?
- What are the risks the Tongan environment faces and what measures have been put forward to minimise them? This could provide lessons for Tonga.
- Where is the environment of Tonga headed based on the assessed thematic areas?

The report uses the Drivers, Pressures, State, Impact and Response (DPSIR) model of reporting. The main aims are to:

- Identify the key drivers and pressures behind the changing environment in Tonga;
- Assess the status of the environment by using the best available information for seven key thematic areas: Atmosphere and Climate, Inland Waters, Land, Marine and Coastal Environment, Biodiversity, Culture and Heritage, and Built Environment;
- Discuss the social, economic and environmental impacts that result from changes in the state of the environment;
- Discuss current responses by Tonga to address changes in the state of the environment that better protect and manage resources; and
- Provide recommendations for Tonga to address key challenges and build on existing strengths, which are linked to actions in the National Environment Management Strategy (NEMS), developed as part of this project.

Changes to the environment in Tonga are driven by broader social, economic, technological and cultural forces referred to as 'drivers'. These include population growth, social and economic influences, land use changes and climate change. The drivers are a source of further pressure on the environment, but can also offer potential solutions to problems.

The pressures on the environment fall into three categories:

- Land Development (urban, agricultural and coastal);
- Resource Extraction (commercial fishing and mining/ quarrying); and
- Consumption and Waste (energy, solid and liquid waste, and water).

This report is comprised of three discussions:

1. **Drivers and Pressures in Tonga: A summary of the main points discussed in the Pressures and Drivers section of the report.**
2. **State of the Environment and Impacts on Society, Economy and Environment: Key findings are provided for each of the seven themes:**
   - Atmosphere and Climate
   - Inland Water
   - Land and Planning
   - Coastal and Marine Environment
   - Biodiversity
   - Built Environment
   - Culture and Heritage
3. **Responses and Recommendations – Challenges in Moving from Policy to Action: This presents key responses, opportunities, challenges and recommendations.**

Parts of the environment and heritage of Tonga are in good condition and improving due to good resources management, and implementation of government initiatives supported by overseas donors. Other parts are in poor condition and deteriorating due to lack of resources and knowledge to manage key areas, lack of coordination in government levels, and the false perception of abundant natural resources that place the environment as a low priority when making government decisions. Poor historical decisions that ignored the risk to the environment have left an ongoing legacy of neglect. Climate change, and growing population and economy growth, increase the pressure on the environment and confront it with new challenges to overcome.

Atmosphere and Climate

The theme of atmosphere and climate has identified key indicators that are in poor condition and with an unknown trend due to a lack of data. For others their status is good and trend improving, for example, emissions based on greenhouse gases have been reduced. The ozone depleting trend is unknown due to a lack of data. However, the increase in importing of goods containing ozone substances points to a need to reduce the level of ozone emissions. Changes in Tonga's physical climate have led to challenges with flooding and sea level rise, compounding the challenges associated with poor land management. While the impact

of climate change on Tonga is continuing with increases in temperature, sea levels rising, changes in rainfall and other physical climatic parameters, the country has put forward a 10-year Joint National Action Plan (2018) aimed at improving the environment and increased resilience to climate change. Improvements in monitoring are required together with training for government staff.

Inland water

The inland water theme focuses on Tonga's water resources. Tonga does not have a river system or a large surface water hydrology due to its topography and soil properties. There is a heavy reliance on the groundwater system, supplemented by rainwater, to satisfy water demand. The groundwater supply only accesses the unconfined aquifers which are influenced by rainfall events through groundwater recharge. The groundwater system is impacted by sea level rising and increased salinity in low-lying areas. Urban areas have no reticulation system for sanitation and sewage as the country relies on septic tanks. These tanks are poorly managed and result in traces of faecal coliform in the groundwater. Clearing of land for agricultural activities and the use of agrichemicals have led to traces of harmful chemicals in the groundwater. Poor infrastructure and lack of maintenance have caused water losses in both urban and rural areas. The water availability is fair and stable, water quality is poor and deteriorating, and infrastructure requires urgent attention to counter increasing water demand due to population growth. An alternative water supply system for Mataki'eua is required.

Land and Planning

The hierarchical land ownership system in Tonga provides benefits for the society and land owners. However, it has also led to clearing of forest due to increased demand for agricultural activities and urbanisation. The native forest is almost extinct. Only a small remnant forest in Tupou College Toloa is left on the main island of Tongatapu. Unsustainable land reclamation in coastal areas has led to a loss of mangroves and marine species vital for local communities. This is a thematic area where the Tongan environment is in a very poor and deteriorating condition with immediate attention urgently required. Proper zoning should be used in urban development to manage this issue. Development of the coastal region (within 10 m of the mean high-water mark) and natural swamp area such as Popua and Sopu should cease.

Coastal and Marine Environment

Tonga's fishing industry is a key sector for economic growth. Coastal communities continue to rely on subsistence fishing. Both inshore and offshore fishing are in fair and stable condition. The Ministry of Fisheries is working to ensure these two indicators are sustainably managed even with a growing market. Other stakeholders have also tried to protect tuna and shark species. Significant collaboration between the Ministry of Fisheries and coastal communities have led to the implementation of special management areas (SMA). This programme has proved a success in protecting marine species and ensuring the local communities maintain their ability to provide for themselves. The Ministry is planning on implementing 60 more SMAs by 2020. This indicator is in good condition and improving. The coral reef is in fair condition with data in a stable trend. While the harvesting of live rocks has reduced in recent years due to government intervention, deposits of non-reef materials have increased. The lakes in the outer island of Niuafo'ou are deemed in good condition. The Fanga'uta lagoon on the other hand is poor and deteriorating. Unsustainable land reclamation around the lagoon banks has led to sedimentation and leakage of septic effluent into the lagoon. A government building is being built in Havelu that fills the mangrove zone with rocks and gravel without proper engineering to reduce sedimentation. The sedimentation has interfered with the current flow and also led to loss of marine species as reported by locals. Although coastal erosion in low-lying areas has occurred, different programmes have been used to reduce erosion and mitigate its effects.

Biodiversity

The biodiversity of Tonga was assessed using three indicators: marine mammals, threatened and endemic terrestrial species, and invasive species. All indicators are in fair condition with mixed trends and deteriorating for invasive species. Marine mammals are thought to be sustainable although there is a lack of data. Some of the threatened and endemic terrestrial species have been reduced to almost extinct. The threat of invasive species is increasing. Different programmes have been put in place to protect and improve the biodiversity of Tonga. More resources are needed to conduct these programmes, along with proper training of agency and government staff involved in the work.

Built Environment

The growing population drives the increase in urbanisation in the main islands. This drives more demand for energy and generates more waste. The main source of energy in urban areas comes from imported fuel. The level of fuel imports has increased although renewable solar energy is also growing. There is an opportunity to increase the amount of energy from solar farms to reduce the use of imported fuel. The energy indicator is in good condition and improving, crediting well-driven government initiatives and the contributions of overseas donors. Sewage and sanitation are big problems for the Tongan environment. There is no sewage reticulation system in the urban

areas and poorly maintained septic tanks leak effluent to the groundwater system. It is strongly recommended that all new development must use proven alternative materials such as fibreglass for septic tanks instead of cement tanks. The efforts of the Waste Authority Limited in collecting waste and disposing of it in the Tapuhia Landfill are to be commended. However, they are hindered by a lack of resources resulting in solid waste not being sorted. The lack of government initiatives to support private entities such as ‘Uiha and Sons Ltd in recycling has led to recyclable materials being disposed off at Tapuhia Landfill. This will fill the landfill quicker than expected. There is no place for hazardous waste separation in the landfill. The Department of Environment has improved the way it carries out environmental impact assessments (EIA). The number of proposed developments registered to have EIA has increased. This trend will reduce the negative impacts on the environment. Government staff need better training in managing the environmental impacts.

Culture and Heritage

This theme was assessed using four indicators. The local language and traditional knowledge have been affected by the introduction of modern knowledge and greater use of English in daily activities. Built heritage and indigenous sites are considered good and stable. However, climate change may affect some of the historical sites especially those in low-lying areas. The cultural industry is considered to be in a good state but is also deteriorating. Tonga needs to maintain its beautiful beaches even with the effects of climate change to sustain its tourism market. Traditional diets have been impacted by the shift from local foods to imported products. The traditional diets need to be maintained and sustained.

As this is the first developed SoE for Tonga, the report will stand as the baseline. Vital information and indicators must be monitored and reported accurately for the next SoE. Government agencies need to collaborate more effectively and make scientific data more readily available.

INTRODUCTION AND BACKGROUND

INTRODUCTION AND BACKGROUND

The Kingdom of Tonga is a country located in the central south Pacific, lying between 15º and 23º 30' South and 173º and 177º West. It has a combined land and sea area of 720,000 km² and consists of an archipelago of 172 islands with a land area of 747 km². There are 36 inhabited islands with an area of 670 km². In 2016 Tonga's population was 100,651 (SOPAC, 2017).

Tonga lies within the south-east trade wind zone of the South Pacific and its semi-tropical climate is dominated by south-easterly trade winds. Rainfall is moderate and variable, defined by two seasons, Wet and Dry. Two main causes of rainfall variation in Tonga are ENSO (El Nino-Southern Oscillation) and tropical cyclones. ENSO events can cause prolonged drought whereas tropical cyclones can result in unusually wet years. Tropical cyclones and earthquakes occur in Tonga and can cause significant damage. Volcanic activity in Tonga has been recorded since 1839, and includes submarine eruptions, and emerging and disappearing islands. In terms of impact on human settlement, there is an active volcano on the island of Niuafo'ou (SOPAC, 2007).

ENVIRONMENTAL REPORTING IN TONGA

Tonga is a constitutional monarchy with a centralised governing structure. Tonga is administratively divided into three main island groups: Tongatapu, Ha'apai and Vava'u. The Monarch, the Head of State, and the two governors, part of the Privy Council elected by the Monarch, have responsibilities in the overall administration and reporting of island affairs. The Head of Government is the Prime Minister who is chosen by the Monarch with all ministries under their authority. There are 13 government ministries which report to the Office of the Prime Minister. The ministries with environmental reporting requirements are:

- Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC);
- Ministry of Tourism (MOT);
- Ministry of Infrastructure;
- Ministry of Lands, Survey and Natural Resource (MLSNR),
- Ministry of Agriculture, Forestry and Food (MAFF), and
- Ministry of Fisheries.

Although these are separate ministries, each monitors environmental impacts. However, there is no clearly defined monitoring system and there is a lack of coordination between the ministries to develop a comprehensive account of the state of the environment. An outcome of the *Tonga Climate Change Policy: A Resilient Tonga by 2035* suggests the implementation of this interaction.

There are a number of regulations and Acts pertaining to reporting on the environment, such as:

- *Meteorology Act 2017* – monitors all meteorological impacts on Tonga and provides an annual report for the Department.
- *Environmental Impact Assessment Act 2016* – requires reporting for all major project proposals for an Environmental Impact Assessment (EIA).
- *Environmental Management Act 2016* – coordinates the role of Government in environmental management, including reporting on climate change issues, and decision-making processes.
- *Fisheries Management Act 2016* – involves the long-term conservation and sustainable use of the fisheries, to protect the ecosystem and minimise pollution and waste.
- *Ozone Layer Protection Act 2016* – requires a permit for the projected emissions by an organisation and annual reporting.
- *Tonga Water Board Act 2016* – an appointed board that provides water supply to parts of Tonga requiring annual reporting on consumption and capacity.

These Acts, among other relevant plans and policies, allow for the monitoring of environmental issues and management of subsequent impacts.

PURPOSE OF STATE OF THE ENVIRONMENT REPORT

The purpose of the Tonga SoE Report is to present the best available information about the current state of the environment as the basis for effective environmental management and planning. The report examines the major drivers of change to the environment that emerge from global, regional and national factors. It also evaluates the main environmental pressures created by these drivers, and examines their social, economic and environmental impacts.

SoE reporting is an internationally accepted reporting method that analyses the condition of a geographic area or jurisdiction's ecosystems and associated natural resources. SoE reports compile and analyse quantitative and qualitative data from a variety of local, national, regional, and international sources to provide a holistic picture of the current state of the environment of a subject location. SoE reports also identify environmental trends, including anthropogenic impacts to natural environments.

SoE Reports prioritise the most important environmental attributes of a given location and identify issues that impact the state of the location's environment. The reports include the condition of flora and fauna species as well as habitats such as native forests, marine and inland water bodies, soils, and vegetation cover. The reports address key aspects of highly modified agricultural and built environments.

Many SoE reports predict a future state of a location, which is often related to problems within that environment. These predictions can help to address growing concerns about the impacts of climate change by offering an idea of the future state of the environment under 'business as usual' scenarios. This can inspire climate change adaptation and mitigation strategies that address emerging issues and threats. SoE reports can also provide well-researched information for local, municipal, and national planners and managers in areas such as natural resource management, town and urban planning, tourism, and resource development.

AUDIENCE

The main audiences for the development of the Tongan SoE Report are:

- Tongan government personnel, particularly in areas relating to the environment, planning and infrastructure, health, and education;
- Citizens and community groups;
- Donor organisations;
- Non-governmental organisations e.g. SPREP, and
- Research institutions and universities, and researchers with interests specific to the SoE thematic areas.

STATE OF THE ENVIRONMENT 2018

The 2018 State of the Environment report outlines the status of the environment in seven thematic areas:

- Atmosphere and Climate;
- Water Resources;
- Land and Planning;
- Coastal and Marine Environment;
- Built Environment;
- Biodiversity, and
- Culture and Heritage.

APPROACH TO 2018 TONGA SOE REPORT

The Drivers, Pressures, State, Impact and Response (DPSIR) model (Figure 1–1) is used in SoE reporting. The model is a global standard for SoE reporting and part of a systems approach that considers social, political, economic and technological factors, as well as forces associated with the natural world.

Three consultation missions were conducted in Tonga between June and November 2018. Members from Water Technology, SPREP and stakeholders from different sectors related to thematic areas attended these workshops. The stakeholders came up with drivers, pressures and themes to be assessed in the SoE 2018. The data on indicators was provided by stakeholders during site visits. They also provided inputs on the draft SoE and confirmed that data was accurate.

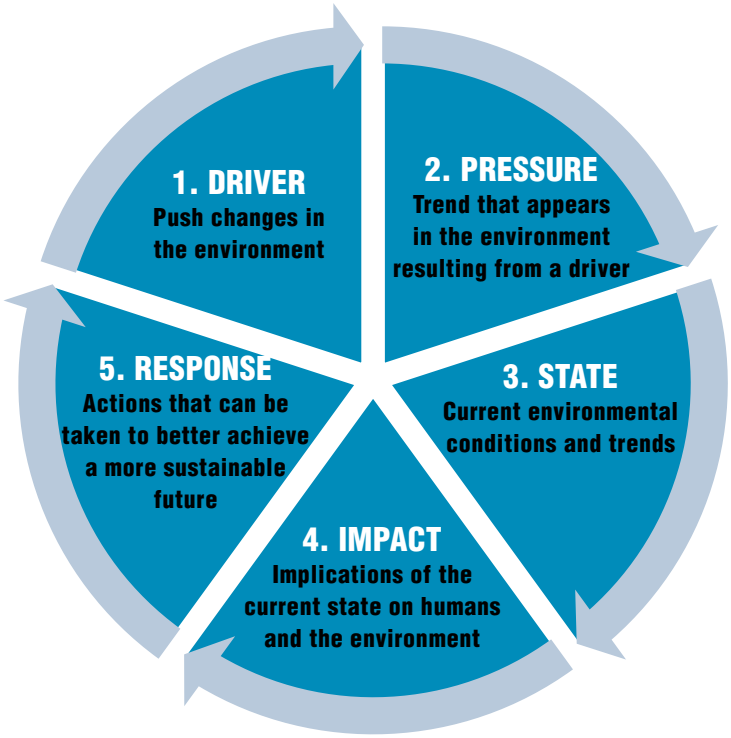


FIGURE 1–1 SoE Report Framework (DPSIR Model)

THEMES OF TONGA 2018 STATE OF THE ENVIRONMENT REPORT

The 2018 SoE Report includes seven thematic areas with important ecosystems and environmental issues, and indicators developed for each one. (Refer Table 1–1 next page).

The indicators for each habitat or sub-topic are used to assess the state of the specific habitat or sub-topic and they are individually rated for State (Good, Fair, Poor), Trend (Deteriorating, Stable, Mixed, Improving) and Confidence in the Data (Low, Medium, High).

The key organisation responsible for providing data and information for each thematic is shown in Table 1–2.

TABLE 1–1 Themes and indicators for the 2018 Tonga SoE Report

Theme	Indicators	Data Analysis
Atmosphere and Climate	Greenhouse Gases (GHGs)	• GHG Trends
	Ozone Depleting Substances (ODS)	• Emission trends
	Physical Climate	• Rainfall • Temperature
	Climate Change Adaption	• National plans and policies
	Drought Proof	• Number of droughts
Inland Water	Water Availability	• Drinking Water • Rainwater • Groundwater Aquifers • Groundwater Extractions
	Water Quality	• Traces of pollutants • Salinity
	Infrastructure	• Infrastructure status
Land and Planning	Forest Cover	• Area of coverage type
	Agricultural Land	• Crop types
Coastal and Marine Environment	Offshore Environment	• Tuna, Tuna-like species and sharks harvested • Catch quantities • Market Availability
	Inshore Environment	• Catch quantities
	Special Management Area	• Inshore area • Offshore area • Extend
	Coral and Marine Species Health	• Coral Reef Ecosystem • Species – Whales and Turtles • Reef monitoring
	Coastal Erosion	• Erosion Areas • Control Measures
	Lagoon and Lake Health	• Fanga'uta Lagoon • Tongatapu Lagoon • Vailahi
Biodiversity	Marine Mammals	• Species types
	Threatened and Endemic Terrestrial Species	• Species types
Built Environment	Energy	• Energy Types • Fuel imports • Consumption level
	Sewage and sanitation	• Reticulation system • Health indicators
	Solid Waste	• Domestic waste • Recycling • Total Waste
	Hazardous Waste	• Level of HW
Culture and Heritage	Language and Knowledge	• Language and Knowledge
	Built Heritage and Indigenous Sites	• Number of heritage sites
	Cultural Industries	• Number of tourists
	Traditional Diets	• Diet records

TABLE 1–2 Responsible Ministries and Departments for Each Thematic

No	Thematic Content	Thematic Lead
1	**Atmosphere and Climate**	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC)
2	**Inland Water**	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC) Ministry of Health Ministry of Lands, Survey and Natural Resources
3	**Land and Planning**	Ministry of Lands, Survey and Natural Resources Office of the National Spatial Planning and Management Authority
4	**Coastal and Marine Environments (Inshore and offshore)**	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC) Department of Fisheries Tonga Community Trust Development (TCTD)
5	**Biodiversity**	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC)
6	**Built Environment**	Ministry of Infrastructure; Waste Authority Limited, Department of Energy
7	**Culture and Heritage**	Ministry of Health; Tourism, TCTD

A READER'S GUIDE TO THE 2018 STATE OF THE ENVIRONMENT REPORT

How to read the report

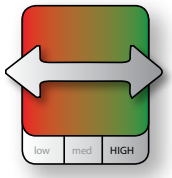
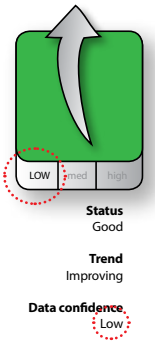
A State of the Environment report condenses a large amount of information on various aspects of the environment into a readable and actionable report. Given the broad spectrum of topics covered, the report has been broken into themes for easier use. The report can be read as a whole, or by themes, noting that most of the themes are connected to each other and to the pressures and drivers behind them. Symbols were designed for each indicator to summarise the State, Trend and Confidence in each assessment. Symbols were also designed for groups of indicators that describe a habitat or sub-topic within a theme. For example, the Land and Planning theme is broken into forest and woodlands, agriculture and pasture, and planning zones and overlays specific to Tonga. Symbols were not designed for each theme because the variety of potential states may not provide a meaningful summary.

Guide to the symbols used

SoE report assessments integrate many data sources and expert opinions. For the Tonga SoE Report, there may not be enough information available to make quantitative assessments of the state of an environment using, for example, an index of 1 -10, or a quantitative threshold figure, that could be compared across themes. Consequently, a generic index was developed that used expert opinions and best available data to inform 'Status' ratings of either 'Good', 'Fair', and 'Poor'.

Assessment symbols (Figure 2) summarise the 'State' of each indicator. The assessment symbols establish baselines to compare the state of each indicator for future assessments, including SoE Reports. The symbol includes ratings for 'Status', 'Trend' and 'Confidence'. Table 2 provides a guide to interpret the symbols and explains how the symbols were derived.

TABLE 1–3 Guide to interpreting the Symbols

	CATEGORY	DESCRIPTION	HOW IS IT DERIVED?	EXAMPLE
State (can be a range)	**GOOD** **FAIR** **POOR**	The level to which the indicator meets or exceeds (good), is close to meeting (fair) or is well below (poor) a given standard for healthy ecosystems, habitats, species, watersheds or an urban environment.	Assessment is based on: Recent trends; • Comparison with similar jurisdictions; and • Comparison with "healthy" habitats and systems. Where little data exists to make an assessment based on these criteria, expert opinion is used.	
Trend	**IMPROVING**	The state of the environment related to the indicator is getting better.	Trends show a significant increase, or based on weight of evidence, indicators are improving.	
	DETERIORATING	The state of the environment related to the indicator is getting worse.	Trends show a significant deterioration, or based on weight of evidence the indicator is worsening.	
	STABLE	The state of the environment related to the indicator shows no detectable change.	Trends show no significant increase or decrease or, based on weight of evidence, the indicator is stable.	
	MIXED	The state of the environment related to the indicator shows a mixed trend; some worse, some better, some better and some stable	Used primarily for sub-topics with multiple indicators, or in cases where data shows two distinct trends.	
	UNDETERMINED	The state of the environment related to the indicator is unclear.	Not enough data exists to determine a trend.	
Confidence	**HIGH**	Confidence in the data and assessment process is high.	Data is of high quality and provides good spatial and temporal representation.	
	MEDIUM	Confidence in the data and assessment process is medium.	Data is either lower quality, geographically sparse or limited temporally.	
	LOW	Confidence in the data and assessment process is low.	Data quality is poor and does not meet any of the above criteria.	

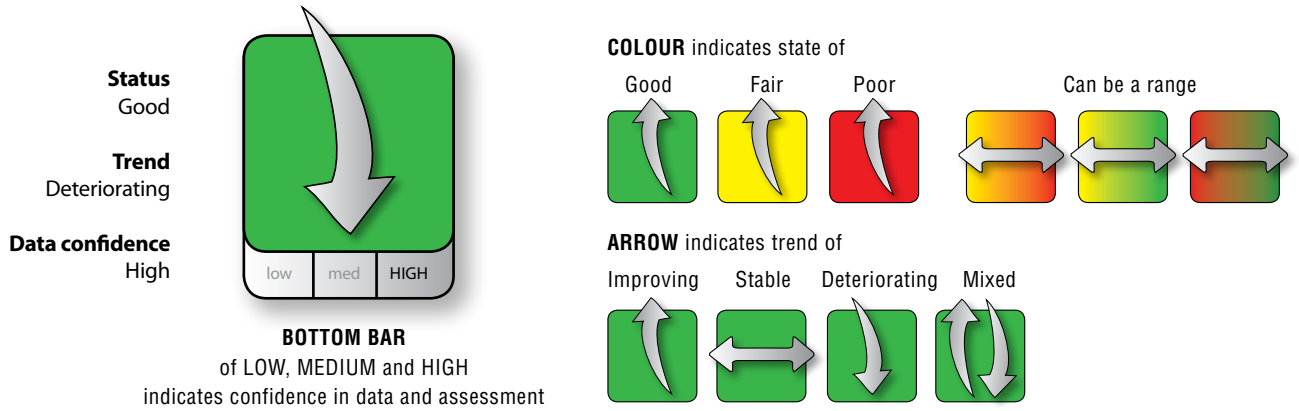


FIGURE 1–2 Explanation of the Indicator Symbols

SDG – Sustainable Development Goals

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The SDGs provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

Throughout this report, the Sustainable Development Goals will be linked to the different indicators, by using the symbols shown in Figure 1–3.

FIGURE 1–3 Overview Sustainable Development Goals

Aichi Biodiversity Targets

The Strategic Plan for Biodiversity 2011–2020, under the Convention on Biological Diversity (CBD), consists of five strategic goals, including twenty Aichi Biodiversity Targets. An overview of these goals and targets is given in Table 3. The Aichi targets will be linked to the indicators in this report, using the different symbols.

TABLE 1–3 Overview of Aichi Biodiversity Targets

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	
 **TARGET 1** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	**OBJECTIVE 1** People are aware of the value of biodiversity and the steps they can take to conserve and use it sustainably
 **TARGET 2** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations
 **TARGET 3** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations
 **TARGET 4** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use	
 **TARGET 5** By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 6** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 7** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 8** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 9** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 10** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	**OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity	
 **TARGET 11** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites
 **TARGET 12** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance
 **TARGET 13** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services	
 **TARGET 14** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 15** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites
 **TARGET 16** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building	
 **TARGET 17** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 18** By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 19** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 20** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011–2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5

PART 2

DRIVERS AND PRESSURES

DRIVERS AND PRESSURES

WHAT ARE THE DRIVERS OF ENVIRONMENTAL CHANGE?

The drivers and pressures faced by the environment and society of Tonga are discussed in this section. Drivers are the underlying natural and human forces that place pressure on the environment (Australian Government, 2016). Pressures have increased in response to changes in drivers such as increase in population and economic activity. Other pressures have historical changes due to changes to land use ecosystems and heritage sites. Drivers and pressures identified for Tonga are shown in (Table 2–1).

TABLE 2–1 Drivers and Indicators

Key Drivers	Pressures
Social and Economic Influences	Pollution Resource extraction Consumption and waste
Population Growth	Pollution Resource extraction Consumption and waste
Land Use Changes	Pollution Resource extraction Consumption and waste
Climate Variability and Change	Resource extraction Consumption and waste

DRIVERS

The key drivers identified above are discussed further in the following sub-sections.

Population Growth

The Tonga 2016 Census of Population and Housing report was used in the estimation of projected population numbers and compared to data recorded from the 1986, 1996, 2006 and 2011 census data. The population in 2011 was 103,252 people (Tonga Department of Statistics, Tonga 2011: Census of Population and Housing, 2013) (Figure 2–1). The latest data put the population of Tonga at 108,020 (The World Bank, 2018). The increase in population has created pressures in the environment and on food security. Providing nutritious and environmentally sustainable food to people is difficult if populations are growing which leads to greater importation of food (Hall, Dawson, Macdiarmid, Matthews, & Smith, 2017). Population increase is also creating pressure on the environment and the economy, terrestrial biodiversity, and on natural resources such as water.

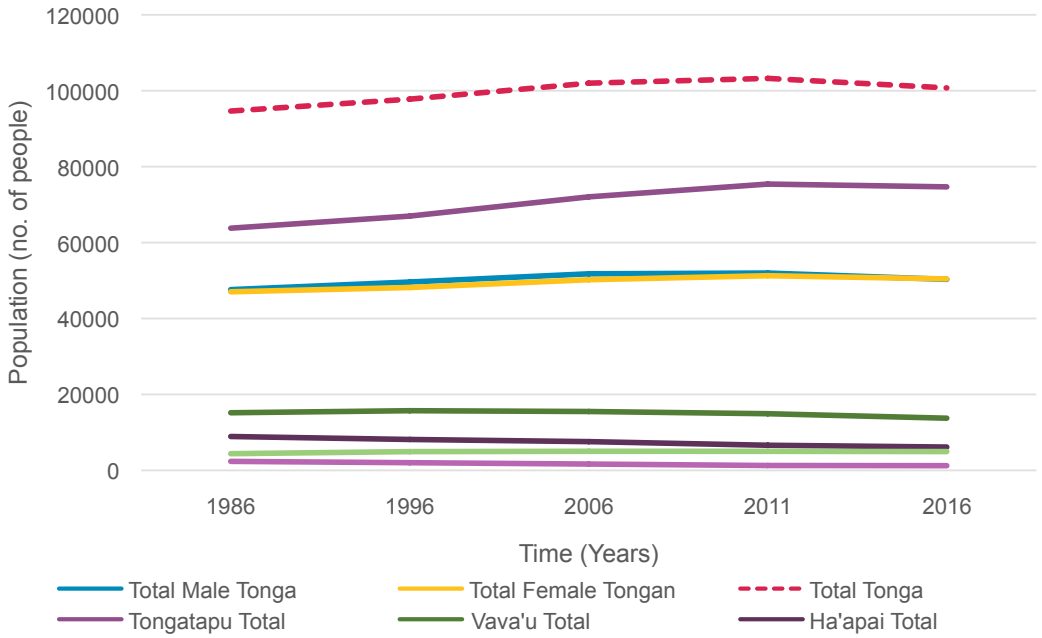


FIGURE 2–1 Population growth in Tonga (Department of Statistics)

The Tongan population is evenly composed of male and females, however, there exists a large skew between the age groups. People aged 24 years and younger are approximately 55% of the population, with a median age of 22 years. The population demographics show a country in a transition phase that is potentially more susceptible to losing some cultural attributes. The younger generation, with their ability to understand and be a part of globalised world, may not have use of some of the old traditions and passing these on becomes a challenge. Globalisation allows for the transportation of goods and services which is increasing throughout the Pacific islands. Much of this increase can be attributed to a younger demographic being able to buy more items. A benefit to a younger population may be the general awareness of environmental issues facing the country, and much of the environmental movement is driven by a younger, more educated and better informed population.

Tonga faces internal migration and immigration that has been occurring since European intervention in 1773 by Captain James Cook (Victoria Museum, 2018). Tonga has five primary island groups – Tongatapu has the largest population, followed by Vava'u, Ha'apai, 'Eua and Ongo Niua. The migration trend during the five years prior to the 2016 census showed only Tongatapu gaining a population of 911 from other island divisions, while Vava'u, Ha'apai, 'Eua and Ongo Niua had a net loss.

The attractiveness of developed nations such as Australia and New Zealand along with the religious interventions are among other reasons for people migrating overseas. In 2004 it was estimated that half of the approximately 216,000 Tongans worldwide lived overseas (FAO Consultant, 2011). The implications on the environment specific to Tonga are varied as much of the historic knowledge is influenced by new knowledge. Waste recycling, over-fishing and the respect that once was prominent in Tongan culture has become diluted. Increases in the number of visitors to Tonga have been observed in recent years with the majority from New Zealand. Australia and USA also have strong visitor numbers on an annual basis as shown by 2017 data (Figure 2–2) (Government of Tonga, 2017). Figure 2–3 shows the net migration to Tonga by air, ship and yacht. In general, more Tongans departed than arrived as young people seek to further their education or find work overseas.

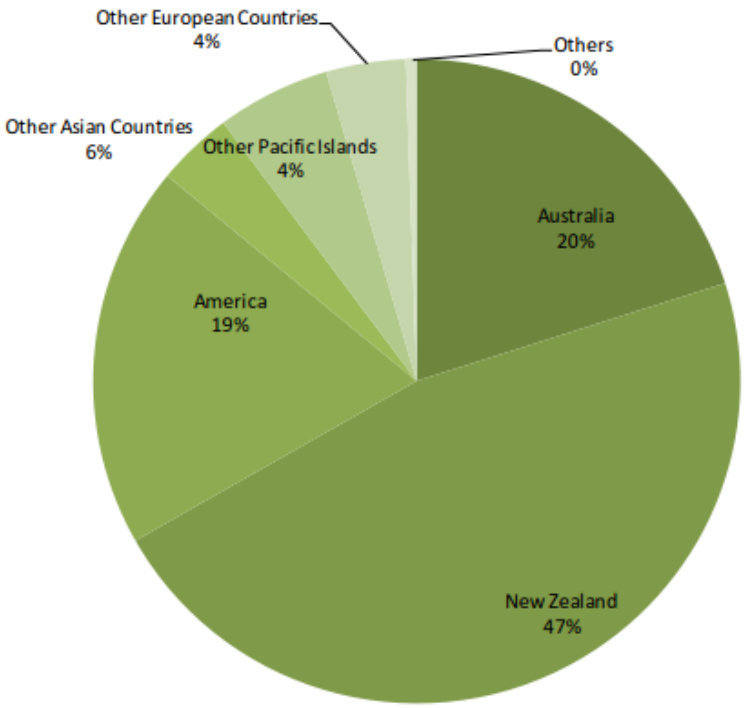


FIGURE 2–2 Air Visitors by Country of Usual Residence June 2017 (Department of Statistics)

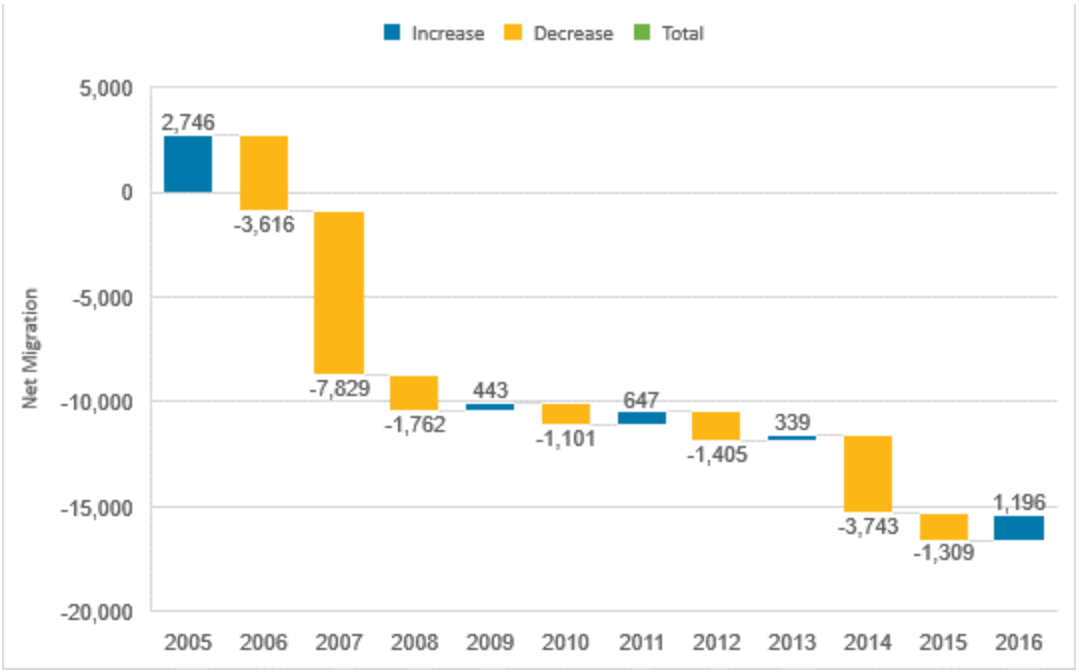


FIGURE 2–3 Net migration, arrival (increase) and departure (decrease) (Department of Statistics)

Social and Economic Influences

EDUCATION

The Tongan population aged 5–14 years have a 94.5% enrolment in schools, however, enrolment decreases rapidly after the age of 15 with 29% of those aged 15 – 19 years not attending schools, particularly among males. The general residential population aged 15 years and over have a 5% rate of achieving a primary school education, with only 19% having a higher-level education (including technical/vocational and university). Educations rates decline outside of urban areas.

Education is often linked to comprehension and awareness of environmental impacts. An educated population provides a platform for discussion on environmental outcomes and prevention or mitigation techniques. It can help make informed decisions and provide the opportunity to change behaviour to prevent further impacts.

TRADITIONS, VALUES, ATTITUDES AND LIFESTYLES

Population and societal norms change with economic and lifestyle changes. Understanding behaviour is used to change interventions for public policy, and understanding problems is essential in the development of solutions from this important driver for climate change (Reynolds, Subasic, & Tindall, 2014). There is an argument to suggest that only through education and persuasion will certain behaviours, such as reducing material consumption, growing food locally and walking or riding to work, reach a 'tipping-point' where it becomes second nature (Kinzig, et al., 2013). Tongans are very proud of their culture and traditional activities such as dancing (Figure 2–4) and singing.

FIGURE 2–4 Tonga Traditional Dress and Dance (Photo: K. Latu)

The main cultural driver is the newfound reliance on imports and exports (Figure 2–6). Tonga imports more goods than it exports and a large amount of the imports consists of food products. The traditional foods include taro, yams and breadfruit, and meat from cattle, pigs and chickens raised locally, and seafood. The reliance on these local and healthy products has shifted. A change from a traditional diet of fish, root crops and fruits and vegetables to a more convenient, cheaper, western diet of imported, less healthy packaged food such as noodles, salty snacks and fatty meat has accelerated in recent years. The main drivers are the decrease in local food production as a result of urbanisation and increased imports of cheaper but less healthy food, together with increased trade with western countries (FAO, 2017). This has led to consumption of inexpensive, high calorie, fatty foods associated with increases in diet-related non-communicable diseases among other health concerns (Evans, Sinclair, Liava'a, & Freeman, 2010).

Tonga has one of the highest expenditures (54%) on food imports compared to its neighbouring countries and spent the largest percentage (34%) on processed food (FAO, 2017). About 95% of agricultural-active households are engaged in subsistence or semi-subsistence agricultural activities, with most basic food items such as flour and sugar being imported.

The top imported foods are meat and edible offal and processed foodstuff such as tinned meat and tinned fish imported from New Zealand, Samoa and other nearby countries. These imported meat products high in fat include mutton flaps, turkey tails, chicken leg quarters and corned beef (FAO, 2017). The local agricultural and fish products in markets and roadside stalls supplement the imported products. In recent years, taxes and duties on some food products have sought to reduce health issues faced by the public.

ECONOMIC

The World Bank recently classified Tonga as an upper-middle-income country with a gross national income per capita of USD4,020 and health expenditure per capita of USD213 in 2014 (FAO, 2017). The reality is that Tonga is still a relatively poor country, largely dependent on foreign aid and remittances from overseas-based Tongans. The country's primary income is derived from tourism and agricultural and fisheries exports. There has been a decline in fishery products exported due to fishing vessels decreasing in number caused by changes in rules and regulations. Other changes have affected economic growth, such as the 2006 political reform and civil servant salary increases. Frequent natural disasters and the global financial crisis in 2008 further impacted economic growth. Recent reports from the Asian Development Bank (ADB, 2018) show a projected growth in Gross Domestic Product (GDP) from 2018 (Figure 2–5). The main service provider is the public sector and the majority of the national budget is allocated to wages and salaries, leaving a smaller proportion for operational expenses. The country has a centralised economy that lacks the capacity to administer and implement delivery of services to the people (FAO, 2017).

FIGURE 2–5 GDP Growth rate of Tonga (ADB)

The Tonga Department of Statistics outlined the following key economic parameters on their website. As per the 2009/2010 values, the GDP (current prices) per capita was USD6,505 while the GDP (constant prices) per capita was USD3,672. The consumer price index was 110.2 while the import and exports are shown in Figure 2–6.

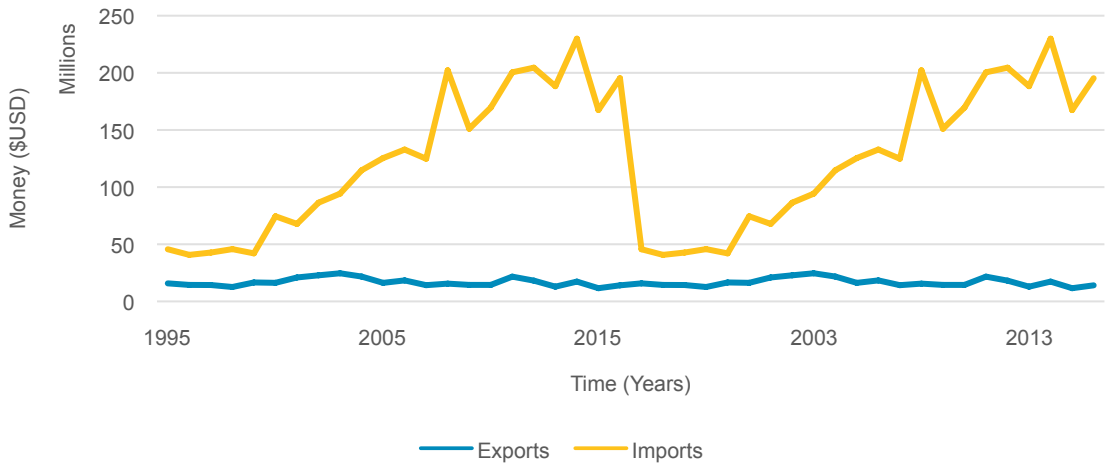


FIGURE 2–6 Import and export (Tonga Department of Statistics)

TOURISM

Due to Tonga's pristine environment many tourists visit to see the white sands, coral reefs and crystal-clear waters. Although financially beneficial to Tonga, there are several implications of increasing tourism. Tourism is susceptible to climate change as it relies on climate, however it also contributes 5.1% to 12.5% globally of greenhouse gas emissions (Zeppel & Beaumont, 2014). These emissions are from the various sources of travel outlined in Figure 2–7. Due to the likely future constraints on carbon emissions, tourism in Tonga will require adaptation specific to a reduction in emissions.

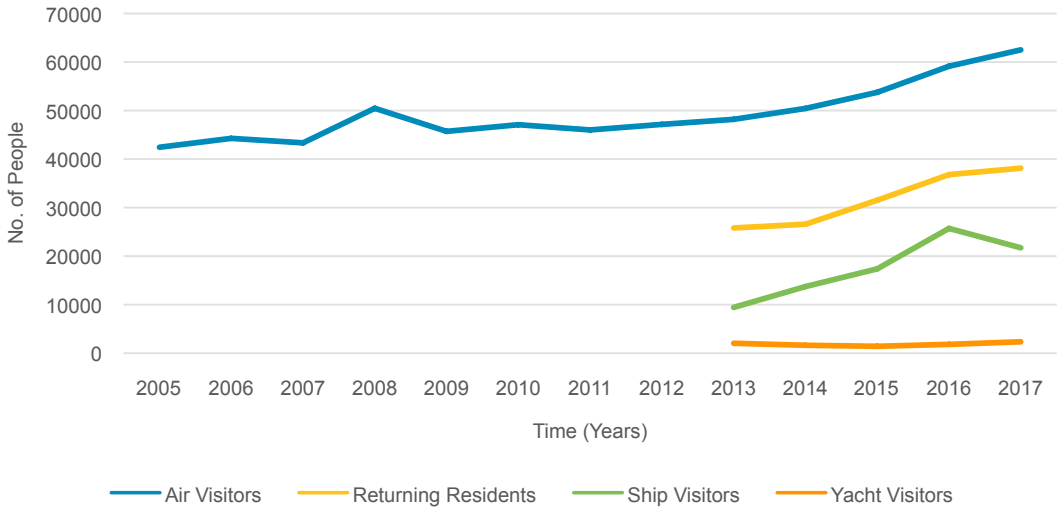


FIGURE 2–7 Tourism and Modes of Transportation (Department of Statistics)

Land Use Changes

Land management systems in Tonga incorporate traditional hierarchical values by which each male of 16 is entitled to 8.25 acres of land. This has had serious implications with a land shortage and political unrest in the region and the government's inability to actively plan the use of land appropriately (Velde, Green, Vanclooster, & Clothier, 2007). Land use in Tonga is generally indigenous habitats, housing, agriculture and forestry as shown in Figure 2–10. Unfortunately, all have suffered from population demands, exports and imports, industry and tourism. As such, land use in Tonga has drastically changed in the last 100 years.

NATURAL HABITAT LAND USES

There is less than 4,000 hectares of natural habitat remaining over all of Tonga (Tu'i'afitu, et al., 2005). Most is located in inaccessible areas i.e. steep cliffs, mangroves and swamps and on the less populated island of 'Eua. The larger islands of Tongatapu and Vava'u have remnant mangroves from the once great mangrove forests. These mangroves have retreated due to limited land availability and the subsequent sub-division and housing encroaching on once mangrove-laden land. This change in land use has meant a reduction in the volumes of fish caught not only from the shore but also out to sea, as smaller fish do not have "safe" spawning grounds (mangroves) and the larger fish have fewer fish to eat. The encroachment of housing to the seawater level has meant flooding and storm surges have spread contamination from the septic and sewerage systems. The flooding will only increase as the mangroves that once provided a barrier to storm surge waves are reduced, and more housing is adding to these impacts.

FIGURE 2–8 Remnant Vegetation (Forestry Division of the Ministry of Agriculture, Forestry, Food and Fisheries, 2017)

TABLE 2–2 Estimated forest and tree cover in toNga (Forestry Division of the Ministry of Agriculture, Forestry, Food and Fisheries, 2017)

Land class	Area %	Island Group					Total
		Tongatapu	Vava'u	'Eua	Ha'apai	Ongo Niua	
Woodland	ha	619	1,133	1,454	2,450	802	6,458
	%	2	9	17	19	11	9
Coconut	ha	22,340	10,079	6,553	8,199	3,924	51,095
	%	82	79	74	63	55	74
Forest plantation	ha	0	0	500	0	0	500
	%	0	0	6	0	0	1
Mangroves and wetlands	ha	1,319	373	0	0	76	1,768
	%	5	3	0	0	1	3
Non-forest	ha	2,809	1,113	300	2,330	2,315	8,867
	%	10	9	3	18	33	13
Total Area	ha	27,087	12,698	8,807	12,979	7,117	68,688

HOUSING AND TENURE LAND USES

Land tenure in Tonga falls into four main uses: own land, short term lease, long term lease, and others. The leasing options are lands belonging to the Crown either hereditary estates of the king, hereditary estates of the royal family, hereditary estates of the nobles and Matapule or Government land. The other uses are associated with households using extended family land.

As mentioned, each male of 16 is entitled to 8.25 acres of land. This "own land" use is for forestry and agricultural enterprises and is a leading factor in the degradation of indigenous habitats and exhaustion of land. Town allotments cover over 5,000 acres of Tonga, a very large portion of the land use, while agricultural activities are becoming common in many of the allotments outlined in Table 2–3.

TABLE 2–3 Township Allotments and Parcels (Ministry of Infrastructure)

Island Divisions	Household with town allotments	Number of parcels	Type of land tenure (no. of parcels)		
			Owned	Short and long-term lease	Other arrangements
Tonga	16,032	17,307	12,015	877	4,415
Tongatapu	11,832	12,502	8,253	541	3,708
Vava'u	2,360	2,598	1,980	240	378
Ha'apai	931	1,055	865	70	120
'Eua	643	827	710	26	91
Ongo Niua	266	325	207	-	118

FORESTRY AND AGRICULTURE LAND USES

Forestry and Agriculture are directly related to housing and tenure in Tongan culture. As of 2015 many households (2,469) were engaged in forestry activities with even more engaged in agricultural activities (13,944 or 80% of the population) (Forestry Division of the Ministry of Agriculture, Forestry, Food and Fisheries, 2017). These land uses have not been adequately regulated for some time.

The forestry on a more commercial scale involves Palm trees (for palm oil) and Nut trees, and on a more local level sandalwood trees for the construction of houses. The agriculture industry varies greatly within households and commercial

use. Household agriculture as shown in Figure 2–9 includes corn, potato, taro, yam, cassava, banana, beans, carrot, onion, lettuce, cabbage, zucchini, cucumber, pumpkin, tomato, cabbage and some livestock. Commercial agriculture includes squash pumpkin, vanilla and taro.

The commercial industry follows bush fallow vegetation as an indicator to find the most fertile soil which leads to clearing of indigenous vegetation. The other large change is the commercial cash crops, where originally indigenous crops were cropped using a traditional sequence system which used all the soils properties. The commercial squash industry does not fit in this cycle, which means the sustainability of the soil and its future use is changed.

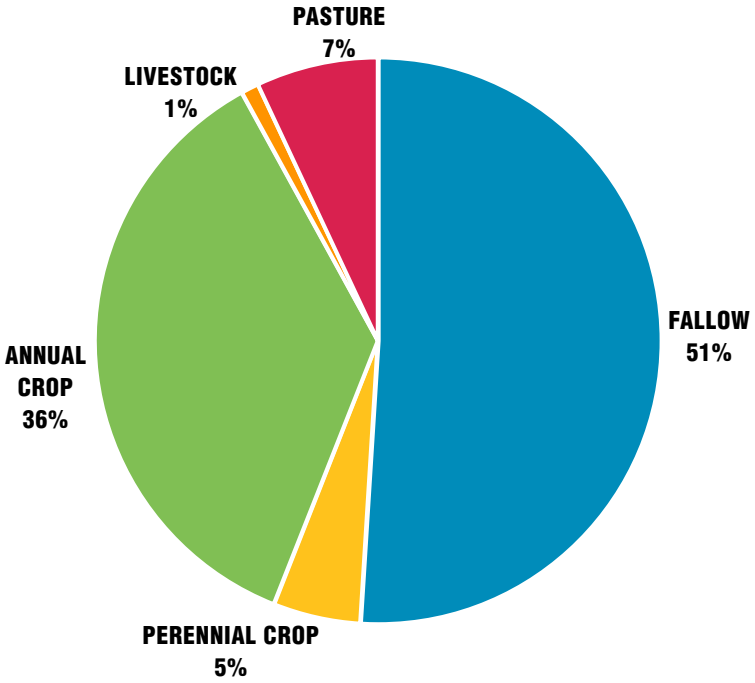


FIGURE 2–9 Agricultural land use in Tonga – 2015 (Ministry of Agriculture)

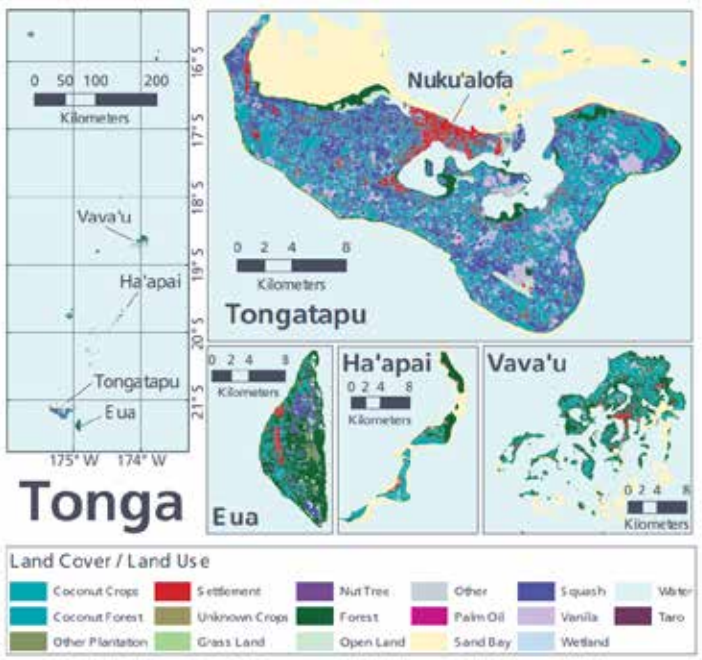


FIGURE 2–10 Land Use in Tonga (Tonga GIS Division)

AGRICULTURE

As per the 2015 Tonga National Agriculture Census (TNAC), a total of 13,944 agriculture active households and organisations were reported. Over 95% of the agriculture active households engaged in subsistence and semi-subsistence agriculture activities with only 5% engaged in commercial agriculture activities. The census also shows most of the agriculturally active households are in the subsistence and semi-subsistence sectors. The agriculture land use has been dominated by annual and perennial crop cultivation followed by livestock activities (Figure 2–9). About half of the agriculture land in Tonga is fallow caused by owners migrating overseas; land left fallow for improvement; or lack of finance to develop the land (MAFFF, 2015).

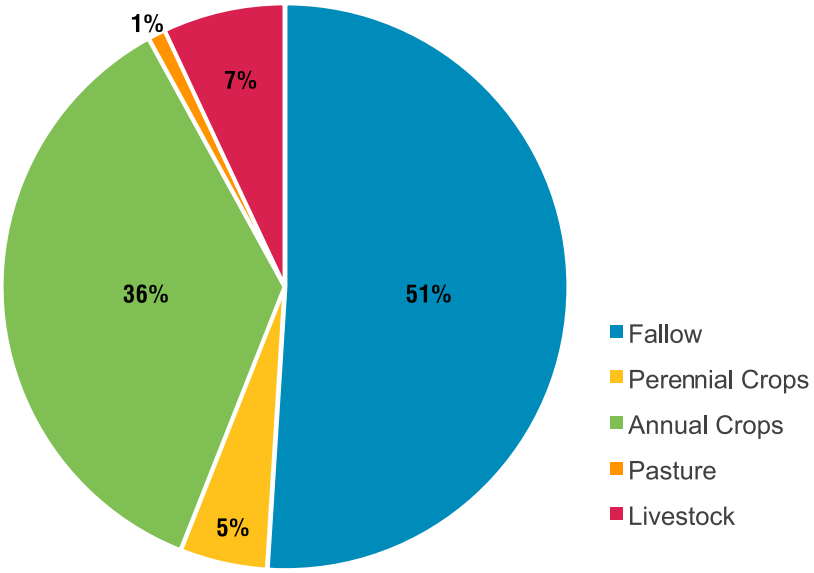


FIGURE 2–11 Agricultural land use in Tonga – 2015 (Ministry of Agriculture, Forestry, Food and Fisheries)

As shown in Table 2–4, the household agricultural activities increased from 15,794 to 16,122 households. The increase put pressures on the environment where clearing of forest and coconut trees are often done to allow cultivating of lands. Commercial products such as squash have a history of large-scale operation that requires clearing more land. Squash growing also requires high levels of agrochemical inputs – agrochemicals use in Tonga is estimated to have more than tripled as a result of the squash industry. This has negative impacts on soil and water resources.

TABLE 2–4 Total numbers of households surveyed – 2016 (Ministry of Agriculture, Forestry, Food and Fisheries)

Island Divisions	Households Enumerated in 2001 TNAC	Households Enumerated in 2015 TNAC	Households Not Enumerated in 2015 TNAC	Total Households in 2015
Tongatapu	15,794	16,122	1,921	18,043
Tongatapu	10,610	11,914	910	12,824
Vava'u	2,267	2,360	454	2,813
Ha'apai	1,296	934	326	1,260
Eua	854	644	219	863
Ongo Niua	370	270	12	282

Agricultural exports depend on the available markets for commercial products such as for squash exports to Japan and Korea. These markets drive exports higher during strong demand as experienced with squash in the early 1990s. Hence, the requirement for land for cultivation is also market driven. The local crops are also exported to Tongans living overseas. These exports have been increasing over the years (Figure 2–12). Growing of Kava for commercial benefits have increased over the years leading to clearing of natural and forestry lands. This requires more land for agricultural activities which put pressures on the environment.

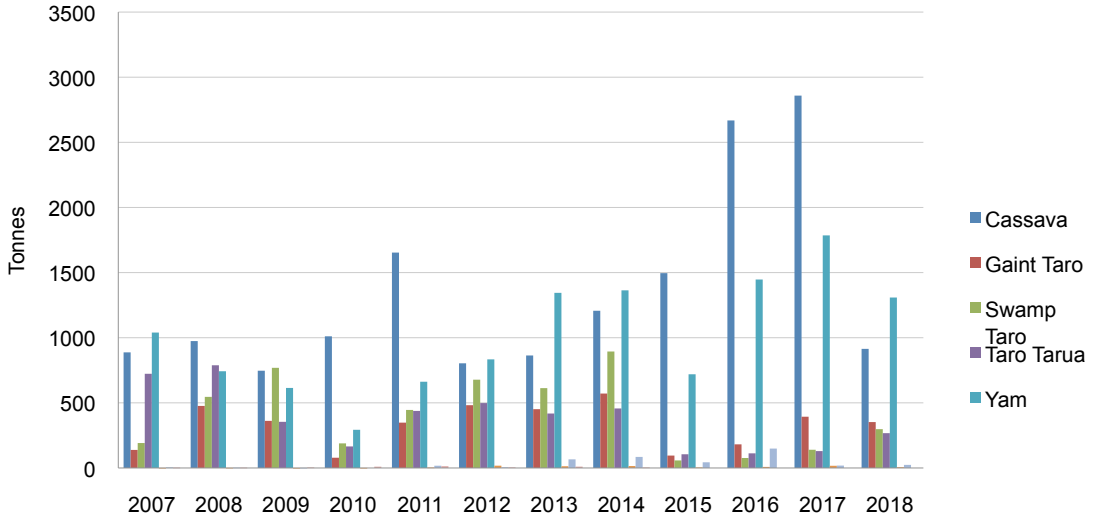


FIGURE 2–12 Exported Crops (Ministry of Agriculture, Forestry, Food and Fisheries)

INVASIVE SPECIES

The forest ecosystems of Tonga in December 2009 (The Kingdom of Tonga, 2010) were estimated at 8,729 ha or 12.6% of the total land mass. It consists of woodlands (6,460 ha – 74%), plantation forests (502 ha – 6%) and mangrove/wetlands (1,767 ha – 20%). The 2009 statistics represent a 26% decrease in the total area of the forest ecosystems from 2006 levels. A continued decline in forest ecosystems is expected, although there is no statistical data to confirm it (The Kingdom of Tonga, 2010). The continued unsustainable land reclamation has reduced the mangroves (Figure 2–13) and wetland forests.

There are more marine species recorded in 2010, compared to a stocktake in 2006. However, in 2010, there was a decrease in the reef fish abundance (on average between 20–40%) and sizes (50% less than actual size for most reef-fish species), including coral cover percentage (20–30% decrease on live coral cover especially back-reef). Natural disasters also play a major part in the status of marine species (The Kingdom of Tonga, 2010).

FIGURE 2–13 Fanga'uta Lagoon Development, mangrove loss and sedimentation since 2010 (Government of Tonga, 2018)

Climate Change

The difference between climate variability and climate change is namely the time period and process. Natural climate change refers to the long-term change in climatic variables caused by natural process – volcanic activity, plate tectonics, and Earth's orbital shift, etc. Climate variability refers to the slow change and fluctuations of seasonality mainly affecting the atmosphere. The El Niño – Southern Oscillation (ENSO) phenomenon occurs in the equatorial Pacific Ocean, where fluctuations of sea

surface temperatures typically alternate every few years between a warming phase (El Niño) and cooling periods (La Niña), with a neutral phase in between. This atmospheric variation has likely impacted tropical cyclones, floods and droughts in the past. Anthropogenic climate change is influenced by the pollution of the atmosphere with increasing particulate matter and Greenhouse Gases (GHG).

VOLCANIC ACTIVITY

Tonga is located near the Pacific "Ring of Fire" (Figure 2–14), which is home to most of the earth's subduction zones where one plate of the oceanic lithosphere is slowly moving under another plate. The interaction of the underlying hot mantle and seawater causes the production of magma which is pushed upward creating volatile eruptions. The volcanic gas sulphur dioxide can cause global cooling over a prolonged period of time, while carbon dioxide, like that emitted by cars and factories, has the ability to promote global warming, shown in (Figure 2–14).

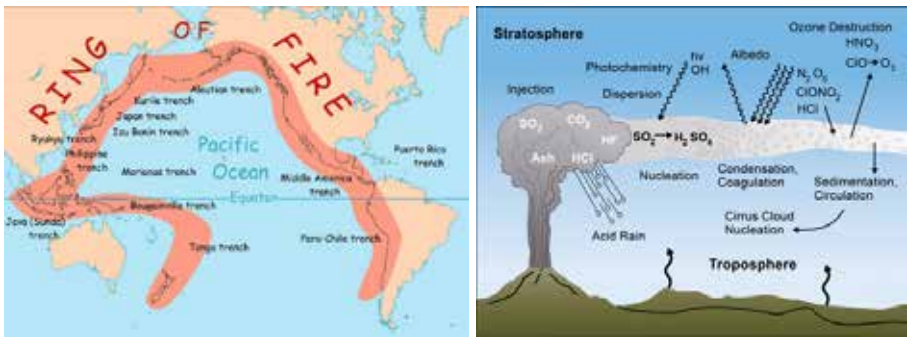


FIGURE 2–14 the Ring of Fire (Evers, 2015) and Volcanoes Climate Effect (USGS, 2018)

In 2014–2015, Tonga saw the birth of new islands, Hunga Tonga and Hunga Ha'apai, to accompany the large number of active volcanoes, both surficial and underwater, surrounding Tonga as shown in Figure 2–15. Although Tonga does not contribute greatly to global climate change from an anthropogenic influence, this volcanic activity has shown it can drastically change the climate for many years afterward. This has to be taken into perspective, however, as although between 100 – 300 million tonnes of CO_2 are released each year, that number still only accounts for 1% of what humans release.

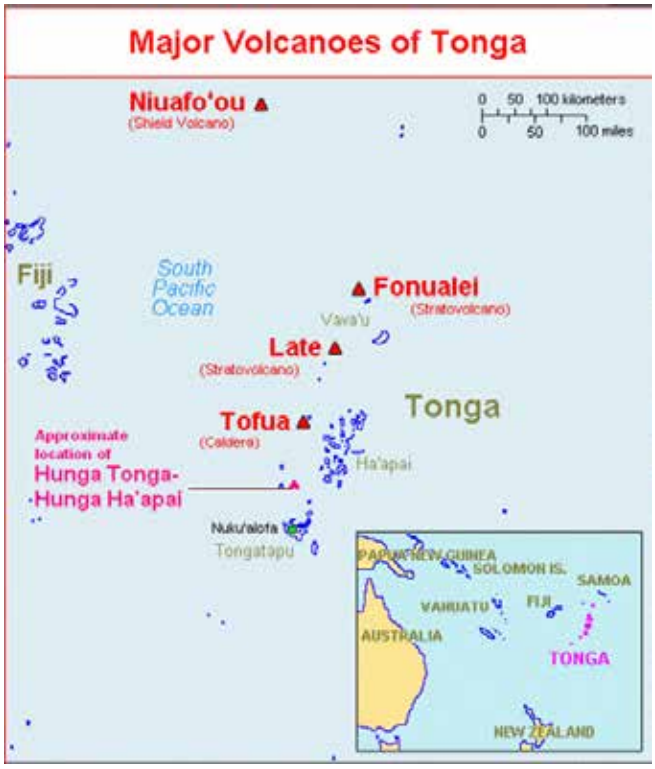


FIGURE 2–15 Tonga Volcanoes (Smithsonian Institution, 2015)

EL NINO-SOUTHERN OSCILLATION (ENSO)

There are three phases of the El Nino-Southern Oscillation (ENSO): the neutral state, El Niño and La Niña. During the neutral phase, trade winds blow east to west, bringing warm moist air and warmer surface waters to the western Pacific, along with the upwelling of warmer waters. This phase shows characteristics of El Niño and La Niña and has the potential of replicating the same consequences. It is generally considered to be an average conditions cycle, however, as average conditions are influencing the neutral phase (Bureau of Meteorology, 2012).

The El Niño event is where trade winds weaken and potentially reverse. It also causes warmer surface waters in the western Pacific region to spread to central and eastern Pacific regions, resulting in higher probability for tropical cyclones, lower rainfall and increases in temperature in Tonga. The opposite occurs in Tuvalu where heavy rainfall occurs.

Finally, the La Niña event is where the Walker circulation intensifies greater convection and stronger trade winds. The consequences of this event are usually a larger volume of rainfall, causing monsoonal storms, and increased humidity. These climatic influences are enhanced by climate changes causing floods, droughts, monsoons and cyclones (Bureau of Meteorology, 2012).

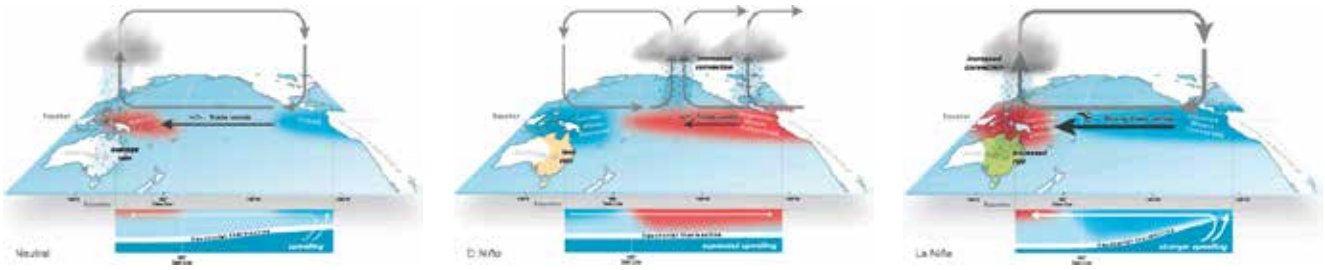


FIGURE 2–16 The Neutral, El Nino, and La Nina Phase of the ENSO (Bureau of Meteorology, 2012)

PRESSURES

This section highlights the key pressures on Tonga's environment and society created by the overarching drivers identified in the previous section. Pressure indicators present data about the main human activities that could adversely affect the environment, and each indicator is linked to at least one of the drivers. Pressure indicators are organised using three classifications: land development, resource extraction, and consumption and waste (Table 4). Some pressures will be covered in the 'State' section.

TABLE 2–5 Key environmental pressures in Tonga

Pressures	Pollution	Resource Extraction	Consumption and Waste
Key Areas	Urban Development	Land Use and Forestry	Energy consumption
	Agriculture	Fishing	Import Goods and Fuels
	Invasive Species	Aquaculture	Solid and Liquid Waste Generation
			Water consumptions

Pollution

While Tonga may not be a major contributor to global pollution (Figure 2–17), local pollution affects the environment in the form of solid, liquid and hazardous waste. Tonga's total greenhouse gas emissions in 2014 were approximately 0.40 metric tons of Carbon Dioxide equivalent ($MtCO_2e$) compared to that emitted by China of approximately 10,000 $MtCO_2e$. This is quite a significant difference and can be mainly attributed to the lack of commercial and industrial activity and much smaller population. Although Tonga's greenhouse gas emissions are low compared to larger developing nations, Tonga's emissions are increasing, which is a concern. The 0.40 $MtCO_2e$ value may be overshadowed by significant embodied energy and pollution associated with imports, that is not accounted for in this value. Goods are imported from China, Taiwan and Bangladesh where, as mentioned previously, large quantities of CO_2 emissions are produced in the production of these

goods. The goods, such as vehicles and refrigeration units, contribute in part to 40% and 23% of the Tongan emissions (Figure 2–18). The amount is difficult to determine and relies upon understanding the embodied potential of all imports, which is not currently recorded, not to mention the emissions produced in transporting these goods. Although the scale at which Tonga is contributing is minor on a global scale, policies and goals can still be set to prevent further contributions to the increasing worldwide greenhouse gas emissions (ClimateWatch, 2018).

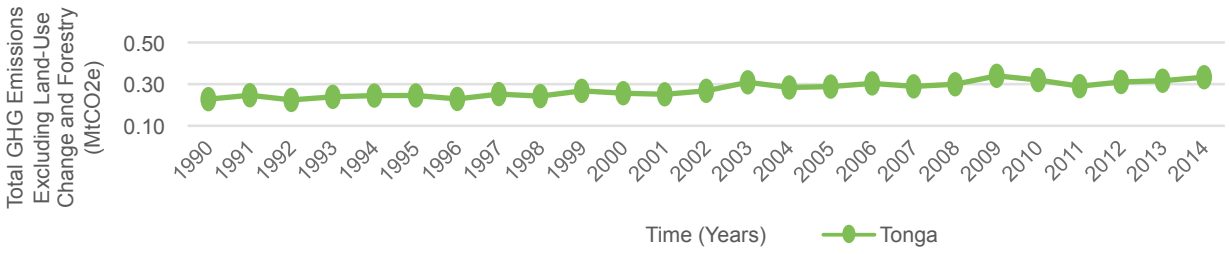


FIGURE 2–17 Emissions in Tonga (ClimateWater 2018)

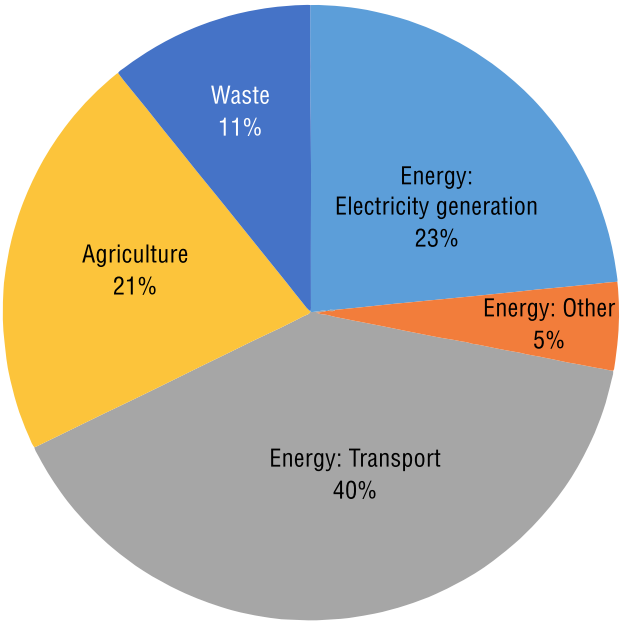


FIGURE 2–18 Percentages of Emission contributions (ClimateWatch, 2018)

There is limited knowledge about the remaining sources of pollution, which may include but are not limited to:

- Groundwater pollution from agricultural activities throughout Tonga which are exhausting the fertility of the soils, degrading and eroding into lagoons;
- Water pollution (surface water and ground water) is a significant issue due to salinization, sewage, dumping activities, toxic chemicals and farming activities. The pollution of water sources leads to the spread of water-borne disease, algal blooms due to eutrophication, and
- Air pollution associated with emissions from cars and refrigeration units, sewerage biological matter, chemicals and other particulates in the air.
- There have been a number of studies of the specific types of pollution outlined above. However regular monitoring and understanding of the point sources has not occurred and has led to deterioration of the environment.
- The data above was provided by the World Health Organisation, the United Nations and the Asian Development Bank.

Resource Extraction

LAND USE AND FORESTRY

The native forestry land in Tonga especially Tongatapu has decreased in the last century. The only native forest recognised in Tonga is the Toloa Forest in Tupou College near the airport. These precious lands have been cleared for residential and agricultural use, leading to declines in some of the medicinal plant species (The Kingdom of Tonga, 2010). Large quantities of coconut plants were cleared in the early 1990s to allow for the boom in the squash market. The spread of urbanisation into rural and natural swamp areas such as Popua has resulted in the loss of plant species and natural land. Tongans living overseas are taking advantage of their land by building rental or commercial properties. With the increase in population, Tongatapu land is under pressure from urbanisation and inter-island migration.

FIGURE 2–19 Rainforest and remnant coastal woodland

FISHING

The Tongan people rely on fishing for both subsistence and commercial needs. The effect of climate change and natural disasters in addition to a lack of effective legislation and regulations has resulted in negative impacts on the fisheries. The main risk to the marine environment is the loss of a high proportion of coral reefs due to a combination of rising ocean temperatures, ocean acidification, overfishing, exploration for deep sea minerals and pollution. Over a third of coral reefs are threatened by overfishing (moderate risk or higher). A number of endangered marine species are present in Tongan waters, including the humpback whale and the manta ray, both of which have high tourism value (The Government of Tonga, 2015). The volume of catch of marine species is subject to the number of licenses approved by the government (Figure 2–20). However, the rejuvenating rate of marine species compared to extraction rate should be the key criteria for license approvals.

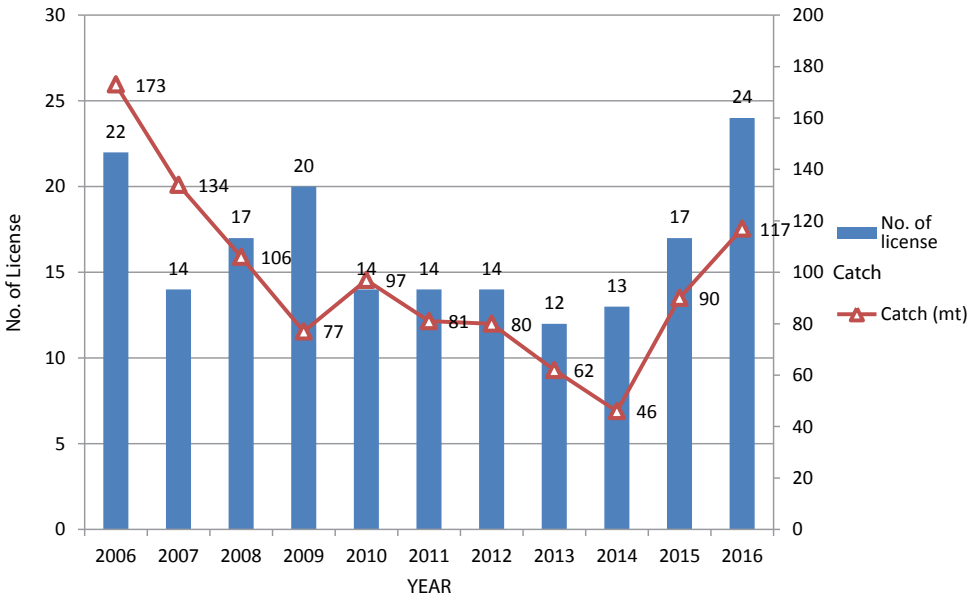


FIGURE 2–20 Number of vessel and catch (Ministry of Fisheries, 2017)

AQUACULTURE

Commercial aquaculture in Tonga started in the late 1990s after establishing a link with the international market for giant clams (Tridacnidae), as a source for ornamental traders of the aquarium market trade. Marine aquarium traders are target customers with licenses issued by the Tongan Fisheries Division to export ornamental products (i.e. live corals, aquarium fish, etc.) to international markets. In 2007, 8,017 giant clams were sold to aquarium traders for export with an estimated value of USD12,000, which represents less than five per cent of total export production from the fisheries sector (FAO, 2011). The extensive harvesting of live coral rock led to a ban on harvesting and exporting of live rock to allow recovery. Figure 2–21 shows the extent of the aquarium species exported between 2006 and 2015. The reduction is a direct response to the over-exploitation of aquarium species. This trend is expected to be maintained.

Apart from giant clam aquaculture, since the mid-1950s, more than five other species have been trialled as potential aquaculture products since the mid-1950s, but have failed to become feasible at commercial levels. Only the winged pearl oyster has managed to develop to a small commercial scale with sales mainly in street markets to visiting tourists. Overall, despite great advances in the last decade, aquaculture in Tonga is still largely experimental for most of potential aquaculture commodities (FAO, 2011).

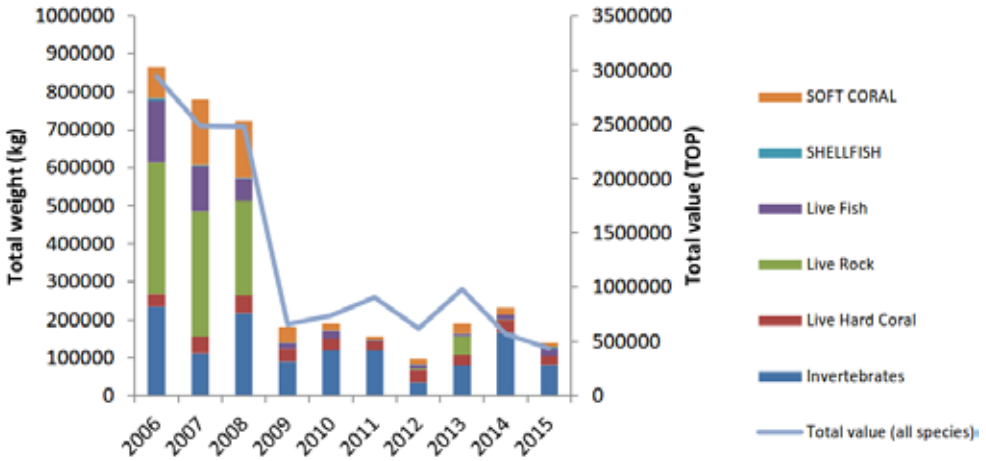


FIGURE 2–21 Total Weight and value of exported aquarium species (2006–2015) (FAO, 2011)

Consumption and Waste

Imports have increased over the years due to a heavy reliance on overseas manufactured products. This increase has a direct correlation with the amount of solid and liquid waste produced in Tonga, degraded air and water quality, and the limited ability to recycle products such as plastic bottles and white goods.

IMPORTED GOODS

In the 1980s, the main sources of transport in the main islands were buses and walking. There were few vehicles. This trend has significantly changed over the years, with a preference to own a car. Vehicles are more affordable and Tongans overseas send vehicles (mostly second-hand) to their families. Tonga does not manufacture vehicles and imports all vehicles from countries including New Zealand, Japan, Australia and the United States of America. The Department of Statistics reported that the number of vehicle registerations increased between 1994 and 2004 (Figure 2–22). A drop in the level of registered vehicles in 2000 and 2001 was caused by changes in regulation pertaining to the age of the imported vehicles. No other data later than 2004 was available during the development of this report. However, it is thought that the number of vehicles in operation (2018) is higher than in 2004.

The increase in the number of vehicles operating in the country could reduce air quality due to high emission levels. The vehicles are often not kept up to standard due to the cost involved with maintenance. Thus, vehicles emitting heavy smoke are often observed on the roads. Lack of maintenance may cause oil leaks that increases the level of hydrocarbons reaching watercourses.

Solid waste is also a major problem caused by abandoned vehicles. The country does not have a recycling facility to take retired vehicles. Hence, these vehicles are abandoned in rural areas or properties in the urban region. Corroded metals and other chemicals leak into the soil and waterways. As informed by a recycling company (‘Uiha and Sons Ltd) in Tongatapu, they cannot recycle old vehicles and ship them overseas as there is no baler available to compact them. The company currently has over 3,000 old vehicles sitting in their yards. There is a need for government initiatives to ship old vehicles overseas to reduce the number rusting in Tonga. This has negative impacts on the environment.

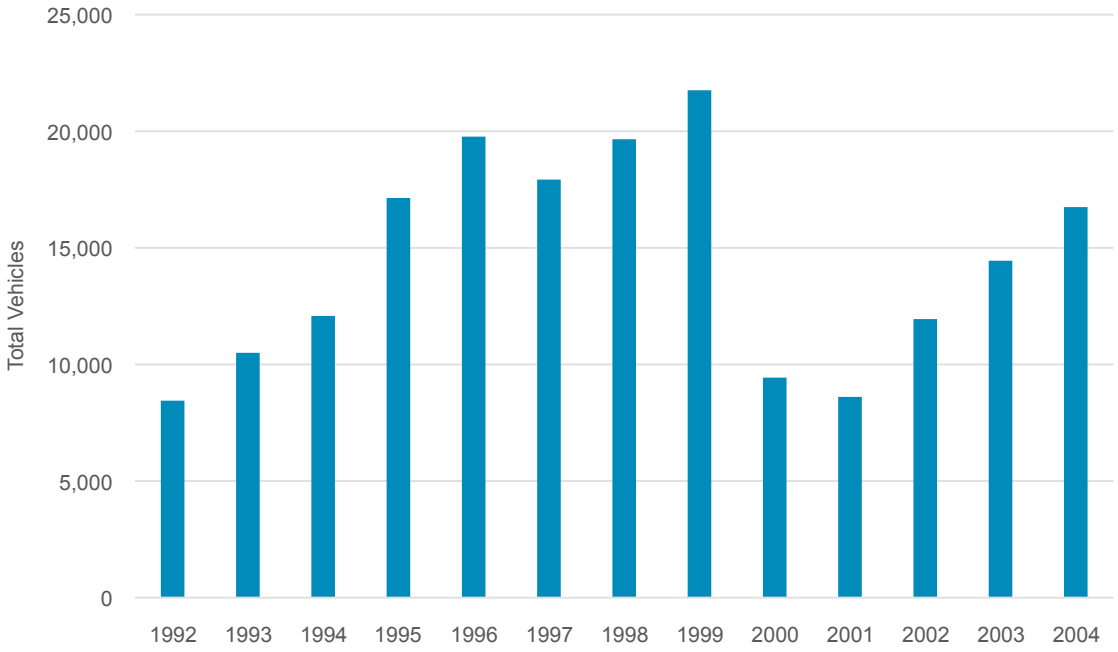


FIGURE 2–22 Motor vehicles registered

SOLID AND LIQUID WASTE GENERATION

Tongatapu Island, including Nuku’alofa, is served by a single integral solid waste management (SWM) system operated by the Waste Authority Ltd (WAL). Reliable data is not available regarding the amounts and types of municipal solid waste (MSW) generated on Tongatapu as regular waste assessments are not undertaken. However, between July 2016 and June 2017, the waste facility received 17,115 m³ of waste. The Asian Development Bank estimated that from 2012 until 2030, assuming nominal growth in population and per capita generation, Tongatapu can be expected to generate in excess of

200,000 tons of household waste, quite a significant amount for a small island nation (ADB, 2013). To put this in perspective, if all the wastes were placed in a single line of waste trucks, the line would extend over 500 km, longer than the distance between Tongatapu and Vava'u.

Many households segregate waste components, including food waste (animal feed) and green waste (compost) as well as reusing items of perceived value such as plastic containers. On a commercial scale, significant recycling initiatives continue through a proactive private recycling company. This recycler, who also operates in Vava'u and is about to commence operations in Ha'apai, collects all ferrous and nonferrous products including plastic bottles, paper and cardboard, automotive batteries and used oil. In 2013, 1,470 tonnes of steel (108 tonnes sourced from Vava'u), 9.5 tonnes of copper, 15.5 tonnes of aluminium, 54,000 litres of used oils and 50.4 tonnes of wet batteries were exported from Tonga by this private recycling company (ADB, 2013). However, government support is required to promote private investment in recycling.

Solid waste is not sorted when disposed at the Tapuhia disposal facility. This means that some of the materials end up in the landfill. The medical waste is treated through a sterilisation process before being transported to the Tapuhia landfill facility for disposal. This treated medical waste is buried in specially excavated holes in the waste mass and then covered (ADB, 2013). Liquid waste is also disposed of at Tapuhia, with an estimated 2,386 m³ of liquid waste disposed of in 2016 – 2017 (Figure 2–23). This liquid relies on the lining capacity of the landfill not to reach the groundwater system.

Although Tonga has significantly improved its waste management based on implementing regulations and installation of a waste disposal facility, there is still a way to go. Recycling needs better initiatives to encourage people to recycle more. Treating liquid waste needs improvement. The water quality of Fanga'uta lagoon is degrading due to the disposal of liquid and solid waste. Reducing waste should be the key focus rather than trying to cure the problem later.

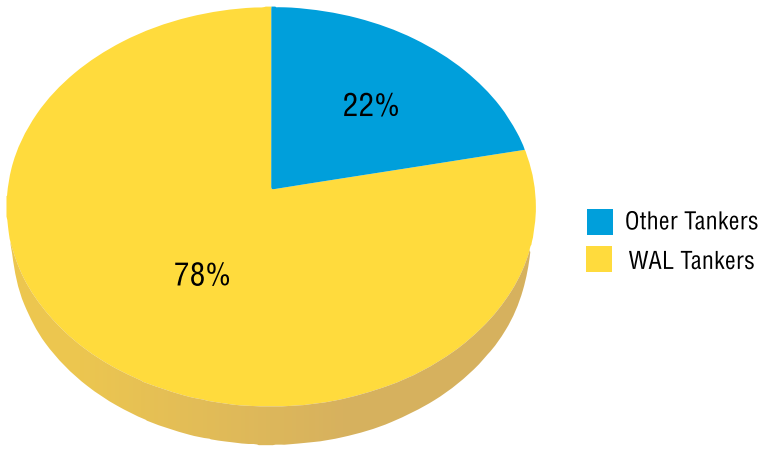


FIGURE 2–23 Liquid waste for 2016–2017 (volume 2,386.5 m³) (Waste Authority ltd)

WATER CONSUMPTION

There are no large surface water supplies in Tonga and the source of domestic, agricultural and industrial water is either from rainwater harvesting or drilled wells tapping a lens of fresh water floating on denser sea water. The water resources of Tonga are primarily sourced from the groundwater aquifers (Pacific Community, 2018). There is a lack of knowledge about the groundwater system on the volcanic islands still exist. Tongatapu is an uplifted coral atoll and composed of emerged and tilted coral limestones of Pliocene and Pleistocene age overlying a base of Pliocene and older volcanic rocks. The limestone has a thickness of about 134 m around Nuku'alofa and 247 m near Fua'amotu in the southeast. The groundwater aquifer is thus entirely composed of limestone (Velde M. v., 2006). More than 50 dug or drilled wells from a few meters to 62.5 m deep are recorded in coral limestone in Tongatapu. The unconfined aquifer in Tongatapu had been estimated to receive between 25 to 30% of the average rainfall penetrates to the water table, and that permeability may reach 1,300 inches/day. At the Mataki'eua water reserve the surface of the fresh water lens is from 50 to 75 cm above sea level. Due to the hardness of the ground water Tongans supplement their drinking water supply with rainwater and purchase filtered ground water. Only part of Tongatapu has access to the municipal water system from Mataki'eua. The outer communities in Tonga rely on their own managed water source from groundwater wells. This is the case in other islands (SOPAC, 2007).

The increase in population has put great pressure on water resources with the greatest demand in Tongatapu. The historical abstractions of water recorded by the Tonga Water Board shows a continuous increase in water demand (Dutch Risk Reduction Team, 2016). This trend would have impacted the groundwater reservoir. Poor infrastructure has resulted in loss of water throughout the transmission lines causing greater costs due to increases in pumping duration. Health issues have also occurred due to more septic tanks built with new houses leaking sewage effluents in to the groundwater. The increased

population leads to increases in agriculture activities that use agricultural chemicals. Observation of the water resources and soil properties in Tongatapu indicate that the environment has degraded due to the use of agrichemicals in agriculture (Velde, Green, Vanclooster, & Clothier, 2007).

The sea level rising is causing major concerns especially in low lying areas. Seawater intrusion in to the groundwater system will increase salinity levels in the aquifers. This will basically turn freshwater into salt water and could have serious impacts on water security.

Throughout this study, no information to confirm the capacity of groundwater systems for Tonga was found except for part of Tongatapu (Dutch Risk Reduction Team, 2016) and there is no estimation on how much future water capacity can be generated from rainfall. Thus, there is an immediate need to determine the future water security of the country. Water demand has not been estimated in order to create a water balance to determine future water requirements and water availability. With the effects of climate change, this is a key knowledge gap that the Government of Tonga must investigate immediately.

STATE OF THE ENVIRONMENT

THEME 1 ATMOSPHERE AND CLIMATE

OVERVIEW

This chapter on the state of Tonga's Atmosphere and Climate focuses on four areas: Physical Climate and Climate trends (air temperature, precipitation, extreme events, etc.); Greenhouse gases (GHGs); Ozone-depleting Substances (ODS); and Climate Adaptation (food security, water security, health and extreme weather risks). The atmosphere and climate are in a constant state of flux with natural and anthropogenic influences contributing to a varied response. Phenomena such as El Nino – La-Nina, and neutral cycles are contributing to higher and lower temperatures at different times throughout the year. The greenhouse effect has seen increased concentrations of GHGs in the atmosphere, directly contributing to climate change resulting in a high frequency of intense storm and drought cycles, increased seawater levels and temperatures.

Tonga's Climate Change Policy – A Resilient Tonga by 2035 is proposed to provide a clear vision, goal and objectives to direct responses to climate change. The policy seeks to achieve a 100% renewable energy consumption, low chemical farming, reduction in land-use for farming activities and protection of habitat and biodiversity, to name a few. There are a few Ozone Depleting Substances Projects operating in Tonga with the primary focus to phase out ODS, in line with the Ozone Layer Protection Act 2010 in order to comply with the Montreal Protocol. There are heritage issues of old refrigerators releasing significant amounts of chlorofluorocarbons (CFCs) directly into the atmosphere. Several studies have been undertaken, with government intervention and training programmes in 'Good practices in refrigeration'.

Climate adaption is a focus for Tonga with the implementation of this report and the projected changes that are outlined coinciding with the *Climate Change Policy – A Resilient Tonga by 2035* and JNAP2. The Joint National Action Plan 2 (JNAP2) 2018–2028 issued by the Government of Tonga discussed the states of climatic parameters and climatic resilience approaches for the next 10 years. Lessons learned from the JNAP1 (2015) have been implemented into JNAP2. The report is comprehensive in the strategies put forward to counter climate change (Government of Tonga, 2018). It aligns with the Tonga Climate Change Policy (TSDF) and the Framework for Resilient Development in the Pacific (FRDP) in preparing Tonga for a more resilient future. This report discusses atmospheric and climate indicators in depth and includes other indicators that are not in the JNAP2 report, such as greenhouse gases.

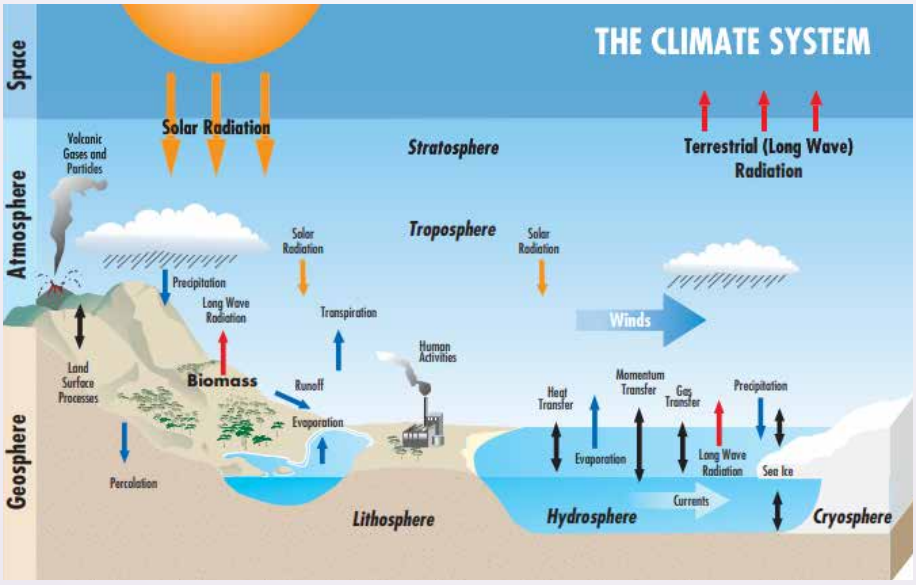
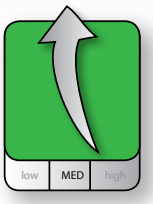
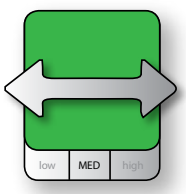


FIGURE 3–1 Climate System (Bureau of Meteorology, 2003)

ATMOSPHERE AND CLIMATE HIGHLIGHTS

KEY AREAS	CURRENT STATUS	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
GHGs	 **Status** Good **Trend** Unknown **Data confidence** Medium	Reduction in emissions between 1994 and 2000, but no scientific data available after that.	Tonga has been trying to reduce its climate impact by reducing dependence on GHGs.
ODS	 **Status** Good **Trend** Unknown **Data confidence** Medium	The contribution of Tonga to ODS is largely unknown due to a lack of scientific data.	Proper monitoring of ODS is required. Reduce the importation of products that increase ODS.
PHYSICAL CLIMATE AND CLIMATE TRENDS	 **Status** Good **Trend** Deteriorating **Data confidence** High	ENSO affects physical climatic parameters of Tonga. These parameters are getting worse such as the continuous rising of temperature.	Increase monitoring programme to include wind, evaporation and evapotranspiration. Implement climatic projections into key models such as a conjunctive water allocation model to manage water resources.
CLIMATE ADAPTION	 **Status** Good **Trend** Improving **Data confidence** Medium	Key plans have been put forward including JNAP 1 and 2. Tonga is aligned with international frameworks in adapting to climate change	Increase staff expertise in climate change analysis. Mainstream climate change resilient approaches into legislation and policies.
DROUGHT PROOF	 **Status** Good **Trend** Stable **Data confidence** Medium	Drought affects water resources as it relies heavily on rainfall. Climate change influence on water resources has not been rigorously modelled.	Factor climate change into water resources management. Model the effects of climate change into water availability.

GREENHOUSE GASES (GHGs)

INDICATOR DEFINITION

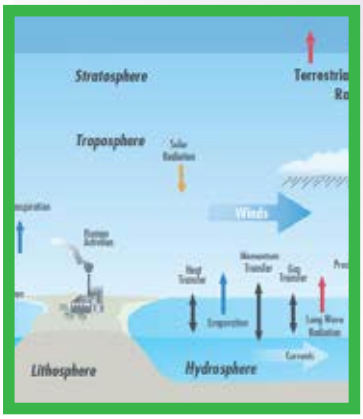
Greenhouse gases enable life to remain on earth by forming a blanket insulating the environment and surface against the freezing temperatures of space (CSIRO, 2017). However, these gases are being added to by human activities (e.g. coal-fired power stations, motor vehicles) which emit high concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3) as well as synthetic gases (those found in spray cans) such as chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) into the atmosphere. The concentrations of these gases are slowly suffocating the climate or thickening the blanket, causing both exponential warming and cooling of the climate. This is done by the gases reflecting and refracting sunlight rays inhibiting the ultraviolet radiation from exiting through the ozone layer. One consequence of the additional CO_2 in the oceans is a 26% increase in acidification.

Greenhouse gases are a global issue as a consequence of the original industrial revolution in 1750 and the new industrial revolution occurring in places like China and India, two of the largest emitters of greenhouse gases.

The Paris Agreement sets in place a framework for all countries to take climate action from 2020. Tonga became a party to the Paris Agreement on 22 April 2016. The key outcomes include:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years, informed by a global stocktake.
- Robust transparency and accountability rules to build confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate impacts.
- Financial, technological and capacity building support to help developing countries implement the Agreement (Australian Government – Department of the Environment and Energy, 2018).

This indicator reviews Tonga's emission of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3), as well as synthetic gases such as chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) since 2018.



Status
Good

Trend
Unknown

Data confidence
Medium

SDG	CBD
13 CLIMATE ACTION	15

Status: Good Trend: Unknown Data Confidence: Medium

STATUS AND TREND DISCUSSION

Tonga became a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) on 20 July 1998. The UNFCCC estimated an 18.7% increase in CO_2 emissions between 1994–2004 in Tonga. Since then, Tonga has been trying to change its climate impact by reducing dependence on fossil fuels.

Greenhouse Gas Mitigation Analysis in Tonga commenced in 2005 to determine the suitability of a range of options to help in reducing consumption. Four sectors were identified including Energy, Agriculture, Land Use Change and Forestry and Waste. Due to the mitigation options outlined in the analysis, Tonga has reduced its GHG emissions, with its large carbon sinks generally incurring a net reduction in CO_2 valuation (UNFCCC, 2018). However, emissions of the other gases are starting to stack.

In 2000, the largest source of GHG emissions was contributed by the Land Use and Forestry sector which accounted for almost 58% of the national total (Figure 3–2). Of the total GHG emissions, 95% comprised carbon dioxide gas. The total emissions recorded from 1994 to 2000 show a decreasing trend with an increase in total removals from -595.24 to -1977.95 Gg. This is likely due to the large carbon sinks throughout Tonga. The energy sector emissions are still increasing as of 2000.

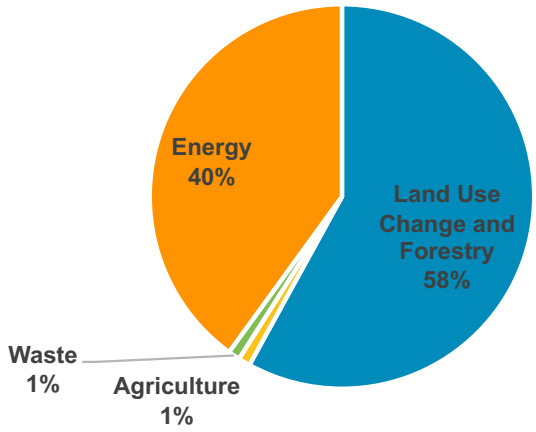


FIGURE 3–2 Greenhouse Gas Emissions in 2000

According to the Intended Nationally Determined Contributions Report (Government of Tonga, 2015), Tonga has a net carbon sink in 2006 in the order of 1,691.91 Gg CO_2. When land use and forestry are considered, Tonga is a net carbon sink, with its forests absorbing substantially more greenhouse gas emissions than is emitted through all other sources. While there is little information about the carbon sinks in Tonga, including terrestrial vegetation appears to be the key carbon sink (Government of Tonga, 2015). Other forms such as the soils and oceans are plausible contributors although the magnitude of their contributions is not available. Therefore, the reduction of emissions from the energy sector, and the maintenance of Tonga's forest resources and preservation of forest ecosystem services for a climate resilient futures should be the primary focus of mitigation actions (Government of Tonga, 2015).

From 1994 to 2000 there was a dramatic change in greenhouse gas emissions, which have been separated into specific sectors (Figure 3–3). The emissions from waste, manufacturing and construction decreased over this period. This is likely due to increased importing of materials and the lack of data collection from the waste industry. There was a significant increase in greenhouse gas emissions in most other sectors over this period, primarily from land-use change and forestry, associated with the increase in population leading to further land clearing for agriculture, forestry and housing.

Tonga's third national greenhouse gas inventories of anthropogenic emission covered sources and removals by sinks of all greenhouses gases not controlled by the Montreal Protocol in 2006. Key contributors are fuel consumption, agriculture activities, land use change and forestry, and waste (Government of Tonga, 2005). The net carbon dioxide emissions for Tonga were 365.59Gg where the emissions were offset by absorption by sinks resulting in net 229.65Gg. Total non-carbon dioxide emissions included methane, 5.04Gg, nitrous oxide, 0.14Gg, nitrogen oxides, 0.49Gg, carbon monoxide, 3.82Gg and non-methane Volatile Organic Compounds (VOC), 0.65Gg (Government of Tonga, 2005). The net removal of CO_2 is a good indicator of improvements in dealing with greenhouse gases.

The inventory study found significant data gaps, and the values and factors associated with the Intergovernmental Panel on Climate Change (IPCC) were not totally applicable to Tonga. Hence, there is a need for national capacity building to establish and maintain appropriate systems for data collection, interpretation and analysis (Government of Tonga, 2005).

IMPACT

Global warming leads to sea level rise that affects Tonga. Other impacts include ocean acidification, changes to the growth and nutritional levels of plants, smog, and ozone pollution and ozone depletion. The contribution of Tonga to these climate aspects cannot be measured due to a lack of data. However, the influence of these factors has been witnessed in rising temperatures and sea level rise.

The climate change impacts observed from all the sectors included increased temperatures, changes in rainfall patterns, tropical cyclone frequency and intensity as well as sea level rise. The vulnerable sectors as identified included water resources, agriculture, fisheries, human settlements and infrastructure as well as the health sector.

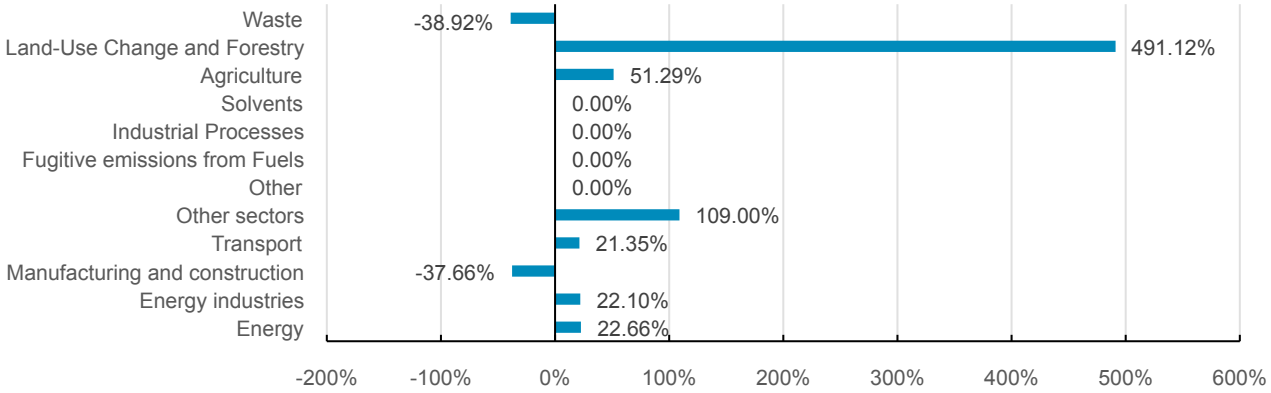


FIGURE 3–3 Change in greenhouse gas emissions/removals from 1994 to 2000 (Government of Tonga, 2015)

RESPONSE AND RECCOMENDATIONS

Tonga has signed international agreements including the United Nations Framework Convention on Climate Change (UNFCCC). The Joint National Action Plan (JNAP2) 2018–2028 focuses on building climate resilience and collaboration across government and society to combat climate change. The plan also aligns strongly with the Framework for Resilient Development in the Pacific and with international agreements and other frameworks (Government of Tonga, 2018). Under the Initial National Communication report, the following recommendations were made:

- Significant efforts required for training, research and data collections.
- Continuous strengthening of local capacity for future GHG compilations.
- Institutional focal points be established to coordinate the inventory preparation and data collection at the sectoral level where significant gaps remain evident.
- Financial assistance is required from respective GEF donors to update the inventory in Tonga.

This report recommends:

- Transparency and cooperation between government bodies especially in sharing data.
- Comprehensive recording of all sectors and specific guidelines and outcomes for each sector.
- Ensure that all relevant stakeholders have access to finance and resources to achieve the goals and targets for a resilient Tonga through accessing the Tonga Climate Change Fund (Government of Tonga, 2018).

SOURCES

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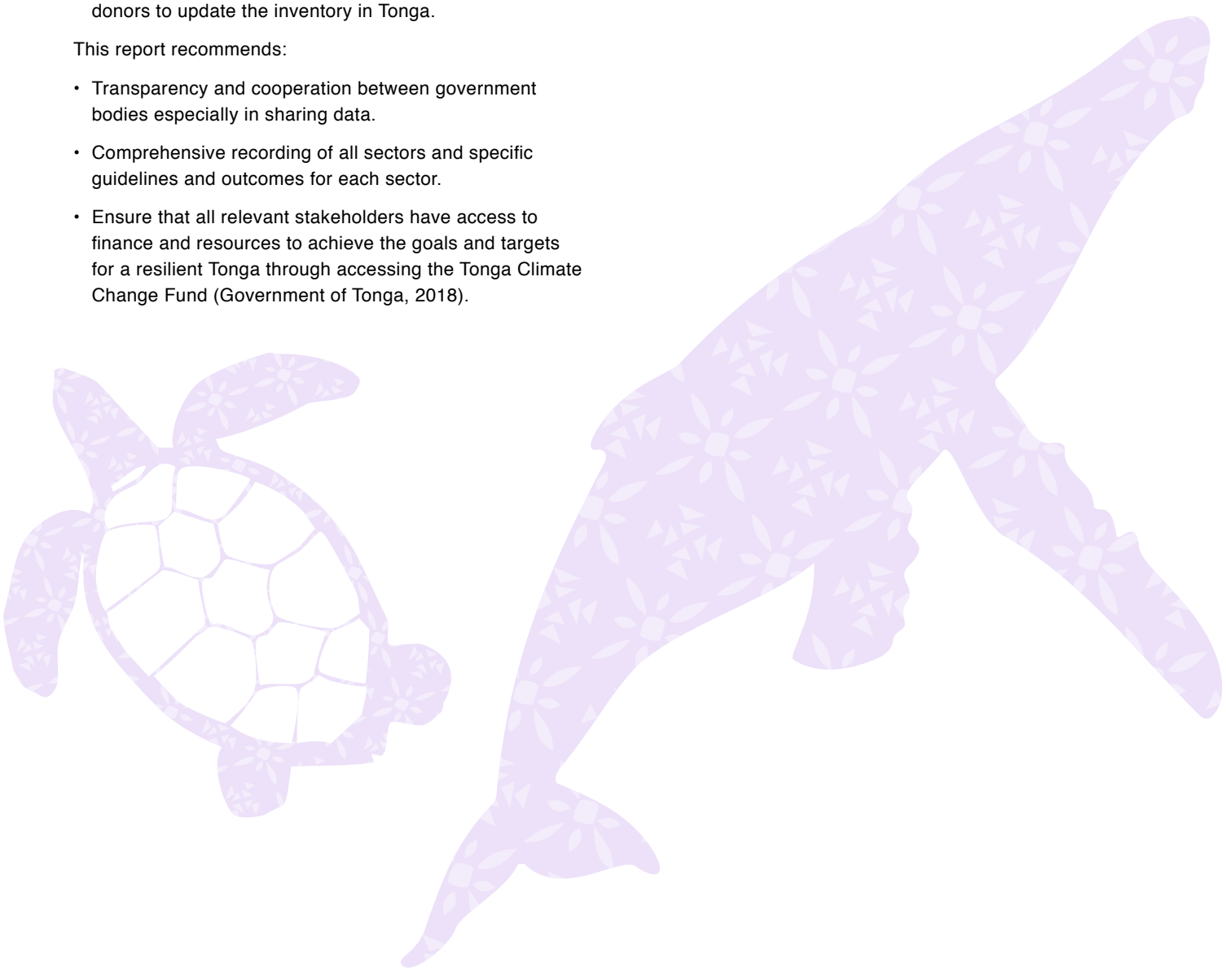

OZONE DEPLETING SUBSTANCES

The ozone layer protects the earth by absorbing ultra-violet (UV) radiation from the sun. Ozone depleting substances (ODS) deplete the ozone layer and allow more UV radiation to pass, causing problems from skin cancer to cataracts in people and damaging agriculture crops. Ozone-depleting substances are mostly found in refrigerators, air-conditioners, fire extinguishers, agricultural fumigants and cleaning agents. The primary controlled substances are: Chlorofluorocarbons (CFCs), halon, Carbon tetrachloride (CCl4), Methyl chloroform (CH3CCl3), Hydrobromofluorocarbons (HBFCs), Hydrochlorofluorocarbons (HCFCs) and Bromochloromethane (CH2BrCl) (Department of the Environment and Energy, 2018).

The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production of ozone-depleting substances. Tonga became a signatory on the 29th July 1998 and implemented the Ozone Layer Protection Act 2010 which outlined the following objectives that coincide with the Montreal Protocol:

- Help protect human health and the environment from adverse effects linked to human activities which modify or are likely to modify the ozone layer;
- Phase out ozone-depleting substances except for essential use; and
- Give effect to Tonga's obligations under the Vienna Convention and Montreal Protocol.

The treaty outlines the prohibition of importing specific ODS substances, with exemptions only for medical ODSs. The indicator reviews Tonga's consumption of ozone-depleting substances for the two primary sources of refrigerators and automobile air-conditioners.

Status
Good

Trend
Unknown

Data confidence
Medium

SDG	CBD
13 CLIMATE ACTION	15

Status: Good Trend: Unknown Data Confidence: Medium

STATUS AND TREND DISCUSSION

The Kingdom of Tonga has ratified the 1985 Vienna Convention and the 1987 Montreal Protocol. Tonga is required under the Montreal Protocol to control CFC and halon consumption (Department of Environment, 2001). According to the National Compliance Action Plan (NCAP) 2001, the country is obligated under the Protocol to freeze its consumption of CFCs from 1st July 2000 to the average level of consumption between 1995–1997. The average level between 1995 and 1999 was 1.44 ODP tonnes. Since CFC consumptions in 2000 were at 0 tonnes (Table 3–1), Tonga was in full compliance with the Montreal Protocol (Department of Environment, 2001). This is a significant improvement in reducing CFC levels.

TABLE 3–1 Consumption of CFCs in Tonga (metric tonnes) (Department of Environment, 2001)

Substances	ODP	1995	1996	1997	1998	1999	2000
CFC-12	1.0	2.112	0.82	1.46	1.96	0.36[2]	0
CFV-115	0.6	0.32	0.49	0.32[1]	0.08	0.06	0
ODP		2.304	1.114	1.652	2.008	0.396	0

[1]CFC-115 consumption in 1997 is an estimate due to unavailability of data

[2]100kg was added to the 1999 CFC-12 consumption to account for the Chinese imports

Australian Government, Department of the Environment and Energy 2018.

According to the NCAP, only three types of ozone-depleting substances are known to have been imported into Tonga in bulk form: chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) for refrigeration and air-conditioning, and methyl bromide used for quarantine fumigation. Other than the use of methyl bromide for fumigation, consumption of ODS in Tonga is exclusively in the refrigeration and air conditioning sector. These products were imported from neighbouring countries Fiji, New Zealand and Australia. The only company that imports ODS and methyl bromide is BOC Gases Tonga Ltd. Chinese traders also imported an unknown quantity of Chinese-made CFCs products, which is a concern.

The imported products are mainly for servicing of refrigeration and air conditioning equipment. Government departments such as the Ministry of Fisheries and Health service their own refrigeration equipment and are among the largest users of CFCs in Tonga. Commercial fishing companies also use different forms of CFC equipment (Department of Environment, 2001).

The use of methyl bromide is mainly in the quarantine and pre-shipment applications. The Quarantine Division of the Ministry of Agriculture carries out all the fumigation at the main port. The NCAP estimated that 10kg is used every week and approximately 500kg per year. Since the NCAP figures, there are no recent data available, therefore the trends of CFC are relatively unknown.

Insufficient data are available to forecast future CFC demand, according to NCAP. It also stated that if the supply of CFCs had not stopped in 2000, it is reasonable to assume that the demand for CFCs would have dropped from its level in 1999 to 0 in less than 10 years as existing equipment was replaced. Under this scenario it is likely that Tonga would have remained in full compliance up until 2010 (Department of Environment, 2001). However, the report also identified the ongoing importation of second-hand equipment and vehicles that have CFCs as a potential threat for Tongan compliance.

Tonga commenced the Pacific Ozone Depleting Substances Project in 2003 outlining teaching practises for reducing ODSs primarily in the refrigeration sector. During the workshops it was determined that no manufacturing facilities used any ozone-depleting substances. However, the influx of migrants has meant the importing of household items from predominately China, Taiwan, and Hong Kong. Refrigerators, televisions, cars and other items contain these substances. For refrigeration and automobiles, there is no statistical data on the consumption percentage.

IMPACT

ODS are not only harmful to the ozone layer, they are also a potent source of Greenhouse Gases (GHGs) and contribute to overall emissions worldwide. Hydrochlorofluorocarbons (HCFCs) have approximately 2000–3000 times greater global warming potential than the most prominent CO_2 gas emissions, however the concentrations in the atmosphere are much less as they are emitted via different mechanisms. The focus from Tonga to phase out ODS products, except for essential items, helps in protecting the ozone layer and also benefits climate change mitigation activities by reducing quantities in the atmosphere. As a signatory to the Montreal Protocol, there are trade implications if Tonga imports, or illegally trades, in ODS.

RESPONSE AND RECOMMENDATIONS

The country has committed to significant efforts to reduce ODS through the implementation of the National Compliance Action Plan (NCAP) 2001. The NCAP plays an important role in determining the level of ODS consumption in the country and reflects the determination of the government to comply with signed agreements and protocols. It provides the way forward for the assessment of ODS, and identifies how the government might lobby for multilateral funds.

Under the NCAP, 10 key phase-out actions were identified as listed below (Department of Environment, 2001). It is recommended that these actions are carried out and assessed on a regular basis;

1. Maintain compliance with the Montreal Protocol while preparing an economically viable accelerated phase-out programme.
2. Establish a Tonga National Ozone Unit (TNOU) office to co-ordinate, implement, and monitor the phase-out programme.
3. Prohibit any new activity related to the import, production or use of ODSs in new equipment.
4. Ban on import of ODS-using and ODS-containing equipment (including new and second-hand domestic refrigerators using CFC-12 as the refrigerant).
5. Introduction of controls on the import (and export) of all ODSs (including licensing, taxation and/or quotas as appropriate).
6. Strengthening ODS import/export monitoring programme by developing a licensing system.

7. Consideration of a system of fiscal incentives/disincentives in favour of non-ODS alternatives and transitional substances.
8. Implement and monitor training of Custom Officers to ensure proper control of import and export of ODSs and information collection and submission.
9. Implement and monitor training of refrigeration service technicians in good practices of refrigeration to minimise the use of ODSs and mitigate their emissions into the air during the service of refrigerators.
10. Conduct public awareness campaign on the importance of protecting the ozone layer and the Government commitment to phase out ODSs.

This report also recommends:

- Maintain compliance with other agreements and protocols committed to by government since 2001.
- CFC products and quantities must be registered and monitored by the Quarantine Division.
- Introduce an ozone levy for the importers of CFCs.
- Develop an infringement system to control illegal importers.
- Monitor and collect data on all ozone-depleting substances (number of people with vehicles, age and date) and the number of people with fridges (age and date).
- Campaign encouraging the purchase and use of non-ODSs.
- Campaign informing about the health hazards associated with ODSs.

SOURCES

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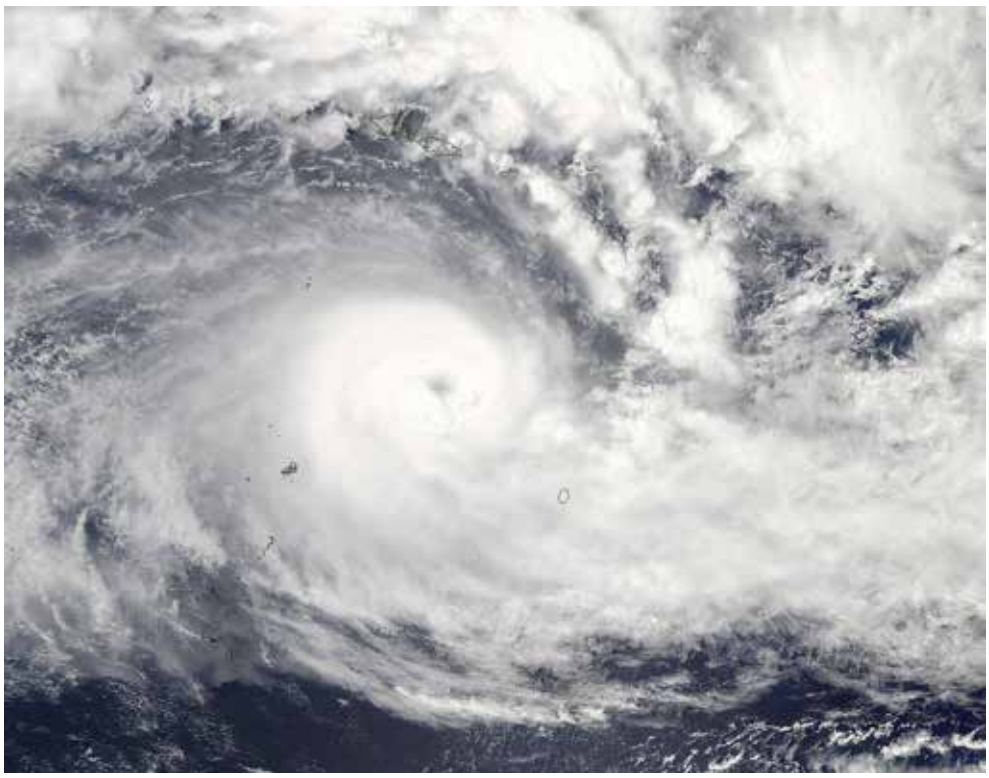


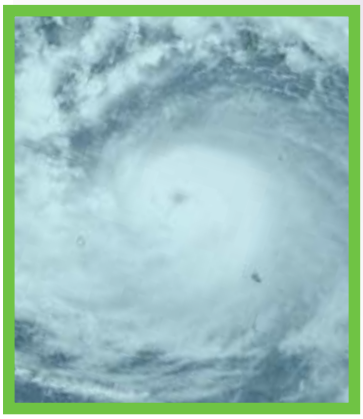
NASA 2016

PHYSICAL CLIMATE

The physical climate includes all nonliving factors that characterise an ecosystem and the process that drives them. The physical climate generally focuses on three areas: the atmosphere, the hydrosphere and the geosphere (lithosphere). The physical climate is dictated by location with Tonga in the Central South Pacific, an archipelago of 172 coral and volcanic islands, 36 inhabited, with the largest having an area of 747 square kilometres. The islands are formed on two parallel submarine ridges enclosing a wide trough. Several active volcanoes exist along the ridges.

Tonga's sub-tropical climate is bound to experience large natural variations with the impacts of climate change exacerbating these variations and causing larger impacts than seen previously (longer droughts, more frequent and intense storms and cyclones, and flooding). The physical climate is generally considered a fluid system with the natural El Nino, La Nina and Neutral cycles allowing for the cyclic variations of cold and warm seawater and wind currents. The wet and dry seasons were relatively easy to predict and manage allowing for appropriate cropping and fishing. These systems have been negatively impacted by climate change causing the wet and dry seasons to start earlier and last longer, the increased effects of the El Nino, La Nina and Neutral cycles causing increased temperatures and the increased GHGs in the atmosphere leading to ocean warming and acidification (Bureau of Meteorology, 2012; IPCC, 2018).

This topic outlines Tonga's past, present and future climate projection of trends, impacts and potential mitigating options. Some of the physical parameters and their trends have been described in the JNAP2 report. The climatic system for Tonga involves observation of atmospheric and oceanic data outlining annual mean climates (seasonality and the ENSO), temperature, rainfall, extreme events (droughts, floods, cyclones etc), ocean acidification, and sea levels. The state of the natural environment can be observed worldwide and have been distributed in this document into Seasonal Cycles, Climate Variability, Observed Trends (temperature, rainfall, sea-level etc), and Projections.



Status
Good

Trend
Deteriorating

Data confidence
High

SDG	CBD
13 CLIMATE ACTION	10

Status: Good Trend: Deteriorating Data Confidence: High

STATUS AND TREND DISCUSSION

There are seven meteorological stations in Tonga as of 2017. This data records observations within a 24-hour period outlining all physical climate characteristics with some sources of data from 1931. The data is not fluid and shows large gaps which dilute the overall understanding of the physical climate system.

There are a number of climate recording sites which were analysed in this section and outline the following key points:

- Seasonal variations in air and seawater temperature due to the sub-tropical climate.
- Two thirds of Tonga's total rainfall is in the wet season from November to April, and is affected by the South Pacific Convergence Zone.
- Rainfall variability is dependent on the El Niño-Southern Oscillation.
- The sea level rise near Tonga since 1993 is at over 6mm per year
- Tonga experiences, on average, 17 tropical cyclones per decade mainly during the wet season, November to April.

CLIMATE VARIABILITY

The El Niño, Neutral and La Niña events occur often in cyclic motion under the El Niño – Southern Oscillation (ENSO) to varying degrees (weak, moderate and strong). The last 40 years has seen a domination of the El Niño events, whilst prior there was a relative equilibrium in the

events whereby El Niño would occur every 3–7 years. Rainfalls increase dramatically during La Niña events throughout the year leading to flooding, particularly during the wet season. The El Niño events reduce total rainfall to below mean averages leading to droughts which are exacerbated during the dry season. The last three major droughts occurred in 1983, 1998 and 2006 during El Niño events. Extreme weather i.e. cyclones tend to occur more often during El Niño, and during the transition between El Niño and La Niña.

Prediction of the El Niño, Neutral and La Niña events involves several monitoring observations, with the primary signal from oceanic temperature and pressure. The range of indicators involve the following: short-term bursts of tropical rainfall activity; water temperatures at sea surface and at depth; ocean heat content – stored energy; atmospheric air pressure and cloudiness. These climate indicators are input into ENSO modelling to predict potential future conditions. Generally, El Niño events last a single cycle i.e. one year, whilst the Neutral and La Niña cycles can last a number of years. As of August 2018, the system remains neutral, however, climate models throughout the world are predicting an El Niño event to occur in the coming months.

Observed Trends

There are six climate gauges, which identify climatic variations and trends throughout Tonga. These gauges are at Niuafo'ou, Niuatoputapu, Lupepau'u Aerodrome, Nuku'alofa, Pilolevu Aerodrome and Fua'amotu Aerodrome. The climatic trends observed are temperature; rainfall; solar; evaporation – transpiration and wind.

RAINFALL

There is a large differential between rainfall in the dry and wet season with the largest downpours occurring during tropical cyclones, convective and intensive cloud systems, and the movement of the South Pacific Convergence Zone (SPCZ). The islands to the north receive higher rainfall per annum than those located further south. The largest rainfall average month is January with 265.1 millimetres, with the lowest rainfall average month in July at 82.3 millimetres. Approximately 65% of Tonga's total annual rainfall is during the wet season from November to April, with the remainder falling in the dry season from May to October. The annual rainfall of the country shows inclining trends based on the data from its rainfall gauge stations (Government of Tonga, 2018). The increased rainfall may cause more frequent and larger flood events in low-lying areas such as shown in Figure 3–5.

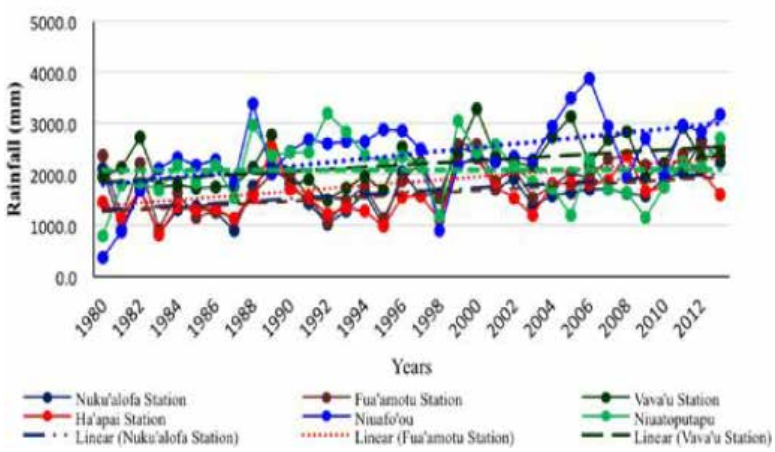


FIGURE 3–4 annual rainfall of Tonga (1980–2013) (JNAP2)

FIGURE 3–5 flooding in Tonga (National Emergency Management Office)

TEMPERATURE

The tropical atmospheric and oceanic temperatures show a system that is dependent on the South Pacific Convergence Zone and the ENSO. There is a marked diurnal, seasonal and spatial variation in the temperatures as shown in Table 3–2 and Figure 3–6. The temperatures are variable within Tonga and rarely measure above 33°C in southern Tonga. The gauge at Nuku'alofa shows a median temperature over the years of 24.3°C, a maximum temperature of 32.2°C occurred during January 2017 and a minimum temperature of 15.3°C during June 2009. The highest daily maximum temperatures occur in February the hottest month, with the coolest months being July and August. The highest overall temperature of 35.0°C was recorded in Vava'u on 11 February 1979. The lowest temperature on record is 8.7°C on 8 September 1994 in Fua'amotu. Temperatures of 15°C or lower are usually measured during the dry season and are more frequent in Southern Tonga than in the north.

The annual atmospheric temperatures represent a net increase from 1993 to 2018 of 0.65°C. This coincides with the predicted increased temperature by the IPCC report on increasing temperature (IPCC, 2018). The report stated that the small islands are projected to experience multiple inter-related risks at 1.5°C that will increase with warming of 2ºC and higher. Climate hazards at 1.5°C are lower compared to 2°C. It further explains that long term risks of coastal flooding and impacts on population, infrastructure and assets, freshwater stress, and risks across marine ecosystems, and critical sectors increase at 1.5°C as compared to present and further increases at 2°C, limiting adaptation opportunities and increasing loss and damage (IPCC, 2018).

TABLE 3–2 Seasonal Distribution of Temperature (1971–2007 data) (Tu'i'afitu-Malolo, et al., 2012)

Location	Season (°C)		Annual mean (°C)	Deviation from mean (°C)	
	Warm	Cool		Warm	Cool
Niuafo'ou	27.1	26.0	26.6	+0.5	-0.6
Keppel	27.6	26.2	26.9	+0.7	-0.7
Vava'u	26.5	24.1	25.3	+1.2	-1.2
Ha'apai	26.4	23.6	25.0	+1.4	-1.4
Tongatapu	25.8	22.3	24.1	+1.7	-1.8

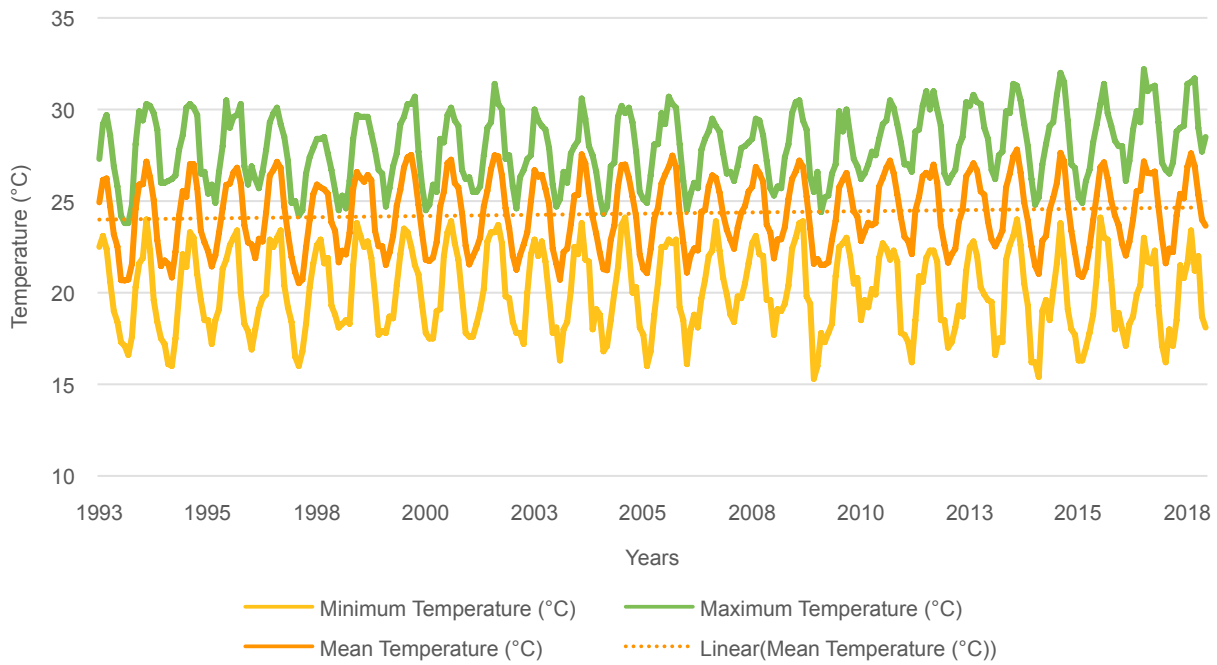


FIGURE 3–6 Temperature variances at the Nuku'alofa gauge station (Bureau of Meteorology, 2012)

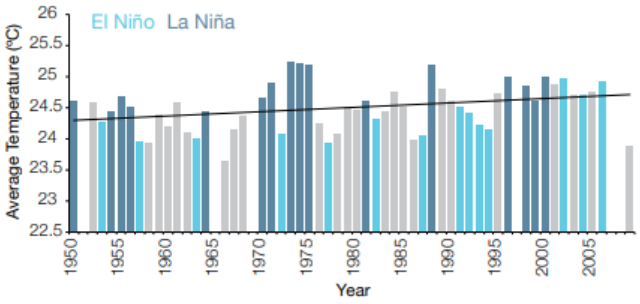


FIGURE 3–7 Historical average temperature (Scientific Assessment and New Research, 2018)

IMPACT

The impacts are primarily subject to the following:

- El Nino and La Nina events will continue to occur;
- Annual mean atmospheric and oceanic temperatures will continue to rise;
- Annual rainfall likely to lessen; and
- Number of extreme weather days will continue to rise.

These occurrences will likely generate less frequent, more intense droughts and storms which will impact food resources, climate adaptability, water resources and land use in Tonga. As such Tonga has never been more vulnerable to climate changes.

RESPONSE AND RECOMMENDATIONS

The key response Tonga has done is the implementation of different initiatives and plans, and signing international agreements that require Tonga to meet target obligations in those agreements. Most significant is the implementation of the JNAP 1 and 2 that defined 10 year strategies and approaches to ensure Tonga is resilient to climate change (Government of Tonga, 2018). This report also recommends:

- Increase monitoring programme to include wind, evaporation and evapotranspiration.
- Provide international training to staff of the Department of Environment and MEIDECC.
- Implement climatic projections into key models such as a conjunctive water allocation model to manage water resources.

SOURCES

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CLIMATE CHANGE ADAPTATION

Adaptation to climate change is defined by IPCC as the "process of adjustment to actual or expected climate and its effects" (CoastAdapt, 2018; IPCC, 2018). The UNFCCC defines it as the actions taken to help communities and ecosystems cope with changing climate conditions (UNFCCC, 2018). Both definitions point to required actions by governments and institutions to cope with changes in the climate. These strategic actions with specific objective seek to lower the risks posed by the consequences of climatic changes.

Climate adaption helps individuals, communities, organisations, governments and ecosystems deal with the severe consequences of climate change involving the management of natural resources risks (droughts, sealevel rise, floods, etc) by creating solutions to protect communities and build resilience (Department of the Environment and Energy, 2018). Adaption is important for the Pacific islands because they are among the most vulnerable nations to the impacts of climate change.

Status
Good

Trend
Improving

Data confidence
Medium

SDG	CBD
13 CLIMATE ACTION	17

Status: Good Trend: Improving Data Confidence: Medium

Source: Tonga Power Limited

STATUS AND TREND DISCUSSION

Rising sea levels, the increase in extreme weather events and the changes in temperature and rainfall will affect the community, biodiversity and the environment. Tonga has been striving to combat these changes by adopting and implementing projects to increase resilience.

Tonga has taken significant steps to improve climate change adaption by addressing key issues in the national planning process through the implementation of the National Climate Change Policy, endorsed by the Government in 2006, and the establishment of the Ministry for Environment and Climate Change. The Tonga Climate Policy – A Resilient Tonga by 2035 – outlines a vision, goals and objectives in response to the growing risk of climate change and environmental disasters. This document requires the multi-sector ownership of the issues Tonga is facing and recognises climate change as the main issue Tonga faces in the future. There are twenty targets to make Tonga more resilient to climate change.

NATIONAL PLANS

The threats to Tonga from climate change, which undermine its sustainable development, provided the impetus to develop the JNAP 1 (2015) and JNAP 2 (2018). Many factors confirm that Tonga is one of the most vulnerable countries in the world to climate change. Hence, the JNAPs provide the strategies and pathways to climate change resilience, with specific goals and objectives to achieve as shown in Figure 3–8 and Table 3–3. The plan is in line with regional, national and international plans

and frameworks. The focus is to make Tonga more resilient and adaptive to climate change. Six main objectives have been set out that include mainstreaming the climate change approach into government legislation, policies and plans; research and monitoring of data, and securing the financial packages to deliver outcomes. Strategies and pathways have been set out with target incomes to be achieved on a set time frame (Government of Tonga, 2018). Its linkages to national, regional and international agreements and plans are shown in Figure 3–9.

GOALS

1. **Improved good governance for climate change adaptation and disaster risk management (mainstreaming, decision making, organizational and institutional policy frameworks)**
2. **Enhanced technical knowledge base, information, education and understanding of climate change adaptation and effective disaster risk management**
3. **Analysis and assessments of vulnerability to climate change impacts and disaster risks**
4. **Enhanced community preparedness and resilience to impacts of all disasters**
5. **Technically reliable, economically affordable and environmentally sound energy to support the sustainable development of the Kingdom**
6. **Strong partnerships, cooperation and collaboration within government agencies and with Civil Societies, Non Government Organisations and the Private Sectors**

FIGURE 3–8 JNAP1 goals (JNAP1)

TABLE 3–3 JNAP 2 Objectives and indicative cost

JNAP 2 Objectives	Description	Indicative Costing (USD in Millions)
1: Mainstreaming for a Resilient Tonga	Mainstream climate change and disaster risk management approaches into government legislation, policies and plans at all levels	$10,375
2: Research, monitoring, data, information	Implement a coordinated approach to research, monitoring and management of data and relevant information	$5,860
3: Resilience-building response capacity	Develop the capacity for resilience building responses throughout government, the private sector and civil society	$5,055
4: Resilience-building actions	Design and implement actions that focus on building a Resilient Tonga by 2035 at national, island and community levels	$125,600
5: Financial Security	Secure and mobilise the required finances and resources to build a Resilient Tonga by 2035	$283
6: Regional and international cooperation	Develop and maintain strong regional and international partnerships and contribute fully to negotiations aimed at transforming to a resilient and sustainable future for Tonga	Less than a million
Total Costing	Estimated cost	$147,173

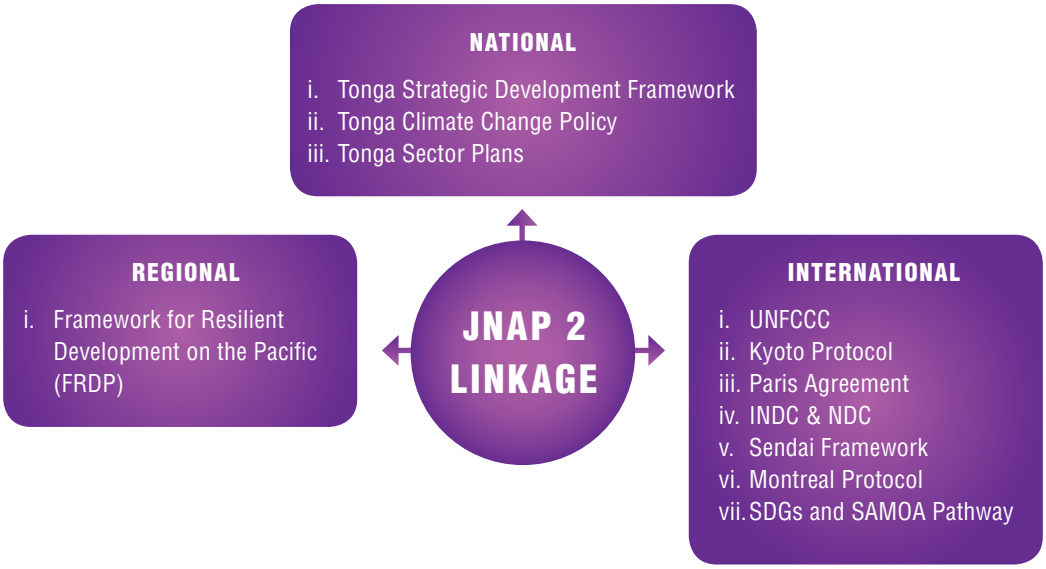

FIGURE 3–9 JNAP2 linkages with national, regional and international frameworks

To determine Tonga's resilience, the following priority areas need assessment. However, because these are assessed in other themes of this report, they are not discussed here.

- Health and Waste
- Land use and development
- Biodiversity
- Energy
- Flood and Sea level rise risk

Tonga has undertaken a number of climate change adaption projects and activities. The list below outlines some recent and ongoing projects:

- South Pacific Sea-Level and Climate Monitoring Project
- International Climate Change Adaption Initiative (ICCAI)
- UNDP-GEF funded climate change adaption and other climate change-related projects
- Coping with Climate Change in the Pacific islands region
- Mangroves Ecosystems for Climate Change Adaption and Livelihoods (MESCAL) project
- University of the South Pacific-EU Global Climate Change Alliance Project
- JNAP 1 and 2

The financial requirement indicated in the JNAP2 to achieve a 10-year plan and meeting different objectives is USD147,173 million. Considering the amount of work required, this indicative budget is considered adequate. Some of the activities listed in JNAP2 require significant backing:

- Strengthen coastal infrastructure through the timely implementation of the Tonga Coastal Resilience Project to replicate this project in the outer islands,
  - A coastal flood model to properly understand the effects of waves, winds and cyclones.
- Design and implement appropriate, environmentally sensitive flood management responses in all low-lying areas around Tonga,
  - This would require a flood model to estimate flood levels for different storm events before a resilience approach can be designed to counter flooding in low lying areas.

While the objectives defined in JNAP2 are necessary for Tonga to counter climate change, the actual cost is anticipated to be much higher than indicated. More funding will allow in-depth and comprehensive assessments of the set objectives. Thus, international funds for Tonga are required to finance this work. Annual aid funds donated by Australia, New Zealand, United States and China (and other countries) should allocate a high priority to the climate resilience approaches stated in JNAP2.

The Conference of the Parties (COP24) to be held in Poland in December 2018 will address the Intended Nationally Determined Contribution and update it with new data. Under JNAP2, the focus is to cut emissions by 50% by 2030.

IMPACT

Climate change adaption measures by Tonga can strengthen its resilience from the negative impacts associated with climate change and build capacity to better adapt to these changes. Adaption generally incurs large financial costs especially for shoreline protection (i.e. bunds, sand bags, etc.), however, there are simple measures, such as the planting of mangroves, that can prevent large storm surges impacting the shoreline. Some of the social drivers for these impacts include:

- Population growth and over-population in urban centres;
- Low elevation and small islands;
- Unsustainable development;
- Localised pollution (including contamination of water);
- Poor waste management and sanitation and environmental degradation;
- Limited resources (particularly food, water and fuel);
- Limited economic potential due to small size and remoteness, and
- High exposure to external market shocks.

RESPONSE AND RECOMMENDATIONS

These key issues include a lack of knowledge, a lack of physical and financial resources, a lack of comprehensive environmental legislation, inherent difficulties in discerning overlapping and unclear management powers, a lack of appropriate policy support, and a lack of public participation coupled with a basic lack of political will and commitment for sustainable development. In recognition of the need for integration of climate change into development planning, Tonga developed the Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management (JNAP1) 2010–2015 and most recently (JNAP2) 2018–2028. The plan comprises six priority goals (Government of Tonga, 2018):

- Improved governance for climate change adaptation and disaster risk management (mainstreaming, decision making, and organisational and institutional policy frameworks).
- Enhanced technical knowledge base, information, education and understanding of climate change adaptation and effective disaster risk management.
- Analyses and assessments of vulnerability to climate change impacts and disaster risks.
- Enhanced community preparedness and resilience to all impacts of disasters.
- Technically reliable, economically affordable and environmentally sound energy to support sustainable development.
- Strong partnerships, cooperation and collaboration within government agencies and with civil societies, non-government organisations and the private sector.
- Applies the resilience activities proposed in JNAP2.
- Increase the indicative budget stated in JNAP2 for resilience activities by 10–20 times in order to achieve the defined 10-year plan.
- Update NDC after COP December 2018.

The SOE also recommends:

- The objectives 4 and 5 to be achieved by 2028 instead of 2035.
- The success of the JNAP2 depends on securing financial support from overseas donors. There is no Plan B outlined in JNAP2 on what to do if the estimated cost for each objective cannot be secured. Therefore, it is strongly recommended that an alternative route to a Resilient Tonga be clearly defined by the Government of Tonga prior to implementing JNAP2.
- The strategies and management approaches specified in the JNAP2 to be implemented immediately once the above points have been adopted.

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Overview

Water is a critical resource for Tonga as there is limited freshwater available. The inland water in Tonga mainly comprises the groundwater system as surface water hydrology is limited to a few lakes in outer islands. Water resources refers to the freshwater available for ecosystem and human uses and focuses on two areas: water storage and supply and hydrogeology. This theme primarily outlines 'unregulated' and 'regulated' parts of the hydrological system with the two sources of freshwater in Tonga of rainwater and groundwater lenses. Rainwater collection is not managed under any regulation, whereas groundwater is managed under several statutes and legislation.

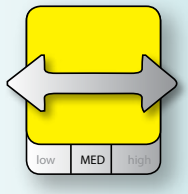
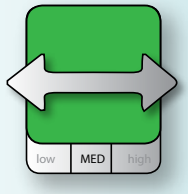
The freshwater resources of Tonga consist mainly of groundwater in the form of freshwater lenses.

The freshwater lenses form on top of seawater in many of the islands due to the difference in density of the two fluids. The interface, or boundary, between the two fluids is not sharp but rather is in the form of a transition zone. Within the transition zone the water salinity increases from that of freshwater to that of seawater over a number of metres. The thickness of freshwater and transition zones depend on many factors, some of which vary throughout the island groups and between islands within those groups. The most important factors are (UNDP; SOPAC; UNEP; Global Environmental Facility, 2007; Velde, Green, Vanclooster and Clothier, 2007):

- rainfall amount and distribution
- quantity and type of surface vegetation and nature of distribution of soils (factors which influence evapotranspiration)
- size of island, especially width from seas to lagoon
- permeability and porosity of the geology, and presence of cave systems and solution cavities
- methods of extraction and quantity of water extracted by pumping.

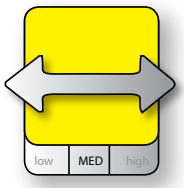
There are a number of organisations involved in Water Resources in Tonga including the Ministry of Lands, Survey and Natural Resources responsible for the assessment, monitoring and future development; the Tonga Meteoritical Service of the Ministry of Civil Aviation responsible for the operation and maintenance of climate stations; the Ministry of Health responsible for the implementation and planning of water supply and quality; the Tonga Water Board for planning, installing and operating the water supply systems, and the Village Water Committees for operating physical village water supply. There are a number of committees responsible for the coordination and monitoring of aid projects and reviewing development in the water resource sector.

WATER HIGHLIGHTS

KEY AREAS	CURRENT STATUS	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
WATER STORAGE AND SUPPLY	 **Status** Fair **Trend** Stable **Data confidence** Medium	• Institutional issues caused poor management of water resources. • Lack of information about the groundwater system in other islands. • There is no water balance available to determine water capacity and availability for the entire nation.	• Groundwater system in Tonga has been studied since 1979. • Institutional management needs improving. • A conjunctive water management plan is required to adequately reflect the physical system. • A new municipal system in the Eastern part of Tongatapu sourcing from Fua'amotu wells to supplement and relieve pressure on the Mataki'eua system. • Develop a conjunctive water balance model to determine water availability for Tonga and use it to guide a water resources management plan.
WATER QUALITY	 **Status** Good **Trend** Deteriorating **Data confidence** Medium	• Seawater intrusion increased groundwater salinity. • Groundwater aquifers around Mataki'eua has increased salinity level over the years.	• Salinity monitoring in Tongatapu aquifers should be continuous. • Seawater intrusions in low-lying areas require immediate attention.
INFRA-STRUCTURE	 **Status** Poor **Trend** Unknown **Data confidence** Medium	• Poor infrastructure has led to water losses through the transmission lines.	• Studies have identified the water losses through transmission lines. • Upgrade the infrastructure to reduce cost and water losses.
CLIMATE CHANGE	 **Status** Good **Trend** Stable **Data confidence** Medium	• Drought affects water resources as it relies heavily on rainfall. • Climate change influence on water resources has not been rigorously modelled.	• Factor the climate change into water resources management. • Model the effects of climate change into water availability.

WATER STORAGE AND SUPPLY

This indicator identifies the water capacity and availability in Tonga to meet water demand.



Status
Fair

Trend
Stable

Data confidence
Medium

SDG	CBD
6 CLEAN WATER AND SANITATION	14

Status: Fair Trend: Stable Data Confidence: Medium

STATUS AND TREND DISCUSSION

Water can be a scarce resource in the Pacific with a growing number of islands reporting water scarcity and even severe water problems (Weber, 2007). This is often due to the lack of viable catchment areas leading to constraints in the harvesting and storage of freshwater. Human population densities, conflicts over traditional resource rights and capacity limitations contribute to these constraints.

Water storage and supply in Tonga is managed by a number of institutions, such as the Ministry of Health (MoH) for the water supply in rural areas in conjunction with the Village Water Committee in each village under the Public Health Act. The Tonga Water Board (TWB) under the Tonga Water Board Act 2016 is responsible for water supply and distribution to a number of Tongan islands. The Ministry of Lands, Survey and Natural Resources (MLSNR) is responsible for monitoring all the groundwater resources. The MoH develops policies and programmes for improvements to water supply and sanitation, while the MLSNR is responsible for managing the groundwater source by controlling the drilling of wells, and monitoring, testing and maintaining the quality of the water.

The Water Supply Regulations set out the various functions of the TWB. The regulations prohibit the selling of water, and the wasteful use of water. Fouling or damaging of public water supplies is also prohibited, but the penalties for breaching these measures are inadequate. Although the careful use of the limited water resource is critical to the development of Tonga, at present the MOH and TWB seem

to deal only with supply and distribution issues. Specifically, the Water Board Act mainly deals with the establishment of the Tonga Water Board: it contains nothing about water conservation, water management (other than the constitution of the Board and its financial responsibilities) or protection of water resources.

Water storage and supply in Tonga is almost exclusively from rainwater harvesting and groundwater extraction. Rainwater is commonly captured from rooftops and stored in household water tanks. Depending on the location in Tonga this may be the only source of freshwater. Previously, large communal stone water tanks were used, however, there were issues with allocation and uses. Generally, rainwater is used for drinking, bathing and washing (clothes and persons). Due to the increase of imported bottled water in the region, bottled water has now become a stable for expatriates and tourists (this data is not available as mentioned in the Municipal Solid Waste section).

Water storage and supply mainly follow two pathways. Rainwater is captured wherever possible into tanks, either plastic or stone, and piped to the community, generally those whose tank it belongs who own the tank. The groundwater is captured from bore wells with mechanical diesel pumps and piped to a reservoir (large concrete storage tank), passing through a chlorination chamber (only present in urban areas) before flowing through to consumers. The groundwater is generally boiled in the rural areas to kill any bacteria.

DRINKING WATER

There is some information on the percentage of households and the de jure population by source, time to collect, and people who usually collect drinking water and percentage of households and the de jure population by treatment of drinking water, according to residence Tonga 2012 (Department of Statistics, 2012). A high percentage (77.90%) of people in urban and rural areas have access to drinking water. The percentage of people who could access water within their premises from either tap water or wells was also high (77.90%). While most people drink treated water, there was a significant percentage (15.60%) of people who did not have any treatment to their drinking water. This trend is expected to improve due to higher accessibility to drinking water bottles. Access to drinking water is anticipated to be higher in 2018 although there is no statistical data to prove it.

RAINWATER

Tonga's primary source of drinking water is rainwater, however in times of drought and tsunami many people in the outer islands run short of water and are vulnerable. During desperate times communities rely upon neighbours (75% Ha'apai, 95% Vava'u, 78% 'Eua, and 88% Niuatoputapu & Tafahi), the church, community halls and water bottles. The capture of rainwater is generally from metal rooftops. A report on '*Rainwater Harvesting report of the outer islands, 2016'* suggests many of the rooftops are 'good' to 'very good'. This results in relatively clean storage sources of rainwater. The storage containers are made from plastic, fibreglass, ferro cement and other materials with a preference for ferro cement and plastic. There is no water balance available to estimate the water availability from rainfall and the future impacts of climate change.

GROUNDWATER

Groundwater is used domestically and agriculturally. The main uses include cooking, sanitation, washing food, bathing, plants, animals and for drinking when rainwater is not available (involving the boiling of water). The Tonga Water Board distributes the water in urban centres, with villages outside these centres operating their own reticulated water system.

The groundwater systems in the outer island are not yet thoroughly investigated but are perceived to be mainly unconfined and influenced by rainfall events. Only the groundwater aquifer in Tongatapu has been studied. There is no definitive estimate on how much water is available in the groundwater system for Tongatapu. This indicates a need for government commitments to ensure sustainability of water availability. There is also a concern with increased urbanisation around the Mataki'eua area, which is the recharge area of the groundwater system. This concern covers both reductions in the recharge capacity of the groundwater and increasing heath issues due to possible leakage from sanitation systems.

Under the vulnerability study of the groundwater system in 2009 (White, Falkland, & Fatai, 2009) it was found that the main threat to groundwater in Tongatapu is the absence of a legal framework for protecting groundwater. Specifically, there is no legal basis for protecting groundwater from harmful activities such as using of agrichemicals on land above the aquifers or over-extraction beyond the natural recharge rates. The lead government Ministry has no statutory basis for protecting, regulating, monitoring or reporting on groundwater resources. In addition, there are also conflicting ministerial roles in the water sector and no incentives for collaboration. Further, there is little obligation for Ministries to report collectively to the Government on the state of the nation's water resources, which could be due to lack of expertise in water engineering. Moreover, there is a serious need for employing trained staff or providing training, as the current water resource management agencies have staff that lack the necessary skills to conduct groundwater monitoring, analysis, assessment, reporting and community consultation.

The 2009 report findings apply today, with the exception of groundwater monitoring where some progress has been made. The Department of Natural Resources confirmed that a monitoring programme is in place with the groundwater level data available to water agencies. Village Water Committees manage water supplies for villages in Tongatapu but are under-resourced and largely untrained for this important technical task, and water is distributed without basic treatment. Improvements in the management and delivery of water supplies at the village level are required. Institutional reform of the water supply sector

through the formation of a single Tongatapu Water Authority for both urban and rural Tongatapu would address this problem and improve service in most rural areas (White, Falkland, & Fatai, 2009).

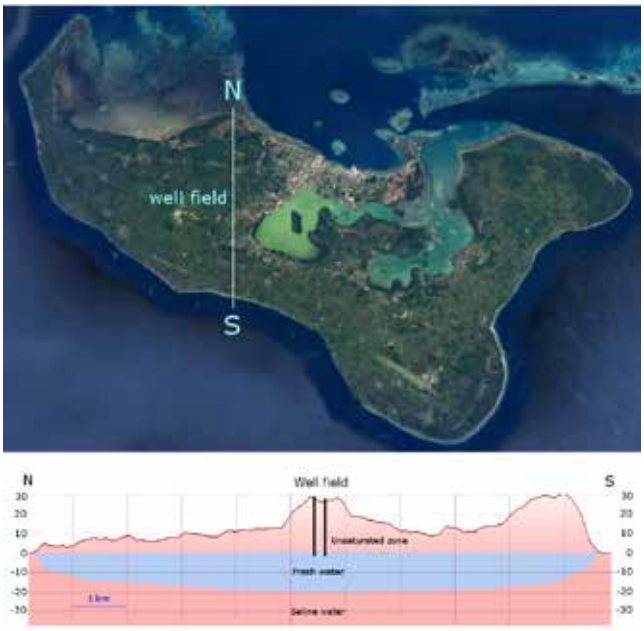


FIGURE 3–10 groundwater profile around mataki'eua (Dutch Risk Reduction Team, 2016)

GROUNDWATER PUMPING

The sustainability of pumping from groundwater is uncertain since there is no accurate metering of the rate at which water is being pumped from groundwater in Tongatapu (White, Falkland, & Fatai, 2009). However, the salinity investigation in 2012 estimated increased pumping rates as shown in Figure 3–11 (Government of Tonga, 2012). This trend continued in 2018 due to urbanisation and a growing population. Total sustainable pumping rate for Tongatapu was estimated to be between 54 and 72 ML/day in 2009 (White, Falkland, & Fatai, 2009). The extraction rate is uncertain, and estimates suggest it could be as high as 13.4 ML/day or 19–25% of the sustainable yield. Approximately 10.7 ML/day, or 80% of this estimated total daily extraction, is sourced from the Mataki'eua region due to the concentration of pumps at the Mataki'eua/Tongamai well field, while the remaining 20% is distributed over the rest of Tongatapu .

This uneven distribution of pumping could be further exacerbated by proposals to increase the number of pumps at Mataki'eua/Tongamai to up to 60. This may create salinity problems in pumped water particularly during dry times. It was suggested that all pumps should be metered and licensed to extract at a maximum of 3.0 L/s (White, Falkland, & Fatai, 2009). However, this figure could be outdated and needs to be reviewed with consideration of climate change and to reduce further groundwater depression.

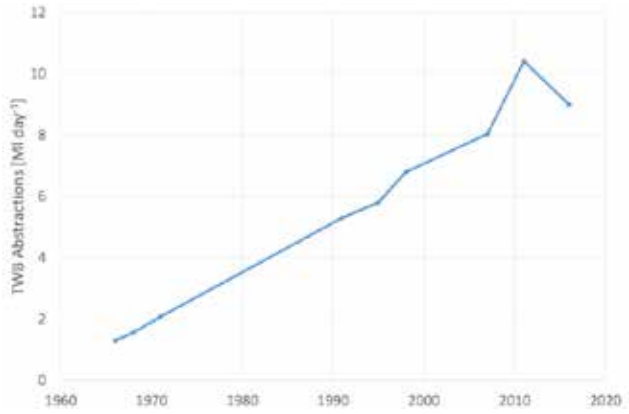


FIGURE 3–11 estimated pumping rate for Matai'eua (Dutch Risk Reduction Team, 2016)

IMPACT

Population growth and increased water demand has caused some impacts on the water resources. Sea level rise and seawater intrusion increases the salinity level of the groundwater reservoir, which reduces the drinking water capacity and requires more treatment. Lack of effective monitoring, governance and management have led to inappropriate practices that affect groundwater quality. Ineffective infrastructure causes water losses and higher cost. Little to no knowledge has been obtained on water supplies outside of Tongatapu. The water resources of Tonga are physically connected but there is no integrated water management policy in place.

RESPONSE AND RECOMMENDATIONS

Groundwater levels in Tongatapu are monitored and data are available to the water authority. Recommendations have been made for a better institutional approach to managing water resources and to giving the authoritative ministry the power to govern and report on the national status of water. In this report the following are recommended:

- Develop a conjunctive water balance model to guide water resources management. The physical nature of the water system must be reflected in the model. This can be developed within eWater SOURCE or RIVERWARE to include hydrological components and the operating rules in a single model.
- Investigate the water capacity and availability for the whole nation from surface and groundwater resources.
- Model the water availability, capacity and demand in Tongatapu.
- Establish a new municipal system on the eastern side of the Tongatapu and source water from the Fua'amotu wells. Confirmation of the sustainable yield is required.
- Connect the Mataki'eua system to the Fua'amotu system to supplement water demand and to reduce pressure on the Mataki'eua system.
- Define and confirm the groundwater direct recharge area

around Mataki'eua (groundwater system) and declare it as a national reserve, which prevents buildings, structures, agriculture and recreational activities from occupying the area. Thus, the natural recharge of the groundwater system is sustained, and no health issue can occur due to septic tank leakage. A major land law change is required to enable nobles to give up land for government purposes.

- All groundwater wells should be metered and registered by the appointed ministry.
- Both existing and new groundwater wells to be registered with the authoritative ministry.
- All commercial bores (hotels) must be metered and charged at the rates applying to the municipal system.
- Ongoing data monitoring is required.
- Better coordination between stakeholders.
- Establishment of a Tonga Water Resource Management Plan (District & Village Plans).
- Establishment of facilities and tools that will enable estimation of available resources and monitoring of use, at Urban and Village Level.
- Training and Capacity Building of Village Water Committees in Effective Water Governance.
- Education and Awareness at all levels of society
- Build bunds (retaining walls) around water supply infrastructure as protection against flooding and contamination.
- Introduce groundwater protection setback zones of 100m around TWB infrastructure to reduce contamination risks.

SOURCES

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WATER QUALITY

The water quality describes the level of chemical, biological and radiological characteristics in both surface water and groundwater. Quality is a good indicator to determine how clean a natural or treated water supply is for domestic and commercial/industrial water demands (Latu, Malano, Costelloe, & Peterson, 2014). It measures different parameters such as salinity, turbidity, pH, dissolved oxygen, quantities of pesticides and heavy metals to name a few.

Status
Good

Trend
Deteriorating

Data confidence
Medium

SDG	CBD
6 CLEAN WATER AND SANITATION	14

Status: Good Trend: Deteriorating Data Confidence: Medium

STATUS AND TREND DISCUSSION

TRACE POLLUTANTS

Because the surface water in Tonga is mainly sourced from rainwater and operated by individuals, there is no water quality data available. This indicator therefore focuses on the groundwater quality.

The use of pesticides and fertilisers in agricultural activities have led to traces of nitrates and other chemicals in the groundwater (Velde, Green, Vanclooster, & Clothier, 2007). The concentrations of nitrates were estimated to be five times the WHO limit for drinking water quality of 11.5 ppm N-NO_3. The study also found pesticide traces of dieldrin, diazinon and carbaryl in some of their samples in Tongatapu. They concluded that the increase in the usage of agrichemicals, combined with the general intensification of agricultural practices and growing populations, is putting the environment of Tongatapu under increasing pressure. Agrichemicals continue to be used and therefore traces of these chemicals are still likely to occur in the groundwater, though data are unavailable to support this assumption.

Leakage from septic tanks is a common threat to the groundwater quality. These septic tanks are often poorly managed and maintained by home owners (Newton, 2008). The influence of septic tanks on water quality is more intense in low-lying areas (Newton, 2008). Newton (2008) stated that the groundwater is contaminated with faecal coliform with traces of *E. coli* bacteria from human and

animal waste, although documents are not made public by the Ministry of Health unless they present alarming results. Bacterial counts found on study villages in Tonga are shown in Table 3–4. This coincided with the E. coli counts found on different sites around other villages in Tongatapu (White, Falkland, & Fatai, 2009). Indicators of bacterial contamination were found in 90% of the 19 water supply wells sampled, and 24% of the wells had indicators of faecal contamination.

While recent data is unavailable on groundwater quality, due to continue urbanisation and lack of government support to private water committees, the trend is expected to be worsen.

TABLE 3–4 Bacterial counts per 100 ml (Newton, 2008)

Village	Rainwater Tank	Village, Urban Water Supply	Piped Groundwater
Fasi	0	0	0
Fo'ui	0	2	15
Ha'ateiho	0	0	27
Hala'ovave	0	N/A	0
Hoi	0	0	14
Kanokupolu	0	4	8
Nakolo	0	0	11
Nukuhetulu	0	2	1

Concentrations of heavy metals were investigated at Tapuhia monitoring well GMW3, between February 2006 and January 2007 (White, Falkland, & Fatai, 2009) (Table 3–5). All metals were below the WHO standards except Lead which exceeded the 10 (ug/L) specified by WHO (White, Falkland, & Fatai, 2009). The cause of the high concentration is not clear but may originate from metals in buildings and fuel.

SALINITY

The salinity levels within the Mataki'eua/Tongamai wellfield were estimated in 2012 as shown in Table 3–6 (Government of Tonga, 2012). The salinity level is increasing reflecting a higher pumping rate. It also showed a lack of maintenance in purging the wells to clear salinity residues. It is important to note that this salinity level ties to the wellfield and the increased levels may be caused by the salinity residues in the wells. This may not mean that the groundwater system has the same salinity level. This also means that the salinity in the groundwater system due to seawater intrusion is not included in the above figure.

The distribution of groundwater salinity in 2009 for Tongatapu is similar to that mapped in 1990. With no initiatives to counter salinity issues in the groundwater, it is possible that salinity levels are still increasing. Water supply projects for the most saline areas and monitoring of their salinity should be of the highest priority. Where possible, water sourced from wells in areas with lower salinity groundwater should be used for supply. The salinity of groundwater increases during droughts which are mostly related to El Niño events (White, Falkland, & Fatai, 2009).

TABLE 3–5 Mean concentration of heavy metals

Trace Metal	WHO (2006) Guideline Value (ug/L)	Mean Concentration (ug/L)		
		8th Feb 06	11th Feb 06	31st Jul 07
Arsenic	10	<Limit of Detection (LoD)	8	2
Cadmium	3	<LoD	0.4	0.2
Chromium	50	2.3	5.4	2.7
Copper	2,000	4.2	13	6.2
Iron	None	444	4,077	621
Lead	10	56	108	105
Manganese	400	21	197	116
Mercury	6	<LoD	<LoD	<LoD
Nickel	70	<LoD	6.5	1.3
Zinc	None	145	203	167

TABLE 3–6 Estimate pumping rates and mean ecs at mataki'eua- Tongamai wellfield

Year	No. Pumps Operating	Pumping Rate (L/sec)	Pumping Rate (ML/day)	Estimated Log Mean EC (µS/cm)
1966	5	15	1.30	646
1968	6	18	1.56	670
1971	8	24	2.07	825
1991	20	60	5.30	917
1995	22	66	5.80	1,259
1998	26	78	6.80	1,175
2007	31	93	8.04	1,231
2011	34	120	10.41	996

Sea level rise will cause seawater intrusion. Salinity caused by seawater intrusion due to sea levels rising has been quantified to maps (Government of Tonga, 2018). The JNAP2 provides a groundwater salinity map for Tongatapu, Ha'apai and Vava'u. The low-lying area at the western side of Tongatapu and Talafo'ou have higher salinity as indicated by the red colour. The freshest groundwater, shown in green, occurs around Pelehake and Fua'amotu area due to being located inland and on higher ground, respectively. Similar results are observed for Vava'u and Ha'apai where only low-lying areas have higher salinity levels.

Salinity levels of groundwater in Lifuka, Ha'apai were found to increase between Jan 2011 and Dec 2012 and also correlated to rainfall. It was also found that the permeable geology of the island is ineffective in constraining the freshwater from tidal mixing. Increasing salinity in the groundwater resource resulting from over-extraction, as well as natural effects such as reduced rainfall during extended dry periods, poses a real threat to groundwater quality for the community of Lifuka (SPC, 2014). There is no recent data available in 2018 to assess the level of salinity.

IMPACT

Sea level rise caused seawater intrusion resulting in higher salinity levels of the groundwater reservoirs located in low-lying areas. Lack of effective institutional rules and management have led to inappropriate practices that affect groundwater quality.

RESPONSE AND RECOMMENDATIONS

Different studies have identified salinity issues mainly caused by seawater intrusion and excessive pumping from wells at Mataki'eua. Seawater intrusion requires urgent attention to reduce salinity levels. Supplementing Mataki'eua supplies with water from low salinity wells has been recommended. This report recommends:

- Purge the wells at Mataki'eua to clear salt residues on a regular basis.
- The area in low-lying areas in Tongatapu to connect to a municipal water treatment plant located on higher ground such as Mataki'eua.
- A second water resource treatment plant should be in Fua'amotu and use gravity to convey treated water to low-lying areas such as Talafo'ou, Makaunga and Manuka.
- Continuous monitoring of water quality parameters to be conducted by an assigned government agency.
- Reduce the residential urbanisation of the groundwater recharge areas.
- Groundwater extraction in Tonga should be licensed.

SOURCES

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Velde, M. v., Green, S., Vanclooster, M., & Clothier, B. (2007). Sustainable development in small island developing states: Agricultural intensification, economic development, and freshwater resources management on the coral atoll of Tongatapu. *Ecological Economics 61*, 456–468.

White, I., Falkland, T., & Fatai, T. (2009). *Vulnerability of Groundwater in Tongatapu, Kingdom of Tonga* . Canberra, Australia: Australian National University.

INFRASTRUCTURE

The status of the infrastructure indicates the ability of a water system to meet water demand by delivering treated and clean water to users. Treatment plants and transmission lines play vital roles in ensuring consumers receive drinking water that meets drinking water standards.

Status
Poor

Trend
Unknown

Data confidence
Medium

SDG	CBD
6 CLEAN WATER AND SANITATION	14

Status: Poor Trend: Unknown Data Confidence: Medium

FIGURE 3–12 Leaked pipe repaired with bicycle tubing

STATUS AND TREND DISCUSSION

Infrastructure issues have always been big problems. Much of the good quality groundwater is lost through pipeline leakage into the polluted and tidal affected groundwater in Nuku'alofa where it discharges into the lagoon and ocean. Village-managed water systems often suffer from lack of resources as indicated by the use of bicycle tubing to repair leaked pipes in Figure 3–12 (White, Falkland, & Fatai, 2009). Lack of maintenance on Mataki'eua has led to longer pumping times. Lack of maintenance on transmission lines has caused leakage losses in the reticulation system. While the leakages are believed to be substantial, there is no adequate data to estimate the exact losses due to failed meters in the system (White, Falkland, & Fatai, 2009).

These losses require urgent attention and work (White, Falkland, & Fatai, 2009). It is believed that little work had been put into addressing losses in transmission lines. Groundwater salinity mapping of groundwater in village wells showed seawater intrusion causes increased groundwater salinity in the Hihifo, Lapaha, Kolonga and Mu'a villages. The water supply problems in the Hihifo region need to be addressed urgently because of its low-lying elevation to prevent seawater intrusion. The freshest groundwater comes from the area around Pelehake and Fua'amotu and should be considered as a future water supply source, particularly in droughts. It should also be considered as a new water resource for a different municipal system to serve the eastern side of the country.

IMPACT

Ineffective infrastructure causes water losses and higher costs. Outer villages are being forced to establish their own water supply system without treatment. Little to no viable knowledge has been obtained into water supplies in other islands.

RESPONSE AND RECOMMENDATIONS

It has been recommended to fix the leaks in the water transmission line for Mataki'eua. Outer villages face the same problems. This report recommends:

- Supplement the water at Mataki'eua from the Fua'amotu wells through a new pipeline with a booster pump system.
- Regular maintenance of the reticulation system is required.
- Trained staff tasked with maintaining the village water systems should be provided by the Tonga Water Board Authority.
- Review the price of water to ensure enough funds for maintenance and upgrading.
- Water balance model is required to account for the supply, demand and losses.

SOURCES

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Overview

This land and planning chapter outlines the key areas of geology, soils and vegetation, agriculture and forestry, and land use and planning. The Ministry of Lands, Survey & Natural Resources, and the Ministry of Agriculture, Forestry, Food and Fisheries, are the main departments in charge of the regulation and health of land. There are a number of regulations e.g. Forests Act (2016), Land Act (2016), National Spatial Planning and Management Act (2016) and the Noxious Weeds Act (2016) that provide a framework for the monitoring and regulation of these sectors. Much of the policy highlights areas that require improvement and opportunities rather than preventing the issues associated with importing foreign plant species, deforestation, and adequate planning controls and measures to limit or prevent disasters.

Source: Rev. Saimonita Paongo, 2018

LAND HIGHLIGHTS

KEY AREAS	CURRENT STATUS	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
FOREST COVER	 **Status** Poor **Trend** Deteriorating **Data confidence** Low	Scrub areas dominate the land coverage with only 370 ha in forest cover	Increase forest coverage area in scrub land. Continue initiatives to grow mangroves. Establish government initiatives to grow native plant species such as Heilala and Ahi.
AGRICULTURE LAND	 **Status** Poor **Trend** Deteriorating **Data confidence** Low	Native forests have been cleared for squash agriculture in the early 1990s and to accommodate increased population through urbanisation. The current practice of farming Kava is also contributing to clearing land with native plant species. Little effort has been done to grow some of the native plant species that are near extinction such as Ahi and Heilala.	Forest areas should be declared under legislation as national reserve rather than purely relying on landowners to protect them. Plant native species.
LAND USE AND PLANNING	 **Status** Poor **Trend** Unknown **Data confidence** Medium	Lack of proper land management is still heavily influenced by chiefly land management. Unsustainable land reclamation has significant environmental impacts on coastal areas and on those who live there.	Introduce a proper zoning policy to allow adequate urban planning. Legislation is required to urgently stop land reclamation in coastal areas. Provide esplanade reserves on coastal area, 10m inland from the mean high-water level.

FOREST COVER

Forest cover or tree cover is a globally recognised measure of the area of intact forest tracked over time. This indicator is a proxy for the state of forests and the suite of environmental values associated with them.

Status
Poor

Trend
Deteriorating

Data confidence
Low

SDG	CBD
15 LIFE ON LAND	5

Status: Poor Trend: Deteriorating Data Confidence: Low

STATUS AND TREND DISCUSSION

Changes in forest cover over time have not been measured by the Tongan Government nor through Global Forest Watch (https://globalforestwatch.org). Only about 4000 ha of natural hardwood forest remains in Tonga, mostly on uninhabited islands, and steep or otherwise inaccessible areas (FAO, 2016). This total includes 1000 ha of forest on Ha'apai Island and 450 ha in the 'Eua National Park on 'Eua Island (FAO, 2016). Only 21 hectares of degraded forest remain on Tongatapu at the Toloa Rainforest Reserve Figure 3–13. Forest types in Tonga include mangrove and coastal swamps, coastal and littoral forest, tropical lowland and upland rainforest, and tropical lowland and secondary forest (FAO, 2016). Secondary forest, the result of previous land clearing or cyclone disturbance, is the dominant forest type in Tonga and comprises a mix of native and introduced plant species (FAO, 2016).

In the Vava'u group forest cover has declined over the last few centuries from nearly 100% to about 10% (Atherton et al. 2014). Remnants of mature forest are still present in some areas that are too steep or rocky for cultivation, including steep coastal slopes and inland scarps and knolls, and on some of the smaller cliff bound islands (e.g. Kitu, Kulo and Luamoko) (Atherton et al. 2014). Areas of mature native forest have also persisted on some of the small, low, southern islands (e.g. Maninita and Taula), and in some more gently sloping parts of 'Uta Vava'u, including coastal terraces and beach flats in the vicinity of Utula'aina Point and Vai-utu-kakau (Atherton et al, 2014).

As per the spatial data provided by the GIS Division, only 6,754 ha of Tongatapu is classified as forest (woodland). Toloa forest has been protected to allow rejuvenation.

FIGURE 3–13 Protected forest of toloa (Atherton, McKenna, & Wheatley, 2014)

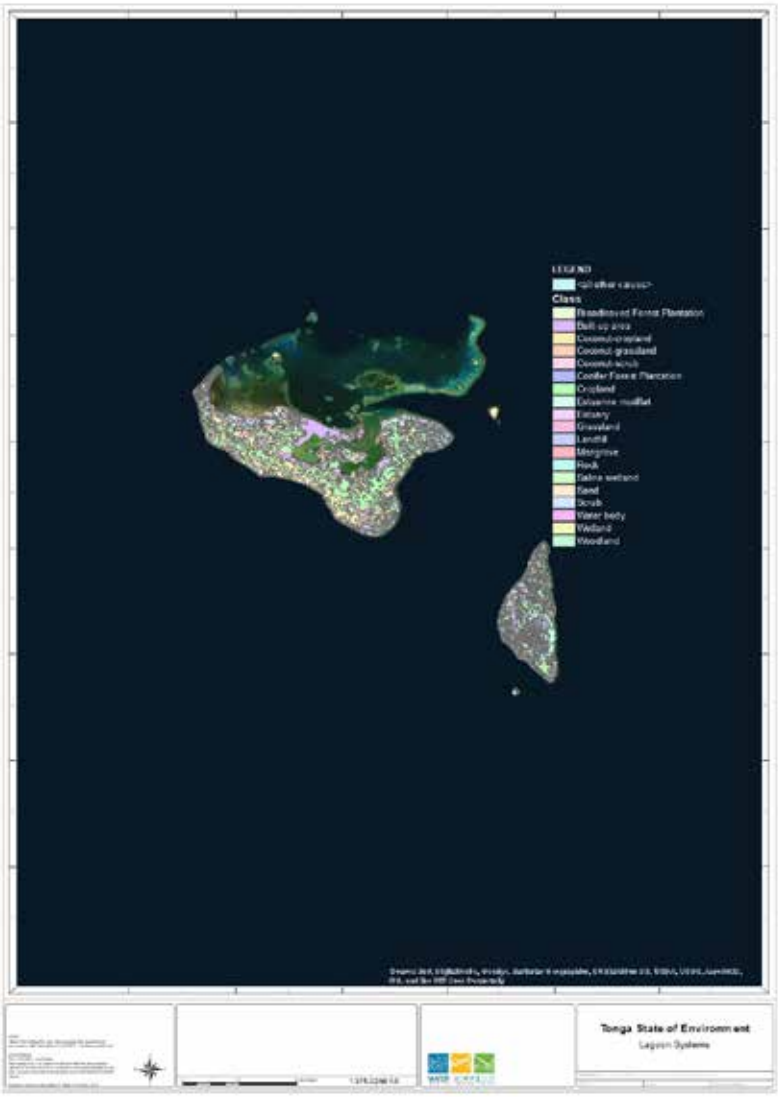


FIGURE 3–14 Forest Cover in Tongatapu and ‘Eua

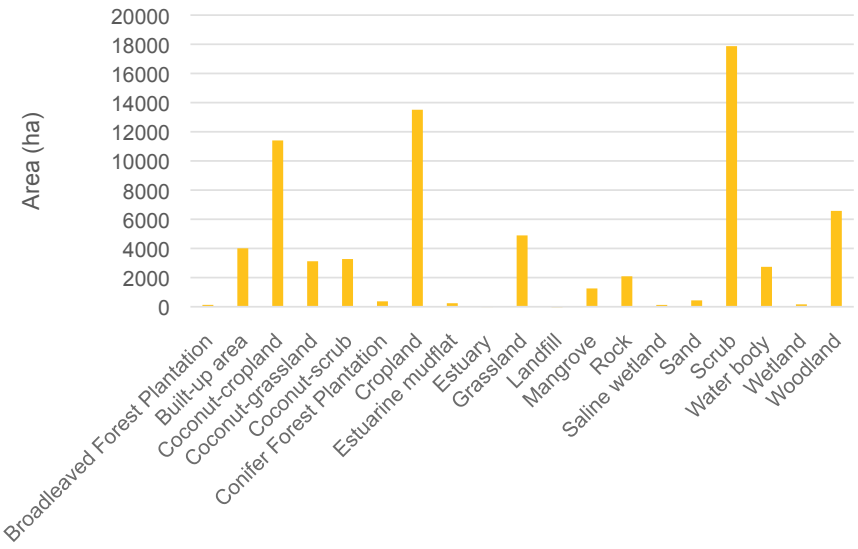


FIGURE 3–15 Areas of land use including forest cover for Tonga

TABLE 3–7 Land use area for Tonga (gis division)

Coverage Type	Area (ha)
Broadleaved Forest Plantation	129.80
Built-up area	4008.26
Coconut-cropland	11405.25
Coconut-grassland	3120.39
Coconut-scrub	3272.76
Conifer Forest Plantation	371.69
Cropland	13510.22
Estuarine mudflat	242.03
Estuary	16.88
Grassland	4892.76
Landfill	4.32
Mangrove	1255.85
Rock	2088.64
Saline wetland	126.49
Sand	437.22
Scrub	17872.13
Water body	2737.62
Wetland	165.36
Woodland (Forest Cover)	6574.37

IMPACT

Reduction in forest cover is associated with a range of environmental issues, including biodiversity loss, decline in threatened and culturally significant species, increase in the spread of invasive species, loss of carbon sequestration, erosion, and reduced resilience to the impacts of climate change. Coastal forest plays an important role in reducing salt damage to crops and other forest vegetation.

RESPONSE AND RECOMMENDATIONS

Tonga's remaining forests require immediate protection through the establishment of a strategic reserve system through the Parks and Reserves Act. All substantial areas of forest should be protected as national parks and reserves and ideally managed for conservation by local land owners.

The Vava'u Rapid Biodiversity Assessment recommended that all remaining patches of forest >10 ha in size in the Vava'u group be protected (Atherton et al. 2014). Eight sites totalling >448 ha of high conservation value forest was listed as the highest priority areas for protection and conservation management. Although some of these sites have existing protection (e.g. Mt Talau National Park), they have not been formally gazetted and are not managed for conservation.

This report recommends:

- Preserve natural forest in all the islands.
- Increase the forest area at Tupou College and other identified forest rehabilitation programmes already in place.
- Replanting programme on identified areas to rejuvenate forest.
- Provide the responsible Ministry with the power and legislation to stop and fine illegal activities such as land reclamation in coastal areas.
- Continue initiatives to grow mangroves.
- Establish government initiatives to grow native plant species such as Heilala and Ahi.

SOURCES

Atherton, J.N., McKenna, S.A, and Wheatley, A. 2014. Rapid biodiversity assessment of the Vava'u Archipelago, Kingdom of Tonga. SPREP, Apia, Samoa.

FAO. 2016. Forests and Forestry Sector, Tonga. Available http://www.fao.org/forestry/country/57478/en/ton/ (accessed 8/11/2018).

AGRICULTURE LAND

Agriculture is an important component of Tonga's economy however there are environmental issues associated with this sector. This indicator tracks the portion of Tonga's land area used for agriculture, including for crops and livestock.

Status
Poor

Trend
Deteriorating

Data confidence
Low

SDG	CBD
15 LIFE ON LAND	15

Status: Poor Trend: Deteriorating Data Confidence: Low

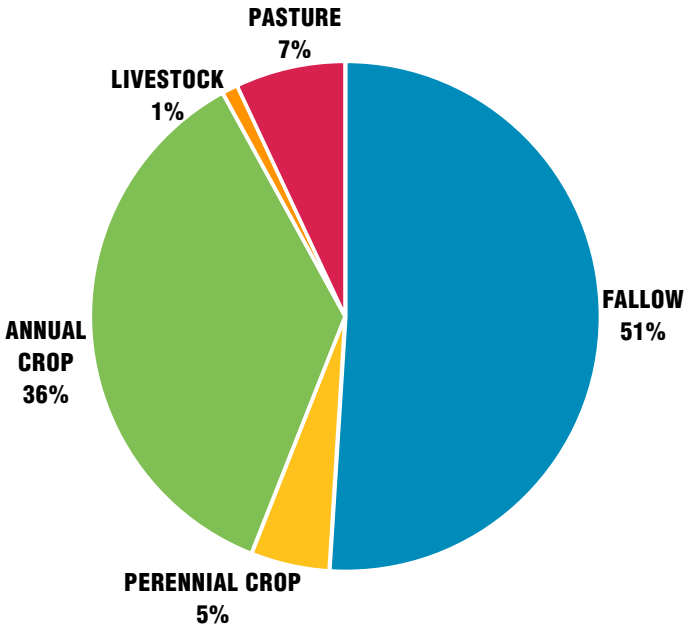


FIGURE 3–16 Breakdown of agriculture land uses in Tonga (MAFFF 2015).

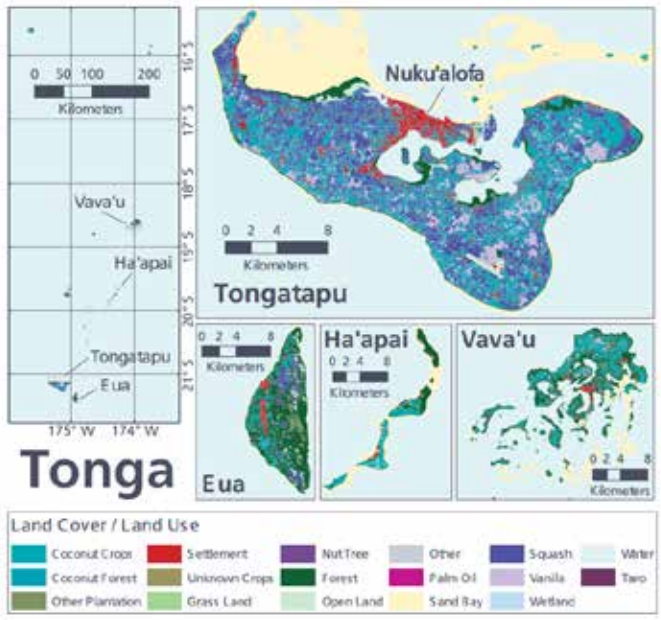


FIGURE 3–17 Land Use Maps of Tonga (Department Of Lands).

STATUS AND TREND DISCUSSION

Agriculture is the dominant economic activity in Tonga, although its relative importance has declined in recent years. The sector's contribution to GDP declined from 26% in 2004–2005 to about 19% in 2009–2010; it further declined to 18% in 2013–2014 (MAFFF 2015).

In 2015, Tonga's total land area under cultivation was 57,713 acres. Annual and perennial crop cultivation comprised 27,206 acres of agricultural land (MAFFF 2015). This represented 47% of the total cultivated land area. The total area of croplands in Tonga in 2001 was reported as 62,000 acres (Kingdom of Tonga 2001), thus there may have been a decline in cultivated area over the intervening period. In 2015 Cassava (manioke) was the largest annual crop cultivated, occupying 10,207 acres (18% of the total cultivated land area). Other crops included yam (ufi) (5,315 acres); yautia (talo futuna) (2,565 acres); sweet potato (kumala) (1,901 acres), and swamp taro (talo Tonga) (1,627 acres)(Figure 3–18). Kava plantations (1,257 acres); mulberry (757 acres) and vanilla (632 acres) were the largest perennial crops cultivated in 2015 (MAFFF 2015).

In 2015 the majority of households in Tonga continued to engage in agriculture, with over 80% or 13,944 households and organisations engaged in one or more activities, namely cropping, livestock, fisheries, handicrafts and forestry (MAFFF 2015). The main purpose of household engagement in agriculture continued to be subsistence and semi-subsistence. Overall, about five per cent of the households engaged in commercial agriculture while 95% engaged in subsistence and semi-subsistence activities.

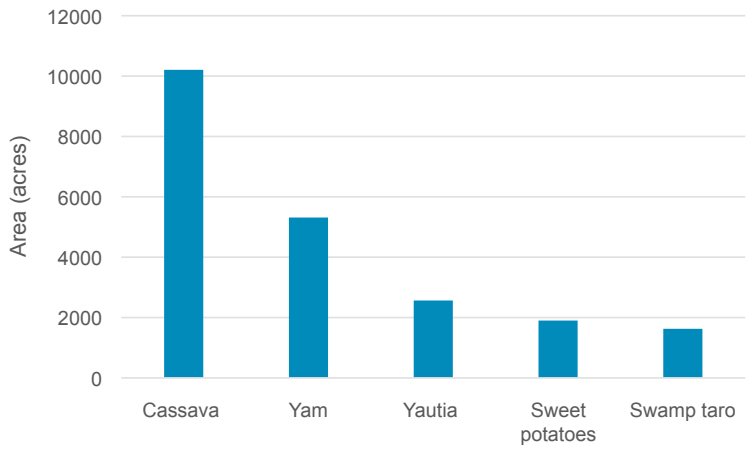


FIGURE 3–18 Dominant Perennial Crops in Tonga 2015 (MAFFF 2015).

Agricultural land continued to be dominated by fallow land with over 50% fallow in 2015. The main reasons for land not being cultivated were land owners who have migrated overseas or land left fallow due to customary or cultural reasons.

IMPACT

The impacts which have negative effects on the agriculture sector include less food being produced locally, more imported food, and loss of traditional agricultural practices. These are the effects of rapid development in the main urban centres, as well as climate change (particularly changing rainfall patterns, drying out of soil and water lenses, and saltwater intrusion). All these factors add to poor soil fertility and loss of land for farming. Reduced agricultural output is also affected by globalisation. For example, the relatively low price of imported food, and the challenges of transporting locally produced crops, makes it harder for local farmers to market their produce. Agriculture itself is associated with a suite of environmental problems including deforestation, pollutants associated with fertilisers and chemicals, faecal contamination of surface and groundwater, and establishment of new weeds.

RESPONSE AND RECOMMENDATIONS

Reccomendations include:

- Monitor land area for each main crop type annuall.
- Protect native forests under national law and international agreements.
- Strengthen replanting programme for plant species nearing extinction.

SOURCES

Kingdom of Tonga (2001). Agriculture census 2001. Ministry of Agriculture and Forestry, Statistics Department, Tonga.

Kingdom of Tonga (2015). Tonga National Agricultural Census 2015. Ministry of Agriculture, Forestry, Food and Fisheries, Tonga Statistics Department, and Food and Agriculture Organization of the United Nations.

LAND USE AND PLANNING

This indicator identifies the effectiveness of land use and planning on the environment of Tonga.

Status
Poor

Trend
Deteriorating

Data confidence
Low

SDG	CBD
	

Status: Poor Trend: Unknown Data Confidence: Low

STATUS AND TREND DISCUSSION

Land use and planning has evolved throughout the Pacific. Economic individualism has been prevalent throughout Tonga alongside individual ownership over customary lands (Connell & Lea, 2002). Urban land for public purposes has in the past been scarce due to unwillingness to exercise Crown Law legal rights to acquire additional customary or individual land for municipal purposes.

Unfortunately working through traditional avenues does not provide an effective option as chiefly systems, which were previously so important for land allocations, have diminished, resulting in pressures on the small amounts of land existing and the opportunity to redevelop for community purposes. This has necessitated the reclamation of land on the urban fringes, lagoons and marine shelfs for public use rather than expropriating land from customary owners.

The land tenure system of Tonga is unique in the Pacific whereby unlike other regions, it does not simply provide for individual ownership but almost guarantees it. This system was largely enacted when there was ample space throughout the Kingdom but has now led to largescale clearing of indigenous vegetation, outlined above, and development on land that does not provide adequate protection. This lack of enforcement and proper zoning and planning has meant that where land is available it is being taken. Ultimately the Crown owns all land, with large estates being divided between nobles, but as the regulations do not exist it is difficult to see where proper planning can be (Connell & Lea, 2002).

The Land Act (2016) states *"All the land of the Kingdom is the property of the Crown" but reemphases the hereditary traditions according to the prescribed rules of succession. There are more in-depth regulations over leasing property and land-use, however these are known not to be adequately regulated and informal agreements are common. The National Spatial Planning and Management Act (2016) outlines broad objectives for land use, but no understanding of directions to achieve them. The objec*tives are:

- Provide for the fair, orderly economic and sustainable use, development and management of land including the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity;
- Enable land use and development planning and policy to be integrated with environmental, social, cultural, economic, conservation and resource management policies at national, regional, district, village and site-specific levels;
- Create an appropriate urban structure and form for the development of the Kingdom so as to provide equitable and orderly access to transportation, recreational, employment and other opportunities;
- Secure a pleasant, efficient and safe working, living and recreational environment for people in the Kingdom;
- Protect public utilities and other assets and enable the orderly provision and co-ordination of public utilities and other facilities for the benefit of the community;
- Balance the present and future interests of all persons; and
- Provide increased opportunity for public participation in planning and assessment.

Though these objectives are focused in the correct place the delegation and achievement has remained unseen. There are no zones, overlays or other planning controls or requirements for planning permits throughout Tonga. This prevents proper management of land use, proper regulations for development and inadequate guidelines for future construction activities. Planning zones and overlays provide regulations and limit illegal operations. In countries like Australia there are:

- Land Subject to Inundation Overlay
- Heritage Zones
- Environmental Significance Overlay

These three planning conventions, if implemented in Tonga, would help by:

- Preventing development in areas likely to be inundated by storm surges and flooding;
- Protecting traditional heritage sites by placing area codes to prevent development or regulate proper development, and
- Protect the unsolicited logging and clearing of forest and other habitats for indigenous flora and fauna.

The document Tonga *Climate Change Policy – A Resilient Tonga by 2035* outlines 'To fully mainstream the goal of a Resilient Tonga into government legislation, policies, and planning at all levels' and focuses on structural and social planning. However, it would be more important to focus on regulation and planning schemes as a bedrock for future development and social communication. Planning schemes (zones and overlays) allow a transparent outline for the community and develop an expectation, allowing government authorities to enforce regulation.

IMPACT

Lack of proper land management is still heavily influenced by chiefly land management. Unsustainable land reclamation has significant environmental impacts in coastal areas and on the lives of those who live there.

RESPONSE AND RECOMMENDATIONS

The establishment of the Land and Water Resources Management Bill (2016) would provide some stability in land use (The Government of Tonga, 2016). This report recommends:

- Introduce a proper zoning policy to allow adequate urban planning.
- Legislation is required to urgently stop land reclamation in coastal areas.
- Provide esplanade reserves in coastal area, 10 m inland from the mean high-water level.

SOURCES

Connell, J., & Lea, J. (2002). Urbanisation in the Island Pacific: Towards Sustainable Development. Routledge: Social Science.

The Government of Tonga. (2016). Land and Water Resources Management Bill 2016. Nuku'alofa, Tonga: The Government of Tonga.

THEME 4 COASTAL AND MARINE ENVIRONMENT

Overview

Similar to its neighbouring countries, Tonga's way of living and culture depends on its inland and ocean resources for food and economic development. Remote islands and rural communities are particularly reliant on agriculture and fisheries and many are highly vulnerable to extreme weather events. The fishing communities face challenges related to climate change such as erratic rainfall, extreme weather events, sea level rise, and loss of coral reefs from rising ocean temperatures, ocean acidification and local environmental degradation. In 2018, tropical cyclone Gita hit Tonga, mainly affecting Tongatapu and causing economic and physical losses estimated to be in the millions. It has been suggested that natural disasters cause average losses of US$15 million per year (4% of GDP) due to earthquakes and cyclones. Isolation and scale also mean that Tonga faces challenges in access to reliable markets due to high costs of transport and energy. About 15% of households own fishing gear and about 5% own a boat, or canoe (The Government of Tonga, 2015; Fisheries Division, 2015).

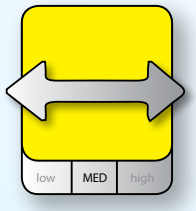
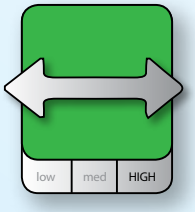
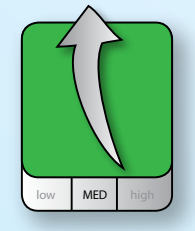
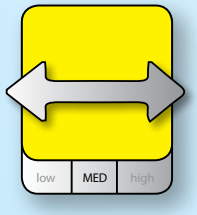
The state of the coastal and marine environment for Tonga is good and in an improving condition.

Tonga's Exclusive Economic Zone (EEZ) has a total area of about 700,000 km². There have been 38 species identified as pelagic fish to be found in both deep sea and coastal zones. Also recorded were 12 species of whales and six species of marine turtles. Humpback whales and bottlenose whales are considered endangered and together with hawksbill turtles are all protected under Tongan legislation. Other turtle species are fished seasonally with a minimum size specified. Snapper and grouper are susceptible to overfishing because they are sought after for export and may require some sustainable measure to be in place. Research suggests that tuna, sea turtles and other deepwater predators concentrate in hotspots, found at intermediate latitudes close to coral reef habitats, shelf breaks and seamounts. Coral reefs are common and widely distributed around the islands. Over-fishing and exploitation of the marine environment for aquariums is evident (Fisheries Division, 2015; Fisheries Division, 2015; Government of Tonga, 2017; Government of Tonga, 2017; Government of Tonga, 2015; The Kingdom of Tonga, 2010).

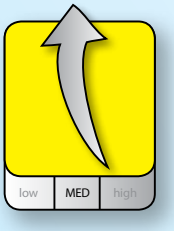
The state of the coastal and marine environment for Tonga is good and in an improving condition.

SPREP 2018

COASTAL AND MARINE ENVIRONMENT HIGHLIGHTS

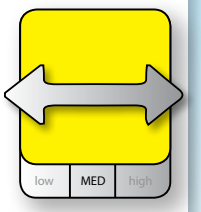
KEY AREAS	STATUS AND TREND	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
INSHORE FISHING	 **Status** Fair **Trend** Mixed **Data confidence** Medium	• Overfishing has reduced stock. • Different measures are in place to increase stock.	• Limit catches on Ha'apai Group. • Implementation of SMA.
OFFSHORE FISHING	 **Status** Good **Trend** Mixed **Data confidence** High	• Tuna stocks are currently stable in Tonga's EEZ. • Different measures are in place to increase stock.	• Tonga has set a precautionary limit of 8,000 tons (all tuna) and 50 vessels in the management plan (the current recommendation is for 16 licenses of which a maximum of 6 are foreign). • Tonga's NPOA shark-plan identified actions to reduce the impact of the longline industry on sharks and other by-catch, but the plan was released without a dedicated budget. • Regularly reviewing of different targets set out in plans is required.
SPECIAL MANAGEMENT AREA	 **Status** Good **Trend** Improving **Data confidence** Medium	• Increase in the number of SMAs. • Illegal fishing activities still occur in SMAs.	• Improve rules and regulations to define and implement SMAs. • This report recommends basing the selection of a SMA on scientific studies rather than purely relying on community consultations.
CORAL REEF HEALTH	 **Status** Fair **Trend** Mixed **Data confidence** Medium	• Over-exploitation of live rock and coral for export is evident. • Lack of species survey and monitoring in recent years.	• Implementation of different plans to guide the management of the reef systems in Tonga. • Different measures have been put in place including prohibitions on fishing, harvesting and exporting of marine aquarium species.

COASTAL AND MARINE ENVIRONMENT HIGHLIGHTS

KEY AREAS	STATUS AND TREND	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
LAGOON HEALTH	 **Status** Poor **Trend** Deteriorating **Data confidence** High	• The main lagoon with significant value to the Tongan people is Fanga'uta. • The lagoon health has declined since the early 1970s. • Illegal dumping of waste, leakage of raw sewage into the lagoon, unsustainable land reclamations and clearing of mangroves are the main sources of the lagoon's decline.	• Different studies have been conducted that resulted in formulating plans to manage the lagoon but unfortunately suffer from lack of resources. • This report recommends the formulation of key legislation, an Act that will govern the management and rehabilitation of the lagoon. . • The lagoon to be rehabilitated immediately based on rigorous modelling and design works.
COASTAL EROSION	 **Status** Fair **Trend** Improving **Data confidence** Medium	• Significant erosion caused by sea level rise, human activities such as unsustainable sand mining and land reclamation, and natural disasters such as cyclones.	• Engineering works have been conducted in different areas to stop erosion and allow sand replenishment. • Coastal protection has been set as a high priority under JNAP. • This report recommends continuous monitoring using GIS techniques based on LiDAR data. • It also recommends the establishment of a new Coastal Division to spearhead coastal protection efforts.

INSHORE

This indicator expresses the status of fishing around the coastal area primarily within 12 nautical miles of the coast in water depths to about 200 m.



Status
Fair

Trend
Mixed

Data confidence
Medium

SDG	CBD
14 LIFE BELOW WATER	

Status: Fair Trend: Stable Data Confidence: Medium

STATUS AND TREND DISCUSSION

A wide range of harvested species support subsistence livelihoods of local communities and small-scale commercial fisheries. Most of the inshore catch is harvested from the reefs and lagoons with only minor quantities of coastal pelagics caught. These fisheries are heavily exploited, and many are depleted with declines in fish density, biodiversity and size (Government of Tonga, 2015). The majority of Tonga's inshore catches were from the Ha'apai group followed by Tongatapu and Vava'u (Figure 3–19). The total catch changed from year to year with the maximum in 2014 in Ha'apai.

Assessing the catches by taxonomic family, the following main species were identified: Acanthuridae (Pacific Orange-Spine), carangidae (trevally), holothuroidae (sea cucumber) and scaridae (parrotfish). In case of the sea cucumber, overseas markets were available providing financial opportunities for both locals and commercial entities. Most of the catches occurred in 'O'ua, Felemea, and Ovaka (Figure 3–21).

Overfishing is the principal cause of depletion, though destructive practices (such as sand/coral mining, mangrove clearing, dynamite fishing) and pollution also contribute

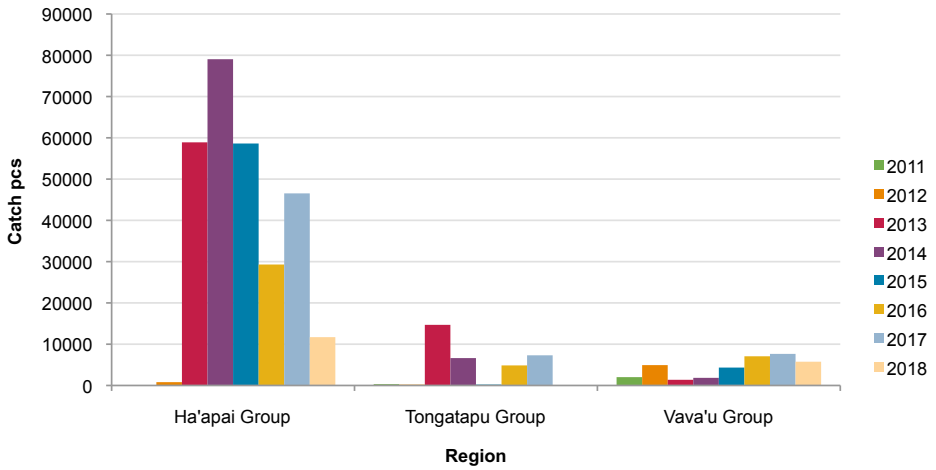


FIGURE 3–19 Total catch by region (Ministry of Fisheries)

to habitat degradation, leading to the decline in catches (Government of Tonga, 2015). A few commercial fisheries have virtually collapsed – sea cucumber and mullet – while some species are close to extinction: coconut crabs, devil clam (Government of Tonga, 2015). Giant clam, octopus and cockles form a significant part of the subsistence diet. The inshore finfish is declining in the Tongatapu market with fishing effort ranging further afield (Government of Tonga, 2015). Recently, there was a tripling of the amount of fish originating from Ha'apai between 1994 and 1995, highlighted in the dataset between 2011 and 2018 (Figure 3–21).

Fishing communities had no preferential access to adjacent resources but special management areas (SMAs) have recently been established to empower communities through establishing their own right-to-access zoning system adjacent to villages. Villages control access to their local fishery and can implement special zones (e.g. no-take zones) to allow fish stocks to recover for the benefit of the community. Special management areas would benefit from monitoring data to track the abundance of key fish, molluscs and other seafood types.

The fishing industry provides great benefits to Tonga. An estimation of the catches and nominal value for 1999, 2007 and 2014 show increases in key areas, such as aquaculture and offshore fishing on volume of catches Table 3–8. The coastal commercial and coastal subsistence are relatively stable in volume of catches but with significant increases in nominal values (Gillett, 2009). The increase in values are caused by market prices. The volume of catches are higher in 2018 due to greater reliance on the fishing industry.

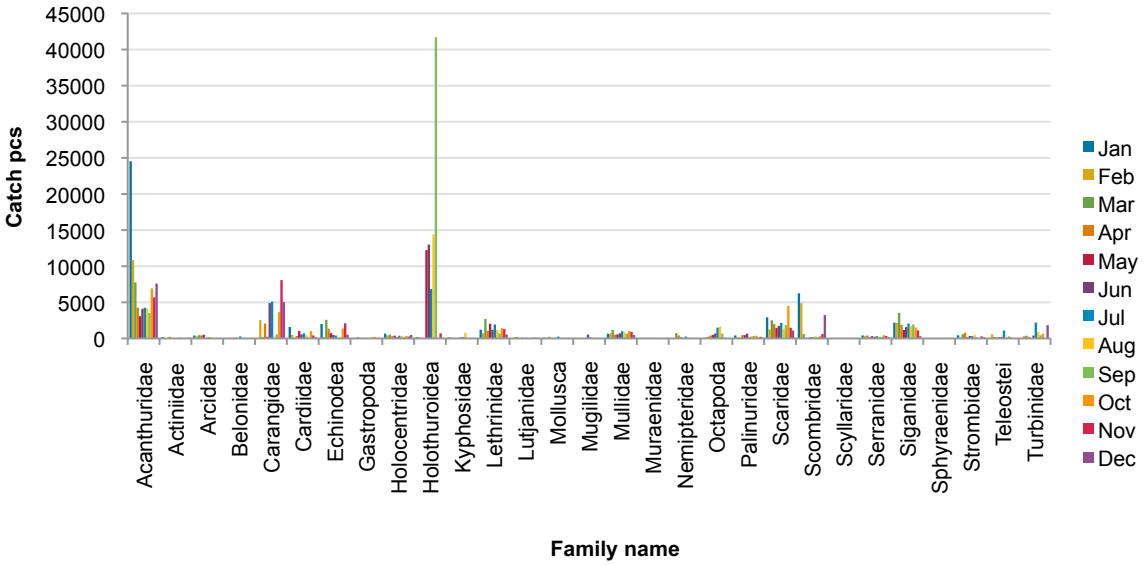


FIGURE 3–20 Total monthly catch pieces (Ministry of Fisheries)

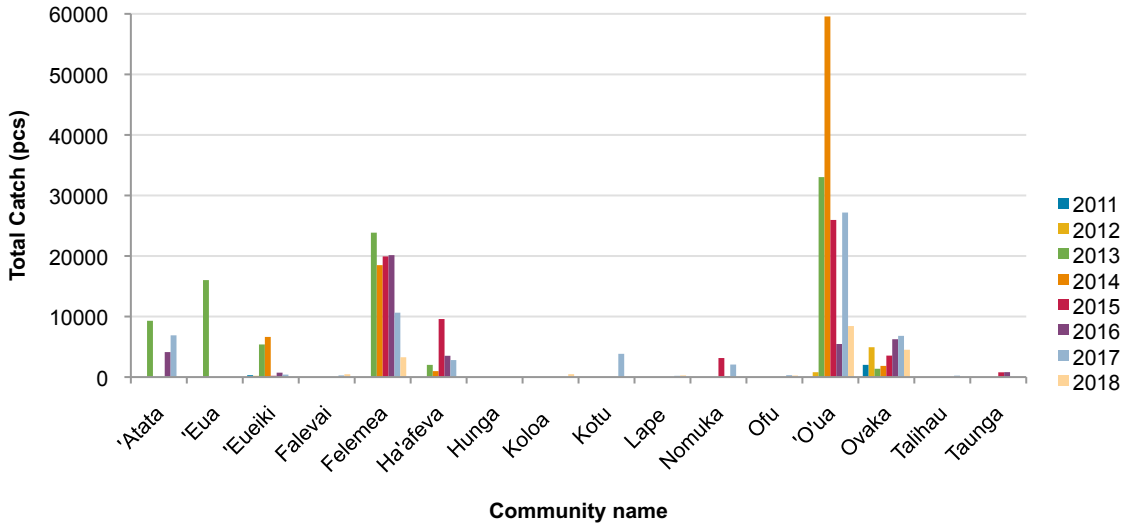


FIGURE 3–21 Total catch by community (Ministry of Fisheries)

TABLE 3–8 estimated by the benefish studies of annual fisheries/aguaculture harvests (Gillett, 2009)

Harvest Sector	Estimate Year	Volume (mt, and pcs where indicated)	Nominal Values
Offshore Locally Based	1999	800	5,880,000
	2007	1,119	6,224,625
	2014	1,363	7,770,000
Offshore Foreign Based	1999	45	166,000
	2007	0	0
	2014	1,891	9,408,000
Freshwater	1999	n/a	n/a
	2007	1	4,000
	2014	1	6,000
Aquaculture	1999	n/a	n/a
	2007	12,334	37,000
	2014	1,291 pcs	28,000

IMPACT

Inshore marine species support the livelihoods of local communities. This is more critical in outer islands affected by over-fishing, and the locals now travel further to catch fish that were more abundant in the past.

RESPONSE AND RECOMMENDATIONS

The implementation of the SMAs has had positive effects on the inshore marine environment. Other measures such as limiting catches on specific marine species have also produced good outcomes. This report recommends:

- Increase the number of SMAs to include all of Tonga's populated coastline.
- Localise the fishing in SMAs to the local communities.
- Collect baseline fish abundance data in SMAs to guide a monitoring programme.
- Limit the catch of specific species in the Ha'apai Group to allow rejuvenation.

SOURCES

Gillett, R. (2009). Fisheries in the Economies of Pacific Island Countries and Territories. Asian Development Bank.

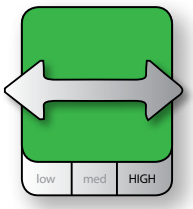
Government of Tonga. (2015). Tonga Fisheries Sector Plan 2016–2024. Nuku'alofa, Tonga: Government of Tonga.

OFFSHORE

Catch data is an important indicator of the health of pelagic and deepwater fish stocks. They provide measures of the state of fisheries and management, as well as the general state of commercial species and by-catch fish populations, including sharks.

Tuna fisheries production is an important factor in the state of the target migratory tuna stocks. The tuna fishery may also capture some important bycatch stocks including sharks and other species. This indicator addresses these two components of the offshore fishery:

- Tuna catch species (tonnes/year)
- Bycatch species number/year or tonnes/year



Status
Good

Trend
Mixed

Data confidence
High

SDG	CBD
14 LIFE BELOW WATER	6

Status: Good Trend: Stable Data Confidence: High

TUNA

Fresh tuna is Tonga's most valuable fish export and provides over US$1 million to the national economy (Government of Tonga 2016). The profitability of the local vessels relies heavily on the export of fresh fish and the size of the fishery is limited by the airline cargo capacity. The Tonga tuna fishery includes both a locally-based long-line fleet and a licensed foreign long-line fishery, the latter mainly targeting albacore (Government of Tonga 2016). Tonga's tuna catches have varied from a high of 1,548 tons in 2001 to 200–300 tons in recent years and catches were generally correlated with the active number of longline vessels (Figure 3–20). Catches from foreign-owned and based longline vessels within Tonga's EEZ have increased substantially in recent years; from 0 tons in 2009 to 2,766 tons in 2013 (Government of Tonga 2016). These vessels generally operate from bases in Fiji and American Samoa where they can access lower fuel prices and improved logistic support. Annual license revenues are around US$120,000 (Government of Tonga 2016).

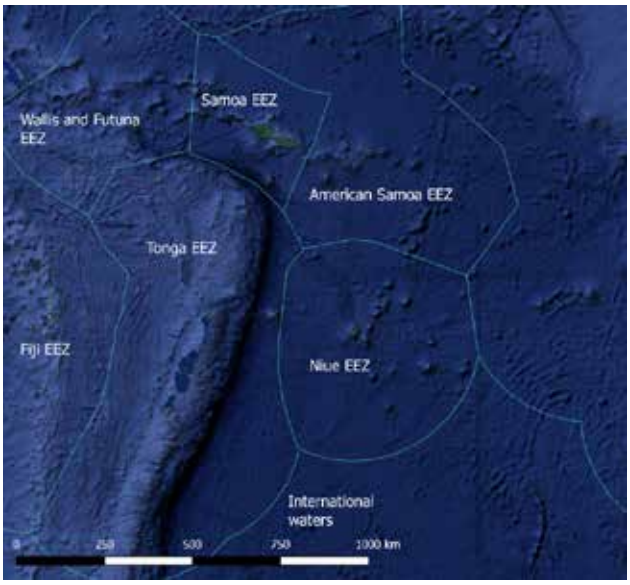


FIGURE 3–22 Location of the Tonga's EEZ in relation to neighbouring Pacific nations and International waters

While the state of regional Albacore tuna stocks in 2017 was determined as 'not overfished' (FFA 2017), ongoing reductions in catch per unit effort (CPUE) may indicate declining fish stocks (Hoyle 2011). This decline is perhaps reflected in the Tongan longline fishery data: Albacore catch has been low relative to the active fleet, particularly post-2008 (Figure 3–20). This observation was supported by the lower correlation between fleet size and Albacore catch (Spearman's rs = 0.626), compared with that of the other tuna species (Bigeye tuna rs = 0.886; Yellowfin tuna rs = 0.708). In 2017 regional Bigeye tuna stocks were determined as 'not overfished', however considerable uncertainty over stock estimates means that overfishing is possibly occurring (FFA 2017). Tongan longline catch data shows no evidence of Bigeye tuna decline in the Tongan EEZ, with low and stable catches (Figure 3–23). In contrast, the yellowfin tuna catch has increased in recent years while the fleet size has remained relatively stable (Figure 3–23), suggesting healthy stocks for this tuna species and/or increased targeting of this species (Tonga Fisheries Division/PIFFA, 2013). In 2017 regional Yellowfin tuna stocks were determined as not overfished, though it may be approaching the overfished threshold (FFA 2017).

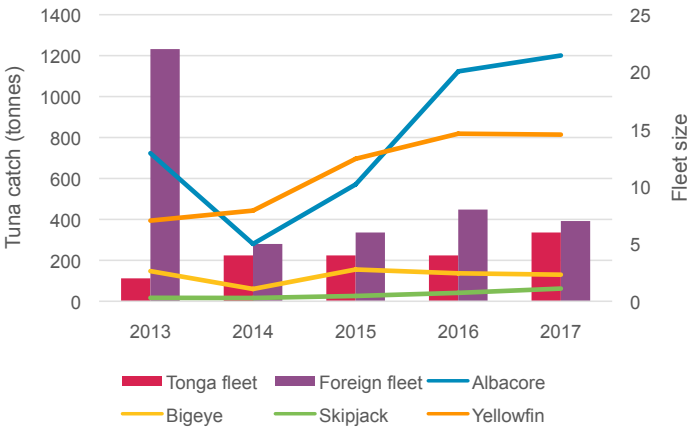


FIGURE 3–23 Annual Tongan longline tuna catch from 1982 to 2016 in Tonga's EEZ (Tuna Fishery Yearbook 2016).

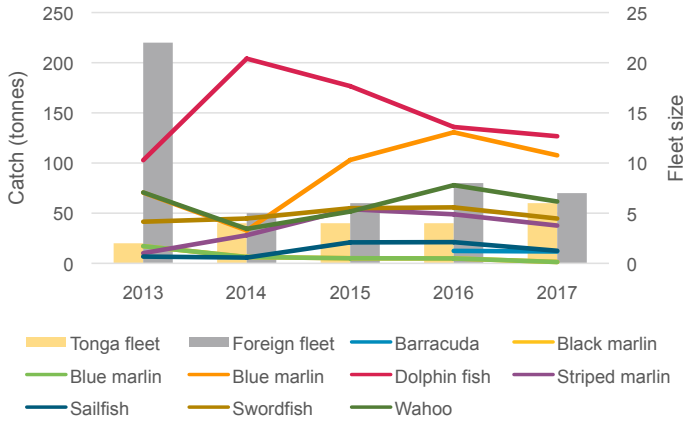


FIGURE 3–24 Annual Tongan longline billfish catch from 1982 to 2016 in Tonga's EEZ (Tuna Fishery Yearbook 2016)

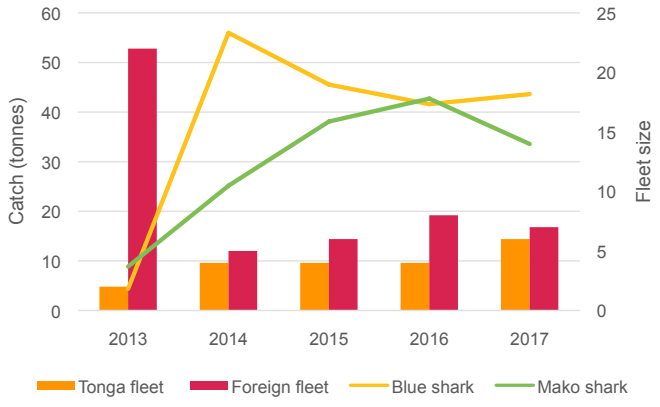


FIGURE 3–25 Annual Tongan longline by-catch from 2007 to 2012 in Tonga's EEZ (Kingdom of Tonga National Plan of Action (NPOA) Shark-Plan 2014–2016).

Tongan longline by-catch includes billfish, mahi-mahi and shark. None of the four species of billfish have evidence of declining capture rates (Figure 3–24). While shark data is limited there was a substantial increase in shark by-catch from 2011–2012 (Figure 3–22). Although shark species were not documented in the data, the by-catch included regionally overfished and IUCN red listed species such as Silky and Oceanic Whitetip sharks (WCPFC 2017). The 2007–2012 decline in Wahoo catch corresponded with the reduction in active fleet size over the same period (Figure 3–24).

The main markets for tuna exports from Tonga are Taiwan, Japan, US (Los Angeles, Hawaii), New Zealand and Australia. The products are exported as fresh chilled tuna. Albacore and bycatch are sold locally due to increase in local demand and lower international market prices. Licensed foreign vessels fishing in the Tonga EEZ land their catches mostly in Suva, Levuka and Pago Pago, but about 50% of the catch by foreign fishing vessels are unloaded in Nuku'alofa then repacked into shipping containers for export. This contributes to government revenue collection through a resource rent charge on exported marine product. As per the TMDP 2015–2017, the total estimated revenue collected from exports in 2013 declined to TOP$2,152,739 compared with TOP$4,376,283 in 2012 (Fisheries Division, 2015).

Tonga has a responsibility to fulfil its membership obligations to the Western Central Pacific Fisheries Commission (WCPFC). Tonga is required to implement conservation and management measures where appropriate. This will provide challenges, but the country is trying to comply with the measures by adopting different approaches as follows (Fisheries Division, 2015).

- Collection, provision of catch and data to meet its reporting requirements,
- For shark, operators shall ensure that tuna longline fishing vessels shall use circular hooks and maintain the 10% retention as stated in current terms and conditions (MTC) of the licenses.
- For turtles, seasonal closures, size limits and prohibited species, have been in place since 1994.
- For sea birds: use appropriate measures during the fishing session to protect sea birds
- Safeguarding the marine environment by prohibiting dumping, discarding or polluting the marine environment with chemicals or volatile substances.
- Other approaches adopted locally include licencing of fishing vessels before they start fishing. Local fleets must obtain longline fishing licenses.

DEEPWATER SNAPPER

Tonga's deepwater snapper fishery targets a multi-species assemblage of the families Lutjanidae (snappers), Lethrinidae (emperors) and Serranidae (groupers) (Ministry of Fisheries 2017). Drop line bottom fishing on Tonga's banks and seamounts occurs to depths ranging from 50 to 450 m (Government of Tonga 2016). Targeted fish species are bottom-dwelling carnivores that feed on benthic fishes and crustaceans (Ministry of Fisheries 2017). The life history traits of these species – longevity, slow-growing, low rates of natural mortality, large size at sexual maturity and spawning aggregations – renders them vulnerable to over-fishing and exploitation (Ministry of Fisheries 2017).

Collection of catch, effort and size frequency data began in 1986 but have not been collected consistently, often due to limited staff and funds (Ministry of Fisheries 2017). The establishment of the Fuel Concession in 2000 provided a mechanism for encouraging supply of quality log-sheet and offloading data from licensed fishers (Ministry of Fisheries 2017). Data collection systems were reviewed in 2004 and since then checking and validation mechanisms have been in place to ensure data quality and completeness. Accordingly, data collected from 2006 to 2016 are of high quality. Annual catches over this period were positively correlated with the number of fishing licenses (Spearman's rs = 0.616; Figure 3–23) and ranged from 46 to 173 tonnes. Catches are well below the precautionary maximum sustainable yield (MSY) of 250 tonnes per year (Government of Tonga 2016).

IMPACT

Over-fishing tuna and deepwater fish species could have social, economic and ecological impacts for Tonga. This is due to the importance of offshore fisheries to the economy and ecological roles of predatory fish (including sharks).

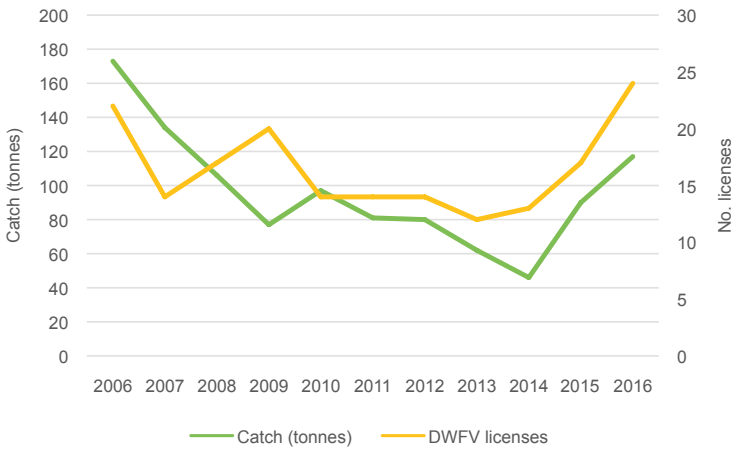


FIGURE 3–26 Annual Tongan deepwater snapper fishery catch from 2006 to 2016 in Tonga's EEZ (Tonga Deepwater Fishery Management Plan 2017–2019)

RESPONSE AND RECOMMENDATIONS

Tonga's tuna fishery is governed by the Fisheries Management Act 2002. Tonga is a member of the Central Pacific Fisheries Commission (WCPFC) and the country receives support from the Pacific Islands Forum Fisheries Agency (FFA) and other partners to implement the WCPFC measures. Tonga has set a precautionary limit of 8,000 tons (all tuna) and 50 vessels in the management plan (the current recommendation is for 16 licenses of which a maximum of 6 are foreign). Based on Tonga's longline catch data, tuna stocks are currently stable in Tonga's EEZ.

The substantial increase in shark by-catch in 2011–2012 is concerning and suggests that sharks were targeted (Tonga Fisheries Division/PIFFA 2013). Tonga's NPOA shark-plan identified actions to reduce the impact of the longline industry on sharks and other by-catch but the plan was released without a dedicated budget. It would be timely for Tonga Fisheries Division to review the status of actions in the plan.

Tonga's deepwater fishery is governed by the Fisheries Management Act 2002 and is guided by a current management plan which outlines strategies and indicators for maintaining an economically viable and sustainable industry (Ministry of Fisheries 2017). The plan includes a detailed implementation strategy and progress will be reported annually to the Ministry of Fisheries (Ministry of Fisheries 2017). Based on Tonga's deepwater fishery catch data, overall stocks are currently stable.

SOURCES

FFA. (2016). *Tuna Fisheries Report Card 2017.* Pacific Islands Forum Fisheries Agency, Solomon Islands.

Fisheries Division. (2015). *TONGA NATIONAL TUNA FISHERIES MANAGEMENT AND DEVELOPMENT PLAN (2015–2017) .* Nuku'alofa, Tonga: Ministry of Agriculture.

Government of Tonga. (2016). *Tonga Fisheries Sector Plan 2016–2024.* Government of Tonga, Tonga.

Government of Tonga. (2015). *Tonga Fisheries Sector Plan 2016–2024.* Nuku'alofa, Tonga: Government of Tonga

Hoyle, S. (2011). *Stock assessment of Albacore Tuna in the South Pacific Ocean.* Western and Central Pacific Fisheries Commission, Micronesia.

Ministry of Fisheries. (2017). *Tonga Deepwater Fishery Management Plan 2017–2019.* Nuku'alofa, Tonga: Ministry of Fisheries.

Tonga Fisheries Division. (2013). *Kingdom of Tonga National Plan of Actions – Shark Plan (2014–2016).* Nuku'alofa, Tonga: Tonga Fisheries Division and Pacific Islands Forum Fisheries Agency.

WCPFC. (2017). *Tuna Fishery Yearbook 2016.* Western and Central Pacific Fisheries Commission, New Caledonia.

SPECIAL MANAGEMENT AREA

The Special Management Area (SMA) is a key indicator that reflects the efforts given by the government agencies together with local fisheries communities to proclaim their interest, incentives to sustainably manage their resources and recognise that adequate community engagement is essential to effective management of these fisheries.

Status
Good

Trend
Improving

Data confidence
Medium

SDG	CBD
14 LIFE BELOW WATER	

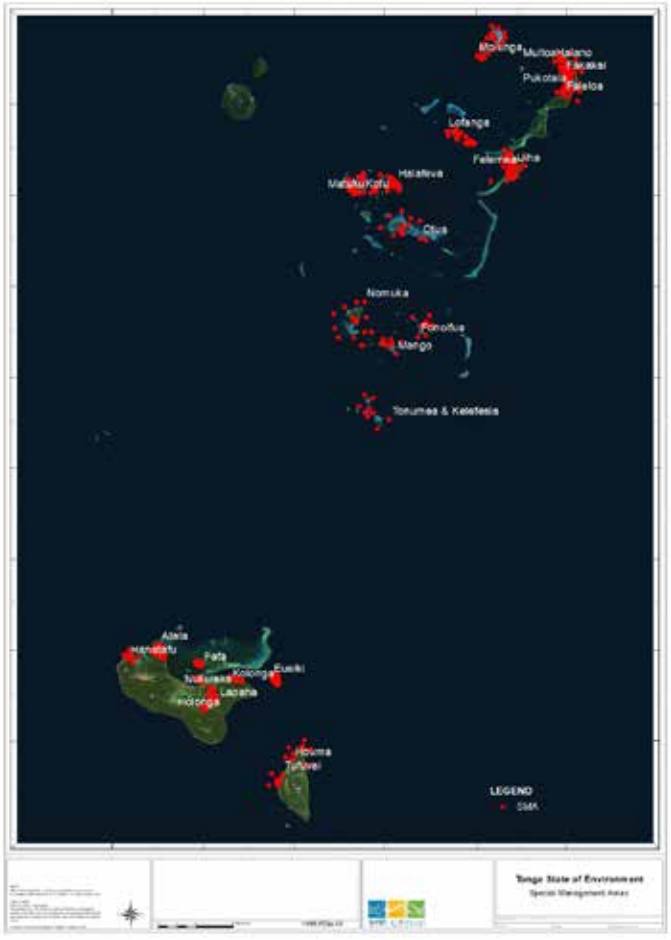


FIGURE 3–27 locations of special management areas (Ministry of Fisheries)

Status: Good Trend: Improving Data Confidence: Medium

STATUS AND TREND DISCUSSION

Different plans developed and implemented by the Tonga Fisheries assigned and approved Special Management Areas (SMAs), and work with the associated local communities in managing them (Tonga Fisheries Division, 2013; Government of Tonga, 2015; Fisheries Division, 2015). These areas are governed under different acts including the Fisheries Management Act 2002, where they are identified and allocated through a legal protocol that involves both the Fisheries Department and the subject community. These areas are restricted or completely prohibited for fishing activities to allow stock recovery. For instance, a longline vessel is not permitted to fish in designated closed areas within 12 nautical miles of any reef or island in the fisheries waters of Tonga, except if given a specific approval (Tonga Fisheries Division, 2013).

The SMAs have expanded since 2008 where four sites were established, and the current extent is shown in Figure 3–27. Most of these areas are located within the reef zones near the islands of Tonga. This mainly covers most of the coastal communities which helps to fully integrate with, and is complementary to, the marine parks network. This helps with the implementation of management plans for the inshore commercial fisheries. Several benefits have been observed such as no more trespassing of outsiders into SMAs and improved conservation of stocks.

There are challenges currently faced by the SMAs. Over-fishing is prevalent within SMAs on all species. There are inadequate rules adopted for rebuilding fish stocks as

communities market increasing proportions of their catches to generate cash income (Government of Tonga, 2015). Pressure from commercial fisheries can be too much for local communities to cope with. These issues highlight a need to develop non-fisheries economic opportunities to alleviate pressure on the SMAs and at the same time meet community financial demands. Other inshore fisheries such as octopus and anadara (cockles) need to be included in management plans. Monitoring is enforced by both the Department of Fisheries and communities but lack of resources (funds and staff) can hinder this work.

Despite the challenges, SMAs are considered a successful approach and with future expansion and more resources will improve its positive effects in the marine environment.

IMPACT

Positive outcomes in fish stocks have been realised since the introduction of the SMAs. The number of SMA sites has increased since 2008. Community engagements are vital for the success of the SMAs.

RESPONSE AND RECOMMENDATIONS

The government implemented different Acts and policies that guided the implementation of the SMAs. The Ministry of Fisheries has planned to increase SMAs with 60 more sites to be established by 2020.

This report recommends:

- The government provides alternative economic opportunities in other sectors (tourism and agriculture) to reduce the reliance of coastal communities on inshore fisheries, thus allowing the SMA stocks to replenish at faster rates.
- Strengthen the power and authority of the community to prosecute illegal fishing and activities conducted in the SMAs.
- Implement monitoring programmes to confirm the status of species in the SMAs and include species that are not currently included in the SMAs such as cockles.
- Provide the local community with adequate resources such as staff, boats and equipment to carry out SMA security surveillance and monitoring programmes.
- Base the allocation of SMAs on a more rigorous scientific research rather than selecting the SMAs based on community consultations.

SOURCES

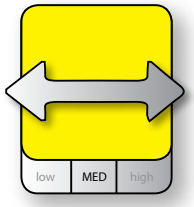
Fisheries Division, 2015. Tonga National Tuna Fisheries Management And Development Plan (2015–2017), Nuku'alofa, Tonga: Ministry of Agriculture.

Government of Tonga, 2015. Tonga Fisheries Sector Plan 2016–2024, Nuku'alofa, Tonga: Government of Tonga.

Tonga Fisheries Division, 2013. Kingdom of Tonga National Plan of Actions – Shark Plan (2014–2016), Nuku'alofa, Tonga: Tonga Fisheries Division and Pacific Islands Forum Fisheries Agency.

CORAL REEFS

Live coral reef cover is a useful indicator of the overall state of inshore reef ecosystems. Factors influencing trends in coral cover include land-use impacts and erosion, relative sea surface temperatures, presence of disease and predators like crown of thorns starfish, and mechanical damage from cyclones and other severe storms. Trends in live coral cover indicate the relative resiliency and health of coral ecosystems across selected sites. The lagoon reef ecosystem is a critical factor in an atoll environment where it provides shelter, protein and income for local communities.



Status
Fair

Trend
Mixed

Data confidence
Medium

SDG	CBD
14 LIFE BELOW WATER	

Status: Fair Trend: Stable Data Confidence: Medium

STATUS AND TREND DISCUSSION

Tonga has a coral reef area of 1,500 km^2 spread across 176 islands (Moritz et al. 2018). Coral reef resources are vitally important to Tonga for income and food security with a population comprised mostly of subsistence farmers and fisherman (Moritz et al. 2018). Coral reefs are widely distributed around all the islands (Figure 3–26) with the largest area in Tongatapu (Figure 3–37).

Live hard coral cover was monitored at 44 plots around Tongatapu between 2009–2015 (Figure 3–27; Moritz et al. 2018). The data shows an increasing trend in mean percentage coral cover between 2009–2013, before a marginal (~0.5%) decline in 2015. Based on the data, hard live coral cover was close to stable over this period.

Harvesting live rock (broken fragments of coral reefs which become habitat for other marine life) has increased since 2001 (Figure 3–28). The harvest rate has significantly declined in recent years (Figure 3–29) since a ban on removal and export of live rock by the Department of Fisheries in 2008. The Department of Fisheries also confirmed that while the harvest and export of live rocks has been banned, coral harvesting is still allowed. There are allocated harvesting areas but in recent years fisheries monitoring has suffered from resourcing shortages.

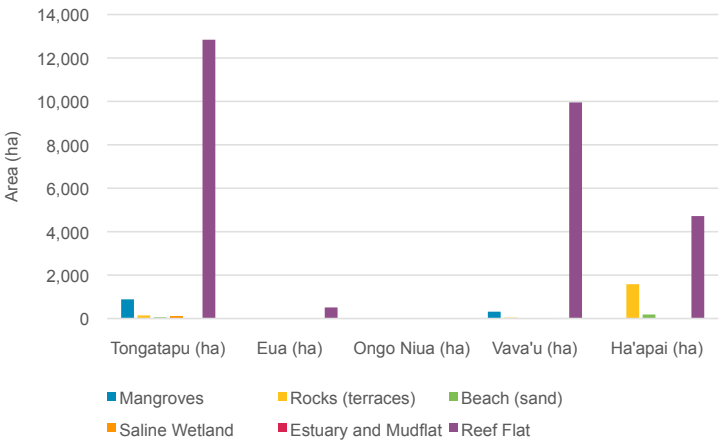


FIGURE 3–28 Coastal and Marine Ecosystem

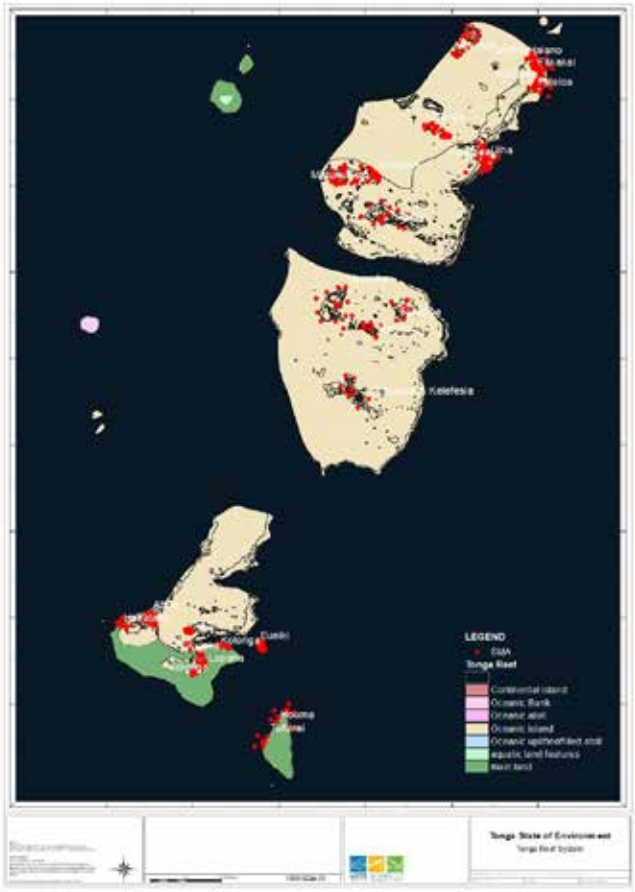


FIGURE 3–29 Reef system in Tonga (Ministry of Fisheries)

A management plan and specific regulations are in place and the future of this fishery lies in encouraging people to better manage aquarium species (Government of Tonga, 2017).

Two studies were conducted in the Vava'u Group in 2016 and 2018. Different sites were surveyed in each study. The 2016 studies found no evidence of bleaching events in the study sites. However, Crown of Thorns, a destructive predatory starfish, were found at three sites (MEIDECC, 2016).

In the 2018 study, average live coral cover and crustose coralline algae were observed at 34% across all sites and reef competitors such as macroalgae, cyanobacteria and turf algae were observed in all sites. The reef builders including live corals cover and crustose coralline algae were found to be higher in the harbour sites rather than sites at the outer oceans. Non-reef materials such as sand, dead corals, rocks and rubbles were also found to be abundant on the sites.

The two surveys provide snapshots of the health of the coral reef as well as a baseline. The findings indicate a concern due to large deposits of non-reef materials and the need for better monitoring.

IMPACT

Coral reef ecosystems support high levels of biodiversity and healthy reef ecosystems provide key ecosystem services, including fisheries.

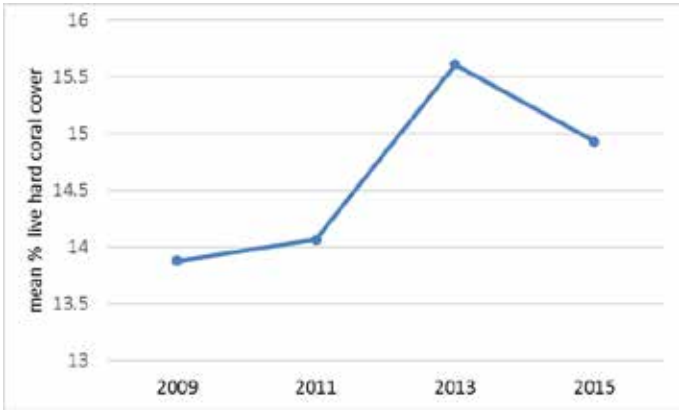


FIGURE 3–30 Mean % live coral cover from 44 plots in Tongatapu 2009–2015 (Moritz et al. 2018)

RESPONSE AND RECOMMENDATIONS

A key priority is to continue the coral cover monitoring around Tongatapu and potentially establish other monitoring sites across the other island groups.

The Government implemented different Acts and developed policies to guide the protection of coral reefs, mammals and marine aquarium species. These plans recommended different measures and prohibitions. This report recomends:

- Conduct marine aquarium species survey and stocktake every four years, similar to the survey conducted in 1996 and 2005. Species density to be recorded and status trend to be recorded in the new editions of the Review of Tonga National Biodiversity Strategy and Action Plan, and the Tonga Marine Aquarium Fishery Managements and Development Plan.

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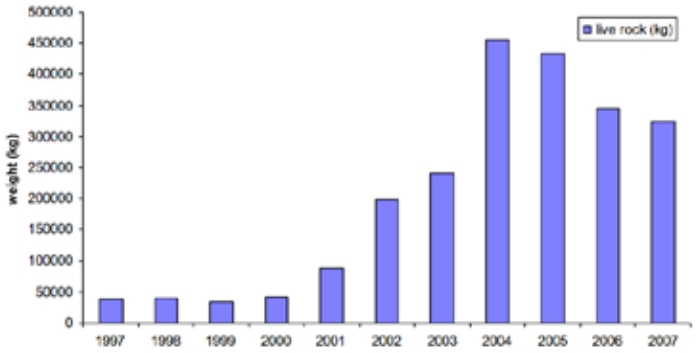

FIGURE 3–31 Total annual live rock harvest (Government of Tonga, 2017)

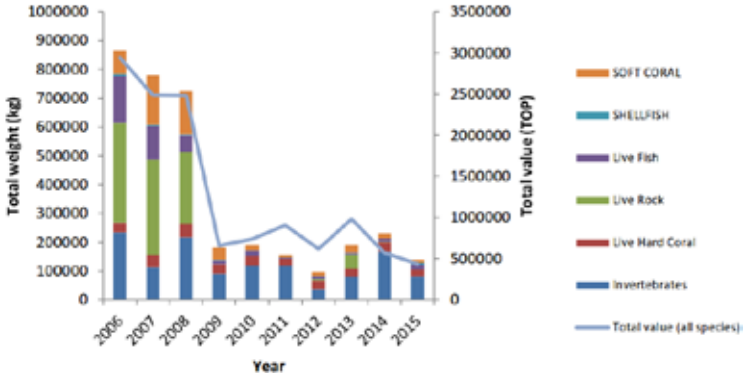

FIGURE 3–32 Total weight and value of exported aquarium species (Government of Tonga, 2017)

LAGOON AND LAKE HEALTH

Tonga contains two main lagoons in Tongatapu and one lake system in Niuafo'ou. These systems are significant natural assets for the people of Tonga. They provide food, storm protection, habitat, and recreation opportunities. Other swamp areas such as Sopu have not been rigorously assessed due to a lack of data. Lagoon and lake health is an important indicator of anthropogenic impacts on the marine environment.

Status
Poor

Trend
Deteriorating

Data confidence
High

SDG	CBD
14 LIFE BELOW WATER	

FIGURE 3–33 Tongatapu and Fanga'uta lagoons

Status: Poor Trend: Deteriorating Data Confidence: High

FANGA'UTA LAGOON

The Fanga'uta Lagoon Catchment includes much of the capital of Tonga, Nuku'alofa, and is home to 47,529 persons in 29 villages and 8,279 households (Aholahi et al. 2016). This accounts for 64% of the population of Tongatapu. The importance of this area and its value to people is not always considered on a day to day basis, by national planners or residents (Aholahi et al. 2016). Many of the communities within the lagoon area depend on the ecosystem services that the lagoon provides for their livelihood and wellbeing (Aholahi et al. 2016). The ecosystem of the lagoon consists of sheltered waters, mangroves, seagrass beds and reef patches. (Prescott, et al., 2001). The area is also important culturally as a place of beauty and enjoyment, and it has a rich archaeological history (Global Environment Facility, 2018).

In 1974, the lagoon was declared a marine reserve. Despite this, the health of the lagoon and its catchment has been in decline for some years, due to a combination of natural and human-induced environmental changes (Global Environment Facility, 2018). These changes include pollution from poorly-managed sewage and run-off from agriculture pesticides and fertilisers; waste dumped in or near the water; changes in tidal flows and water circulation; fragmented land-use decision-making; increased competition between competing land-use practices; increased fishing pressure; and unsustainable urban and agricultural practices that cause habitat loss

and degradation; and mangrove clearing and illegal land reclamation (Global Environment Facility, 2018). Fanga'uta lagoon is enclosed with a unique shallow entrance and only the tide generates a significant current in its vicinity. Its water circulation is complex as tide, wind and wave-induced currents have significant roles in water movement (SOPAC, 2008).

Water quality monitoring data was available for Fanga'uta lagoon to allow a comparison between 1999–2000 to 2015–2016 (Aholahi et al. 2016). Levels of dissolved oxygen and acidity were relatively stable between the two periods. While Nitrate (NO_3) levels declined dramatically over this period, and by 2016 were within Australian and New Zealand safe thresholds for recreation, the reduction of levels has not yet led to reversal of the symptoms of eutrophication, including algal overgrowth (Aholahi et al. 2016). Ammonia and phosphate levels have also declined to safe levels for recreation over the same period (Aholahi et al. 2016). In 2015, the level of coliform counted in different springs and wells showed significant readings (in 'Umusi, Halaleva, Havelu and Vaini, indicating excessive leakages of septic sewage into the lagoon (Figure 3–34; Pale and Sunia, 2015).

The apparent improvement in water quality was not observed in surveys of benthic (bottom-dwelling) animals and plants which have continued to decline, particularly since 2015 (Aholahi et al. 2016). Corals are virtually absent from the entire lagoon system and have remained so since 1998 (Aholahi et al. 2016). Average seagrass covers in all sections of the lagoon dropped to 4.5% in 2016, declining from a high of 29% in 1999 (Aholahi et al. 2016). Algae cover dropped to 13% in 2016 from a high of 25.5% in 1999 (Aholahi et al. 2016). At the same time, the amount of mud, sand, rubble and rock has increased and now covers 73% of the lagoon floor (Aholahi et al. 2016). That is, the cover of the lagoon floor is now mostly non-living sediments, showing that conditions in the lagoon are overall continuing to deteriorate (Aholahi et al. 2016).

The Tonga Ridge-to-Reef project, which started in 2014, has facilitated the development of the Fanga'uta Stewardship Plan, to replace the older Fanga'uta Lagoon Management Plan. The Stewardship Plan is a legal document gazetted under the Environment Act, but it does not only focus on environmental conservation – it is an integrated, local area management plan that provides a framework to guide decision-makers in achieving sustainable development of the catchment area, with focus on environmental risks and strengthen resilience. The plan provides mechanisms to improve compliance with existing national laws related to fisheries, waste management, environmental management and impact assessment, spatial planning, and the management of water resources. They allow stakeholders to recognise their role as guardians and stewards of natural resources in the lagoon and its catchment, and through which they commit to sustainable management of the resources within their care (Global Environment Facility, 2018).

Water quality and health

A study conducted in 1994 took water samples from different parts of the lagoon. The analyses were conducted for the water quality parameters: salinity, NO2-N, PO4-P, NH4-N, NO_3-N, Cr6+, CU, phenol and CN along with DO and pH. It was found that the inner western part of the lagoon water is brackish; salinity changes widely from place to place under the strong influence of water inflows from the land, and the water has been moderately eutrophicated (Panongo, 1994). Further study conducted between 1998–2000 found that the levels of nitrate, phosphate and faecal coliforms all exceeded the Australian Standards for seafood, recreational use, and risk of algal blooms in at least one time during the duration of the study

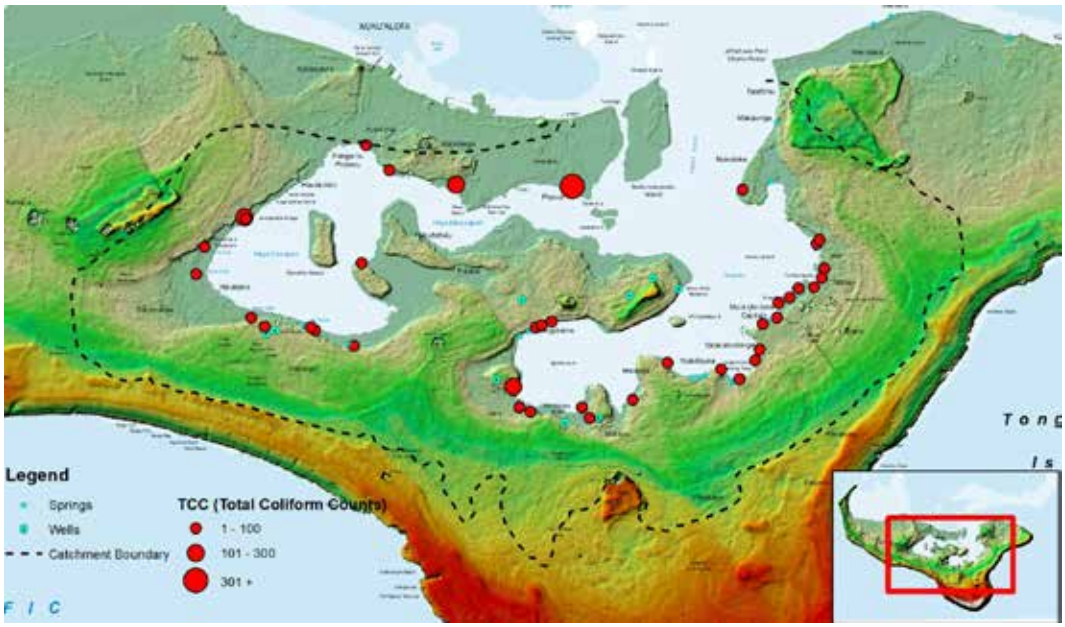

FIGURE 3–34 Coliform Counts from springs and wells In 2015 (Pale and Sunia, 2015)

(Fakatava, Lepa, & Matolo, 2000). In 2015, the levels of coliform counted in different springs and wells showed significant readings (Figure 3–34) in 'Umusi, Halaleva, Havelu and Vaini (Pale & Sunia, 2015). This indicates excessive leakages of septic sewage into the lagoon. No other recent water quality studies after 2015 were found but it is considered that the water quality of the lagoon has declined further due to illegal activities such as waste dumping and unsustainable land reclamation.

Mangroves

Mangroves perform significant ecosystem services by protecting shorelines from winds, waves and floods, preventing erosion and stabilising sediments with their complex dense root systems. They also provide water quality roles in filtering pollutants and sediments originating from upstream catchments. Mangroves are home to a large variety of fish, crab, shellfish and mollusc species.

FIGURE 3–35 Popua Mangrove loss of approximately 48.7%

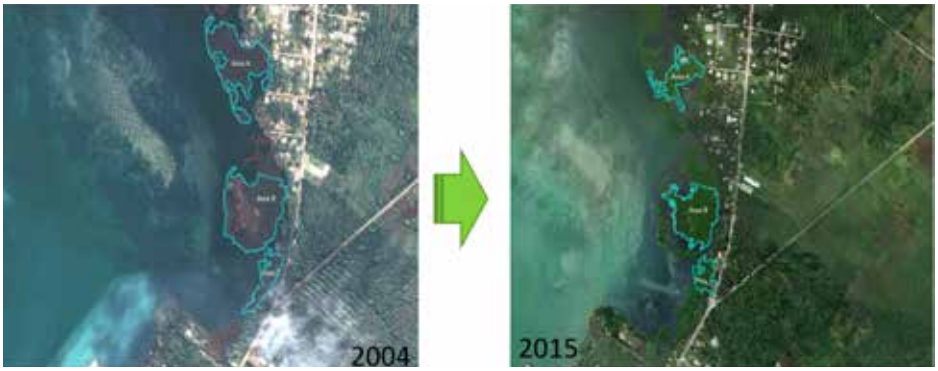

FIGURE 3–36 hoi mangrove loss of approximately 30.7%

FIGURE 3–37 nuku mangrove loss of approximately 35% in comparison to 2004

The Tongan people also recognised other values that are socially and culturally important such as using the red fluid from mangrove bark to paint and decorate tapa mats. Usually, the bark is scraped off and the plant left to recover.

Recently large mangrove areas were removed in Fanga'uta in illegal and unsustainable land reclamations that are not engineering certified. The Ministry of Lands and Natural Resources used a GIS approach in 2015 to estimate mangrove losses in key areas of the lagoon as shown in Figure 3–35 to Figure 3–37. Between 2004 and 2015, there were ~48.7% losses in Popua, ~30.7% losses in Hoi, and ~35% losses in Nuku. Other areas have also had significant losses, for example between Halaleva and the area in front of Vaiola hospital, but no data is available. It is also important to recognise that the coastlines of the lagoon were mainly and naturally covered with mangroves before settlement took place.

TONGATAPU LAGOON

Tongatapu lagoon is open to the ocean as shown in Figure 3–33. Its water circulation is complex as tide, wind and wave-induced currents play significant roles (SOPAC, 2008). The lagoon consists of a large reef system and islands. Water circulation in the lagoon was analysed and determined that there was a dominant lagoon flushing from east and north driven by tidal flow from the open ocean in the north, easterly winds that dominate 70% of the year, and currents created from waves breaking over the reef at the southeast corner of the lagoon rim (Pakoa, Friedman, & Damlamian, 2010). There is also a system of weak currents in the central lagoon in front of Nuku'alofa where the currents converge. At this convergence zone, current flow weakens, and any floating trochus larvae are expected to sink to the bottom and settle on suitable reefs (Pakoa, Friedman, & Damlamian, 2010).

FIGURE 3–38 Trochus niloticus presents among the alga *turbinaria ornata* on the reef of Tongatapu lagoon (Pakoa, Friedman, & Damlamian, 2010)

Trochus niloticus was introduced into Tonga in 1992 and 1994 at different locations, including within the Tongatapu lagoon (Figure 3–38). Surveys conducted at released sites from 1995 to 2000 indicate positive recruitment of trochus on the reefs of Tongatapu (Pakoa, Friedman, & Damlamian, 2010). Trochus distribution across the lagoon was uneven, with western areas having denser aggregations than eastern areas. Aggregations were found on lagoonal reefs, fringing reefs of Atata and Poloa islands, and Sopu Reef. This finding supports the 'source and sink' phenomenon, where the central lagoon area (Atata Island to Nukualofa Harbor) receives larval recruitment originating from the source population (breeding stocks) at the lagoon's eastern sector. This result explains the dense aggregation of trochus found in the western sector of the lagoon at Atata Island (Pakoa, Friedman, & Damlamian, 2010). The distribution and size of the trochus are shown in Figure 3–39.

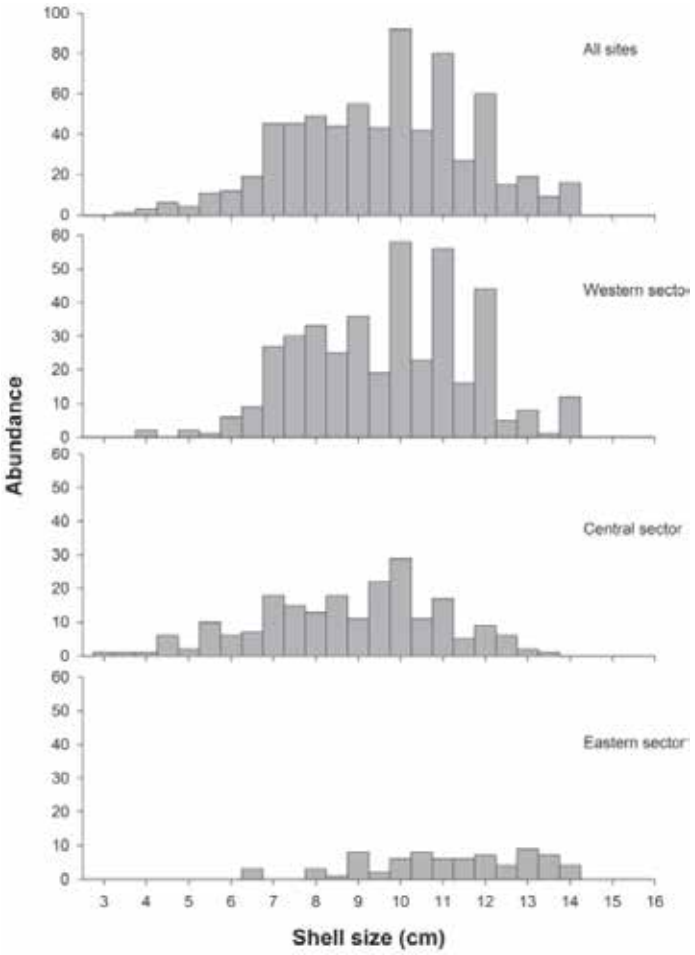

FIGURE 3–39 Trochus population structure in Tongatapu lagoon

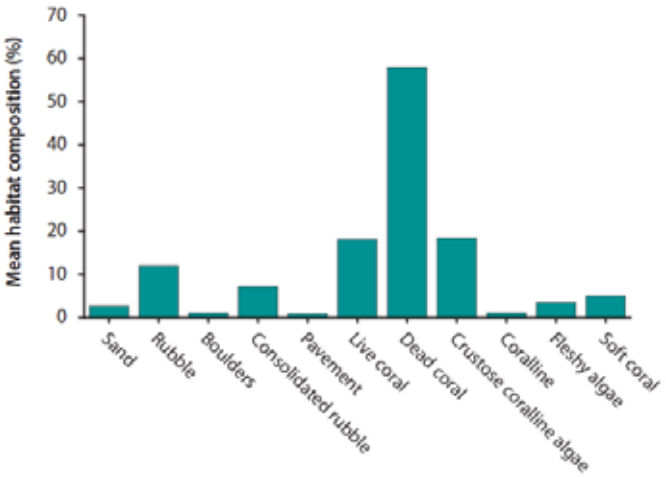

FIGURE 3–40 Mean habitat composition at Tongatapu lagoon (Pakoa, Friedman, & Damlamian, 2010)

Reef habitat data within the lagoon were collected in order to understand the status of resources in relation to habitat condition (Pakoa, Friedman, & Damlamian, 2010). Mean habitat condition was analysed as a percentage of habitat composition and is presented in Figure 3–38. Dead coral was the dominant substratum, representing approximately 60% of the composition. Dead coral covered by encrusting crustose coralline algae (CCA) was moderately high (20%). Therefore, dead coral with or without algae accounts for approximately 80% of the substratum, indicating that a large part of the reef at Tongatapu lagoon is dead. Growth of CCA on dead coral rocks is the main component of 'live rock', which is one of Tonga's main export products for the aquarium trade. Most live rock is harvested from Tongatapu lagoon, mainly around the central reefs such as Ulanga Uta and Ulanga Lalo and up to Fafa and Onevai.

The findings of this analysis indicate that although the dead coral is the dominant substratum, the lagoon is in a stable health condition.

VAI LAHI – NIUAFO'OU

Niuafo'ou is located north of Tongatapu and contains ten lakes within its caldera. The largest of these is called Vai Lahi (Big Water), while the other lakes are much smaller in size. Vai Lahi is about 120 m at its deepest point and has a surface area of 13.6 km² and volume of almost 1 km³. Vai Si'i, the next biggest lake, is 1.14 km² and has a volume of 0.0115 km³ (Hansleier, Kempe, & Seckbach, 2012). Vai Lahi together with other small lakes and ponds play vital environmental roles in the ecosystem of Niuafo'ou. Lake water can be used for drinking, and food includes the fish Lapila (tilapia) which was introduced. The locals also use the lakes for recreation. There is very little scientific information available about the health and the ecosystem of the lake. However, due to its remoteness and Niua remaining unindustrialised or commercialised, Vai Lahi and its associated lakes are considered to be largely in pristine condition.

FIGURE 3–41 Vai Kona by Vai Lahi (Sean Kois)

IMPACT

The Tongatapu lagoon and the lake system in Niuafo'ou are in a good state of health. In contrast, Fanga'uta lagoon is in a very poor state which affects the ecosystem and those who depend on it. Although no scientific data is available, the locals have confirmed that shell and fin fish stocks have declined. Murky water has been recorded due to changes in current waves and energy. This is due to increased shallowness of the lagoon entrance from sediments accumulated from clearing mangroves and unsustainable land reclamation.

RESPONSE AND RECOMMENDATIONS

Different plans have been defined but implementation is limited due to a lack of funding. Recent initiatives and studies have highlighted the clearing of mangroves and poor water quality of the lagoon. This report recommends:

Immediate formulation of legislation to:

- Stop piecemeal land reclamation within 10 m from mean water level around the coastlines including the lagoon.
- Provide an esplanade reserve starting from the mean water level and 10 m inland.
- Ban and fine illegal dumping of liquid, hazardous and solid wastes into the lagoon and within 10 m of the lagoon.
- Give the Department for the Environment the authority to prosecute illegal land reclamation and other unsustainable activities they may identify.
- Give the Department for the Environment the authority to manage the lagoon and be assigned a budget for this work.
- Ban the removing of mangroves and other coastal plants and flora from the coastline.
- Use of fertiliser and pesticide chemicals must not be applied within 100 m from the mean water level.

- Other activities deemed necessary by the Department for the Environment to protect the enmvironment.
- Remove existing septic tanks that are located less than 10 m from the mean water level and replace them with fiberglass or approved plastic tanks to reduce raw sewage leaking into the lagoon.
- Any new building to be erected within the defined catchment of the lagoon must use fibreglass or other engineering approved materials for septic tanks rather than the traditional cement tanks.
- The Department for the Environment to be immediately tasked with seeking aid to finance the rehabilitation of Fanga'uta lagoon. A design based on rigorous modelling to identify areas to be dredged to improve current movements, reduce sediment and stop eutrophication within the lagoon.
- Stop liquid discharge into the lagoon from Vaiola hospital or other industrial or commercial entities.
- Monitoring of water quality should be ongoing using auto logger stations to record key water quality parameters.
- Monitoring of faecal coliform levels should be on a monthly basis until the levels drop to an acceptable measure according to international standards.
- Continue initiatives that encourage community involvement in keeping the lagoon clean and sustainable.
- Encourage recreational activities that require the lagoon to meet water quality standards.

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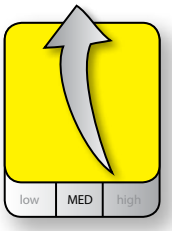
COASTAL EROSION

Coastal erosion is a key indicator in identifying the damage to the coastlines and its associated catchments. Coastal erosion has been most severe in low-lying areas such as Popua. However, different measures and approaches have been implemented resulting in improving status.



Status
Fair

Trend
Improving

Data confidence
Medium

SDG	CBD
14 LIFE BELOW WATER	

Status: Fair Trend: Increasing Data Confidence: Medium

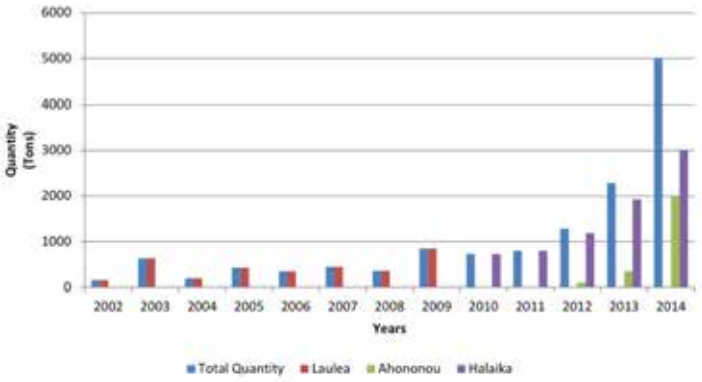


FIGURE 3–42 Quantity of sand mined

FIGURE 3–43 Over-topping along the eastern part of Tonga

FIGURE 3–44 Erosion at lifuka

STATUS AND TREND DISCUSSION

Coastal areas of Tonga are losing ground to erosion and flooding, disrupting food plantations, cemeteries and homes, and causing increased movement and dislocation. This is shown in Figure 3–43, where sea water overtopped the adjacent main road to the eastern part of Tongatapu (Mead, Hiliau, & Phillips, 2015). Other parts of the country also experienced erosion such as at Lifuka, in Ha'apai as shown in Figure 3–44 (Australian Government, 2011).

Other activities such as beach sand mining have accelerated the erosion in coastal areas. Sand mining has increased (Figure 3–42). While the locals understand the beaches are the first defence against coastal erosion and they provide an important recreational facility, beaches are the main sand source. In 1993, the British Geological Survey conducted a survey of the effects of sand mining on beach erosion (Tappin, 1993). They found that on Tongatapu, the extraction of sand from the beaches has led to the movement landward of the main beaches by as much as 50 m. No other information is available on the status of beach sand mining in recent years but by general observation, these beaches should be left untouched so the natural replenishment rate can take effect. Unsustainable land reclamation and building on natural swamp areas such as Sopu and Popua have caused significant erosion with negative impacts such as homes being inundated during high tides Figure 3–45.

Extreme weather events such as cyclones can cause coastal erosion and significant damage to coastal control measures. Erosion of agriculture land and erratic weather changes have severely disrupted the cultivation practices, resulting in low yields and prolonged droughts. Loss of economic opportunities due to loss of land is also experienced. Damage to the coastal ecosystem is not well documented but they are affected when the natural habitats for marine organisms, shellfish and finfish are disrupted. Erosion also occurred on the north-western side but there is no data to assess the significance of impacts.

CONTROL MEASURES

Under the Tonga's Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management 2010–2015 (JNAP), managing the risk of sea level rise and coastal inundation was identified as a priority (Australian Government, 2011). The north coast of Tongatapu, the lagoons and Nuku'alofa are low-lying and vulnerable to sea level rise. Low-lying villages in the Nuku'alofa areas such as Sopu and Popua are affected by tidal inundation, particularly during spring tides. People who have migrated from outer islands are building on reclaimed land in the tidal zone of the lagoon (Popua), exacerbating vulnerability to sea level rise (Figure 3–43).

Different projects have been implemented to mitigate erosion. One project trialled different coastal protection measures along a six kilometre stretch of coastline where six villages and roads are vulnerable to coastal erosion, the impacts of which would be exacerbated by sea level rise. The measures consist of 'hard engineering measures' including offshore breakwaters and semi-permeable groynes, combined with 'soft engineering measures' such as beach nourishment and the planting of indigenous coastal plants and trees. These coastal controls have been largely successful with groynes and other structures to stop sand erosion and replenish the beach (Mead, Hiliau, & Phillips, 2015). Adaptation to future sea level rise requires a sound understanding of the potential impacts of coastal inundation in high-risk areas such as Popua and Sopu. A lidar survey conducted under Australian Aid provided high-resolution topographic data to improve the accuracy of inundation modelling and subsequently the estimation of risk to infrastructure and communities. They also provided shallow-water bathymetric data to better inform assessments of how sea level rise may affect inundation through changing wave direction and energy (Australian Government, 2011).

IMPACTS

Beach erosion and loss of land. Inundation of low-lying areas during high tides. Force migration of people from low-lying outer islands.

RESPONSE AND RECOMMENDATIONS

Identifying that sea-level rising and coastal inundation as a priority under JNAP. Engineering works have been conducted to counter erosion caused by natural disaster and sea-level rising. Reducing the sand mining in beaches. This report recommends:

- Determine the sand replenishment rate at each beach and then reduce beach sand mining to fall below the rate.
- Consider sourcing sand from deepwater sand mining but carry out an environmental impact assessment to assess any negative impacts and identify the best locations and safe mining rate.
- Mandate the ceasing of land reclamation in low-lying areas such as Popua and Sopu.
- The Department for the Environment to work together with a qualified organisation such as CSIRO of Australia or consultants to conduct an extensive study of sea level rise to identify vulnerable areas in Tonga.
- Continue to apply both hard and soft engineering measures on eroded coastal areas.
- Establish a coastal section under the appropriate environment entity and task them with providing coastal environment initiatives and planning.
- Produce LiDAR topography and bathymetry data every four years to assess which areas are eroded and which areas have recovered.

FIGURE 3–45 High tide in the village of popua (Australian Government, 2011)

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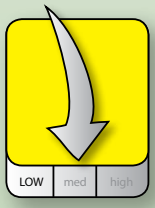
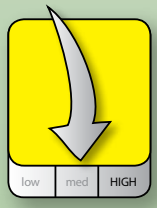
Overview

According to the JNAP2, Tonga has adopted a broad interpretation of biodiversity to encompass plant and animal species that are of ecological, cultural and economic importance. This covers agrobiodiversity, terrestrial fauna, forest and marine ecosystems (Government of Tonga, 2018).

The combined impacts of climate change, natural disasters and poor management lead to great difficulties in biodiversity conversation. It takes a considerable period for a marine ecosystem to recover. Tropical cyclones such as Ian and Gita caused significant damage to the forests in Ha'apai, 'Eua and Tongatapu. The largest remaining native or endemic forest in Tonga is in 'Eua.

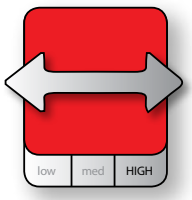
Clearing forest for agricultural activities is one of the negative impacts caused by agriculture development. Loss to biodiversity is a major concern as few traditional crop species are being found on small islands. Commercial farming, including kava, clears land containing these precious crop species and have led to their decline. Prolonged drought also reduced agrobiodiversity (Government of Tonga, 2018). These events highlight the need for a sustainable development pathway to preserve biodiversity in the face of climate change, while trying to satisfy economic demands from limited resources.

BIODIVERSITY HIGHLIGHTS

KEY AREAS	CURRENT STATUS	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
TERRESTRIAL PROTECTED AREAS	 **Status** Poor **Trend** Stable **Data confidence** High	Approximately 122 km2 or 15.9% of Tonga's total land area is protected in some form.	• Continue to grow national terrestrial protected areas network to meet Aichi target of 17% protected by 2020. • Ensure all high conservation areas are included within protected area network. • Train local landowners as rangers to manage protected areas and ensure sufficient ongoing funding in place for management activities.
MARINE MAMMALS AND TURTLES	 **Status** Fair **Trend** Mixed **Data confidence** Low	Catches of marine mammal species are thought to be sustainable.	• Involve local whale-watch operators and regular sea users to gain further knowledge on cetaceans other than humpback whales. • Implement a monitoring programme for nesting beaches and turtle catches to address sustainability in Ha'apai
THREATENED AND ENDEMIC TERRESTRIAL SPECIES	 **Status** Fair **Trend** Deteriorating **Data confidence** Low	Some of the terrestrial species have been lost or are almost extinct.	• Species conservation projects are currently underway led by MEIDECC. • Design and implementation of species recovery plan.
INVASIVE SPECIES	 **Status** Fair **Trend** Deteriorating **Data confidence** High	Three management actions have been put in place to counter invasive species.	• Review and update next NISSAP, including a review of animal species priorities. • Review priority invasive species following surveys, assess risk and include in next NISSAP if relevant. • Update changes to pathways and their lists of invasive species in the next NISSAP • Complete restoration plans for further priority areas. • Awareness, training and capacity. • Train biosecurity officers in the identification of environmental risks identified from existing pathways. • Complete Early Detection Rapid Response plans for high priority species which don't have plans, carry out simulation exercises and procure equipment ready for standby. Engage with the Police who are legislated to manage these risks.

TERRESTRIAL PROTECTED AREAS

Area of established terrestrial protected areas managed for conservation.



Status
Poor

Trend
Stable

Data confidence
High

SDG	CBD
15 LIFE ON LAND	11

Status: Poor Trend: Mixed Data Confidence: High

STATUS AND TREND DISCUSSION

Approximately 122 km^2 of Tonga's 767 km^2 and area is protected. This equates to 15.9% of Tonga's land area, near to the 17% Aichi target 11 for 2020 set by the Convention on Biological Diversity. However, some island and island groups are poorly represented, for example the only inland protected area on Tongatapu (zoom 1) is the 21 hectare Toloa Rainforest Reserve (Figure 3–46; Atherton 2014). In creating new terrestrial protected areas and priorisising protected area management, priority should be given to high conservation areas (e.g. Atherton et al. 2014).

IMPACT

Protected areas are a key means of reducing risks and avoiding adverse impacts on biodiversity and other values, including:

- Erosion and water contamination through silt runoff.
- Loss of ecotourism opportunities.
- Declines and extinctions of threatened and endemic species.

RESPONSE AND RECOMMENDATIONS

Key recommendations include:

- Continue to grow national terrestrial protected areas network to meet Aichi target of 17% protected by 2020.
- Ensure all high conservation areas are included within protected area network.
- Train local landowners as rangers to manage protected areas and ensure sufficient ongoing funding in place for management activities.
- Develop action plans/plans of management for protected areas in consultation with key stakeholders.
- Encourage sustainable ecotourism in protected areas.

SOURCES

Atherton, J.N., 2014. Operational Plan Toloa Rainforest Restoration Project 2014–2020. SPREP, Apia, Samoa.

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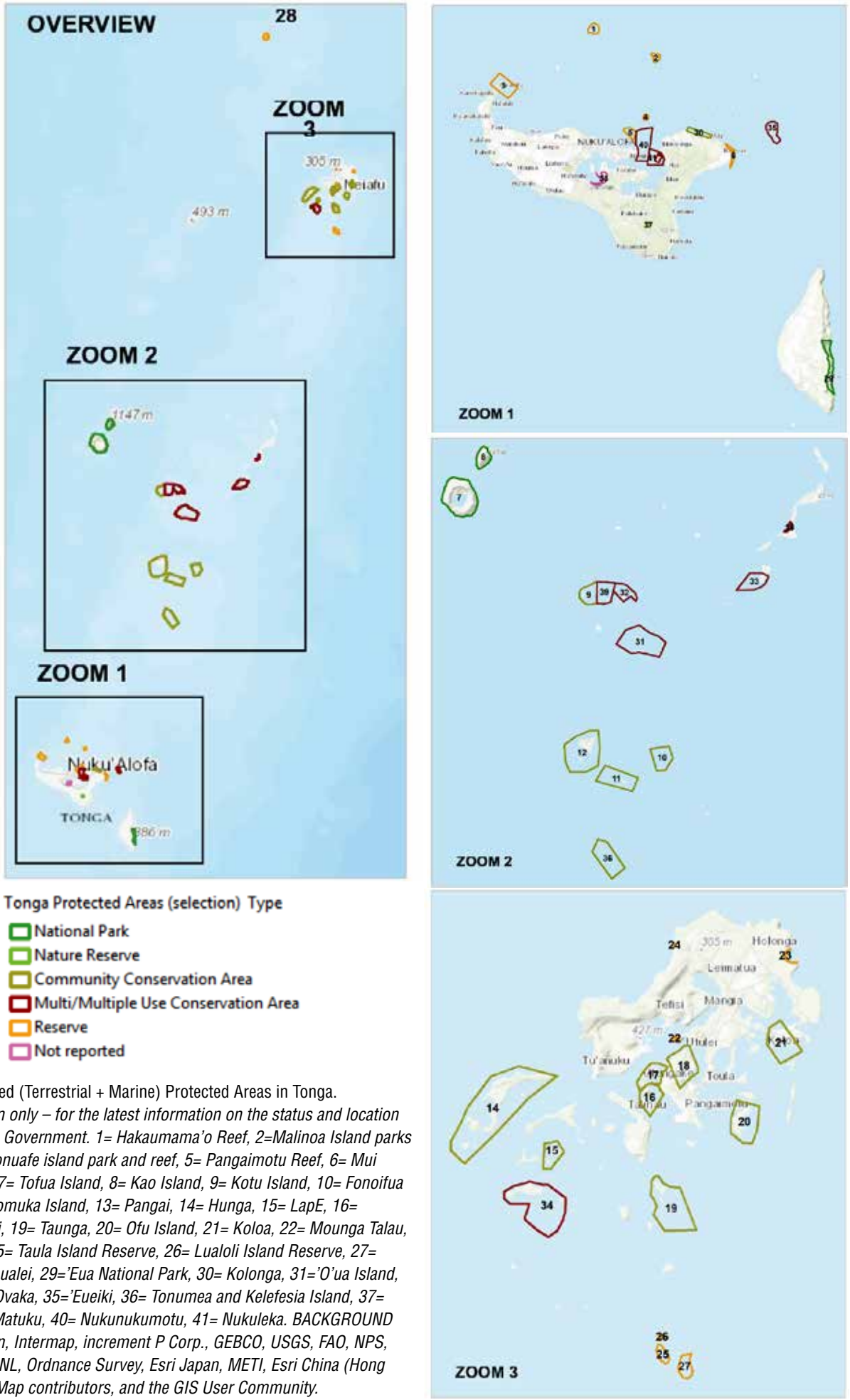

FIGURE 3–46 Terrestrial and Mixed (Terrestrial + Marine) Protected Areas in Tonga.
Note that this map is an indication only – for the latest information on the status and location of protected areas, contact Tonga Government. 1= Hakaumama'o Reef, 2=Malinoa Island parks and reef, 3=Ha'atafu beach, 4=monuafe island park and reef, 5= Pangaimotu Reef, 6= Mui Hopo Hoponga Coastal Reserve, 7= Tofua Island, 8= Kao Island, 9= Kotu Island, 10= Fonoifua Island, 11= Mango Island, 12= Nomuka Island, 13= Pangai, 14= Hunga, 15= LapE, 16= Talihau, 17='Utungake, 18='Utulei, 19= Taunga, 20= Ofu Island, 21= Koloa, 22= Mounga Talau, 23= Vaiutukakau, 24= Talehele, 25= Taula Island Reserve, 26= Lualoli Island Reserve, 27= Maninita Island Reserve, 28= Fonualei, 29='Eua National Park, 30= Kolonga, 31='O'ua Island, 32= Ha'afeva, 33= Felemea, 34='Ovaka, 35='Eueiki, 36= Tonumea and Kelefesia Island, 37= Vaomapa, 38= Nukuhetulu, 39= Matuku, 40= Nukunukumotu, 41= Nukuleka. BACKGROUND MAP Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community.

MARINE MAMMALS AND TURTLES

This indicator assesses the status of two high profile groups of marine fauna: marine mammals and turtles.

Status
Fair

Trend
Mixed

Data confidence
Low

SDG	CBD
14 LIFE BELOW WATER	

Status: Fair Trend: Mixed Data Confidence: Low

STATUS AND TREND DISCUSSION

The waters surrounding Tonga are an important mating and birthing area for a population of around 2000 humpback whales (*Megaptera novaengliae*) (Figure 3–47). Each austral winter the whales migrate to the warm waters around Tonga which is one of the most important overwintering areas for humpback whales in Oceania (Constantine et al. 2012). Humpback whale populations are still recovering since whaling was banned in the southern hemisphere in 1966 and the species is listed as Least Concern on the IUCN Red List (Reilly et al. 2008).

Vava'u in particular is a humpback whale hotspot and whale watching and swimming with whales has become an important component of Tonga's tourist industry, contributing an estimated USD700,000 to the economy in 2002 (Orams 2010). A further 13 species of marine mammals have been recorded in Tonga's EEZ (Atherton et al. 2014). Of these, only the sperm whale (*Physeter* macrocephalus) is listed as threatened on the IUCN Red List, with a Vulnerable status.

FIGURE 3–47 Humpback whales

Turtles live throughout Tonga but the island groups of Ha'apai and Vava'u support the largest populations (Atherton et al. 2014). All marine turtles recorded from Tonga are listed as threatened on the IUCN Red List (Table 3–9). In 2007 an estimated 608 turtles were caught in three villages of Ha'apai (Havea and MacKay 2009). While it was unknown whether that catch is sustainable, most fishermen perceived that the catches were not declining or were stable (Havea and MacKay 2009). However, increased catch rates in Tungua for the commercial market may be of concern, particularly given the possible decline in green turtle nests (Havea and MacKay 2009). The Tonga Conservation and Management Regulation 1994 prohibits the harvesting of turtle eggs and the commercial sale of hawksbill turtles. However, both of these activities were reported by Havea and MacKay (2009) to be occurring on Ha'apai.

TABLE 3–9 Marine turtle status and sighting in Vava'u (Atherton et al. 2014)

Species	Notes	IUCN Red List category
Green turtle (*Chelonia mydas*)	Commonly seen throughout Vava'u and commonly targeted by fishers.	Endangered
Hawksbill turtle (*Eretmochelys imbricata*)	Reported sightings in select locations in Vava'u. Recorded as common nesting species.	Critically Endangered
Leatherback turtle (*Dermochelys coriacae*)	One recorded sighting in 2009.	Critically Endangered
Loggerhead turtle (*Caretta caretta*)	Purchased from local fisherman in Tongatapu and photographed in 2011.	Endangered

In 2012–2013 nesting surveys were conducted as part of the Vava'u Turtle Monitoring Program, which identified nesting activity on four islands: Maninita, Fonua'one'one, Mu'omu'a and Luatafito (Atherton et al. 2014). However, successful nesting occurred only on Maninita and Fonua'one'one (Atherton et a. 2014). The 2013–2014 nesting survey was disrupted by rough seas in December and Cyclone Ian in early January, resulting in a low survey effort pre-cyclone and no evidence of nesting activities post-cyclone. Pre-cyclone evidence of nesting would have been obscured by the significant changes to the outer island beaches (Atherton et al. 2014).

IMPACT

The humpback whale migration is important to the economy of Tonga. Turtles are an important traditional food source.

RESPONSE AND RECOMMENDATIONS

The following are recommendations for marine mammal and turtle conservation in Vava'u and Ha'apai (Atherton et al. 2014; Havea and MacKay 2009):

Marine mammals

- Involve local whale watch operators and regular sea users to gain further knowledge on cetaceans other than humpback whales. A workshop could be organised to raise awareness and provide basic training for species identification and simple data collection. Communication through the local media would be useful.

Turtles

- Implement a monitoring programme for nesting beaches and turtle catches to address sustainability in Ha'apai.
- Protect the beaches of Maninita, Fonua'one'one and Taula islands either as part of a system of marine managed or protected areas, or during the turtle nesting season.
- Limit and regulate fishing methods and activities in documented important turtle foraging grounds such as Blue Lagoon of Foeata Island, Hunga Lagoon of Hunga Island and the waters surrounding Mala Island. Currently gill netting is practised in these areas by the local communities (K. Walker, personal observation) and the nets are often laid across areas of open, deep water where turtles are known to surface regularly. These netting activities need to be either banned or regulated by zoning of the key foraging areas. Another fishing practice which needs to be banned is fishing for sleeping turtles on the reef at night by fishermen using scuba gear.
- Instigate a nationwide awareness programme on the Fisheries Management (Conservation) Regulations 2008 focusing on the protection of female turtles all year and a guide to identify male from female turtles.
- Practice active monitoring and enforcement of the above-mentioned regulations.

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Orams, M.B., 2002. Humpback whales in Tonga: an economic resource for tourism. *Coastal Management*, 30(4), pp.361–380.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. Megaptera novaeangliae. *The IUCN Red List of Threatened Species 2008:* e.T13006A3405371. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T13006A3405371.en. Downloaded on 08 November 2018.

THREATENED AND ENDEMIC TERRESTRIAL SPECIES

Threatened species are determined as having an elevated risk of extinction. The International Union for Conservation of Nature (IUCN) uses criteria to evaluate whether species are threatened. Some threatened species require management intervention to prevent their extinction. Monitoring threatened species populations over time is the best means of determining status and trends. Endemic species are restricted to one country or region and are often threatened due to their limited distribution and inability to move into new habitats.


Aviceda, Wikipedia

Status
Fair

Trend
Deteriorating

Data confidence
Low

TABLE 3–10 Tonga terrestrial animals and plants listed on the International Union for Conservation of Nature (IUCN) Red List of threatened species

Species	Status*	Species	Status*
Animals		*Plants*	
'Eua Forest Gecko (*Lepidodactylus euaensis*)	CR	*Aglaia heterotricha* (tree)	CR
Lau Banded Iguana (*Brachylophus fasciatus*)	EN	*Aglaia saltatorum* (tree)	VU
Olive Small-scaled Skink (*Emoia lawesi*)	EN	*Cycas seemannii* (cycad)	VU
Pacific Sheath-tailed Bat (*Emballonura semicaudata*)	EN	*Podocarpus pallidus* (conifer)	VU
Crampton's Samoana tree snail (*Samoana cramptoni*)	CR	*Pritchardia thurstonii* (palm)	VU
Fat Eua snail (*Eua globosa*)	CR		
Black Petrel (*Procellaria parkinsoni*)	VU		
Bristle-thighed Curlew (*Numenius tahitiensis*)	VU		
Shy Ground-dove (*Alopecoenas stairi*)	VU		
Tongan Scrubfowl (*Megapodius pritchardii*)	EN		
Tongan Whistler (*Pachycephala jacquinoti*)	NT		
*CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened			
Extinct or regionally extinct species: Phoenix Petrel (*Pterdroma alba*), Oceanic Parrot (*Eclectus infectus*), Tonga Ground Skink (*Tachygyia microlepis*).			

SDG	CBD
15 LIFE ON LAND	12

Status: Fair Trend: Deteriorating Data Confidence: Low

STATUS AND TREND DISCUSSION

Tonga supports 419 plant species and about three percent of those are endemic (Whistler 1992). Plant species richness on individual islands includes 340 on Tongatapu, 300 on 'Eua, 145 on Late, and 107 on Vava'u (Sykes 1981). Tonga has five plant species listed as threatened on the IUCN Red List (Table 3–10) and two of these are endemic to Tonga – the tree *Aglaia heterotricha* and the conifer *Podocarpus pallidus.* No monitoring programmes are in place for Tonga's threatened plants.

Twenty reptile species have been recorded in Tonga – one iguana, nine geckos, nine skinks, and the Pacific boa (*Candoia bibroni*). Two of these species are listed as threatened on the IUCN Red List; the Lau banded iguana (*Brachylophus fasciatus*) and the 'Eua forest gecko (*Lepidodactylus euaensis*). The iguana is believed to have been introduced to Tonga by people (Keogh, Edwards, Fisher, & Harlow, 2008), while the gecko is endemic to 'Eua where agricultural development threatens its remaining forest habitat. There is no monitoring programme in place for the 'Eua forest gecko and no data on population trends.

Bird fauna of Tonga includes 18 land, 23 migratory, 22 seabirds, and 19 waterbirds, three endemic species, including one island group endemic, the near-threatened Tongan whistler (*Pachycephala jacquinoti) in the Vava'u Group* (Rinke, 1986; Stattersfield, Crosby, Long, & Wege, 1998; Bird Life International, 2018). Four species of Tongan birds are listed as threatened on the IUCN Red List. The Polynesian megapode (*Megapodius pritchardii*) occurs on Niuafo'ou Island and as a reintroduced population on

Fonualei Island. A survey of Niuafo'ou in 2010 revealed a substantial decline in active nesting since the early 1990's (Figure 3–48), when there were an estimated 188–235 adult pairs (Butler, Field Surveys and Consultations to Support the Conservation of the Endemic Malau, Polynesian Megapode, 2014; Göth & Vogel, 1995). In contrast, the population on the uninhabited Fonualei Island appears to be stable or increasing, with an estimated population as high as 600–1000 in 2012 (Butler, Bird Surveys of Late and Fonualei Island, Vava'u, Kingdom of Tonga, 2013). The megapode inhabits broadleaved forest and relies on hot volcanic ash to incubate its eggs, with nesting sites confined to areas of loose soil close to vents (Todd, 1983). In 1993 a study showed that all nesting sites on Niuafo'ou were harvested and this resulted in 50% of eggs being collected or destroyed (Göth & Vogel, 1995). However, egg collecting has declined substantially, and younger people are reportedly not interested in maintaining this tradition (MEECCDMMIC, 2014). Possible causes for the decline on Niuafo'ou include changes in soil temperature, hunting of adult birds, predation by cats and dogs, and pig disturbance of foraging habitat (Tilmouth, 2011; Lloyd, 2011). Because Fonualei is uninhabited the threats of hunting and human disturbance are less immediate.

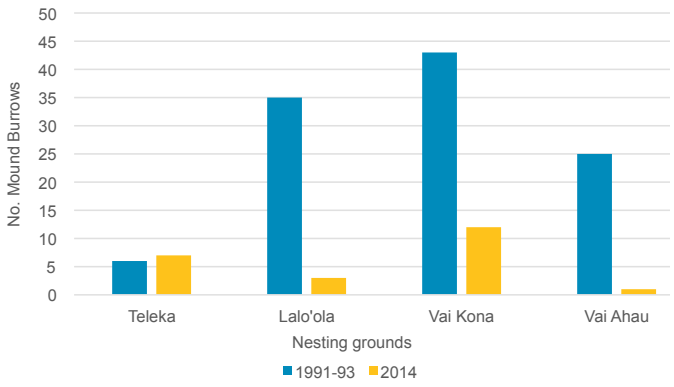

FIGURE 3–48 Change in number of active malau (polynesian megapode) burrows at four nesting grounds on Niuafo'ou Island, Tonga

Of the remaining threatened birds, the Black petrel (*Procellaria parkinsoni*) and Bristle-thighed Curlew (*Numenius tahitiensis*) are migratory species that do not nest in Tonga. The shy-ground dove is found in several Pacific island countries and in Tonga may be reasonably common on Late and Fonualei (Baptista, Trail, & Horblit, 1997) and occurs on smaller islands in the Vava'u group (Atherton, McKenna, & Wheatley, 2014). More than 100,000 sooty terns (*Sterna juscata*) are believed to breed in the volcanic crater on Fonualei Island in the Vava'u Group (Jenkins, 1980).

Two of Tonga's land snails are listed as threatened on the IUCN Red List and both are endemic to 'Eua. The Samoan tree snail (*Samoana cramptoni*) has not been seen since the type specimens were collected in 1933 and the Fat 'Eua snail (*Eua globosa*) has not been seen since 1970 (O'Fioighil, 2012). Much of 'Eua's original forests have been cleared and both species are considered possibly extinct.

IMPACT

As with most Pacific island countries, Tonga has lost many terrestrial species since the arrival of humans. What remains of Tonga's biological wealth should be protected for future generations. Some threatened species have important ecological roles that will not be fulfilled if they become extinct; for example, pigeons, doves, and fruit bats are excellent seed dispersers. The loss of culturally significant species, such as the Polynesian megapode, would also affect the persistence of cultural practices.

RESPONSES AND RECOMMENDATIONS

There are two projects aimed at species conservation currently being executed by the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications (MEIDECC) – conservation of the Polynesian megapode and invasive species management (see Invasive species indicator).

MEIDECC developed a threatened species recovery plan for the Polynesian megapode covering the period 2014–2024. The recovery plan lists 29 actions under 14 objectives and, while the recovery plan does not include a timeline for implementation, it states that MEIDECC will undertake annual assessments on implementation of actions. Given the halfway mark of the recovery plan is approaching, it would be timely to review the status of all actions. If not already met, objective 14 to 'Establish a national repository for information on the Polynesian megapode' could be achieved using Tonga's existing DKAN environmental data portal.

TABLE 3–11 Linking SOE and NEMS

NEMS Action Area	Strategies	Targets	Performance Indicator	Responsible stakeholders
Threatened and endemic species	Review status of Polynesian megapode recovery plan and identify priority actions	2019	Status of actions determined, and remaining actions prioritised	MEIDECC

SOURCES

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INVASIVE SPECIES

Invasive species are the main driver of extinctions of single-country endemic species, as classified under the IUCN Red List, as well as a threat to island biodiversity, economic and resource sustainability, human health and the provision of ecosystem services.

The Guidelines for Invasive Species Management in the Pacific (SPREP, 2009) provides a comprehensive framework of thematic areas and objectives to form a robust programme to meet these obligations. Indicators which measure the implementation of the guidelines help to determine whether the goals are being met. A series of indicators are evaluated each year by each country and territory with the assistance of experts where required. The 2017 indicators for Tonga show the current state of invasive species management in the country and assist in determining where more attention is required.

Status
Fair

Trend
Deteriorating

Data confidence
High

SDG	CBD
15 LIFE ON LAND	12

Status: Fair Trend: Deteriorating Data Confidence: Low

STATUS AND TREND DISCUSSION

There are 388 verified records of introduced species in Tonga (Global Register of Introduced and Invasive Species). A desktop review (Invasive Species Specialist Group) identified 141 plants and eight animal species reported as introduced and invasive.

Between 2011 and 2016 a major project focused on environmental invasive species was implemented in Tonga. The Prevention, Control and Management of Invasive Species in the Pacific Islands Project focused on managing invasive species impacting on the environment and was the beginning of the Invasive Species Programme in Tonga. This programme is divided into three thematic areas with their own actions and indicators, as outlined below.

The first thematic area is 'Foundations' which outlines indicators required to support a comprehensive invasive species programme. While there are opportunities to build on existing success in this area – particularly increasing the size of the invasive species workforce, increasing their base skills for key activities, completing the harmonised legislation and implementing the Ballast Water Management Strategy – Tonga has done well in the short time frame for which environmental invasive species has been a priority. These foundation achievements are an excellent base to work from which includes good political support, good agency and regional collaboration, a full-time Invasive Species Coordinator and an up-to-date National Invasive Species Strategy and Action Plan (NISSAP).

TABLE 3–12 Status of indicators from the 'Management Action' thematic area of Tonga's Invasive Species Programme as of 2017

Management Actions	
C1: Biosecurity	
C1.1	Invasive species evident in countries with existing pathways are identified but environmental issues are not fully incorporated into national biosecurity
C1.2	Species detected, and response actioned under Early Detection Rapid Response plan
C1.3	Priority risk species from neighbouring islands identified for inter-island biosecurity
C2: Management of established Invasive	
C2.1	No priority invasive plant species under management
C2.2	No priority invasive plant species have been eradicated
C2.3	4 invasive plants with biocontrol agents in place
C2.4	No priority invasive animal species under management
C2.5	1 animal invasive species (excluding rats) has been eradicated (Mongoose from Tongatapu)
C2.6	5 islands have had rats eradicated
C2.7	No priority marine invasive species are under management
C2.8	No priority marine species have been eradicated
C3: Restoration (some data also shown on the histogram above)	
C3.1	2 priority mainland sites are under restoration
C3.2	1831 hectares of sites with a restoration plan
C3.3	24 hectares of sites with invasive plant management
C3.4	31 hectares of sites with predator control
C3.5	3000 plants planted this year for restoration
C3.6	4000 plants planted to date
C3.7	7 native species reintroduced to priority sites

The second set of indicators focuses on the thematic area of 'Problem Definition, Prioritisation and Decision-Making' for establishing and outlining the priorities to be addressed within a comprehensive invasive species programme (Table 3–12). Baseline surveys, particularly for priority invasive plants, need to be completed. Some priority invasive species are identified within the NISSAP but need to be added to distribution surveys. Pathways have been identified (ISSG), however implementation of monitoring the pathways needs to be promoted. Priority sites are identified within the NISSAP. Tonga maintains good links with regional agencies and organisations and uses the assistance offered. Best practice methods have been adopted.

The third set of indicators focuses on the thematic area of 'Management Action' which is the most important set of indicators to measure progress (Table 3–12). Biosecurity has not yet fully responded to environmental threats. Successful Early Detection Rapid Response has been actioned (in response to the arrival of the Indian mongoose (*Herpestes edwardsi*) in Nuku'alofa in recent years) but response plans for many priority species and particularly inter-island biosecurity are absent. Species-led management has been implemented for the Indian mongoose and biological control agents have been introduced to help manage the following invasive plants: purple nut sedge (*Cyperus rotundus*), lantana (*Lantana camara*), giant sensitive plant (*Mimosa diplotricha*) and elephant's foot (*Elephantopus mollis*). No other priority invasive species have received any management outside of priority sites. Management carried out in the following priority areas: Toloa Rainforest, the largest remaining stand of indigenous forest on the main island of Tongatapu; Mount Talau, Vavaú, a seven-hectare National Park with the single island endemic population of Hengahenga (Tongan whistler, *Pachycephala jacquinoti*) and the plant *Casearia buelowii* which is endemic to Mount Talau. Rats have been removed from three islands within the Vavaú group (Maninita, Fangasito and Luahaipo) benefitting the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles, and two islands in the Motutapu group (Motutapu and Malinoa).

The efforts saw an increase in the number of endemic species such as those in Figure 3–49.

FIGURE 3–49 *Casearia buelowii* (left) endemic to Mount Talau has benefitted from rodent (rattus spp) control and pig *Sus* (*scrofa*) exclusion. The hengahenga (Tongan whistler, *Pachycephala jacquinoti*) also endemic to Vavaú has also increased in population size following rodent control. (Photos: Hoifua Aholahi and Karen Stone)

IMPACT

Invasive animal predators such as pigs, rodents, cats and yellow crazy ants predate on native birds and their eggs, land and marine crabs, reptiles and insects, and also consume seeds and seedlings of forest plants essential for forest regeneration. Invasive plants often outcompete native plants and restrict the regeneration of forests, particularly following disturbance from natural disasters. Rodents, cats and other invasive mammalian species also support higher densities of *Aedes spp.* mosquitoes (Nigro et al., 2017), raising the risk of mosquito-borne diseases.

Invasive species also impact the resilience of terrestrial and coastal marine ecosystems and reduce the options available for communities to adapt to climate change.

RESPONSE AND RECOMMENDATIONS

Key responses and recommendations include:

NISSAP review and planning

- Review and update next NISSAP, including a review of animal species priorities.
- Review priority invasive species following surveys, assess risk and include in next NISSAP if relevant.
- Update changes to pathways and their lists of invasive species in the next NISSAP
- Complete restoration plans for further priority areas.

Awareness, training and capacity

- Train biosecurity officers in the identification of environmental risks identified from existing pathways.
- Complete Early Detection Rapid Response plans for high priority species which lack plans, carry out simulation exercises and procure equipment ready for standby. Engage with the Police who are legislated to manage these risks.
- Increase awareness of the spread of marine invasive species from infested sites, such as port areas, to marine managed areas.
- Increase the availability of native plants through increased nursery capacity and engaging with the private sector.
- Maintain and build new links with regional assistance.
- Identify any new research requirements and locate a provider.

Surveys and monitoring

- Monitor marine priority sites annually.
- Complete priority terrestrial surveys annually.
- Complete further terrestrial priority biodiversity site surveys.
- Complete invasive plant ground survey along road networks in Tongatapu, Ha'apai and Vava'u. Capture in geo-referenced database.
- Complete surveys for rodents and predators on priority islands.

Control and restoration programmes

- Initiate control programmes for high priority species following baseline surveys.
- Maintain species programmes for those priority species which can be eradicated.
- Reinstate the biological control of weeds programme targeting weeds that have existing effective agents available. Determine priorities for novel targets.
- Eradicate priority invasive animals as they are detected.
- Systematically eradicate rats from further islands prioritised by their biodiversity value, both terrestrial and marine values.
- Maintain current restoration programmes and add new priority areas for community management.
- Maintain invasive plant management within existing priority sites and build capacity in the community for further priority sites.
- Maintain predator control within existing priority sites and build capacity in the community for further priority sites.
- Continue to improve the structure and diversity of priority sites with suitable native species.
- Continue to reintroduce species extirpated from high priority sites including rare plants and animals.

SOURCES

SPREP, 2009

THEME 6 BUILT ENVIRONMENT

Overview

As per the census report 2016, more than 90% of the population live in an urban area. Infrastructure development and economic trade allow residents easier access to imported goods, including vehicles, fridges and other white goods. Although urbanisation has environmental impacts, the lack of guiding policies to direct waste minimisation and the lack of government incentives to encourage private sector recycling produce the greatest impacts on the environment. There are no improvements in drinking water supply over the last 20 years apart from an increase in the supply area in Tongatapu. Significant improvements have been made in the energy sector with options available for households in terms of solar energy. Advances in energy technology cater for the higher electricity demand. Significant improvement in solid waste has been made due to a new waste facility. However, solid wastes are not sorted, and hazardous wastes are not separated or recorded. Recycling is done solely by a private company, but the focus is on steel, copper and electronic materials. There is no recycling scheme for recyclable plastics due to the cost of exporting and difficulties in inter-governmental waste transfers. This area can be greatly improved with government incentives. Sewerage contamination remains a problem with most households still using septic tanks.

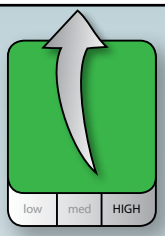
Pollution of the environment from waste is a problem worldwide. Problems with waste remain a high priority concern in Tonga. Waste is poorly managed which affects the environment and people, and creates a barrier to economic development. There are three key areas that the Waste Management and Pollution Control Section is responsible for: solid and liquid waste, hazardous waste and chemicals and other waste. Each causes significant human health and/or environmental effects. Key concerns associated with solid and liquid waste include:

- Mosquito-borne diseases such as dengue – solid waste poorly disposed of becomes a breeding ground for mosquitoes, and dengue outbreaks are common.
- Water-borne diseases such as diarrhoea, dysentery and other gastrointestinal illnesses and skin diseases caused by drinking water contaminated by human and animal waste.
- Environmental effects of increased nutrients in coastal waters and groundwater.
- Aesthetic effects of litter and indiscriminate dumping of solid waste in drains and waterways, and on public and unoccupied private land.
- The Section is also responsible for ensuring that the Waste Management Act 2005, the Hazardous Waste and Chemical Act 2010, and signed International Agreements are implemented.

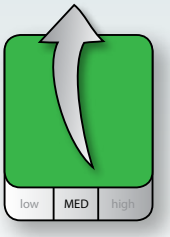
This chapter outlines Tonga's Waste and Pollution, focusing on two primary areas: Municipal Solid Waste and Hazardous Waste. Municipal Solid Waste (MSW) is the inevitable by-product of human activity and is highly influenced by the socioeconomic and political drivers in society. This is due to social and economic changes allowing large quantities of materials to move freely worldwide. MSW includes many different types of household items i.e. clothing, electronics, packaging, etc., and is produced at an alarming rate.

Tonga's *Climate Change Policy – A resilient Tonga by 2035* outlines the target of the development and implementation of a zero-waste policy, with the existing Waste Management Act 2005. Tonga is at risk of increased land-use pressure associated with its traditional method of landfill.

BUILT ENVIRONMENT HIGHLIGHTS

KEY AREAS	STATUS AND TREND	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
ENERGY	 **Status** Fair **Trend** Mixed **Data confidence** Medium	• Significant investment has been put into the energy sector. • Energy availability has increased over the years due to the increase in use of renewable energy such as solar.	• Establishment of the Energy Department drives the focus of the country to achieve more energy efficiency. • Legislation and policies have been put in place since 2000 have helped the country shift focus to more reliable and renewable energy sources.
SEWAGE AND SANITATION	 **Status** Fair **Trend** Unknown **Data confidence** Low	• There is a significant lack of data in this section. There is no data on the number and type of onsite treatment units in operation. • Leakage from onsite systems have caused health and environmental issues.	• The government moved the wastewater treatment from Paatangata to Tapuhia. • Recommendations in this report to reduce the negative effects of onsite systems on the environment include: mandate the replacement of cement septic tanks with better materials such as fibreglass or plastic. • Introduce a levy or tax-based fee for the government to service septic tanks rather than relying on the community to do it.
MUNICIPAL AND SOLID WASTE	 **Status** Poor **Trend** Mixed **Data confidence** High	• The country relies heavily on food imports which reduce the consumption of traditional diets. Knowledge and use of traditional diets is being lost.	• Sort rubbish into different categories and improve record taking. • Implementation of composting schemes. • Implementation of recycling initiatives. • Mandate a stop to sending recyclable materials to the landfill.

BUILT ENVIRONMENT HIGHLIGHTS

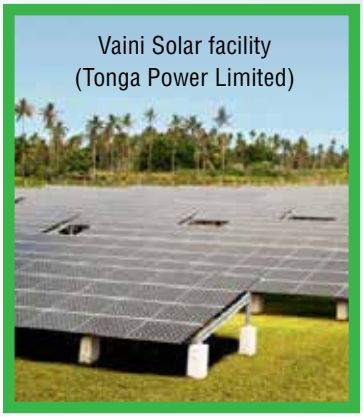
KEY AREAS	STATUS AND TREND	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
HAZARDOUS WASTE	 **Status** Poor **Trend** Unknown **Data confidence** Low	• Human health risks and environmental risks associated with spillage. • Economic risks associated with tourism where nature is the major drawcard. • Groundwater and surface water impact and risks. • Agricultural practices impact on soil and groundwater.	• Separate hazardous chemicals from municipal waste and recyclable materials. • Dispose of hazardous waste correctly • Monitor amount of hazardous waste disposal and hazardous compounds entering Tonga.
ENVIRONMENTAL IMPACT ASSESSMENT	 **Status** Good **Trend** Improving **Data confidence** Medium	• Increase in the numbers of EIA registrations indicates better oversight of proposed projects.	• Review of current legislation and policies is required. • Proper training of staff is required to ensure they conduct the assessment adequately. • EIA consultants to be registered with the Department of the Environment.

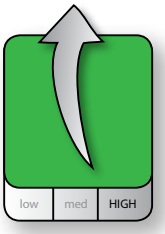
ENERGY

Tonga is much like its neighbouring countries, it has specific socio-economic and environmental features that create unique challenges for achieving sustainable energy development. Access to energy services is hindered by the relatively small energy industry available to serve multiple and dispersed islands. Other challenges include significant reliance on imported technologies as well as diesel and MoGas fuels delivered through long and easily interrupted supply chains. This puts Tonga in a vulnerable position with high risks due to possible future oil price shocks. The state of energy services is also challenged by the lack of environmentally sound technology, issues of social acceptance in regard to safety, electricity bills and the type of services required for cultural and income generation activities (Department of Energy, 2016).

The Tonga Department of Energy established in July 2015 is responsible for energy planning and development. The staff are well trained on issues and demands in the energy industry. In 2000, 75% of the energy supply relied on imported petroleum products with its grid-supplied electricity wholly generated from imported diesel fuel. The establishment of the energy department was a government initiative to find alternative energy sources and reduce the reliance and vulnerability of the country to oil price shocks. It also sought to improve access to modern energy services using a more financially and environmentally sustainable approach (Department of Energy, 2016).

Overall the energy sector has a good status and continues to improve through set goals and investments. It reflects a government initiative that has been successfully implemented.





Status
Fair

Trend
Mixed

Data confidence
Medium

SDG	CBD
7 AFFORDABLE AND CLEAN ENERGY	17

Status: Good Trend: Improving Data Confidence: High

STATUS AND TREND DISCUSSION

ENERGY AVAILABILITY

The establishment of the Energy Department has led to a shift to greater use of renewable energy. Some villages in the outer islands of Vava'u and Ha'apai have replaced diesel water well pumps with solar-powered pumps. This reduces the environmental risk due to leakage of diesel fuel and lubricants to the groundwater system. Significant numbers of solar panels (Figure 3–50) are installed in the islands. The availability of energy sources is shown by the number of pumps installed in some islands in Ha'apai (Figure 3–51). In 2016, about 90% of street lights in Tongatapu were solar, and this has extended to the outer islands including 'Eua, Ha'apai, Vava'u and the Ongo Niua (Department of Energy, 2016).

FIGURE 3–50 Solar Home System in one of the islands

RESCOs	Island/Village	Year of Installation	Source of Funds	No. of SPS	Total Capacity Wp	Current Status
Ha'apai Outer Island Electricity Society Inc. - HOISES Inc	Ha'ano	Oct 2014	Danish	1	1520	operate very well
	Pukotala	Oct 2014	Danish	1	1710	operate very well
	Falelua	Oct 2014	Danish	1	1710	operate very well
	Lotofoa	Oct 2014	Danish	1	1520	operate very well
	Fotua	Oct 2014	Danish	1	1140	operate very well
	Fangala'unga	Oct 2014	Danish	1	1140	operate very well
	Kouo	Oct 2014	Danish	1	1520	operate very well
	Holopeka	Oct 2014	Danish	1	570	operate very well
	Uiha	Oct 2014	Danish	1	1520	system currently down
	Felemea	Oct 2014	Danish	1	570	operate very well

FIGURE 3–51 14 solar pumps operated in ha'apai

FIGURE 3–52 Matatoa solar farm in Tonga

On October 2017, the Matatoa Solar Farm (Figure 3–52) was commissioned as a step towards Tonga achieving its renewable energy goal of 50% renewable energy generation by 2020. The farm consists of 7,440 solar panels, and the 2-megawatt facility is expected to generate more than 2.8 million kilowatts of electricity during its first year of operation. The power station was estimated to save approximately 680,000 litres of diesel fuel in the first 12 months, cutting emissions and the cost of generating electricity. Another solar facility located in Vaini (Mata 'o e La'a) was commissioned in March 2015, with a total capacity of 1 megawatt and expected fuel savings of 327,000 litres. The panel supplements the grid supply to the country.

FUEL IMPORTS

Fuel imports increased between 2000 and 2016 (Figure 3–53). Diesel and Mogas are the two main fuel types with most used in on-grid power generation. Lubricants and grease have increased over the years since 2011. Jet fuel is relatively steady except for 2013 (Department of Energy, 2016). Despite no imported fuel data for 2017 and 2018, the generated power by diesel fuel (on-grid power source) has a data set that indicates a possible reduction in fuel imports (Figure 3–54). The figure shows a significant reduction in the amount of power generated from diesel fuel in 2017 compared to previous years. Other years show similar correlation between the fuel imports and power generated from diesel fuel. Thus, it is plausible that the fuel imports in 2017 and possibly 2018 have reduced compared to previous years and especially 2016.

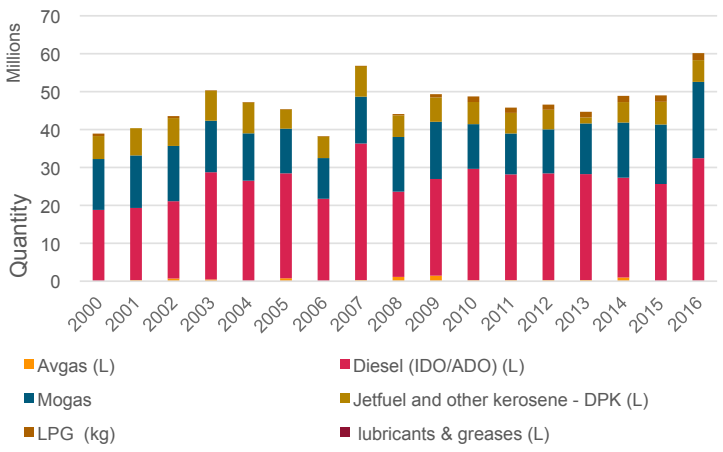


FIGURE 3–53 Fuel Imports between 2000 and 2016 (Department of Energy)

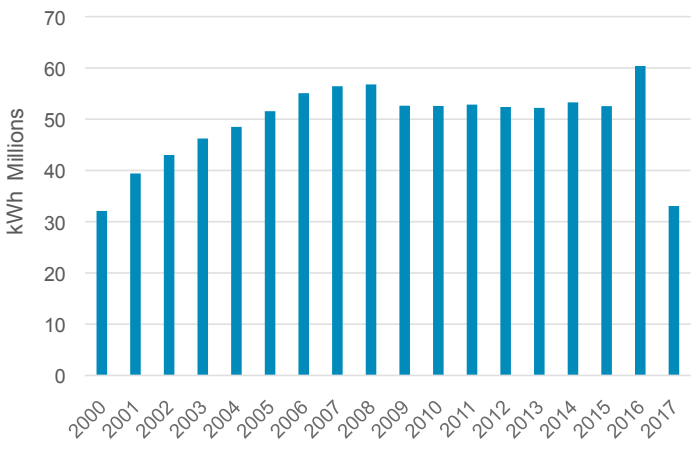


FIGURE 3–54 Power generated by diesel fuel (Tonga Power Limited)

CONSUMPTION

The energy sector in Tonga is supplied through two sources: on-grid and off-grid. The on-grid is supplied by Tonga Power Limited, a 100% state owned enterprise providing reliable, safe and affordable electricity. TPL was established in July 2008 to act as the concessionaire in a concession-based electricity regulation regime. It generates power for the on-grid system from diesel plants, then distributes and sells to commercial and residential customers in Tongatapu, Vavaú, Ha'apai and 'Eua (Table 3–13), where the on-grid system is available (Tonga Power Limited, 2018). The company has been an electricity provider since 2008 and serves 21,000 customers of which 3,963 are commercial customers (Tonga Power Limited, 2018). The distribution of residential and commercial customers in the on-grid system is shown in Figure 3–55.

The off-grid system is sourced from solar energy. There have been major investments in the solar energy sector in 2015 such as the "Mata 'o e La'a" Solar Facility in Vaini, Tongatapu. These facilities have significant savings in term of the amount of fuel that would have been used to produce the same number of watts (Tonga Power Limited, 2018; Department of Energy, 2016).

TABLE 3–13 Tonga Power Limited power plants

Location	Plant Type and Capacity
Tongatapu	Diesel Generation with a capacity of 13.8 MW generating at 11kV. As of March 2015, TPL had installed firm generating capacity of 16.5 MW in all 4 Islands and a 1.4 MW Solar Plant.
	2014–1.4 MW Solar Plant (Ma'ama Mai)
	2015–1 MW Solar Facility (Mata 'oe La'a)
Vava'u	Diesel Generation with a capacity of 1.872 MW generating at 415 volts.
Ha'apai	Diesel Generation with a capacity of 0.4 MW generating at 415 volts.
'Eua	Diesel Generation with a capacity of 0.4 MW generating at 415 volts.

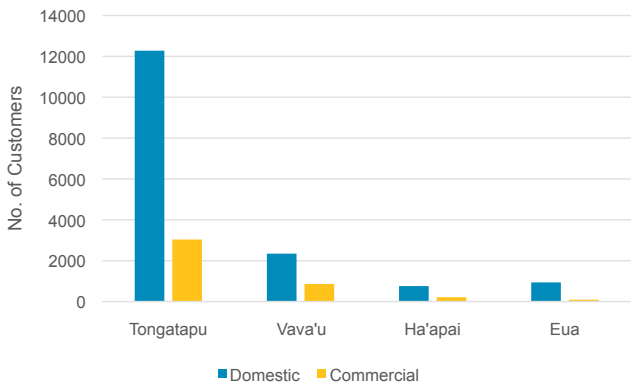


FIGURE 3–55 On-grid Customer distribution (Department of Energy)

The amount of energy generated from diesel plants for the on-grid system is shown in Figure 3–55. The amount of energy usage by customers between 2000 and 2017 were estimated from electricity billed to the customers. It was lower than the energy generated due to transmission loses, etc. The energy consumption from the on-grid system has increased between 2000 and 2016, reflecting the increase in population, increase in the number of houses built and connected to the grid system, availability of the grid network to customers, and the ability of people to buy electricity. In 2017, the data provided only covered January to July, but it could have similar levels to those of the last five years (Department of Energy, 2016).

The amount of kWh produced from solar (Figure 3–57) shows an increase.. Significant amounts of solar power is generated in Vava'u for all types of solar types – Solar Home System (SHS), Solar Pump System (SPS) and Solar Freeze System (SFS).

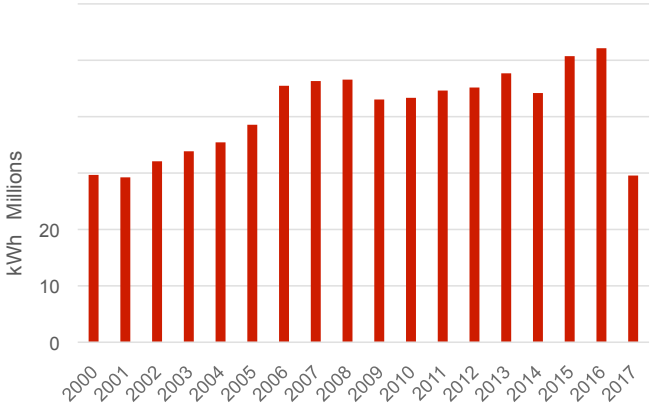


FIGURE 3–56 quantity of energy billed to customers from the on-grid system (Department of Energy)

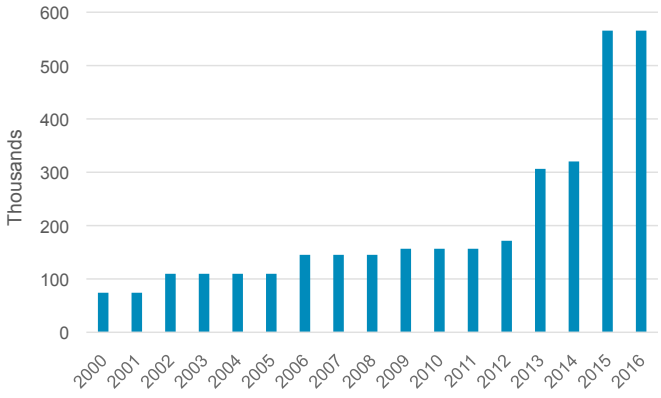


FIGURE 3–57 Total energy from solar system (kwh) (Off-Grid) (Department of energy)

IMPACT

Positive outcomes have been found in terms of energy availability, consumption and possible reduction in diesel fuel usage. Significant investments undertaken since 2012 in renewable energy are paying dividends. The outer islands are using solar-powered systems that are affordable and better for the environment.

RESPONSE AND RECOMMENDATIONS

The establishment of the Energy Department as part of a government effort to find alternative and cheaper sources of energy is the main response that improved the energy sector. Other responses include:

- Energy legislation such as the Electricity Act 2007 and Renewable Energy Act 2008.
- Energy policies such as the Tongan Energy Road Map (TERM), a 10-year plan launched by the government in June 2010, and the Renewable Energy and Energy Efficiency I and II.
- Development of the Tonga Energy Sector Bill 2016.
- The Tonga Energy Efficiency Master Plan developed in 2018.
- Under the Energy Department, different divisions are tasked with key aspects of the energy industry with targets to be achieved by 2020.

This report recommends:

- The Energy Department conduct energy forecasting using state-of-the-art modelling software. This will help the government decide future energy investment more accurately and set out achievable targets.
- Produce solar energy plants that can generate rates of 10 MW instead of 1 to 2 MW.
- Coordinate the feeding of the grid system from fuel energy generation and solar energy to reduce the use of imported fuels.

SOURCES

Department of Energy 2016, 2016. *Annual Report,* Nuku'alofa, Tonga: s.n.

Tonga Power Limited, 2018. [Online]

Sewage and Sanitation

Sewage originates primarily from domestic, commercial, and industrial sources. In many developed countries, these wastes typically are delivered through a reticulation system to a centralised sewage treatment facility before the cleaned effluents are released to the environment (Hummel, Berry, & Stacey, 2017). These state-of-the-art facilities and reticulated systems are not available in many of the Pacific Islands, including Tonga. Consequentially, sewage is one of the most significant sources of marine and groundwater pollution in Tonga due to on-site treatment systems such as septic tanks and long drop pit toilets (SOPAC, 2007).

Status
Fair

Trend
Unknown

Data confidence
Low

SDG	CBD
6 CLEAN WATER AND SANITATION	8

Status: Fair Trend: Unknown Data Confidence: Low

STATUS AND TREND DISCUSSION

The on-site systems are supervised and assessed by the Ministry of Health (MOH) when resources permit. This means that the wastewater management is mainly in the hands of the community and their ability to maintain them. Poorly constructed or inappropriate sanitation systems are common, resulting in the potential for pathogens and nutrients being introduced into the surrounding environment, including ingress to groundwater and leakage of untreated sewage to the coastal areas. Excess nutrient loads appear to be impacting the environmental health of the near shore reef in the Nuku'alofa area, and the Fanga'uta lagoon. Algal growth can be seen in both areas due to excessive levels of nitrogen and phosphorus. Thus, there are concerns that fish harvested in these areas, particularly shellfish, may be contaminated (SOPAC, 2007). A concern with the current sanitation practice is the potential for contamination of the aquifers designated for the Tonga Water Board and village reticulated supply. This can be worsened by groundwater over-extraction (SOPAC, 2007). Natural disasters such as cyclones can inundate low-lying areas causing surges of sewage and other contaminants (SOPAC, 2007)

RETICULATION AND TREATMENT SYSTEMS

There are a few small-scale wastewater treatment plants (AWTS) at institutions, such as Vaiola hospital, and at the new (solid) Waste Management Facility, but in Nuku'alofa sanitation systems are mainly flush toilets with septic tanks and vertical soak ways. Some houses have both pit latrines and septic tank systems, and in the non-urban areas of Tonga many people still use pit latrines. Residential septic tanks are required to be pumped once every five years. Some tanks are never pumped because they have no base to the tank, or it has disintegrated over time. Sludge and effluent seep into the soil and groundwater. Septic tank sludge can now be treated at the new facilities at the Tapuhia Landfill.

There are no accurate data on the number of septic tanks in use in Tonga. However, as per the Census 2016, there were 101,991 households in 2011. Assuming that every house has a septic tank, then in 2011, they were over 100,000 septic tanks in Tonga. In 2017, 405 buildings were approved. These buildings are mainly residential houses but also include commercial buildings. Based on these data, the number of households in Tonga is more than 100,000.There are no data showing the location of the onsite treatments, dimensions, or the exact number in operation. There are no data on effluent loadings to the groundwater system from the septic tanks and pit toilets. This is an area of real concern with immediate improvement required.

IMPACT

There is great concern over the contamination of coastal areas and groundwater from wastewater onsite treatment systems.

RESPONSE AND RECOMMENDATIONS

Recognising the negative effects of untreated effluent on the environment, the government has moved the wastewater treatment facility to a new location at Tapuhia. Other approaches include the assessment of septic tanks by the Ministry of Health. Unfortunately, this work has stopped due to lack of resources. This report recommends:

- Mandate the replacement of old cement septic tanks with plastic or fibreglass tanks or other approved materials to reduce leakage from septic tanks to the groundwater system and low-lying coastal areas.
- Produce a database of the old and new onsite treatments. Based on this data a mandate outlining pumping maintenance should be specified for each septic tank.
- A levy should be implemented and collected to fund governmental treatment of septic tanks instead of solely relying on owners to pump their tanks.
- Move the city from onsite treatment units to a reticulated system. There is a tremendous cost for this approach but with seawater levels rising, there is no alternative.
- Continue the use of advanced onsite treatment options in remote islands.
- Specify esplanade reserves along coastal areas where no building or onsite system should be built to prevent effluent from leaking to coastal areas.

SOURCES

Hummel, M. A., Berry, M. S., & Stacey, M. T. (2017). Sea Level Rise Impacts on Wastewater Treatment. *Advancing Earth and Space Science*, 6, 622–633.

SOPAC. (2007). *National Integrated Water Resource Management – Tonga.* South Pacific Applied Geoscience Commision.

SOLID WASTE

Management of solid waste is an ongoing issue in Tonga and across the Pacific, due to physical, resource and human capacity limitations. The primary limiting factor is the available land to deal with the increasing amount of waste accumulation. Imported products worldwide are more easily available leading to large amounts of waste. This indicator focuses on household and commercial by-products as there is limited industry on the islands. The specific products are paper, plastic, metals, garden and kitchen wastes.

Traditional waste practises of burning and dumping must be overcome in order to benefit the community. Long standing habits of disposal and public perception must be altered. Modern wastes such as plastic, foil, and disposable diapers have replaced the traditional uses of coconut baskets and banana leaves (Dutton & Helu). This has increased the waste volumes as many items are not recyclable or biodegradable. Burning is a common method of waste disposal. The dumping or burning of waste on private land is fiercely defended by the community, leading to difficulties in establishing proper waste management and disposal.

There are growing waste problems from abandoned vehicles and agricultural waste which is often left on land to degrade. The agricultural sector is yet to adopt composting more widely, which can reduce waste.

Recycling is another sector that is not widely practised in Tonga. There are four companies exporting non-ferrous and ferrous metals overseas, however, it is difficult to be financially viable.

http://www.worldbank.org/en/topic/urbandevelopment/publication/results-based-financing-for-municipal-solid-waste

Status
Poor

Trend
Mixed

Data confidence
High

SDG	CBD
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	8

Status: Poor Trend: Mixed Data Confidence: High

STATUS AND TREND DISCUSSION

Tonga relies on landfill for waste disposal. There is no separation of recyclable materials, municipal solid waste and hazardous waste. The Waste Authority Limited (WAL) is the waste collection and disposal utility in Tonga, a state-owned operation. WAL was set up in 2016 to be responsible for waste management services of the country. The company lacks governmental support and proper training for staff, which limits their ability to deal with waste.

DOMESTIC WASTE

In the 2016 census 12,358 people used a personal bin for public collection, 749 people took their waste to the dump themselves, 4,556 burnt rubbish, 148 composted rubbish, 182 buried rubbish in their yard or the bush, eight people dumped waste in the ocean and other water bodies, and four people used other ways. Most of those who burned, buried and composted their rubbish were located in rural areas.

- The rubbish is collected for $10 per month.
- The idea of community-based collection services has been promoted in isolated islands and communities by a number of development partners, with the purpose of introducing appropriate waste management practices in the absence of any government-funded service. This has been practiced by some communities in Vava'u, and the lessons learnt are useful for other Pacific island countries.
- Little information is available on agricultural waste.

RECYCLING

- Recycling in Tonga is only conducted by a private business (‘Uiha and Sons Group). They collect and sort the recycled materials before shipping them to recycling stations overseas. The data for this report runs from September 2017 to August 2018, and uses quantity rather than type of material. In September 2011, a total of 13.1 tons of recycled materials, mostly vehicle motors, were shipped overseas (Figure 3–58). This figure increased to 20.5 tons in Feb 2018 (Figure 3–59), mainly steel. Two more shipments in June and August 2018 weighed 40 tons, nearly half of it steel.
- The materials do not include vehicle bodies as there is no baler to compact the vehicles for shipment. Vehicles are still collected but further action will await possible help in securing a baler. Plastic bottles are no longer shipped overseas due to the cost, as well as changes to international waste transfer rules.
- There is a lack of government incentives to encourage recycling in Tonga. Private companies such as ‘Uiha and Sons Group are left to conduct the recycling on their own. Private recyclers get no discounts such as lower prices for taking left-over material to the landfill. The government must provide more support, including dealing with international waste transfers, to encourage private recyclers to invest more in the sector.

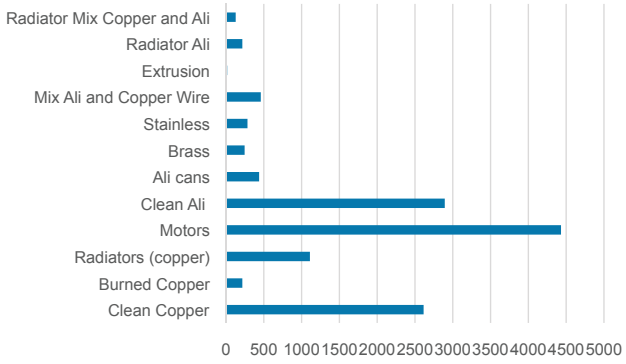


FIGURE 3–58 Recycling materials shpped overseas on Sep 2017

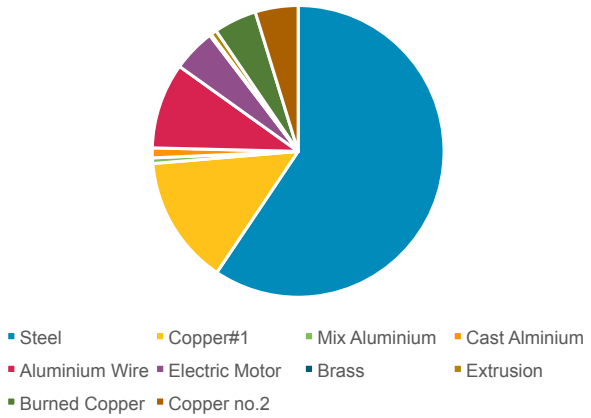


FIGURE 3–59 Recycling material shipped overseas on Feb 2018

TOTAL WASTE

- Municipal solid waste (MSW) is collected by a fleet of six vehicles.
- Current estimates for key waste streams are 114,600 to 18,250 tonnes of MSW per annum, with a composition of at least 50% organic (green and food waste) and an approximate Net Calorific Value (NCV) of 6 MJ/kg. Based on the data between 2016 and 2017, total waste disposal is increasing (Figure 3–60). This trend will continue due to growing imports and a move away from burning rubbish.
- Total solid waste collected in 2016–2017 was 11,667 tonnes and total liquid waste was 2,386,500 litres, most of it collected by the Waste Authority Limited (WAL). Waste is not sorted, and recyclable materials end up at the landfill. Liquid waste is also being dumped at the landfill.

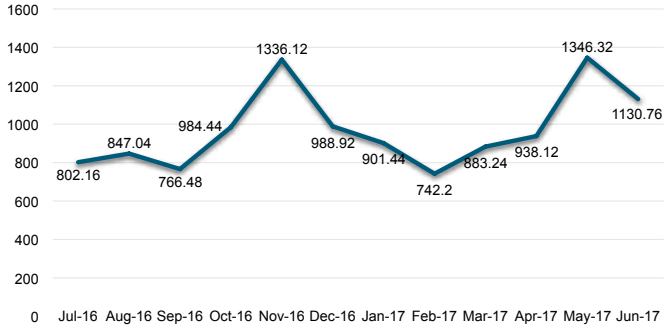


FIGURE 3–60 Total waste collected 2016–2017 (Waste Authority Ltd)

IMPACT

- Groundwater and Surface water contamination – if the landfills are not adequately sealed. The waste will fill the landfill sooner than expected, as it takes general waste as well as organic and recyclable materials.

RESPONSE AND RECOMMENDATIONS

- There is insufficient funding for WAL to cater for all the waste in Tonga. Broken garbage trucks and lack of equipment often lead to public complaints. These reflect the lack of resources and government support. WAL relies heavily on donors to provide resources. However, there is a need for government funding for WAL to be more effective.

WAL has run programmes to encourage recycling, such as reusing shopping bags. This report recommends:

- Sort rubbish into categories and improve record taking.
- Promote composting.
- Implement further recycling initiatives.
- Mandate the diversion of recyclable materials from the landfill.
- Government funding to both WAL and recycling entities is necessary to help reduce waste.
- Waste collection fees should be reviewed annually.
- Training should be made available for WAL staff and private recyclers, funded by government.

SOURCES: Data obtained from WAL and ‘Uiha and Sons Ltd (personal communication)

HAZARDOUS WASTE

Hazardous waste data is not recorded, however strict rules and regulations under the Basel Convention prevent the import (unless in compliance with international obligations), movement or dumping of any hazardous substances. This indicator reflects the ability of Tonga to adequately deal with hazardous waste.

Hazardous wastes generally include the following: Explosive, Flammable, Poisonous, Toxic, Ecotoxic and Infectious. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, accepted by Tonga on 26 March 2010, classifies hazardous wastes including;

- Clinical waste;
- Waste oils/water, hydrocarbons/water mixtures, emulsions;
- Wastes from production, formulation and use in resins, latex, plasticisers, glues and adhesives;
- Wastes resulting from surface treatment of metals and plastics;
- Residues arising from industrial waste disposal operations; and
- Wastes which contain compounds; copper, zinc, cadmium, mercury, lead and asbestos (Department of Environment and Energy, 2015).

Status
Poor

Trend
Unknown

Data confidence
Low

SDG	CBD
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	8

Status: Poor Trend: Unknown Data Confidence: Low

http://ergenvironmental.com/blog-listing/household-hazardous-waste/

STATUS AND TREND DISCUSSION

Tonga does not monitor hazardous waste or dispose of them safely as all waste is dumped or buried in landfill or on individual properties.

IMPACT

The impacts associated with hazardous waste are:

- Human health risks
- Environmental risks associated with spillages
- Economic risks associated with tourism where nature is the major drawcard
- Groundwater and surface water impact and risks
- Soil –agricultural practises

Increased pressures are observed from growing population and urbanisation, leading to likely increases in hazardous waste imports and subsequent disposal. Climate change risks are likely such as sea level rise impacting on dumping locations, waste impacting the groundwater reserves (used as potable and agricultural water), and lower economic returns from the visual images of pollution.

RESPONSE AND RECOMMENDATIONS

This report recommends:

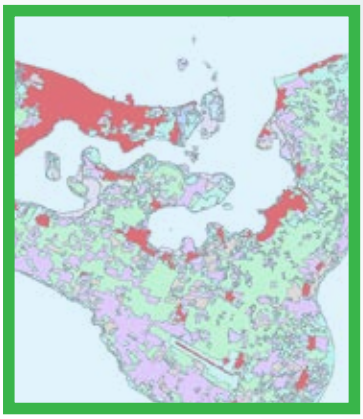
- Separate hazardous chemicals from municipal waste and recyclable materials.
- Disposal of hazardous waste correctly.
- Monitor amount of hazardous waste disposal and hazardous compounds entering Tonga.

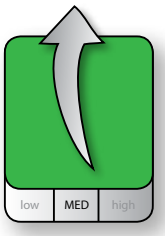
SOURCES

Department of Environment and Energy;. (2015, Jan 19). What is hazardous waste? Retrieved from Australian Government – Department of Environment and Energy:

ENVIRONMENTAL IMPACT ASSESSMENT

Land development can cause negative impacts. An environmental impact assessment (EIA) provides a framework to ensure proposed projects are sustainable and keep environmental damage to a minimum.





Status
Good

Trend
Improving

Data confidence
Medium

SDG	CBD
11 SUSTAINABLE CITIES AND COMMUNITIES	11

Status: Good Trend: Stable Data Confidence: Medium

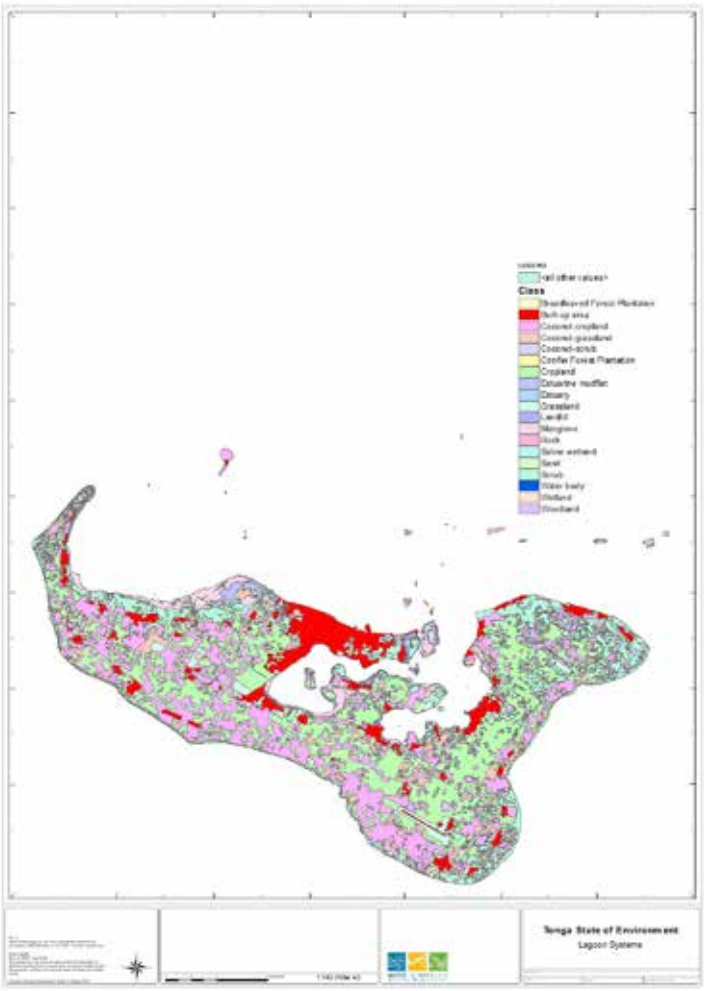


FIGURE 3–61 land use in Tongatapu (GIS Division, 2018)

STATUS AND TREND DISCUSSION

LAND DEVELOPMENT

Land development is a process that changes land use from one type to another such as taking a natural and unoccupied parcel of land and developing a township. This process has been used by every country since the dawn of time.. While this provides economic benefits, it puts pressure on the environment due to changes to the natural environment. Natural and sensitive habitats are replaced with impervious roads and homes, which result in removing flora and fauna, and changes to the hydrological cycle. Urbanisation also adds more waste and pollution, while hazardous and harmful substances often find their way into the nearby watercourses. These changes are managed in developed countries with funding and resources to limit damage to the environment. This is not the case in many developing countries including Tonga. Lack of resources in Tonga has seen a decline in environmental health from urbanisation due to inadequate development approaches and unsustainable land reclamation in coastal regions. Nuku'alofa and the nearby townships have been urbanised so too as other towns in outer region of the island as per (Figure 3–61).

Inadequate land development approaches caused by a lack of resources has led to the use of septic tanks in urban areas as there is no sewage drain network. This has led to septic tanks leaking raw sewage to the groundwater and the coastal regions. There is no stormwater reticulation system to retain and detain runoff during storm events. The runoff from roads, painted roofs and other surfaces, finds its way untreated

to the ocean or the groundwater. The groundwater table has lower safe yields as the runoff impairs the ability to recharge the groundwater.

Both commercial and residential developments, reported to the Minister of Environment under the Environmental Impact Assessment Act 2003, have increased in recent years (Figure 3–62). While this data is for Tongatapu, the other islands are also urbanising but at a different rate. This indicates that urbanisation is continuing. However, the increased registration means the authority assesses the proposed development and ensures they will comply with rules to minimise environmental impacts.

IMPACTS

While it provides economic benefits, development puts pressure on the environment. Natural and sensitive habitats are replaced with impervious roads and homes, which result in removing flora and fauna, and changes to the hydrological cycle. Concentrating and increasing waste discharge and air pollution in developed urban areas. Introducing of hazardous and harmful substances that find their way into the nearby watercourses.

RESPONSE AND RECOMMENDATIONS

This report recommends:

- A review of the Environmental Impact Assessment Act and Regulations in 2019.
- Increase public awareness and training of staff of the Department of Environment and other sectors (Compliance and Enforcement) – National/Regional and International Training).
- Registration of EIA Consultants with the Department of Environment by 2019 to ensure they meet the required standards and use state-of-the-art knowledge in their assessments and recommendations.
- Make submission to CEO/Minister to raise the resources capacity of the EIA Unit in terms of staff, monitoring equipment and finance.

SOURCES

GIS Division. (2018). *Forest Cover.* Nuku'alofa: Department of the Environment.

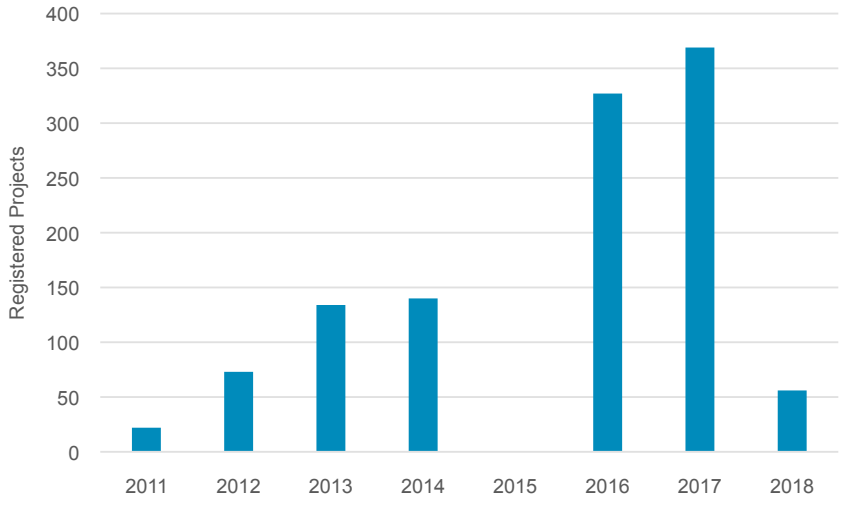


FIGURE 3–62 Registered projects (Ministry of Infrastructure)

THEME 7 CULTURE AND HERITAGE

Overview

This chapter discusses the culture and heritage significance in Tongan society in relation to the environment and the impacts of a changing environment. Tongan culture has strong links between people, society, culture and the environment. Four main indicators have been chosen to reflect the current relationship between culture and the environment:

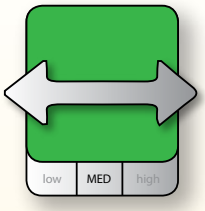
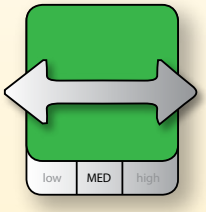
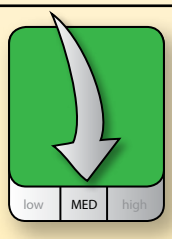
1. The state of languages and its link to environmental aspects pertaining to heritage sites, social hierarchy and traditional stories and beliefs.
2. The state of heritage sites and how they are influenced by the environment.
3. The state of the cultural industries.
4. The state of traditional diets and its link to culture, health, environment, food security and trade.

The Tongan people are very proud of their culture and heritage. The culture identifies with core beliefs dating to Aho'eitu (first King of Tonga in about 950 AD) (Latukefu, 1990). The country has two languages: Tongan and Niuafo'ouan, with the former being the common spoken language where it is taught in primary and secondary schools, while the latter is spoken only by people at the Ongo Niua and to a much smaller extent in 'Eua. English is increasing used and is also taught in schools.

Tonga has four core values: respect, loyalty, humility and reciprocity. These values are cultivated into the structure of society which is divided into three major groups: Monarch, Nobility and Commoners. A deeply religious country with over 12 main churches and 14 smaller churches. Traditional music and dance have significant value in society. Tongan culture also values the natural world (sun, moon, stars and winds) as well as the behaviour of birds and animals. Their abilitiy to navigate the vast ocean based on reading different signs of nature have decreased over the years due to more reliance on advanced technology. Climate change makes these practices and knowledge more difficult to maintain and preserve. The significance of the structure of society in the lives of Tongans provides the impetus to protect heritage sites such as 'Langi' (Monarchy Cemetery) and palaces.

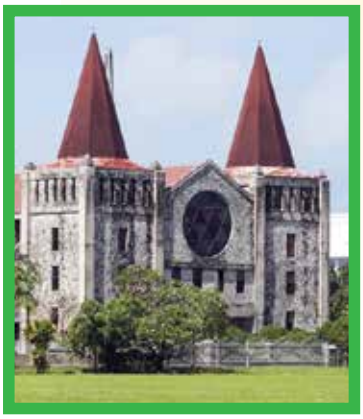
Historical monuments, sites, buildings, parks and resources are among the treasures which are valued. These heritage sites are spread around the islands. Underwater heritage has not been registered, such as caves or water supply sources such as (Vai ko Komo) in Faleloa. These sites are protected through legislation, and may be impacted in future by climate change. The effects on culture and heritage cannot be gauged by statistical analysis as there is a lack of statistical data, so some of the effects are based on arbitrary judgement.

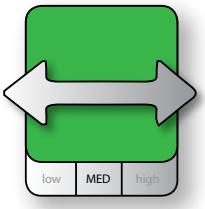
CULTURE AND HERITAGE HIGHLIGHTS

KEY AREAS	CURRENT STATUS	KEY TRENDS	RESPONSE AND RECOMMENDATIONS
LANGUAGE AND KNOWLEDGE	 **Status** Good **Trend** Stable **Data confidence** Medium	• The Tongan language is evolving with the loss of older words and changes in grammar. It is adopting some English words due to advances in technology and other influences. The Niuafo'ou language is under threat as it is only spoken at the Ongo Niua and has no formal literature to preserve it. • English is taught in schools and is increasingly used on a daily basis in business and socially. • The use of Tongan allegories and metaphors is declining in younger generations. • The Tongan music (hiva kakala) and traditional dances such as lakalaka and ma'ulu'ulu help preserve older words in the Tongan language.	• The Tongan language is taught in schools as part of the education syllabus. • Most of the population speaks, reads, and writes in Tongan. • Different programmes were recommended in 2011 to preserve the Niuafo'ou language, as it needs equality with the Tongan language. • The Tongan language is generally divided into three different registers, each respectively used when addressing the societal hierarchy. The addressing of the hierarchy and specific types of use in rituals are taught in schools.
HERITAGE SITES	 **Status** Good **Trend** Stable **Data confidence** Medium	• There are 47 main historical sites in Tonga. Most are in good state and well preserved. • The main cause of deterioration to sites is the climate change in the form of seawater rising.	• Different programmes have been recommended since a 2011 culture mapping study. • There is no data to show these programmes were implemented. • School curriculum teaches students about some of these sites and their significance in the Tongan culture.
CULTURAL INDUSTRIES	 **Status** Poor **Trend** Deteriorating **Data confidence** Medium	• Architectural knowledge is still preserved by professionals. Young generations do not have the knowledge and experience to construct traditional buildings (fale). • Other crafts such as making katoalu (bags) are in decline as fewer people know how to make them. • Cultural items are being replaced with modern items. • The market for cultural industries relies on Tongans overseas, and prices differ between countries.	• Different programmes have been recommended since a 2011 culture mapping study. • There is no data to show these programmes were implemented. • School curriculum teaches students about traditional items and how to make them.
TONGA TRADITIONAL DIETS	 **Status** Poor **Trend** Deteriorating **Data confidence** High	• The country relies on imported food resulting in a lower consumption of traditional diets. Knowledge of preparing some traditional diets is being lost.	• Different programmes have been recommended since 2011 culture mapping study. • There is no data to show these programmes were implemented. • School curriculum teaches students about traditional diets and how to make them.

LANGUAGE AND KNOWLEDGE

This indicator looks at the ability of Tonga to maintain its native languages and local knowledge.





Status
Good

Trend
Stable

Data confidence
Medium

SDG	CBD
4 QUALITY EDUCATION	

Status: Good Trend: Stable Data Confidence: Medium


Source: FirestarSydney, 2018

STATUS AND TREND DISCUSSION

There are two main languages in Tonga: Tongan and Niuafo'ouan. The Tongan language is the main language. Only a small number speak the Niuafo'ou language and it is rarely written or read. Children at the Ongo Niua do not learn their mother tongue at school and it is under threat of being extinct (Fua, Tuita, Lotaki, & Fuko, 2011). The Tongan language is part of the education syllabus and it is taught in both primary and high schools.

Tongan society traditionally consists of three main groups that rank by hierarchy: Tu'i (monarch); Hou'eiki (nobility) and Kakai (commoners). The Tongan language follows this hierarchy with three different registers, each respectively used when addressing the king, nobles and commoners. The traditional organisation also includes the tribes (*ha'a*) headed by the noble or the 'Ulumotu'a. With increasing population and migration, most Tongans are not aware of their ha'a, or have ignored this traditional organisation. Tongans now tend to focus on their villages/towns or religions rather than their ha'a. The essence of the Tongan language comes in the form of poems, songs and proverbs that are highly metaphorical. One of the key features is the use of allegories and metaphors whose meaning is only understood by those with knowledge of the events, time and place. There are signs of the young generation losing this art and failing to learn and practice the use of traditional allegories and metaphors (Fua, Tuita, Lotaki, & Fuko, 2011).

Traditional music, dance and ritual help to preserve the Tongan language. There are two types of music, religious

songs in the form of hymns, and secular songs containing poetic love songs and other traditional forms (hiva kakala). The dance is organised into groups and performed by males, females, or both. Some of the main dances include lakalaka, ma'ulu'ulu and tau'olunga (Fua, Tuita, Lotaki, & Fuko, 2011). Rituals and customs highlight the core values of Tongans as they are associated with traditional culture and religious practices. Traditional performing arts are a crucial component of Tongan rituals and ceremonies. The traditional Kava ceremony uses older Tongan words specifically formed to differentiate the ranking in society. These rituals preserve the Tongan language and link closely with the environment as items such as tapa, mats, kava and other materials use natural resources.

Advances in technology have seen an increase in the use of English, as in the field of communication and information technology. The Tongan language is adapting by producing new words that follow the sound of the English words. For example, the word 'telefoni' is the Tongan interpretation of the English word 'telephone'. These new words are commonly used together with Tongan. Young generations are growing up with these new words which may contribute to the loss of older Tonga words.

Agriculture and fishing are the main sources of living and income in Tonga. Traditional knowledge about the land, conservation methods and weather patterns are still practiced by farmers, especially those living in remote islands. Crops are grown for both commercial and home use. The knowledge associated with agriculture, while still practised, is largely considered to be lost (Fua, Tuita, Lotaki, & Fuko, 2011). The increasing pressures associated with climate change and the impact of sealevel rise in certain islands provides the impetus to revisit the traditional knowledge for conservation and planning (Fua, Tuita, Lotaki, & Fuko, 2011).

The skills needed for fishing and traveling the ocean continues to play vital parts in the lives of the Tongan people, especially those living in outer islands. There are over forty traditional fishing types (Fua, Tuita, Lotaki, & Fuko, 2011), which are at risk of being lost due to greater reliance on advanced fishing techniques and equipment. The over-fishing of various marine species including sea cucumber is resulting in a lack of shellfish and small reef fish. Excessive clearing of mangroves due to land reclamation has reduced the spawning area for fish. Environmental impacts compounded by unsustainable commercial approaches to the fishing industry is depleting the marine offshore and inshore resources available for local fishermen.

Tongan people have a proud history relating to their navigation skills that allowed them to settle in Tonga. Early voyagers used ocean currents and guiding stars known as *kaveinga to navigate the open seas to their destinations* (Piazza & Pearthree, 2007). These skills continued until the late seventies where the reliance on traditional skills shifted to the advanced technology provided by a compass and other navigation equipment. As a result, there are very few navigators who know and use traditional navigation skills. The lack of practice and use of these skills has added to the loss of this valuable knowledge system.

Traditional medicine is still practised and complements modern medicine, although there is often friction between the two with certain illnesses. Traditional medicinal plants such as uhi, nonu, lautolu and lepo are available.

The data for this section comes from the Cultural Mapping, Planning and Policy: Tonga scheme developed in 2011. No statistical data is available to estimate scientific trends for the languages and knowledge.

IMPACT

Both the Tongan and Niuafo'ouan languages are changing due to the influence of new technology and the inclusion of the English language in schools. The Niuafo'ouan language is under threat of becoming extinct while the Tongan language is losing some of its older words particularly with the younger generation.

Traditional music and dance is considered to be well preserved although the use of poetic metaphors is decreasing. Rituals are still practised reflecting the values of the hierarchical society. Traditional agriculture and fishing practices are being replaced with modern techniques. Traditional navigation skills are considered to be lost.

RSPONSE AND RECOMMENDATIONS

Under the Cultural Mapping, Planning and Policy: Tonga scheme developed in 2011, key responses and recommendations were developed to counter the impacts on language and knowledge (Fua, Tuita, Lotaki, & Fuko, 2011). The responses and recommendations are summarised as follows:

- Preserve the Niuafo'ouan language by promoting it in schools, particularly for Niuafo'ou and 'Eua. Promote it as one of the native languages that Tongans must recognise.
    - The key recommendation is to promote the Niuafo'ouan language in the curriculum, including teaching and learning materials.
        - Develop a language council specifically for the protection, promotion and development of the Niuafo'ou language.
- Protect the Tongan language grammar and vocabulary, ensuring guidelines are widely known and followed by publishing companies, media and schools.
    - Promote the use of the Tongan language in government correspondence and documentation, and use the Tongan language for public signs.
    - Promote the Tonga National Language Policy.
    - Promote events for Tongan literature that will encourage poetry, plays, music and performing arts.
        - Develop new Tongan words to describe new phenomena.

    - Develop a guide to ensure that both Tongan and Niuafo'ouan languages are equally important.
    - Develop courses at higher education institutions.
    - Develop a Tongan literature organisation to focus on promoting written Tongan text for all reading levels.
- Protect social traditional structure by encouraging events for tribes (*ha'a) to come* together.
    - Promote the importance of *ha'a* among nobles and key figures in villages.
        - Develop council that will protect *ha'a* and promote harmony among them.
- Traditional knowledge system (TKS) to be protected by detailed documentation of systems, including inventories and archives where the public can access records.
    - Promote the preservation TKS through educational programmes.
    - Promote traditional performing arts in schools, churches and communities.
        - Develop teaching and learning materials for communities in each TKS area, and develop community training programmes.
        - Develop programmes that use TKS to address the impacts of climate change and to ensure food security.

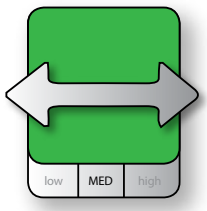
SOURCES

Fua, Seu'ula Johanson, Tu'ilokomana Tuita, Kanongata'a Siosiua Lotaki, and Koliniasi Fuko. 2011. *Cultural Mapping, Planning and Policy: Tonga.* Nuku'alofa, Tonga: Secretariat of the Pacific Community.

Piazza, Anne Di, and Erik Pearthree. 2007. "A New Reading of Tupaia's Chart." *Centre National de Recherche Scientifique Centre de Recherche.* Marseille.

BUILT HERITAGE AND INDIGENOUS SITES

This indicator assesses the status of heritage and indigenous sites in Tonga.



Status
Good

Trend
Stable

Data confidence
Medium

FIGURE 3–63 Blow holes in Houma

SDG	CBD
11 SUSTAINABLE CITIES AND COMMUNITIES	

Status: Good Trend: Stable Data Confidence: Medium

STATUS AND TREND DISCUSSION

The land (*fonua) encompasses not only the land, animals and plants but also the ocean and sky* (Fua, Tuita, Lotaki, & Fuko, 2011). The most recognised tangible heritage for Tonga consists of historical monuments, sites, buildings, parks and resources considered of cultural significance to Tongan society (Fua, Tuita, Lotaki, & Fuko, 2011). Tonga's cultural and natural heritage includes plants, animals, the sky and treasures of the ocean. It should be noted, however, that in Tongan classification it is not always easy to separate 'cultural' from 'natural' and 'tangible' from 'intangible' cultural heritage, as they are often intertwined. Most of the sites are located in Tongatapu (Figure 3–64 and Figure 3–65). A list of representative sites is shown (Table 3–14) (Fua, Tuita, Lotaki, & Fuko, 2011).

FIGURE 3–64 Location of historical sites in Tongatapu and ‘eua.
Ministry of Tourism

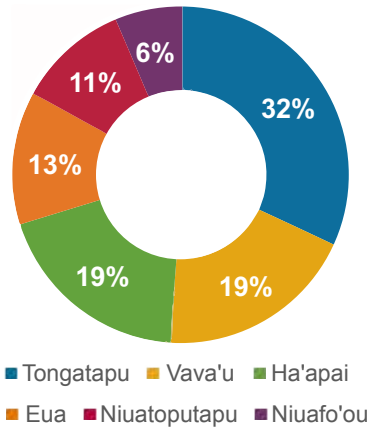


FIGURE 3–65 Main cultural and natural heritage sites in Tonga

TABLE 3–14 cultural and heritage sites in islands ((Fua, Tuita, Lotaki, & Fuko, 2011)

Island	Cultural and Natural Heritage	Brief Description
Tongatapu	Ancient capital of Tonga	Includes the royal tombs, old forts, ports, traditional homes at Mu'a.
	Ha'amonga Historic Park	Includes the Tu'itīātui historic seat and surrounding monuments at Niut'ua.
	Captain Cook’s landing	Situated at 'Alaki.
	Royal palaces	Includes the royal palaces in Nuku'alofa and Fua'amotu.
	Mala'e Kula (royal tombs)	Current dynasty’s royal tombs in Nuku'alofa.
	Mapu 'a Vaea (blowholes)	Of natural significance, including legends of Houma.
Vava’u	Pouono	Of historical significance to forming modern government.
	Lolo 'a Halaevalu	Historical site where Vava'u’s main harbour is now located.
	'Ana Pekepeka ('Otea)	Cave located by the ocean and accessible by boat.
Ha’apai	Royal palace at Lifuka	Architectural and historical significance.
	Makahokovalu	Site of eight slabs of rock forming a square, associated with history and legends.
	Royal tombs at 'Uiha	Burial grounds of high-ranking chiefs, with associated history and legends.
‘Eua	Lī'angahuo 'o Maui	Entryway where ocean enters island, creating an inland pond.
	Matalanga 'a Maui	Large inland crater said to have been dug by the god Maui.
	'Ana'ahu	Deep inland cave that descends underground.
Niuatoputapu	Volcano of Tafahi	Piu 'o Tafahi includes fort, freshwater crater and associated legends.
	Vai ko Niutōua	Inland freshwater pool with associated legend.
Niuafo’ou	Volcano of Niuafo'ou	One of the live volcanoes of Tonga, the island is habitable.
	Vai Lahi and Vai Si'i	Freshwater craters.

There are no data to determine if the above heritage sites have deteriorated over the years. Hence, their status cannot be judged. However, most of these sites are extant and by general observations are in a good state as per the advice given by the Ministry of Tourism.

In 2004 Tonga acceded to the Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention, 1972) (Fua, Tuita, Lotaki, & Fuko, 2011). The core function of the convention is to give cultural and natural heritage a function in the life of the community and to integrate the protection of that heritage into comprehensive planning programmes. This provides the umbrella that protects these sites. Since signing the convention Tonga has appointed a focal point on world heritage for Tonga, as part of a Pacific world heritage. The Minister for Agriculture, Forests and Fisheries, Lord Vaea, is collaborating with the Australian government into designating the Lapaha royal tombs and Ha'amonga as world heritage sites.

IMPACT

The impact of the environment and human activities on cultural sites cannot be gauged without data. However, climate change and sealevel rise will have negative effects on some of these sites. For instance, sea level rise may increase the wave heights and cause more erosion to the 'Makahokovalu' in 'Uiha as it stands on the beach. Natural disasters can also have negative effects on heritage sites.

RESPONSE AND RECOMMENDATIONS

The following responses and recommendations have been outlined to protect the cultural and natural heritage sites (Fua, Tuita, Lotaki, & Fuko, 2011):

- Form committee for cultural and natural heritage.
- Develop clear terms of reference for national committee.
- Develop a legal framework to support the protection, promotion and development of the cultural and natural heritage of Tonga.
- Develop a local committee for cultural and natural heritage that is built into existing local councils.
- Develop, in collaboration with local councils, clear terms of reference for local committees working on the protection, promotion and development of cultural and natural heritage.
- Develop processes and systems to provide funding support for local committees to carry out their work.
- Continue the identification and formalisation of sites.
- Build education and awareness programmes for the promotion of national cultural heritage.
- Conduct an inventory of Tonga's cultural heritage; develop and maintain a database for inventory, and ensure the database is open to the public.
- Complete work on the Ha'amonga and royal tombs for submission as world heritage sites.
- Work on submitting other sites and artefacts for consideration as cultural heritage.
- Collaborate with Tonga Tourism on the development and maintenance of national cultural sites, including publication of tourism material on the sites.
- Collaborate with schools, youth groups and community groups on developing programmes that foster pride and build better understanding of cultural sites.
- Develop education and awareness programmes for the promotion of national natural heritage.
- Conduct an inventory of natural heritage and add this to a cultural heritage database.
- Collaborate with key stakeholders (Tourism, Lands & Environment, community, etc.) in developing programmes to sustainably manage natural heritage, including maintenance of natural heritage sites, and programmes to encourage environmentally sound and sustainable farming.

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CULTURAL INDUSTRY

Culture industries have been a major source of income for the tourism industry. It allows trade between the locals and tourists where artefacts, materials and local delicacies are sold. This section provides information to show the current status of cultural industries in Tonga. In general, 'cultural industries' include advertising, architecture, the art and antiques market, crafts, design, designer fashion, film and video, interactive leisure software, music, performing arts, publishing, software and computer games, and radio and television (Fua, Tuita, Lotaki, & Fuko, 2011).

Status
Poor

Trend
Deteriorating

Data confidence
Medium

SDG	CBD
	

Status: Good Trend: Deteriorating Data Confidence: Medium

Museum of New Zealand, 2018

STATUS AND TREND DISCUSSION

ADVERTISING

In 2011, advertising agencies were growing in Tonga. Advertising is mainly through newspapers, television, the internet, text messages and billboards. The growth of advertising platforms has also seen an increase in advertising agencies. Previously, the agencies were linked to radio and newspaper outlets, but are now joined by private firms who focus on advertising. The market has expanded from a local focus to include regional and international interests, largely due to the internet and improved communications (Fua, Tuita, Lotaki, & Fuko, 2011).

ARCHITECTURE

Traditional houses (*fale*) are becoming rare in Tonga due to cheaper modern materials. However, there are modern buildings with fale-shaped domes (e.g. Tupou College's church, the Tonga National Centre, and Falemasiva of Tailulu College) and some modern houses with traditional sinnet weaving found inside (fale lalava). The traditional building skills and sinnet weaving are vanishing as modern building styles take over. A few historical buildings are maintained in Tonga, including the newly renovated Royal Palace in Nuku'alofa and the Free Wesleyan Church's Centenary Church. Traditional Tongan architecture now includes not only fale, but also the 19th-century colonial style (as in the royal residences in Fua'amotu, Kauvai and Polata'ane). Contemporary building styles do not have a

single strong architectural influence to reflect a distinctive Tongan style. Architectural patterns are sometimes seen in church buildings, as in those of the Latter-day Saints, the Catholic Church and Free Church of Tonga. Residential buildings generally reflect where the building materials were imported from or a local influence (Fua, Tuita, Lotaki, & Fuko, 2011).

ART MARKET

Events such as the Kava Kuo Heka Festival give local artists an opportunity to display and sell their art. However, these events are uncommon even though there is a market for them. Local artists tend to use local materials, including *ngatu* and pandanus, in their work and their paintings and creations have a strong Tongan identity. Occasionally, overseas-based Tongans join local exhibitions. The current art market is very much ad hoc and depends on opportunities for exhibitions (Fua, Tuita, Lotaki, & Fuko, 2011).

TONGAN CRAFTS

Tonga's main cultural industry is handicrafts, which includes the production and sale of mats, *ngatu (tapa cloth), jewellery, carvings, and so on. The 2006 census showed that 9,242 people were involved in the production of handicrafts, representing 26.4% of the active working population* (Fua, Tuita, Lotaki, & Fuko, 2011). In the 2016 census, this number increased to 17,250 people (Tonga Statistics Department, 2016). These producers were spread across all the island provinces of Tonga, and most were women. Only the private sector exports these goods. The value included mats and plaiting materials, *ngatu*, other Tongan handicrafts, basketwork, wickerwork and other articles. The main markets were New Zealand, Australia and the United States of America, while smaller markets included American Samoa, Samoa, Fiji and Italy. There are two main markets for Tongan handicrafts: Tongans both locally and internationally, and tourists. All of the products sold for the Tongan market are used to meet cultural obligations for birthdays, weddings, funerals and other community festivals and activities. The products sold for the Tongan market tend to preserve the traditional methods. Other than a few alterations in patterns and the use of raw materials, the measurements and basic design of mats and ngatu have remained the same over time. The value and volume of the products for the Tongan market have significantly increased over the years, with more overseas Tongans able to afford mats and ngatu. The sale of mats and ngatu for overseas Tongans provides a healthy business for some local communities (Fua, Tuita, Lotaki, & Fuko, 2011).

IMPACT

Few people still have the knowledge to build a traditional fale. Younger generations are growing up with modern houses and have not practised the arts of building a fale from natural materials. Other crafts such as making *katoalu* bags also have fewer weavers. The market for cultural items relies on Tongans overseas.

RESPONSE AND RECOMMENDATIONS

The following responses and recommendations have been made (Fua, Tuita, Lotaki, & Fuko, 2011):

- Protection of traditional cultural industries by promoting the traditional knowledge systems associated with handcrafts, arts, and architecture, and promote livelihoods in cultural industries.
  - Develop programmes based on economic and art incentives to strengthen understanding and use of traditional knowledge systems associated with handicrafts, arts, music and performing arts.
  - Develop education and training programmes that will encourage livelihoods through handicrafts, arts, music and performing arts. These include creation of unique Tongan products; reproduction of these products; and promotion, communication and marketing strategies to encourage wider distribution of products and consumer understanding.
- Promote education in cultural industries.
  - Develop programmes and activities to assess the economic potential of each cultural industry, i.e. how much money can the industry earn?
  - Develop programmes that will train and encourage people to work in cultural industries.
  - Develop mechanisms that will provide quality checks and standards for products.

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Traditional Diets

Traditional diets for Tongans were obtained from natural resources. Food sources such as yams and taro were grown with vegetables. Protein sources were mainly from seafood, chickens, pigs, cattle and birds. Water was obtained from groundwater wells supplemented by rainwater and coconuts. Food was prepared using open fires or the Tongan oven (*umu*). Preserving food was only for a short period as there were no preservative chemicals. Diets were mainly fresh and organic. These organic diets and way of living have changed since the 1960s.

Status
Poor

Trend
Deteriorating

Data confidence
High

SDG	CBD
2 ZERO HUNGER	

Status: Poor Trend: Deteriorating Data Confidence: High

STATUS AND TREND DISCUSSION

Globalisation allows people, ideas and goods to move in and out of the country. This has led to greater reliance on food imports and a shift away from traditional foods (Evans, Sinclair, Liava'a, & Freeman, 2010). Imported food contains fatty meats, especially corned beef, mutton flaps, and chicken parts, and dense simple carbohydrates, such as refined sugar and flour, which are among the main causes of the rising rates of health issues. The greater consumption of imported food is based on economic factors such as lower price or wider availability. Although Tongan people still prefer traditional foods and accurately perceive these as more nutritious, their consumption patterns do not coincide with preference or nutritional value. The consumption of inexpensive, high calorie, fatty

FIGURE 3–66
Traditional foods at market

foods are associated with increases in diet-related non-communicable diseases. Under globalisation where the rate of consuming imported food has increased, it has also had profound consequences on health, as shown by the rising rates of non-communicable diseases throughout the Pacific (Evans, Sinclair, Liava'a, & Freeman, 2010).

Figure 3–67 which shows the rate of 'sausages and similar products, of meat offal or blood food preparations based on other meat products' imported between 2004 and 2014 (Statistics Department, 2016). The quantity of imports in 2014 is over three times the amount imported in 2006. This trend is mirrored by other food imports. The current diet in Tonga consists of a mixture of local and imported products. The most frequently consumed per week are cassava (eaten an average of 1.89 times per week), bread (2.09), mutton flaps (2.26), taro greens (2.30), hibiscus greens (2.46), fish (2.61), yams (2.78), and imported chicken parts (2.90) (Evans, Sinclair, Liava'a, & Freeman, 2010).

The reliance on imported food has a negative impact on the knowledge of Tonga diets especially in recipes and food preparation. Certain dishes such as *hami (from coconut) are lost* (Malo Tonga, 2018), while others are rarely made and only by older generations, such as *faikakai Malimali* (cassava dessert). Some of these recipes are documented but no longer made. Younger generations are not being taught to preserve the knowledge on Tongan diets.

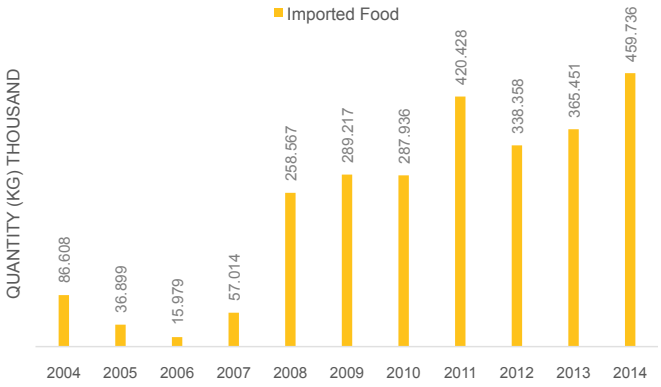

FIGURE 3–67 Imported Sausages and other meat products (Statistics Department, 2016)

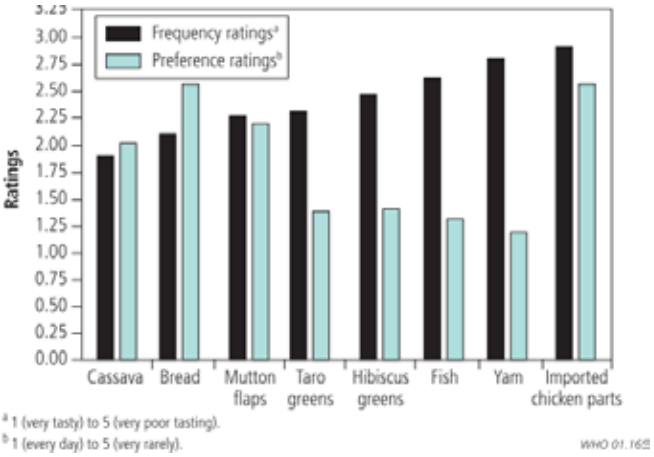

FIGURE 3–68 Ratings of frequency of consumption and preference for foods consumed more than once as week (Evans, Sinclair, Liava'a, & Freeman, 2010)

IMPACT

The negative impact due to higher consumption of imported food in comparison to traditional diets is shown by the growing incidence of non-communicable diseases. Traditional diets are in sharp decline. Local diets are now a mix of mainly imported, and some local, products. Food imports also add to waste from packaging and plastic containers.

RESPONSE AND RECOMMENDATIONS

No definitive response and recommendation has been found during this study to preserve traditional diets. However, health concerns highlighted in studies and programmes indicate that the health sector to reduce consumption of food imports, and lift the use of healthier traditional diets.

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