# Climate Impacts on Pacific Water Security and Water Resource Management:

A stocktake of institutional settings and management challenges in eight Pacific Island countries.

Australian Aid | Australia Pacific Climate Partnership

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# Acronyms

| | |
|---|---|
| ABOM | Bureau of Meteorology (Australia) |
| ADB | Asian Development Bank |
| AWP | Australian Water Partnership |
| CBD | Central Business District |
| CCA | Climate Change Adaptation |
| CCDA | Climate Change Development Authority (PNG) |
| CBLUP | Community-Based Land Use Planning |
| CLEWS | Climate Early Warning System |
| CLTS | Community-led total sanitation |
| CMIP5 | Coupled Model Intercomparison Project Phase 5 |
| DDA | District Development Authorities, PNG |
| DFAT | Department of Foreign Affairs and Trade, Australia |
| DRR | Disaster Risk Reduction |
| EIB | European Investment Bank |
| ET | Evapotranspiration |
| EU | European Union |
| ENSO | El Nino Southern Oscillation |
| FCPF | Forest Carbon Partnership Facility |
| GCCA+SUPA | Global Climate Change Alliance plus Scaling Up Pacific Adaptation |
| GDP | Gross Domestic Product |
| GCF | Green Climate Fund |
| GEDSI | Gender equality, disability, and social inclusion |
| GEF | Global Environment Facility |
| GIS | Geographic Information Systems |
| GPM | Global Precipitation Measurement |
| GSA | Greater Suva Area of Fiji |
| GWSP | Global Water Security and Sanitation Partnership |
| ICM | Integrated Catchment Management |
| IWRM | Integrated Water Resource Management |
| KCCP | Kiribati Climate Change Plan |
| KJIP | Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management |
| KOIFWP | Kiribati Outer Islands Food and Water Project |
| KMISE | Kiribati Ministry of Infrastructure and Sustainable Energy |
| KSA | Key Strategic Action |
| LLG | Local Level Government (PNG) |
| MAR | Managed Aquifer Recharge |
| MFAT | Ministry of Foreign Affairs and Trade, New Zealand |
| MHEWS | Multi-Hazard Early Warning System |
| MLMR | Ministry of Lands and Mineral Resources, Fiji |

| | |
|---|---|
| MLNR | Ministry of Lands and Natural Resources, Vanuatu |
| MMERE | Ministry of Mines, Energy & Rural Electrification, Solomon Islands |
| MMRD | Ministry of Maritime and Rural Development, Fiji |
| MOA | Ministry of Agriculture Fiji |
| MOCC | Ministry of Meteorology Geological Hazards and Climate Change, Vanuatu |
| MOFNP | Ministry of Finance and National Planning, Tonga |
| MOIT | Ministry of Infrastructure and Transport, Fiji |
| MOWE | Ministry of Waterways and Environment, Fiji |
| NWSHA | National Water, Sanitation and Hygiene Authority, PNG |
| NAPA | National Adaptation Programme of Action |
| NBS | Nature-based solutions |
| NZ | New Zealand |
| PMU | Program Management Unit |
| PNG | Papua New Guinea |
| PUB | Public Utility Board, Kiribati |
| REDD+ | Reduction in Emissions from Deforestation and Degradation plus reforestation and conservation management |
| R2R | Ridge to Reef catchment management |
| SDG 6 | Sustainable Development Goal 6 |
| SEA | Social Enterprise Alliances |
| SI | Solomon Islands |
| SIWA | Solomon Islands Water Authority |
| SDD | Statistics for Development Division of SPC |
| SPC | Pacific Community |
| SWA | Sanitation and Water for All |
| SWA | Samoa Water Authority |
| TLTB | iTaukei Land Trust Board Fiji |
| WAF | Water Authority of Fiji |
| WASH | Water Sanitation and Hygiene |
| WB | World Bank |
| WISH | Watershed Interventions of Systems Health |

# Glossary

**Coupled Model Intercomparison Project Phase 5**: global climate model simulations used as references by the United Nations Framework Convention on Climate Change.

**Evapotranspiration:** The sum of water evaporation and transpiration from a surface area to the atmosphere, commonly measured in mm / year.

**Integrated Catchment Management**: Integrated management of land, water, and related biological resources in order to achieve the sustainable and balanced use of these resources (Australian Water Association).

**Integrated Water Resource Management**: A process which promotes the co-ordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. (Global Water Partnership).

**Managed Aquifer Recharge (MAR)**: Refers to the intentional recharge of water to aquifers for subsequent use or environmental benefit.

**One Health initiatives**: multi-sectoral responses to food safety hazards, risks from zoonoses, and other public health threats at the human-animal-ecosystem interface.

**Sustainable Development Goal 6:** Aims to ensure availability and sustainable management of water and sanitation for all by 2030.

# Executive Summary

This stocktake report explores the climate impacts on water security and water resource management in eight Pacific Island nations and outlines the governance and institutional systems managing such impacts. In doing so, this report also outlines current and future water resource management challenges and opportunities for future development assistance investment. Legislation, policies, and scientific literature were reviewed and supplemented by consultations with water scientists and water professionals from academic institutions, Pacific regional organisations and civil society organisations.

In terms of water security, the impacts of climate change in the Pacific can be summarised as:

- **Increased risk of floods**: Higher rainfall intensity causes damage to infrastructure, overwhelms existing drainage systems and increases health risk from polluted water. Mean rainfall is highly variable across the Pacific region, however, in many locations, increases in equatorial rainfall is expected. In the Pacific, longer term risks from flooding include food insecurity from crop loss, soil erosion, loss of riparian vegetation and damage to reefs and onshore saltwater ecosystems.
- **Drought**: The frequency, severity, and duration of droughts on high islands leads to reductions in stream flows and lowering of perched aquifer water tables and, on low islands, to contraction in the thickness, areal extent and volume of freshwater lenses and coastal aquifers, and to reductions or seasonal cessations in spring flows (Falkland & White, 2020). Severe droughts have caused major health impacts including malnutrition from reduced food supply, conjunctivitis, scabies, influenza-like illnesses and diarrhoea (Falkland & White, 2020).
- **Storm surges**: In addition to short-term flooding effects, storm surges contribute to saltwater intrusion and contamination of fresh groundwater lenses. Many months or even years may be required for rainfall recharge to 'flush' the saltwater from freshwater lenses and restore wells to a potable condition (Falkland & White, 2020). Sea levels, a strong influencer of storm surge, are projected to continue to rise throughout the 21$^{st}$ century and beyond (IPCC, 2019). However, considerable intra-regional variations exist, and the impact of sea level-rise and storm surge will also depend on island topography (e.g., volcanic vs low-lying atolls) (ABOM & CSIRO, 2014)

Despite many initiatives to improve data collection for water, sanitation, and hygiene (WASH), and water governance more broadly, information remains patchy, but it is evident that most Pacific Island countries and territories will not meet the 2030 targets for Sustainable Development Goal 6 – clean water and sanitation. Papua New Guinea, Kiribati and Solomon Islands are particularly concerning in relation to improved drinking water, and most other Pacific Island countries have very limited coverage and access to sanitation systems.

To address these issues, the focus on water resources and WASH needs to be elevated. It is has been proposed that high-level priorities for improvement in the region should be in the areas of: (1) strengthened leadership on water; (2) strengthened local capacity; (3) investment in evidence-based decision-making; (4) increased advocacy; (5) coordination across sectors; and (6) more effective frameworks for action.

At the regional level, there are a number of areas that would benefit from additional targeted assistance and support through regional organisations, additional co-financing with major donors or bilateral assistance to national governments.

Areas where regional support would contribute to greater climate resilience in water include:

- Legislation and administration
- Regional governance of WASH
- Fostering greater inclusion of and leadership by women
- Integration of hydrologic and demographic planning
- Drought preparedness planning
- Irrigation design and management
- Urban planning and design
- Alternative models of service provision
- Training
- Desalination
- Integrated Catchment Management.

A set of recommendations for future support are made for each of the eight Pacific Island countries in this report. Where possible and appropriates, these recommendations are closely aligned with the national development goals of each Pacific Island country.

# Research objectives and methods

The primary objective of the stocktake report is to develop the evidence base needed for effective actions and funding priorities to support Pacific Island nations improve long-term water security (considered in terms of quality and quantity) in the context of climate change and identify key challenges and 'hot spots' or 'pressure points' in Pacific water governance and management.

The stocktake focuses on the governance and management of hydrological systems at national, provincial, and local scales, and systems for water allocation, particularly in the context of rural and peri-urban water use, including issues relating to water supply that are often referred to as the Water, Sanitation and Hygiene (WASH) sector. The stocktake presents regional- and national-level interventions that can be prioritised through the Australian aid program.

Eight Pacific Island countries were selected for this stocktake; selected to represent a cross-section of the issues facing Pacific Island countries and territories. Selected countries are Fiji, Kiribati, Papua New Guinea (PNG), Samoa, Solomon Islands (SI), Tonga, Tuvalu and Vanuatu.

The report was guided by the following research questions:

1. What are the key implications of climate change for water security?
2. What is the institutional setting for water resources management - policy, legislation, institutions, governance at national, subnational and community levels?
3. Who has the mandate for deciding on water allocations at these levels?
4. How are these agencies/groups taking account of climate change?
5. What are the characteristics of 'hotspots' where access to reliable potable water is compromised/stressed and compounded by climate change impacts?
6. What are the barriers and enablers of improved water governance?
7. What are the opportunities under the Australian aid program to address these, including through programs such as the Australian Water Partnership and Water for Women?

The stocktake was undertaken using two methods of data collection: expert consultation and document research. A total of 10 expert consultations (via interviews and conversation) were carried out with senior academics, past or current senior managers from national ministries and key regional coordinators operating under the auspices of the Pacific Community (SPC). Documents reviewed in this assessment include peer-reviewed academic articles and authoritative scientific reports (e.g., the IPCC's assessment reports), reports by donors and regional organisations, and government legislation, policies, and plans, with a particular focus on water, catchment management and climate change adaptation.

The remainder of the report is divided into two sections. The following section provides a regional perspective. Climate projections are described (focusing on variables important to the water sector), followed by progress towards the achievement of SDG 6; specifically, indicators on integrated water resource management (IWRM) and national water supply coverage and sanitation. Regional priorities

are then outlined, followed by recommendations and opportunities for future investment.

The second section provides stocktakes for each of the eight countries, separately. This section provides an outline of the country-level climate change projections, compounding issues, water management frameworks, and the pressures and responses relating to urban, peri-urban and rural water governance. Each national stocktake concludes with recommendations for future funding opportunities at regional and bilateral levels.

An overview of existing water-related programs implemented in the Pacific is given in Annex 1. An overview of the coverage of relevant legislation for all eight countries is given in Annex 2. The responsible ministry and their scope of responsibility is provided in Annex 3.

# Pacific regional overview: Climate change projections, SDG 6 progress and priorities

## Introduction

Water (surface water, groundwater, and rainwater) is the main way that people experience climate variability, climate change and hazards. Too much or too little clean water directly affects the livelihoods and wellbeing of Pacific people. For this reason, many agencies and actors have strengthened their investments and efforts in water resource management, ridge-to-reef approaches to the environment and targeted action on household water, sanitation and hygiene (WASH), recognising the centrality and multiple benefits of this work.

Climate change is not the first thing that communities raise in relation to the quality and quantity of their water. Illnesses of children, travelling to collect water, drought-affected crops, reduced income, scarcity of fish, equitable access – these everyday concerns are the pressure points for communities. Therefore, enduring programs tend to take a holistic approach to improving water management, that includes improvements to other factors of wellbeing and human dependency on the natural environment. On the 'high' islands of the Pacific (i.e., of volcanic origin), this ranges from the onshore reefs that protect coastlines, the floodplains of urban settlements, all the way to the headwaters of the mountains (the 'ridge to reef' view of catchments). On the atoll islands the dependency again starts with the onshore reefs that provide protein and coastal protection and extends to the precious areas of groundwater recharge, and the vegetation that protects the thin soils and the quality of the water.

Because water is integral, there are not always appropriate, fit for purpose governance arrangements for water. At national and provincial levels, aspects of legislation relating to climate change and water are often implicit and reflect the changing understanding and vocabulary over time. Just as most legislation prior to the 1980s does not mention terms such as 'sustainability,' legislation prior to 2010 rarely mentions 'climate change.' National policy and project funding frequently moves in advance of slower legislative processes. Similarly, institutions are only gradually realigning themselves to emerging realities and demographic shifts – for example, the establishment of national disaster management organisations (NDMO), trends towards integrated catchment management (ICM) or IWRM and in some cases, the emergence of new authorities to administer WASH. Added to this, countries are grappling with the right mix of public and private service delivery and mechanisms to achieve competitive markets and water use efficiency, such as through enabling consumer choice.

## Key messages from climate science

Detailed summaries of current climate and future scenarios developed using internationally agreed processes (i.e., global climate model simulations taken from the international Coupled Model Intercomparison Project Phase 5 (CMIP5)) (Taylor et al., 2012) are provided for the Pacific by Australia's Bureau of Meteorology (ABOM) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (see ABOM & CSIRO, 2014.). These are quoted in the summary data for each

country. Lough et al. (2016) provide a synthesis of climate change projections for Pacific Islands. Recent work by Falkland and White (2020) provides further analysis and understandings. The most recent reports by the Intergovernmental Panel for Climate Change (IPCC), including the Sixth Assessment Report (IPCC, 2021), the Special Report on Oceans and Cryosphere in a Changing Climate (IPCC, 2019), and the Special Report – Global Warming of 1.5°C (IPCC, 2018), were also used to update regional and country summary data. Using these sources, projections for key variables are presented and synthesised below.

- **Temperature change**: Observed trends indicate an increase in mean temperature. The global surface temperature was, on average, 1.09°C warmer in the past decade (2010-2020) than in pre-industrial times. It is very likely that the tropical Western Pacific has warmed by 0.9°C since the mid-twentieth century.

  Globally, temperatures are extremely likely to exceed 2°C warming during the 21st century if greenhouse gas emissions do not start to decline significantly before 2050. In the Western Pacific, temperatures are expected to increase by between 2°C and 4.5°C by the end of the 21st century relative to 1961-1990.

  The Pacific is therefore projected to face increased heat stress in the near future. This will be experienced though an increase in the number of days with an apparent temperature at levels dangerous to human health. While there are limited projections relating to evapotranspiration (ET) (which is also affected by cloud cover (or lack thereof), wind speed and relative humidity), higher temperatures will increase the rate of evaporation from plants and soil on land, offsetting the benefits of potential rain increases and contributing to lowered freshwater availability and increased water stress. In terms of communities dependent on surface water storages, night-time evaporation can be significant (Hipsey, 2008).

- **Rainfall**: there is high confidence that the frequency and intensity of extreme rainfall will increase in the tropical Western Pacific in the 21st century, even under low-emission scenarios, though there is low confidence in the size of these changes (IPCC, 2021). Though rainfall events will become more intense and frequent, higher temperatures may result in increased risk of drought. Note that many fewer extreme events still cause significant damage.

- **Sea level rise:** Global sea levels are projected to rise by 0.10-0.25 m by 2050, irrespective of reductions in greenhouse gas emissions. By 2100, it is likely that there will be a rise of 0.28-0.55 m under very low emission scenarios and 0.63-1.01 m under very high-emission scenarios, relative to 1995-2014 levels. Beyond 2100, sea levels are projected to continue to rise.

  For the Pacific, sea level rise contributes to increased risk of inundation, coastal erosion, and saltwater intrusion (Lough e al., 2016) These impacts will be exacerbated with the increase in frequency and intensity of extreme weather events such as storms and tropical cyclones, which periodically elevate local sea levels above mean levels (with a consequent reduction in the length of recovery periods between such events).

  Some islands in the Western Pacific (Solomon Islands, Papua New Guinea, and Marshall

Islands) have experienced a higher rate of sea level rise (up to 6 mm/year), compared to other islands further east (Samoa and Kiribati). This difference in sea level rise is mainly attributed to large scale trends in trade winds (Falkland & White, 2020). Of more immediate consequence, short term fluctuations due to El Niño Southern Oscillation (ENSO) can create dramatic differences. Fluctuations in sea level above and below normal levels of between 0.2 m and 0.4 m during the major El Niño events of 1982–1983 and 1997–1998 have been documented (Falkland & White, 2020).

- **El Niño-Southern Oscillation (ENSO):** The variability and extremes of the weather created by ENSO are very likely to continue as the major source of interannual climate variability. ENSO is the dominant climate influence across the equatorial Pacific region and defines a natural climate system involving complex, large-scale interactions between the ocean and atmosphere in the equatorial Pacific region. ENSO impacts the year-to-year variability of rainfall, drought, flood, and TC risk, as well as influencing extreme sea level and coral bleaching. The impact of ENSO on rainfall, temperatures, TC activity and drought risk varies considerably across the region (ABOM & CSIRO, 2014). The frequency of extreme El Niño and La Niña events are expected to increase in the future

In terms of water security, the consequences of these changes can be reduced to three key impacts:

- **Floods:** Higher rainfall intensity causes damage to infrastructure, overwhelming of existing drainage systems and increased health risk from polluted water. Longer term risks are food insecurity from crop loss, soil erosion, landslides, reduced groundwater recharge, loss of riparian vegetation and damage to reefs and onshore saltwater ecosystems.
- **Drought:** There is a one in two chance of drought conditions increasing in the Pacific (ABOM & CSIRO, 2014). Even if future rainfall increases in line with projections in the Pacific, higher temperatures increase the rate of evaporation from plants, and soil on land. This offsets the benefits of potential rainfall increases and further contributes to lowered freshwater availability and increased water stress. Drought-related impacts will differ across the Pacific region. The frequency, severity, and duration of droughts on high islands leads to reductions of stream flows and lowering of perched aquifer water tables and, on low islands, to contraction in the thickness, areal extent and volume of freshwater lenses and coastal aquifers, and to reductions or cessations in spring flows (Cai et al., 2014; Wang et al., 2017). Severe droughts have caused major health impacts including malnutrition from reduced food supply, conjunctivitis, scabies, influenza-like-illnesses and diarrhoea (Cai et al., 2014; Wang et al., 2017). Falkland and White (2020) observe that stream flows, groundwater recharge and water availability have significant potential to be impacted by changes in mean rainfall and evaporation, particularly in the drier parts of the year. National trends from modelling mask more serious localised implications for water scarcity, and these need finer-scale data and modelling.
- **Storm surges:** In addition to the short-term flooding effects, storm surges contribute to saltwater intrusion and mixing of fresh groundwater lenses. Many months or even years may be required for rainfall recharge to ‘flush’ the saltwater from freshwater lenses and restore

wells to a potable condition (Falkland and White, 2020).

A summary of projections and associated levels of confidence for each of the eight countries, adapted from Falkland & White (2020), is presented in Table 1. While useful for overview, the comments about local variation and extremes must be borne in mind.

*Table 1 Summary of climate projections*

| Country | Mean rainfall | Drought frequency & duration | Extreme rainfall frequency & intensity | Tropical cyclone frequency |
|---|---|---|---|---|
| **Fiji** | Little change | Slight decrease | Increase | Decrease |
| **Kiribati** | Increase | Decrease | Increase | No projections |
| **PNG** | Increase | Decrease | Increase | Decrease |
| **Samoa** | Little change | Similar | Increase | Decrease |
| **Solomon Islands** | Slight increase | Slight decrease | Increase | Decrease |
| **Tonga** | Little change | Slight decrease | Increase | Decrease |
| **Tuvalu** | Little change | Slight decrease | Increase | Decrease |
| **Vanuatu** | Little change | Similar or slight decrease | Increase | Decrease |

| Key | High confidence in projections | Medium confidence in projections | Low confidence in projections |
|---|---|---|---|

*(Adapted from Falkland & White (2020))*

## Progress towards Sustainable Development Goal 6

There have been many international efforts to draw together resources to address SDG 6).[1] Other frameworks for action also exist, such as the Asian Water Development Outlook (ADB, 2020c) which developed a national water security index based on five key dimensions of water security: Security for Rural Households; Security for Agriculture Industry and Energy; Security for Urban (including access to sanitation; Security for Catchment and aquatic health and Security from water-related disasters. Focusing on SDG 6, an overall summary and database are maintained to track progress (UN Water, 2021). For the goal of IWRM, the UNEP surveyed countries in 2020 and scored their progress in four areas: enabling environment; institutions and participation; management instruments and financing. Two countries fell in their scores from 2017 (PNG and Tuvalu). Countries with higher scores are in a better position to adapt to additional pressures imposed by climate change. The scores are shown in Table 2.

[1] In 2015, UN Member States adopted the 2030 Agenda, setting 17 sustainable development goals targets. This includes a dedicated goal on water and sanitation, SDG 6: Ensure availability and sustainable management of water and sanitation for all. The SDG 6 includes 8 targets and 11 associated indicators.

*Table 2. Summary of progress of eight Pacific Island countries to achieving Integrated Water Resource Management (SDG 6.5.1)*

| Country | Enabling Environment | Institutions and participation | Management instruments | Financing | Final IWRM Score |
|---|---|---|---|---|---|
| Fiji | 28 | 61 | 70 | 63 | 56 |
| Kiribati | | | | | |
| Papua New Guinea | 17 | 20 | 30 | 7 | 19 |
| Samoa | 78 | 78 | 74 | 70 | 75 |
| Solomon Islands | 30 | 30 | 35 | 24 | 30 |
| Tonga | 40 | 40 | 49 | 10 | 35 |
| Tuvalu | 48 | 69 | 38 | 24 | 45 |
| Vanuatu | 53 | 63 | 49 | 16 | 45 |

*Where the following thresholds are used to define 2020 IWRM implementation status:*

| IWRM score | Status of IWRM implementation | Key |
|---|---|---|
| 0 to <=10 | Very low | |
| >10 to <=30 | Low | |
| >30 to <=50 | Medium low | |
| >50 to <=70 | Medium high | |
| >70 to <=90 | High | |
| >90 to >=100 | Very high | |
| No data | No data | |
| Not applicable | N/A | |

*Assessed in 2020 (UN Water tables. Accessed 30/5/2021)*

For the purposes of overview, national summary data on availability of drinking water are shown in Figure 1. These categories exclude unimproved (drinking water from an unprotected dug well or unprotected spring) and surface water (drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal).[2] From the point of view of climate change vulnerability, the population without improved water supplies are more vulnerable to critical seasonal shortages or illnesses caused by drinking polluted water.

[2] Definitions from new JMP ladder for drinking water. WHO / UNICEF Joint Management Program (JMP). Accessed 31/5/2021.

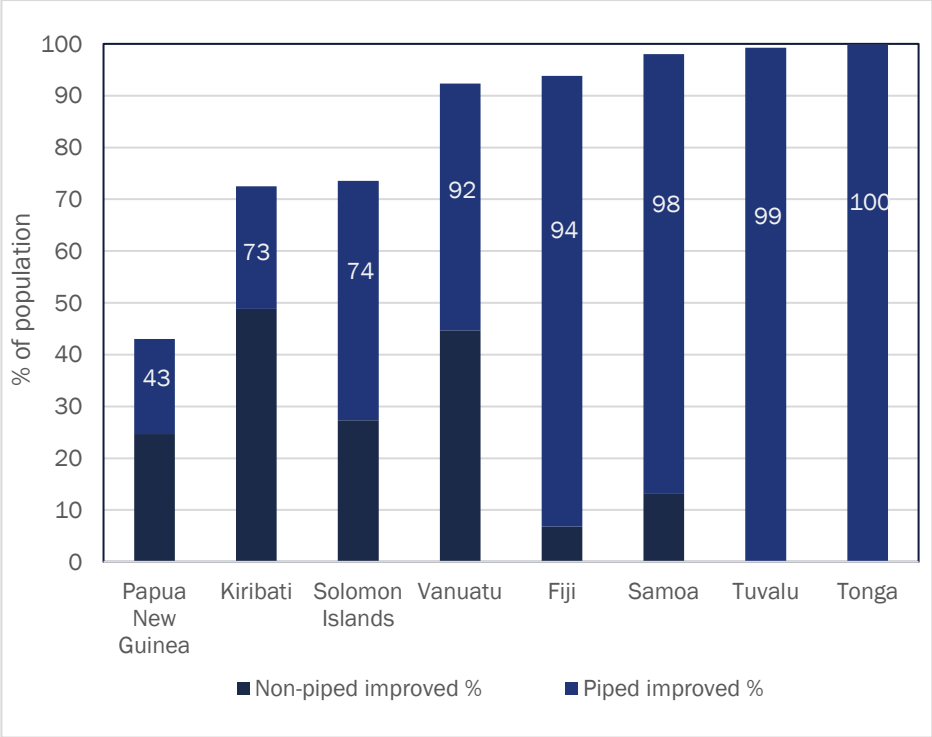


*Figure 1 National water coverage, as a percentage of the population with access to pipe and non-piped improved water sources.*

*(Source: WHO/UNICEF JMP data, 2017; includes SAFELY MANAGED, BASIC, LIMITED categories)*

The data for sanitation is even less satisfactory (Figure 2). The WHO/UNICEF data is collected according to the following standard categories:

- **Safely managed:** Use of improved facilities which are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site.
- **Basic**: Use of improved facilities which are not shared with other households
- **Limited**: Use of improved facilities shared between two or more households
- **Unimproved:** Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
- **Open defecation**: Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches and other open spaces or with solid waste.

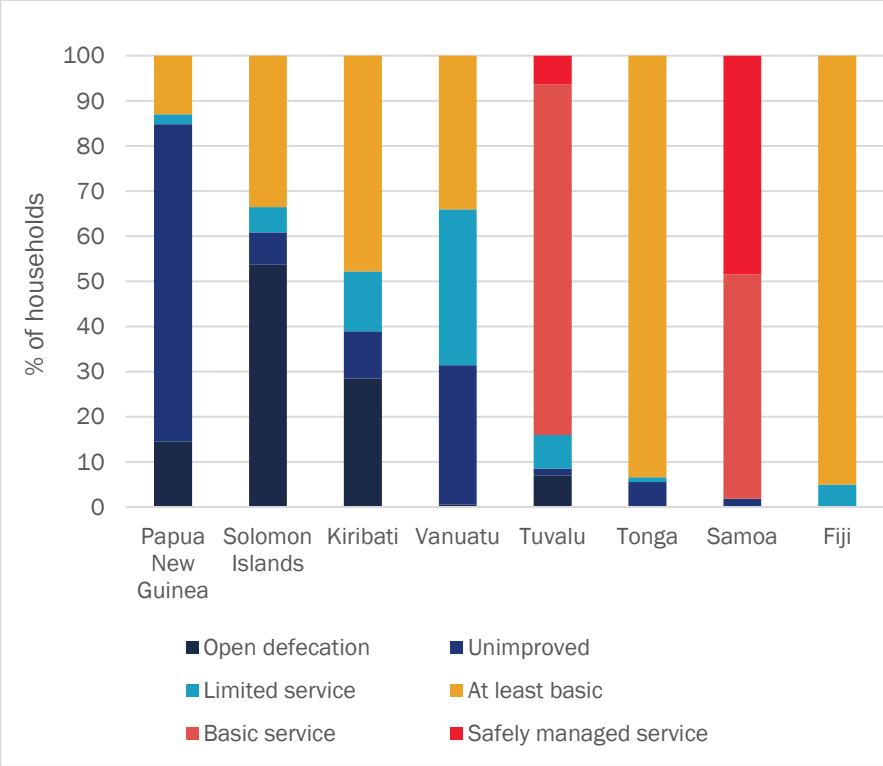


*Figure 2 National sanitation systems for the eight countries included in the stocktake*

*(Source: UNICEF JMP data 2017).*

Other data are available from the UN-Water website. The UN-Water Summary Progress Update (UN-Water, 2021) makes for grim reading with its opening sentence, '*Even before COVID-19 struck, the world was off track to meet Sustainable Development Goal 6 (SDG 6) - the goal of ensuring water and sanitation for all by 2030.*' This is generally still the case for the eight countries considered in this report, with the possible exception of Samoa. The most serious issues are faced by PNG, with its large urbanising population and disparity between need and service capability. Access to piped water has declined since 2000, and the proportion of the urban population using non-piped water has almost tripled from 12% in 2000 to 34% in 2020 (WHO-UNICEF, 2021).[3]

Following the calls by UN-Water to accelerate progress towards SDG 6 targets (UN-Water, 2018), the Pacific Community (SPC) held a forum in November 2019 which nominated six regional priorities (RP)[4]:

RP1. Strengthen leadership on water and sanitation.
RP2. Increase support to strengthen local capacity for resilience.
RP3. Invest in evidence-based decision-making.
RP4. Harness advocacy for change.
RP5. Coordinate efforts across sectors.
RP6. Establish effective frameworks for action.

[3] https://washdata.org/data/country/PNG/household/download. In the PNG country data spreadsheet, the tab 'Estimates' provides a harmonised estimate from multiple sources. Accessed 8/9/21.

[4] Pacific High-level Dialogue on Water and Sanitation: A Call to Action. 25 November 2019.

Similar global calls are coming from the Sanitation and Water for All (SWA) partnership (Sanitation and Water for All, 2020) The investment in the Pacific Water and Wastewater Association (PWWA), through the Australian Water Partnership (AWP), has improved the focus and coordination across water supply and disposal authorities. However, the PWWA remit does not cover water resources generally and the principles of IWRM, except where they affect water supply. There would appear to be a gap in IWRM within the context of terrestrial natural resource management.

## Recommendations and opportunities for future regional investment

Building on current and future projected challenges and governance gaps outlined above, the following sets out a number of regional-level recommendations. These recommendations are made to build upon, support or extend regional programs that are already working towards improving results for SDG6 in the Pacific. Existing regional programs are outlined in Annex 1.

Where the recommendations relate to the six high-level regional priorities described above, this is indicated in square brackets. Consideration of gender equality, disability, and social inclusion (GEDSI) is cross-cutting throughout these recommendations. However, the general principle is to design and build systems that improve water supply and management considering the special needs of women, girls, the disabled, gender-diverse and other marginalised and vulnerable people.

### Legislation and administration

- Support processes of critical review to reframe, revise and update relevant legislation in Pacific Island countries, notably Fiji and Solomon Islands. [RP5]

  Governance processes are frequently opaque or have responsibilities distributed across multiple departments. There is sometimes a misalignment of legislative responsibility and staff capability within the responsible ministries.

- Support improved administration with technical advice on organisational management, with a particular focus on operational issues such as drought preparedness planning, water quality monitoring and maintenance and management of water supplies to outer islands and remote communities. [RP2]

  Technical assistance will help to ensure that looming areas of water stress and scarcity are addressed and guided, to the extent possible, by strong science, localised decision making and effective enabling processes for equitable access to water for all.

- Water allocation processes vary from country to country and would benefit from support through regional initiatives to improve allocation processes and principles of arbitration, especially in relation to identification of competing demand, particularly as this relates to drilling, management of springs and groundwater. [RP3]

- Support improved deliberation and definition of frameworks for traditional allocation / prioritisation of water use, including allocation of water to the environment. [RP6]

- Support review and improved application of regional minimum water quality standards for river outflows to ensure the health of marine ecosystems and systems for monitoring marine

pollution, based on WHO (2003). [RP3]

### Regional governance of WASH

- Support improved regional governance and coordination of WASH, including improving the accuracy and timeliness of data collection processes and systems for prioritisation, which will strengthen community resilience to the current pandemic and support One Health[5] initiatives on hygiene, with a particular focus on the needs of women, girls, the disabled and other marginalised and vulnerable groups. [RP6]
- Support and build regional processes to facilitate independent prioritisation, design and economic evaluation of WASH projects, commencing with incorporation of gender equality, disability and social inclusion (GEDSI), into the practice of IWRM. [RP3]

  There is currently no method to prioritise WASH implementation that systematically prioritises community needs within the context of drought frequency and duration, flood occurrence and alternative water supplies, and the trade-off between catchment mitigation activities and urgent village and peri-urban priorities.

### Foster greater inclusion and leadership by women

- Support the UNICEF UNESCO Call for Action (UNESCO, 2021), particularly by implementing the principles of:

  i. gender-equal funding
  ii. narrowing the gap between policy and practice
  iii. fostering women's leadership beyond participation
  iv. countering norms and stereotypes which disadvantage women and girls
  v. prioritising the collection of sex-disaggregated data.

  Women and girls do much of the work in collecting water and in preparing meals, housekeeping, managing scarce water resources, maintaining animals and kitchen plots, and running microenterprises. These activities are all impeded by the crises of local water scarcity. Poor WASH facilities in schools disproportionately affect the attendance of post-puberty girls and teachers. By supporting pathways to leadership for women, these problems, and those of other vulnerable groups are more likely to be centralised into decision making. [RP1]

### Improved hydrology data and catchment modelling

- Support better definition of current and future allocation stresses on major river systems [RP3], through strengthened capability in catchment hydrology modelling.
- Support improved measurement and modelling systems to provide the basis for early warning flood systems and provide evidence for community-decision making on water use and allocation, particularly in times of drought.

[5] See Glossary.

Better measurement and modelling will assist in identifying strategic opportunities for improved irrigation management and possibly managed aquifer recharge (MAR). [RP3]

- Strengthen the capacity of regional service providers to provide technical assistance to contribute to strategic decision making for groundwater management and integration of groundwater-surface water management, in anticipation of increasing demand for water supply planning and disaster risk reduction. [RP3]

  This should include better understanding the effects of flooding on recharge of groundwater and the opportunities for passive managed aquifer recharge through improved land management practices and localised techniques such as infiltration pits (Dixon-Jain et al., 2014).

- Support hydrologic predictive modelling of future land use and landscape restoration planning as an input to national strategic planning and urban planning. [RP6]

  Additional support for regional hydrological modelling and management would enable country planning at a finer scale than is currently available which will facilitate demographic and urban planning with improved knowledge of water resources.

### Integration of modelling into national and urban planning processes

- Strengthen governance systems and harmonisation between different levels of decision making, through support for systematic, reliable and regular water data (groundwater and surface water). [RP2, RP3]
- Support government and community conversations about water use efficiency and prioritisation. [RP4]
- Strengthen pathways for input of water scarcity modelling and water risk analysis into national macro-economic planning and service delivery in the long term. [RP3]

### Drought Preparedness Planning

- Support drought preparedness planning by assisting with the design and implementation of improved rainfall monitoring and water balance monitoring. Countries could also be supported to anticipate and manage logistics to ensure that communal water supplies remain above critical levels. [RP2]

### Irrigation design and management

- Support investigation of strategic opportunities to improve use of field irrigation and crop water use efficiency to improve food security and equitable water allocation. [RP3]
- Support opportunities and training in drip irrigation and appropriate micro-irrigation technology to improve crop water use efficiency and improve food security. [RP3]

### Urban planning and design

- Support a new focus on Pacific urban planning and design to incorporate better floodplain

management, with sufficient land allocated for household gardens and which considers possible relocation of settlements from low lying vulnerable areas. [RP5]

Unlike many western cities, household gardens may not be co-located with the house itself. One example of this could be the design of greywater treatment and re-use (after treatment to remove heavy metals and other contaminants) into the urban garden landscape, minimising effluent outflow to reef systems and supporting improved food resilience.

- Explore financial models and support options for improved urban water planning [RP5].

  Given the 3-4% urban population expansion predicted for many Pacific urban areas, 'front-loading' finance for improved town water planning will pay long-term dividends. The model of the Fijian Housing Authority and its coordination with the Water Authority of Fiji (WAF) is one model that deserves further investigation. [RP5]

- Investigate or provide support for peri-urban governance models to reduce utility non-revenue water, to increase piped water service levels and enhance water security.

  Failure to pay for water is one of the biggest challenges of financial sustainability for utilities in PNG (WaterAid, 2021) and potentially elsewhere. In settlements many households already pay for water including paying someone who controls an illegal connection. Past initiatives to explore options other than community management and collective payment need to be re-visited and evaluated to develop better context-specific models of equitable water supply.

### Alternative models of service provision

- Review the options for decentralised sewerage treatment systems and use of natural filtration in conjunction with greywater management. Smaller, localised approaches will contribute to more water efficient, cooler, and more liveable cities. [RP2]

- Review the current business models for providing urban sanitation services, and the Cost: Benefit implications to assist urban water authorities in improving the structure of public and private infrastructure build and management. [RP3]

  Sanitation service arrangements vary from: a) composting toilets with managed compost removal; to b) no fee / no management septic tanks; c) individual septic tank maintenance provided as a 'public good' service where a fully-sewered urban development is unaffordable; d) micro-water treatment plants that locally process and distribute re-use water to garden areas (with water quality management undertaken by private contractors); and e) 'conventional' fully sewered urban developments.

### Training

- Expand capacity building in both vocational and higher education training for the water sector. [RP1]

  As noted by Dahan (2018), the capacity for Pacific Island governments (and their education and training institutions) to offer quality education and training for water-related skills is low. The nascent Pacific Water Centre should be strengthened to provide a stronger focus for water

training in the Pacific. Australia could also facilitate more training obligations into all project work. Bilateral approaches to the problem are limited, and the regional capacity of SPC and USP should be supported and expanded to offer systematic regular training. Training gaps vary from country to country, but there is a need for more 'para-plumbers' (analogous with the long running 'para-vet' course) who are able to utilise their skills in maintaining and improving basic water infrastructure. Specific attention and approaches should be created to ensure that there is active participation of women, to ensure that the needs of women, the disabled and gender-diverse minorities are considered.

- Support increased professional development courses for senior administrators and scientists to increase their understanding and application of modelling and forecasting services, based on improved meteorological data and forecasting services. [RP1]
- Specialised training in the management and maintenance of desalination plants, which is urgently required. [RP2]
- Support increased community water quality monitoring. [RP2, RP4]

  Water quality monitoring is the most effective capability to give to communities to self-manage their water supplies and strengthen the role of village water committees. This will complement efforts to prevent, detect, and control infectious diseases in animals and people and needs to be socialised into villages as a component of visits to remote communities (Saylors et al., 2021).

### Desalination

- Undertake a review of various scale models of desalination technology, including the costs and benefits of approaches that have been deployed globally that may have relevance to the Pacific. [RP3]
- Develop an inventory of desalination plants and a support network for the industry would be beneficial. In the first instance this may be able to take the form of a support desk. [RP4]

### Integrated Catchment Management

- Review the significance of existing integrated catchment management projects, nature-based solutions and the use of compliance incentives to support and enhance local livelihoods. [RP5]
- Continue to support bid development of regional and national partners with technical assistance and advocacy in international forums including SWA, emphasising the pathway and benefits of integrated catchment management for high islands as an organising principle. [RP2]

  The direct and practical approach of Fenemor et al. (2010) could be proposed as a model and included in a review compliance incentive that supports local livelihoods.

# National stocktakes

## Fiji

The population of the Republic of Fiji is 894,961, the land area is 18,333 km$^2$, population growth rate is 0.41 % and the GDP per capita is USD$6,152 (SPC SDD Statistics, 2020). The unicameral parliament consists of 50 members, elected for a four-year term.

In rural areas there are provincial councils and the chiefs of the 14 provinces are Fiji's traditional leaders. The government administration consists of four divisions, each headed by a divisional commissioner and district officer.

There is no specific climate change legislation, but the key policy is the National Climate Change Policy 2018-2030 (National Climate Change Policy, 2018-2030).

### Climate change projections for Fiji

- There is very high confidence that temperatures will rise. Under all climate scenarios the warming is up to 1.0°C by 2030, relative to 1995
- The temperature on extremely hot days is projected to increase by about the same amount as average temperature
- The frequency and intensity of extreme rainfall events are projected to increase but there is low confidence about the magnitude of the change (ABOM & CSIRO, 2014)
- There is low confidence in how rainfall will change in Fiji. This suggests that the consequences of both more intense flooding and attenuated localised drought need to be included in planning (Lough et al., 2016).

### Compounding issues

Fiji is especially vulnerable to floods and tropical cyclones; the average asset losses due to tropical cyclones and floods are estimated at more than F$500 million per year,[6] representing more than 5 percent of Fiji's GDP (Fiji, 2017). The same vulnerability assessment notes that flood and cyclone losses translate into an average of 25,700 people being pushed into poverty every year in Fiji (Fiji, 2017). Other climate-related water issues include:

- Water quality issues resulting from flooding, exacerbated by inappropriate land use practices.
- Water shortages particularly in outer islands due to extreme weather events.
- Cyclone damage to infrastructure is a high risk.

[6] Tropical cyclone losses are based on figures from the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI), adjusted with new exposure estimates, and flood losses are from an analysis by SSBN (Sampson, Simon, Bates and Neal from University of Bristol, UK.), using the SSBN Global Flood Hazard Model. These losses include the consequences of high-frequency low-intensity events, such as those occurring on average once a year, which are not usually recorded in disaster databases.

- Social and institutional problems obstruct application of Integrated Water Resource Management (IWRM) approaches.
- Increased urbanisation creating localised pressure on water resources and increased risk of pollution.[7]

[7] Asian Development Bank Country Partnership Strategy: Fiji 2014-2018. Sector Assessment Summary: Water and Other Urban Infrastructure and services. Fiji's urban centres comprise two cities, 12 incorporated towns, and seven unincorporated towns. These centres have a population of about 457,900, equivalent to 48% of the total population, and are expected to increase to about 60% of the national population by 2030. Greater Suva Area (GSA)—comprising the city of Suva and the three incorporated towns of Lami, Nasinu, and Nausori and their respective peri-urban areas—accounts for about 57% of the urban population

## Institutional framework

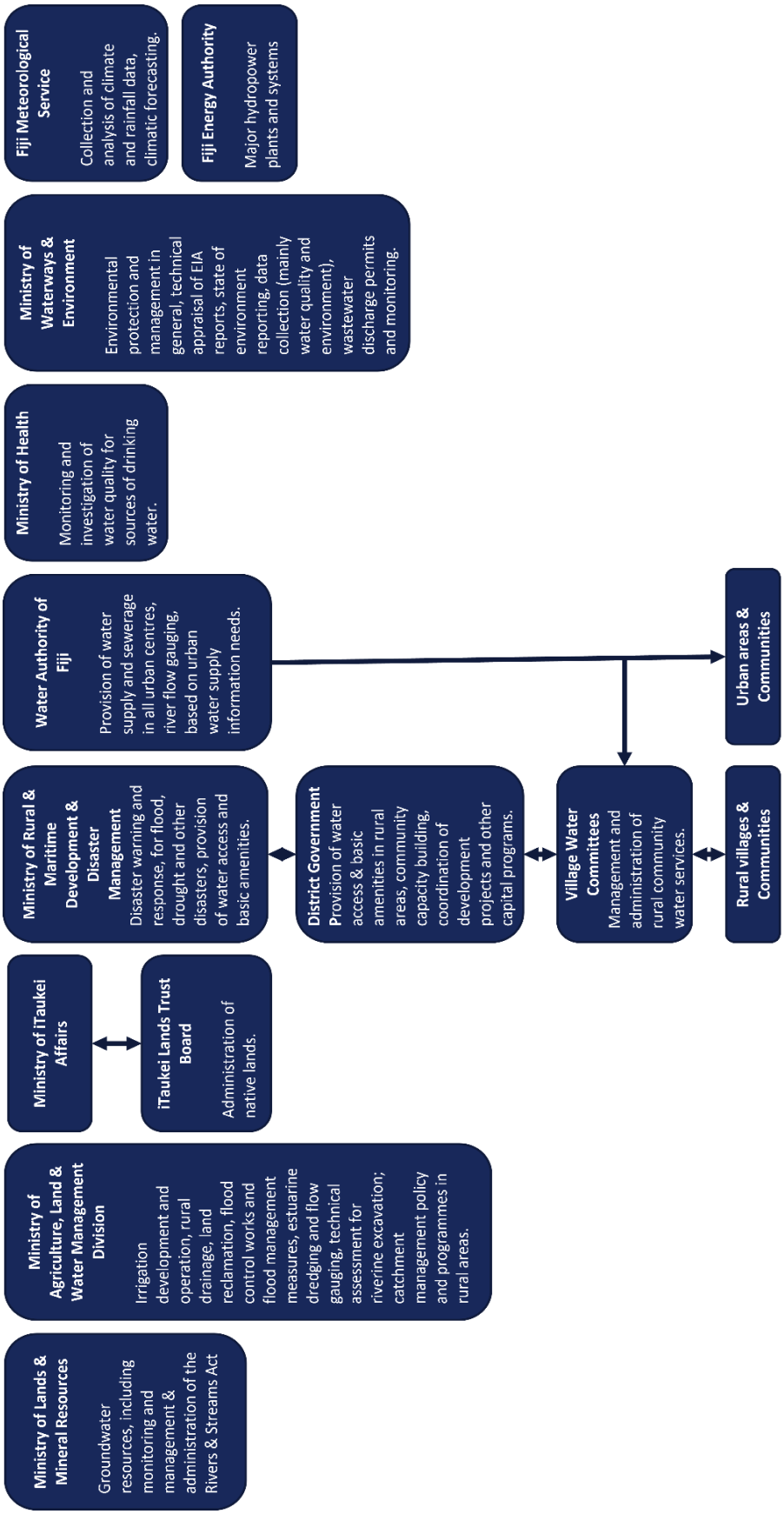


*Figure 3 Key ministries and water authorities relating to water and climate change for the Republic of Fiji.*

The key line ministries for water management are the Ministry of Waterways and Environment (MOWE), the Ministry of Agriculture (MOA) and the Ministry of Lands and Mineral Resources (MLMR).

The MLMR oversees the development of groundwater resources in Fiji (groundwater assessment and borehole drilling) and also has influence over land use through the Agricultural Landlord and Tenant Act 1979. The Ministry of Economy (MOE) is particularly influential however, having carriage of the National Adaptation Plan, the National Development Plan and the National Climate Change Policy.

Urban water supply is provided by the Water Authority of Fiji (WAF). WAF is responsible for providing access to quality drinking water and wastewater services to over 152,261 residential and non-residential metered customers residing largely in urban areas and also setting up water supply systems in rural schemes, reaching over 829,110 people nationwide.[8] While WAF has the mandate, it does not necessarily have the resources and reach to fully implement improved water resource management across the country.

Fiji's land is permanently vested in the traditional owners (*iTaukei*) in rural areas of Fiji, owned collectively by *mataqali* (extended family groups). There are extensive areas which are leased out through a coordinating agency called the iTaukei Lands Trust Board (TLTB).

The Ministry of iTaukei Affairs controls the administration of native lands through the TLTB (under the iTaukei Lands Act 1940) and the coordination of land and water through the Divisional administration structures (under the Fijian Affairs Act 2006). The TLTB is the most important landlord in Fiji. Any dealings regarding native land and water without the consent of TLTB is deemed null and void by Law (Vakadravuyaca, 2008).

The Ministry of Maritime and Rural Development (MMRD) ensures that Fiji's rural areas are provided with the same access to opportunities and basic amenities that are enjoyed by the urban areas. This is done through its district administrations which are involved in community capacity building, coordinating the development projects like upgrading of rural roads and other capital programs in their respective districts.

Through the MMRD, the Fiji government is supporting the development of Village Water Committees to manage and administer water services in communities, complementing the traditional role of the village chief. Village concerns and priorities are raised through the process of village discussion and presentation to the provincial council via the village chief (*Turaga ni koro*), who then takes village issues to the divisional commissioner. Many village issues are identified this way, including water shortages and infrastructure priorities.

Boundaries for land and water management still revolve around *tikina* (an aggregation of village boundaries) as well as colonial administration boundaries. However, land and water management decisions are often heavily influenced by the *roko* or the Commissioner. This is seen as a strong barrier to improved protection of water supplies and coordination of land-use planning to protect water resources (P. Sinclair, pers. comm.)

[8] Water Authority of Fiji website. Accessed 22/4/2021.

## Key challenges and emerging responses

### Urban and peri-urban areas

The government faces the complex challenge of delivering urban services to growing informal settlements in both urban and peri-urban areas. The majority of these settlements are located along the Lami–Suva–Nausori corridor, the Nadi–Lautoka–Ba corridor, and in Labasa. Almost all informal settlements lack access to basic services, particularly improved sanitation, drainage, and solid waste management. Settlements are commonly located on land which is prone to flooding.[9]

It has been noted that 'threats to water quality exist and are increasing through urban expansion, intensive agriculture, forestry practices, poor animal husbandry and industrialisation. Increased development in catchments leads to the potential for greater pollution downstream and in near-shore waters and this needs to be addressed in a systematic and proactive manner' (Fiji National Water Policy, 2014).

Wong (2016) promoted the importance of learning from others' mistakes and 'leapfrogging' straight to better solutions (see Figure 4). One example of this could be the design of greywater treatment and re-use (after treatment to remove heavy metals and other contaminants) into the urban garden landscape, minimising effluent outflow to reef systems and supporting improved food resilience.

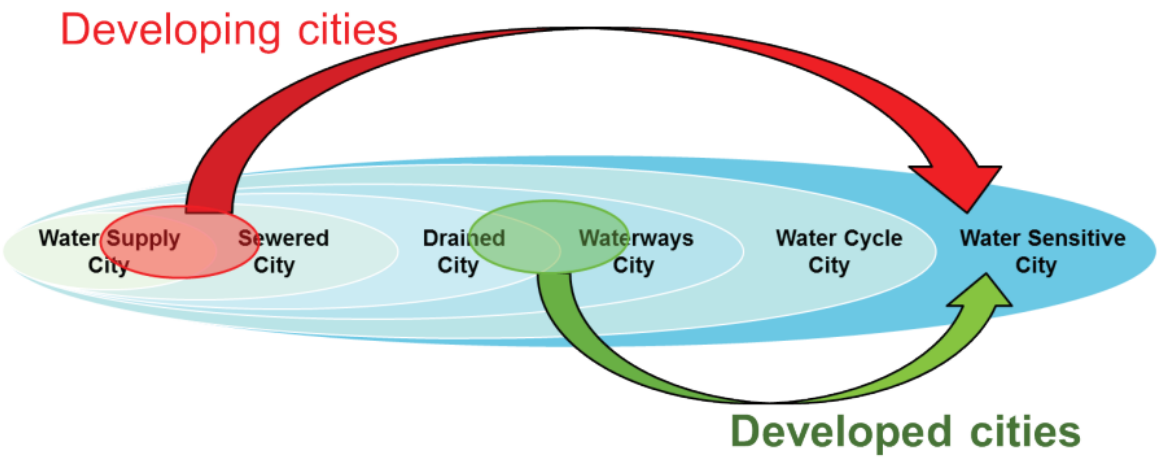


*Figure 4 Linear approaches to urban water resource development and 'leapfrogging'.*

*Leapfrogging may enable more integrated planning and infrastructure that delivers greater water use efficiency, flood mitigation, pollution control and environmental design (from Wong, 2016).*

A new Urban Water Supply and Wastewater Management Investment Programme, financed by the ADB and other large donors, is working to improve access to sustainable water supply and sewerage

[9] Asian Development Bank Country Partnership Strategy: Fiji 2014-2018. Sector Assessment Summary: Water and Other Urban Infrastructure and services.

services in the greater Suva area.[10]

### Rural areas

A core challenge in rural areas is that agricultural policy does little to manage off-farm damage or pollution. Instead, much of the focus is on flood mitigation and consideration of the economic consequences, without adequate consideration of the causes. The National Climate Change Policy Objective 3.2 'To increase ecosystem protection, natural resource redundancy, and environmental resilience through nature-based solutions' and proposes to improve 'The management of the interactions between waterways, extractive practices, and land-based development through activities and policy' proposing that 'Natural resource management and compliance incentives are used to support and enhance local livelihoods.'

Fiji has had a total of eight irrigation schemes maintained under which 2,292 hectares of land developed is used for rice and vegetable cultivation, however many of these are no longer in active use (A. Singh, pers. comm) There are at least 92 drainage schemes servicing sugarcane and other crops across the country (MOA, 2015, p.45) and these remain a significant focus of the Ministry of Waterways and Environment. There is room for significant improvements in the design and operation of these schemes, which will increase their water use efficiency and resilience to climate change.

In the forestry sector, a recent deal with the Forest Carbon Partnership Facility (FCPF) of the World Bank (WB) will contribute a modest USD12.5 million to integrated land use planning, native forest conservation, and sustainable pine and mahogany plantations. Water security will be enhanced through the use of payments for ecosystem services, such as watershed protection and reducing erosion from degraded steep slopes, which directly benefits farming communities in the lower reaches of these forested watersheds (Conservation International, 2020).

The current Strategic Plan of the MOWE proposes a focus on (i) policy and regulation reforms; (ii) conservation measures in the upper catchment to counter the environmental damage resulting from uncontrolled forestry and agriculture; (iii) flood forecasting and warning systems; (iv) capacity building of MOWE staff; (v) push to develop land use planning regulations, (vi) plans to strengthen watershed management, and (vii) drainage guidelines (MOWE, 2020). These directions are laudable, but prioritisation and resourcing are key.

## Recommendations

1. Support MOWE with holistic review, revision, and consolidation of the 'Land and Water Resources Management Bill 2016' to ensure appropriate inclusion of (i) IWRM principles; (ii) flood risk mitigation through nature-based solutions as well as engineering solutions; (iii) provision for the effects of climate change on water flows and (iv) integration of groundwater and surface water management DRR elements. Provision of high-level advice to facilitate progression through the Parliament would be beneficial for preparing Fiji for the impacts of climate change on water security.

[10] https://www.adb.org/projects/49001-003/main#project-pds

2. Contribute technical assistance to prepare an envisaged National Waterways Policy. At present this is anticipated to establish 'institutional arrangements to 'comprehensively manage waterway resources and address related issues' (MOWE Strategic Plan 2020-2024. p.13) including advice on design of integrated regulation and market mechanisms of water allocation and trade.

3. Support re-framing of the National Waterways Policy, which appears to remain narrowly focused on MOWE's current primary mandates under the Environment, Irrigation and Drainage Acts. The mandate could be broadened, emphasising not just the mitigation benefits but also the improved equity and productivity of *mataqali* lands, the affirmation of ties to *vanua* (analogous to an Australian 'Caring for Country' concept), reduced costs of engineering solutions, and improved water and human health outcomes. This would build on pilot work of watershed planning (GCCA+SUPA Soa Soa watershed) and strengthen the linkages with community-based land use planning (CBLUP) undertaken by R2R and GEF (2020) and encompassing initiatives such as WISH and the aspirations of Village Water Committees. These social structures are precursors to various Payment for Environmental Service (PES) programs, such as those envisaged by the national REDD+ program.

4. Support Integrated Catchment Management with economic assessment of the costs of inaction. Support and expand community governance structures to strengthen durable adaptations, particularly where these can be integrated with social enterprises that enable communities to see tangible short-term benefits and enhance livelihoods and food systems resilience.

5. Support the national government's direction to improve utilisation of land through better irrigation design and management (MOWE Strategic Plan 2020-2024) using water-smart technologies and improved drainage design and control.

6. Support an independent review of freshwater protection strategies and risk assessment to reduce the vulnerability of basic service provision (NCCP, Obj. 3.3) and make recommendations for management and infrastructure adaptation.

7. Review and recommend on innovative, low cost, scalable, and sustainable risk finance tools are developed for risk prevention, retention, and transfer purposes that serve to protect improvements in water supply and sanitation, and which reduce both physical risks and financial burdens on citizens, private sector and government (NCCP Obj. 3.5).

8. Support a comprehensive review of the barriers to afforestation and regeneration programmes including relevant incentive schemes, national levies, and sub-national government enforcement mechanisms and the supporting business or administrative structures, with a view to achieving improved nature-based protection of waterways, particularly in slowing surface water flows and achieving flood mitigation, in conjunction with conformance with NDC targets (NCCP Obj 4.3).

## Kiribati

The population of Kiribati is 118,744, the land area is 811 km$^2$, population growth rate is 1.69% and the GDP per capita is USD$1,636. The Republic of Kiribati comprises 32 atolls and reef islands and one raised coral island, Banaba. These islands are dispersed over 3.5 million square kilometres of ocean (SPC Statistics for Development Division). There are three island groups: the Gilbert Islands to the west, where the capital of Tarawa is, the Phoenix Islands, and the Line Islands.

Kiribati is a unitary republic with a unicameral parliament. The House of Assembly has 44 elected members, one ex-officio member and one representative of Banaba. At the local government level there are three town councils: Kiritimati Island Urban Council, Betio Town Council and Teinainano Urban Council and 23 island councils; all of which face considerable problems with communication due to their distance from the capital.[11]

There is no specific climate change legislation.

### Climate change projections for Kiribati

Current climate trends show that at Kiritimati, in eastern Kiribati, there has been an increase in November–April rainfall since 1946. Average annual rainfall of Kiritimati shows a significant increasing trend of about 7 mm/year for 1951–2017 data with similar increasing rainfall trends for Tarawa (Falkland & White, 2020). The remaining annual and seasonal rainfall trends for Kiritimati and Tarawa and the extreme rainfall trends for Tarawa show little change. Warming trends are evident in both annual and half-year mean air temperatures at Tarawa from 1950 (ABOM & CSIRO, 2014; Falkland & White, 2020)

Climate projections for Kiribati for the period to 2100 indicate that:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.
- Annual mean temperatures and the hottest days will become more hot (very high confidence).
- Average rainfall is projected to increase (high confidence), along with more extreme rain events (high confidence).
- Droughts are projected to decline in frequency (medium confidence).
- Ocean acidification is expected to continue (very high confidence).
- The risk of coral bleaching will increase in the future (very high confidence).
- Sea level will continue to rise (very high confidence); and
- Wave height is projected to decrease in December–March (low confidence), waves may be more directed from the south in October (low confidence).

[11] CLGF Country Profile 2017-18 The local government system in Kiribati. Commonwealth Local Government Forum. Accessed 20/5/2021.

The Kiribati Climate Change Plan (KCCP, Kiribati, 2018) and its implementation plan, the Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP) factor in the following conditions by 2030: Annual and seasonal mean temperature will increase by 0.3–1.3°C for the Gilbert Islands and by 0.4–1.2°C for the Phoenix and Line Islands; Sea-surface temperatures will increase by 0.6–0.8°C; Mean sea level is projected to rise by 5–15 cm and Ocean acidification causing losses of live coral of >25%.

## Compounding issues

- Unemployment is high at 30.6%, with youth unemployment rate at 54% in 2010 (Kiribati, 2016).
- Pressure on water supply is compounded by increased urban migration. The rural-urban population ratio in 2016 was 43%-57% (Kiribati, 2016).
- High risk of pollution of shallow wells used to access groundwater.
- Kiribati is particularly vulnerable to food insecurity. According to data collected in the Household Income and Expenditure survey in 2020, 8% of i-Kiribati are undernourished, with 41% experiencing moderate to severe levels of food insecurity (FAO, 2020).
- Pollution of onshore reef systems and the lagoon (Graves et al., 2021).
- The country's freshwater lenses, which currently supply fresh water to most of Kiribati's population, are highly vulnerability sea flooding

## Institutional framework

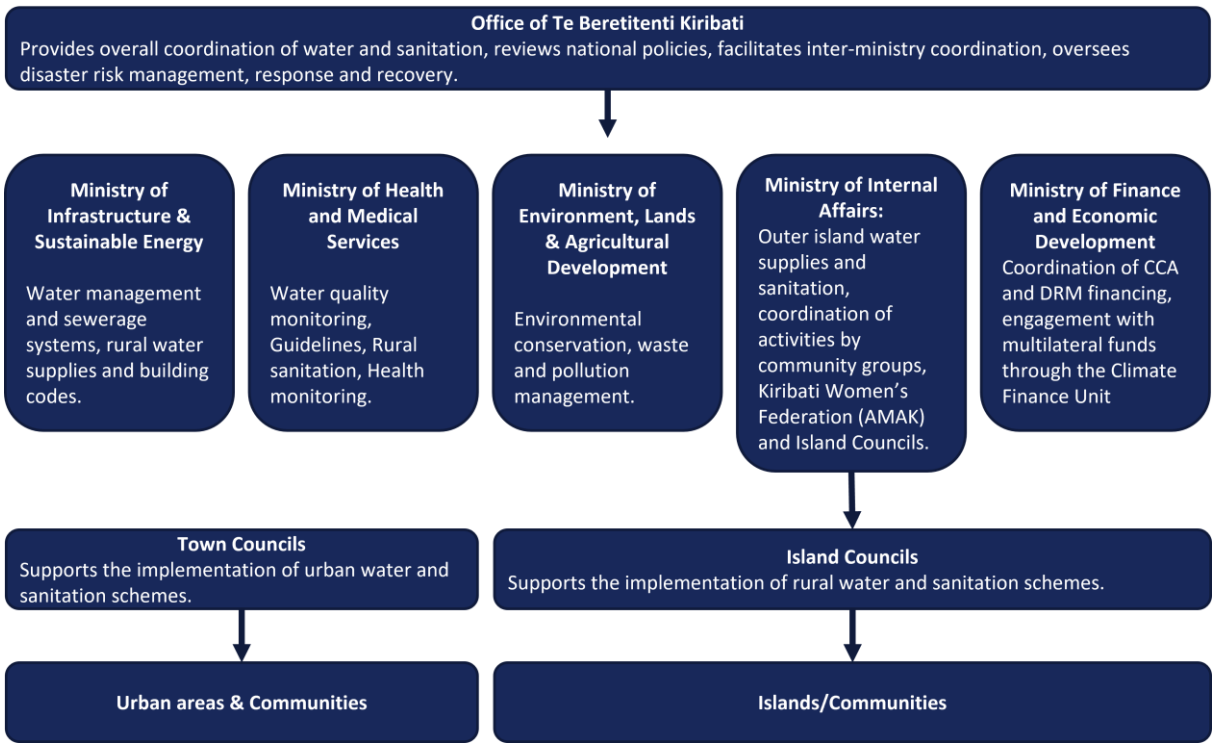


*Figure 5 Key ministries and authorities relating to water and climate change for the Republic of Kiribati.*

At the national level, the main law relating to water supply systems and infrastructure is the Public Utilities Ordinance 1977 under the Ministry of Infrastructure and Sustainable Energy (MISE). Pollution is covered by the Environment Act 1999, which is, along with land planning, under the Ministry of Environment Lands and Agricultural Development (MELAD). While there is no separate climate change legislation, the Ministry of Finance and Economic Development (MFED) has been entrusted with a key role in coordinating CCA and DRM financing to support implementation across all sectors. The role entails facilitating access to multilateral climate financing sources through the Climate Finance Unit. The key national policies are Kiribati Climate Change Policy and the Kiribati 20 Year Vision 2016-2036.

A large proportion of land in South Tarawa is leased by the Government for a period of 99 years under the Native Lands Ordinance. General land use planning for designated areas is determined by the Central Land Planning Board, established under the Land Planning Ordinance (Kiribati, 2016 p. 20).

Policies governing water have not been updated. They consist of the Kiribati National Sanitation Policy (2010) and the Kiribati National Water Resources Policy (2008).

Local councils have mandate to develop their own policies relating to matters scheduled under the Local Government Act 1984.

Land tenure on state lands such as Kiritimati, Tabuaeran and Teraina is governed by the State Lands Act and the State Pre-Emptive Act, which combines land tenure with planning requirements for the sustainable use of land resources (Government of Kiribati, 2016).

## Key challenges and emerging responses

The Kiribati Joint Implementation Plan (KJIP) 2019-2028 has two strategy areas that relate to water: Strategy 4: Increasing water and food security with integrated and sector-specific approaches and promoting healthy and resilient ecosystems, and Strategy 6: Promoting sound and reliable infrastructure development and land management.

### In urban areas

Reticulated water and sanitation services are currently provided free by the nation's Public Utilities Board (PUB) to domestic customers. PUB, however, charges water delivery to domestic, commercial, and industrial customers. As largely non-revenue generating, these services are heavily subsidised by electricity sales and this practice has negatively affected the financial performance of PUB. Since 2016, PUB has been relying on the annual Community Service Obligation (CSO) payments from Government to assist with the delivery of water and wastewater services (Government of Kiribati, 2016).

At the same time, various development projects have been implemented to improve water and sanitation services and provide more efficient management of freshwater lenses in South Tarawa. They include the South Tarawa Sanitation Improvement Sector Project. the Water, Sanitation and Hygiene for Schools, Kiribati Water and Sanitation Project (KIRIWATSAN), the Kiribati Adaptation Programme Phase III, and the Kiribati Outer Island Food and Water Project, to name only a few (Government of Kiribati, 2016). These programs have also helped reduce leakages in the reticulation system of South Tarawa by 50%.

ADB approved a USD 13 million grant for the South Tarawa Water Supply Improvement Project in

2019, in conjunction with finance from the GCF and World Bank, making a total project of USD 61.8 million. The project includes of climate-resilient and low-carbon water supply infrastructure and an awareness campaign in the project community regarding water, sanitation, and hygiene practices.

The Government of Kiribati plans to continue to provide support for the provision of improved water and sanitation services. Government aims to extend access to potable water to 75% of households by 2019 and to all households by 2036. Government also aims to increase access to suitable sanitation facilities to 50% by 2019 and to all households by 2036. (Government of Kiribati, 2016).

KIRIWATSAN II aims to improve access to clean drinking water and appropriate sanitation and improve local capacity to manage and maintain infrastructure. Each of the 35 villages will have either rainwater harvesting tanks, communal wells, or individual well improvements with Tamana pumps or village reticulated wells using low yielding solar submersible powered pumps to provide water.

### In rural areas and the outer islands

Work on improving water security in the outer islands occurs in conjunction with improving food and livelihoods, through community-led processes that enable villagers and individual householders to nominate their priorities.

Importantly, there have been recent water supply improvements on Kiritimati Island, in the Line Islands, with construction of three new infiltration galleries at the Decca groundwater reserve, 12 new solar pumping systems, a disinfection system, 250 thousand litres of water storage, and four km of pipeline.

Training for on-going development, operation, and maintenance of outer island water supply systems, including desalination systems, remains a gap amongst the multiple programs that have undertaken water-related work to date.

## Recommendations

Recommendations are drawn primarily from the Kiribati Joint Implementation Plan (KJIP) (Kiribati, 2019).

1. Support further development of tools for community-led monitoring of groundwater quality and the ability to test rainwater supplies on a systematic basis, as a major contribution to public health improvements. This could include Integrated monitoring of water-borne pollution from poor sanitation into environmental monitoring programmes (KJIP, 5.6 1e. p. 136).

2. In conjunction with regional and national agencies, support identification and assessment of potential groundwater sources (and capacity), taking into consideration current variability and climate change projects on all islands including: a. Support conduct of water reserve assessments on all the islands of Kiribati including: Line and Phoenix Groups (including sustainable yield estimation of major groundwater resources); b. Provide training on the application of inundation models developed for the Bonriki water reserve and its applicability to other similar water reserves or water protection zones; c. Establish and provide training on GIS and database applications for water resource management

and monitoring of water quality, infrastructure standards, water systems and potential yield of groundwater resources on all islands; e. Develop water maps that integrate seasonal climate predictions and water availability and g. Support the conduct of an education campaign to explain the results of assessments and dangers of over-pumping to communities. (KJIP, 6.4, 2., p. 143).

3. In conjunction with regional and national agencies, support assessment of rainwater catchment capacity on outer islands (private households, public buildings such as schools, government offices, health centres, churches and Maneaba) to a) Identify most appropriate water sources and technological actions such as infiltration galleries; protection of household wells from wave overtopping, contamination and heavy rain; rainwater harvesting; desalination plants, and b) Conduct cost–benefit analysis for the different options to select the most appropriate approach (KJIP, 6.4, 3. p. 144).

4. Identify suitable regulatory responses and enforcement approaches to enhance water security and safety, e.g., managing unsuitable settlement, land-use planning, building code compliance for rainwater harvesting. (KJIP 6.4, 3e., p.144).

5. Support continuous and long-term monitoring of the coastal and marine environment to fully understand the scope and evolution of pollution issues and to provide the appropriate baseline data for informed prioritisation of mitigation and recovery actions.

6. Develop incentives and strategies for engaging local communities in harvesting and protecting water sources for public water supply and form village water and sanitation committees: a) Conduct cost–benefit analysis for providing free water to the landowners where the reserves are located and b) Implement the results of the cost–benefit analysis (KJIP, Result 4.5, p. 129).

7. Strengthen management of water resource during drought through a) developing drought management plans for all islands of Kiribati, b) implementing drought-response activities for affected islands, c) developing a water-use Sector Operational Plan during drought for all islands, d) reviewing drought methodology for South Tarawa, and e) supporting timely response of National Disaster Council and Drought Committee during droughts (KJIP, Result 4.5, p. 130).

8. Commercial business development is limited by constrained water and energy supplies (Republic of Kiribati, 2016) and targeted support to look at options for increasing water use efficiency and energy efficiency may provide innovations to overcome current processing constraints and strengthen livelihood resilience, particularly during times of drought.

9. Support development and implementation of asset management plans for water and sanitation resources (KJIP, result 6.4, 6, p. 145) including review of financing mechanisms for including review ongoing maintenance of community water and sanitation systems and maximising incentives for water use efficiency, public good and affordability for both households and service providers.

10. Support stocktake of actions and gap analysis of the National Water Resources Policy and Implementation Plan with respect to the KJIP and develop annual workplans and reporting against the KJIP (KJIP 6.4 1b, p. 143).

11. Ensure access to improved sanitation facilities, including monitoring the impacts of pollution sources. Develop sanitation and an open defecation-free environment for improved health in support of adaptation initiatives including supporting the design and construction of community and school toilets and hand wash facilities, with a particular focus on facilities suitable for women and the disabled.

## Papua New Guinea

The population of Papua New Guinea (PNG) is 8.9 million, the land area is 462,840 km$^2$, population growth rate is 2.15 % and the GDP per capita is USD$2,815 (SPC Statistics for Development Division). PNG is a federal constitutional monarchy with a 111-member unicameral parliament consisting of 89 single member electorates and 22 provincial members (CLGF, 2019). There are 22 province-level divisions, which include 20 provinces, the autonomous region of Bougainville and the National Capital District of Port Moresby. The provinces can be grouped into four regions as follows:

- Highlands Region: Simbu, Eastern Highlands, Enga, Hela, Jiwaka, Southern Highlands, and Western Highlands.
- Islands Region: East New Britain, Manus, New Ireland, Bougainville (North Solomons), and West New Britain.
- Momase Region: East Sepik, Madang, Morobe, and West Sepik (Sandaun).
- Southern Region: Central, Gulf, Milne Bay, Northern Province (Oro), Western (Fly), and the National Capital District.

Below the provincial level, there are 89 districts, which include a District Development Authority (DDA) responsible for water service development and delivery including WASH. Districts are further divided into local-level government (LLG) areas. There are 31 urban LLGs and 265 rural LLGs in total.

PNG has two pieces of climate change legislation: the United Nations Paris Agreement (Implementation) Act 2016 and the Climate Change (Management) Act 2015.

### Climate change projections for Papua New Guinea

Current climate trend show that warm temperature extremes have increased, while cool temperature extremes have decreased for both Port Moresby and Kavieng (New Ireland province, eastern PNG). There has been a decrease in the number of days with rainfall since 1957 at Kavieng. Meanwhile, the annual, half-year and extreme rainfall trends show little change at Kavieng and Port Moresby.

Climate projections for Papua New Guinea for the period to 2100 indicate that:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence).
- Average rainfall is projected to increase in most areas (medium confidence), along with more extreme rain events (high confidence).
- Droughts are projected to decline in frequency (medium confidence). However, the frequency of mild drought is projected to increase slightly, while the frequency of severe and extreme drought is projected to decrease slightly. The duration of mild drought events is projected to remain stable,
- Ocean acidification is expected to continue (very high confidence).

- The risk of coral bleaching will increase in the future (very high confidence).
- Sea level will continue to rise (very high confidence).
- No changes in waves along the Coral Sea coast of Papua New Guinea are projected (low confidence). On the northern coasts, December–March wave heights and periods are projected to decrease (low confidence).

## Compounding issues

- High population growth rates have contributed to rapid urban population growth and an increase in informal settlements in Port Moresby and other major district capitals such as Lae, Arawa/Kieta, Mount Hagen, Madang, and Wewak (ADB, 2016)
- Elevated temperatures will increase the risks of water-borne and insect-transmitted risks, making improvement in drainage (to remove flood and storm water) and sanitation systems to remove and treat polluted water, more important.
- Changes in temperature and rainfall patterns affect rivers and groundwater in PNG, the quality of surface water resources, and flood risk (Kutan & Sofe, 2020). Droughts are already a serious issue in localised parts of the country and will persist under climate change.
- Infrastructure is not keeping up with growth, and risks of water-borne diseases are increasing.
- Issues of ownership, water quality and reserve sufficiency are still not being adequately addressed in urban water supplies (Kutan & Sofe, 2020).
- Data collection and management remain poor, governance and management capacity needs strengthening, and financial sustainability of water supply programs needs analysis and support.
- Uncontrolled illegal logging and mining activities impacting on water quality.

## Institutional framework

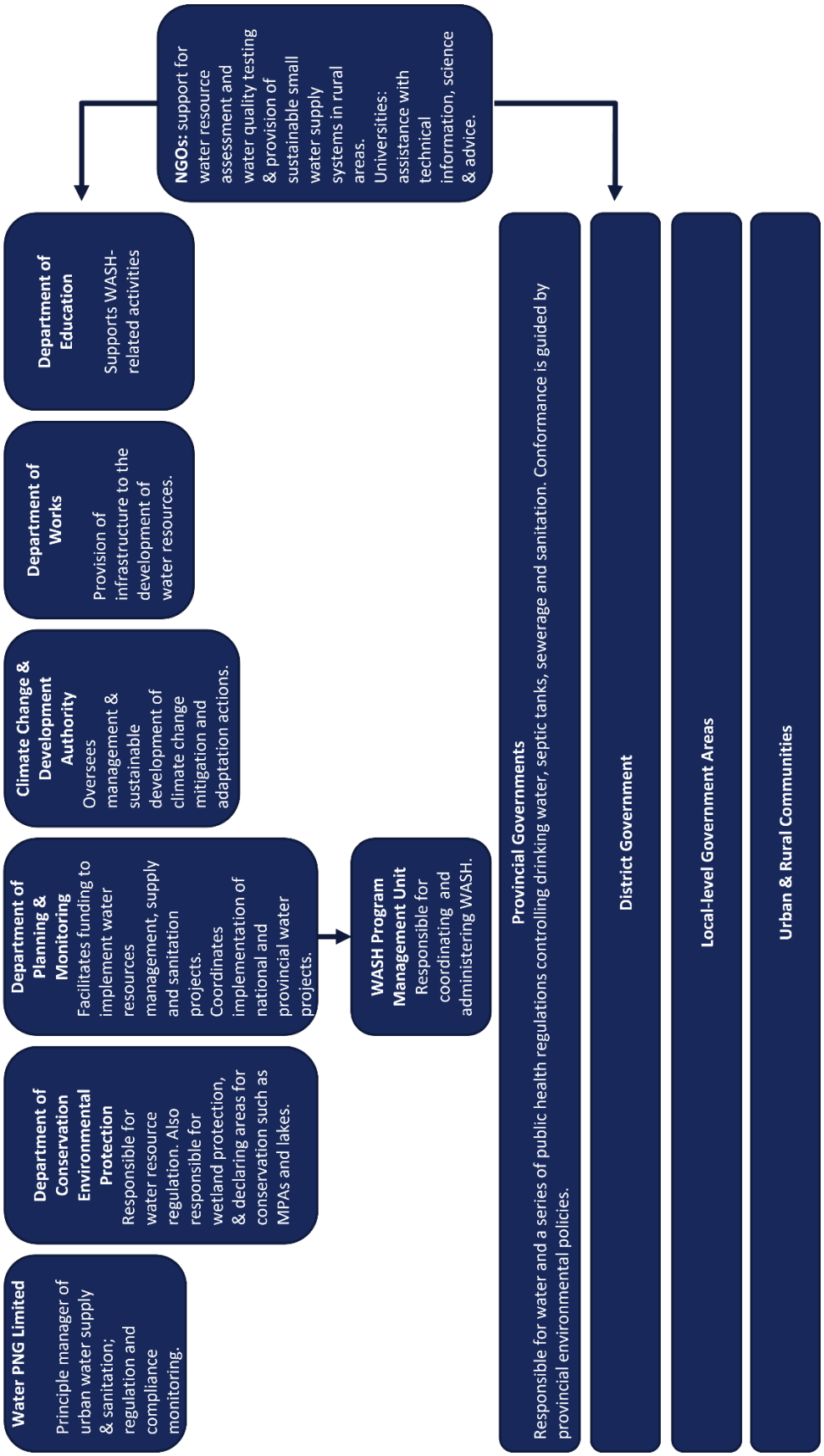


*Figure 6 Key ministries and authorities relating to water and climate change for PNG*

At the national level, provisions relating to water resources and water supply have been incorporated into the Environment Act 2000. The Climate Change (Management) Act 2015 specifies obligations for planning and reporting and the development of Climate Change Adaptation Plans to prepare for climate induced natural events relating to coastal or inland flooding, climate-induced migration, water and sanitation and other activities. There is no national plan relating to climate change, and the PNG Development Strategic Plan from 2010 has very little that directly relates to fresh water supply or catchments. PNG has produced a National WASH Strategy 2015-2030. Current issues relating to urban water supply have been analysed in a recent paper by Kutan and Sofe (2020).

Much of the data required to report against SDG 6 is not available or has not been collated.[12]

To address issues relating to water resource regulation, drinking water quality standards, and regulation of operations, the Government vested various responsibilities with the Department of Environment and Conservation operating under the Environment Act 2000, the Department of Health under Public Health Act, and Water PNG under National Water Supply and Sanitation Act 2016.

The WASH Program Management Unit (PMU), located within the Department of National Planning and Monitoring (DNPM), has responsibility for coordinating WASH, including through a WASH Task Force (Chaired by the Secretary of DNPM) and subcommittees. A peri-urban WASH committee was set up as one of the sub committees of the PMU (WaterAid, 2021).

Water PNG Ltd is a commercial statutory authority fully owned by the Government of Papua New Guinea and is the principal manager of urban and peri-urban water supply and sanitation. Water PNG has a "community service obligation" to provide water to the poorest, however so far this has not operated effectively (WaterAid, 2021). Water PNG Ltd operates 20 declared Water and Sewerage Districts throughout the country. The total urban population served by Water PNG is about 300,000, which represents less than six percent of the total population.[13] Currently, Water PNG Ltd services 14 urban towns and seven districts, serving mainly urban and peri urban residents.[14]

Water PNG Ltd also regulates and monitors compliance to set standards in engineering and water quality on 141 private water supply and sewerage systems (systems not operated by Water PNG) throughout the country. Many more such operators are yet to be regulated under this function.

Responsibilities for water are devolved to provincial level governments under the Organic Law for Provincial and Local-level Governments Act 1998 and a series of public health regulations control drinking water, septic tanks, sewerage and sanitation. Conformance is guided by provincial environmental policies.

Generally, there is lack of human and budgetary capacity to implement water resource management and environmental protection of water sources. While some efforts have been made to improve public financial management and integrated financial management (Chapman, 2010), broader systemic

[12] UN-Water Papua New Guinea SDG 6 data report. Accessed 17/5/2021.

[13] Energy and Utilities Asia Outlook profile on Water PNG Ltd. Undated. Accessed 28/5/2021.

[14] The towns services by PNG Water Ltd include: Alotau, Kavieng, Kimbe, Kokopo, Kundiawa, Lae, Madang, Mt Hagen, Wabag, and Wewak. The district towns include Kainantu, Maprik, Bereina, and Kwikila (Kutan & Sofe, 2020).

resourcing is required.

A new statutory authority has been proposed: the National Water, Sanitation and Hygiene Authority (NWSHA), which will oversee policy formulation, coordination, and execution. In saying this, Kutan & Sofe (2020) caution that there is a risk of duplication of roles, and poor alignment, particularly at the provincial and district levels of implementation.

## Key challenges and emerging responses

### Urban areas

The relatively high access to improved water sources and sanitation services is masked by the sheer size of informal settlements. Service providers have a clear mandate to deliver services for informal communities through a Community Service Obligation to provide water for poor communities, and to be reimbursed for fulfilling these obligations. However, this mechanism has not operated effectively, and funds spent by utilities have not been recovered from government. Reasons for this may include limited understanding of the CSO framework, a lack of willingness to exercise it, or lack of appropriate administration procedures (Marshall, 2020). As a result, the statistics tend to overestimate actual sector development in urban areas (ADB, 2016). For example, Port Moresby alone is home to at least 0.5 million residents, of which more than 50% is dispersed in 20 planned settlements and 79 unplanned settlements; households in these low-income communities tend to be overcrowded, having an average of 8–10 persons per household (ADB, 2020).

### Peri-urban and rural areas

Papua New Guinea's peri-urban and rural areas**,** representing over 87% of the population, remain poorly served, with estimates of 34.6% access to safe water (WHO /UNICEF JMP Data 2017) (up from 24% in 1990) and only 9.1% access to improved sanitation (down from 13% in 1990) (WHO /UNICEF JMP Data 2017).[15] While Water PNG has a mandate to 'promote access to water and sanitation in rural areas' it has been largely inactive due to its urban priorities. DDAs and their LLGs are responsible for WASH service delivery. Provincial Health Authorities undertake health, sanitation and hygiene promotion through Environmental health officers but generally don't delivery water supply projects. A consequence of the government's limited investment and activities in the sector is that the majority of WASH services in rural and peri-urban areas are provided by the non-government sector (PNG WASH Policy, 2015).

The majority of PNG's rural population depend on creeks, streams and wells for cooking and drinking. Climate induced coastal and inland flooding is highly likely to contaminate freshwater sources, increasing the risk of water-borne diseases for rural communities and create breeding grounds for disease carrying insects such as mosquitoes (CCDA, 2019). Given the likely on-going gap in service delivery by government and non-government organisations, a stronger focus on supporting communities with the training to improve their self-supply of water (Dahan, 2018) and sanitation

[15] Only 9.1% of the rural & peri-urban population has access to an improved latrine, septic tank, or sewer.

services, and monitor the water quality and safety, should be a priority.

## Recommendations

1. Support for capital investment in ageing and dilapidated water infrastructure (catchment, storage, treatment and supply mains) remains crucial, including extension into peri-urban areas.
2. Support for business re-design and development is needed to create incentives and regulatory approaches to address non-revenue water (NRW), which includes leakage and illegal tapping and commonly unpaid water bills.
3. Support for training of water industry personnel continues as a major need. An assessment of the human resources needs to provide water supply and sanitation services in PNG (IWA, 2013) identified a massive shortfall in trained personnel to meet SDG 6 targets for PNG, particularly engineers.
4. Support for implementation of improved governance and management training at Provincial and LLG levels, with a specific focus on water management would be beneficial. This could build on the Provincial Capacity Building Program supported by AusAid and described by Chapman (2010) and could focus on expansion of National WASH monitoring systems through national training programs and strengthening of routine monitoring processes at District and LLG level
5. Further coordination of funding across the sector is necessary. This may be best achieved by supporting the WASH PMU or the proposed NWSHA with technical assistance. In rural areas, additional initiatives to provide training and incentives for managing self-supply as a formal service delivery mode should be supported, in conjunction with support for community-based land use planning to protect water quality of catchments and rivers.
6. Support further analysis of the nature of public-private partnerships such as maintenance out-sourcing, revenue collection and management of village-level distribution networks.
7. Support for community-based land use planning processes to protect catchments and mitigate floodwater run-off that causes soil loss and pollution through damage to inadequate sanitation.
8. Support improvement of the linkage of actions on WASH and IWRM to initiatives for climate action, such as those anticipated in the ‘Papua New Guinea – Australia Climate Change Action Plan’ (2018) and other plans being developed by PNG.
9. Support expansion of the national WASH monitoring system through national training programs and strengthening of routine monitoring processes at District and LLG level.

## Samoa

The population of Samoa is 198,646, the land area is 2,934 km$^2$, population growth rate is 0.58% and the GDP per capita is USD$4,284 (SPC Statistics for Development Division). In the 49-seat unicameral parliament, all 47 Samoan Members of Parliament are *matai*, performing dual roles as chiefs and modern politicians, with the exception of two seats reserved for non-Samoans. At the local level, much of the country's civil and criminal matters are dealt with by some 360 village chief councils, *Fono o Matai*, according to traditional law, a practice further strengthened by the 1990 Village Fono Law

There is no climate change legislation for Samoa. The key policy is the Samoa Climate Change Policy 2020 (Samoa Climate Change Policy 2020).

### Climate change projections for Samoa

Current climate trends show that annual and May–October rainfall has increased at Apia since 1890. There has been little change in November–April rainfall since 1890 and extreme daily rainfall since 1961.

Climate projections for Samoa for the period to 2100 indicate that:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence).
- While little change in mean annual rainfall is projected (low confidence), more extreme rainfall events are projected (high confidence).
- Incidence of drought is projected to decline or stay approximately the same (low confidence).
- Ocean acidification is expected to continue (very high confidence).
- The risk of coral bleaching will increase in the future (very high confidence).
- Sea level will continue to rise (very high confidence).
- A reduction of wave period in December–March is projected with no change in wave height (low confidence). No change is projected in June–September (low confidence).

The Climate Change Policy (Samoa, 2020) uses a very high emissions scenario to anticipate that by 2030, there will be an average annual temperature rise between 0.5–1.1°C, sea level rise of 7 – 17 cm and an increase in the average maximum windspeed of cyclones of 2-11% and an increase in rainfall intensity of about 20% within 100 km of the centre of cyclones.

### Compounding issues

- Increasing urbanisation is taking place in Apia and putting pressure on the city's water supplies.
- Upper catchment management affecting water quality and flooding in the Apia flood plain.

- Affordability of expansion of sanitation is a challenge, which may be alleviated by local, scale-appropriate sewerage treatment.

## Institutional framework

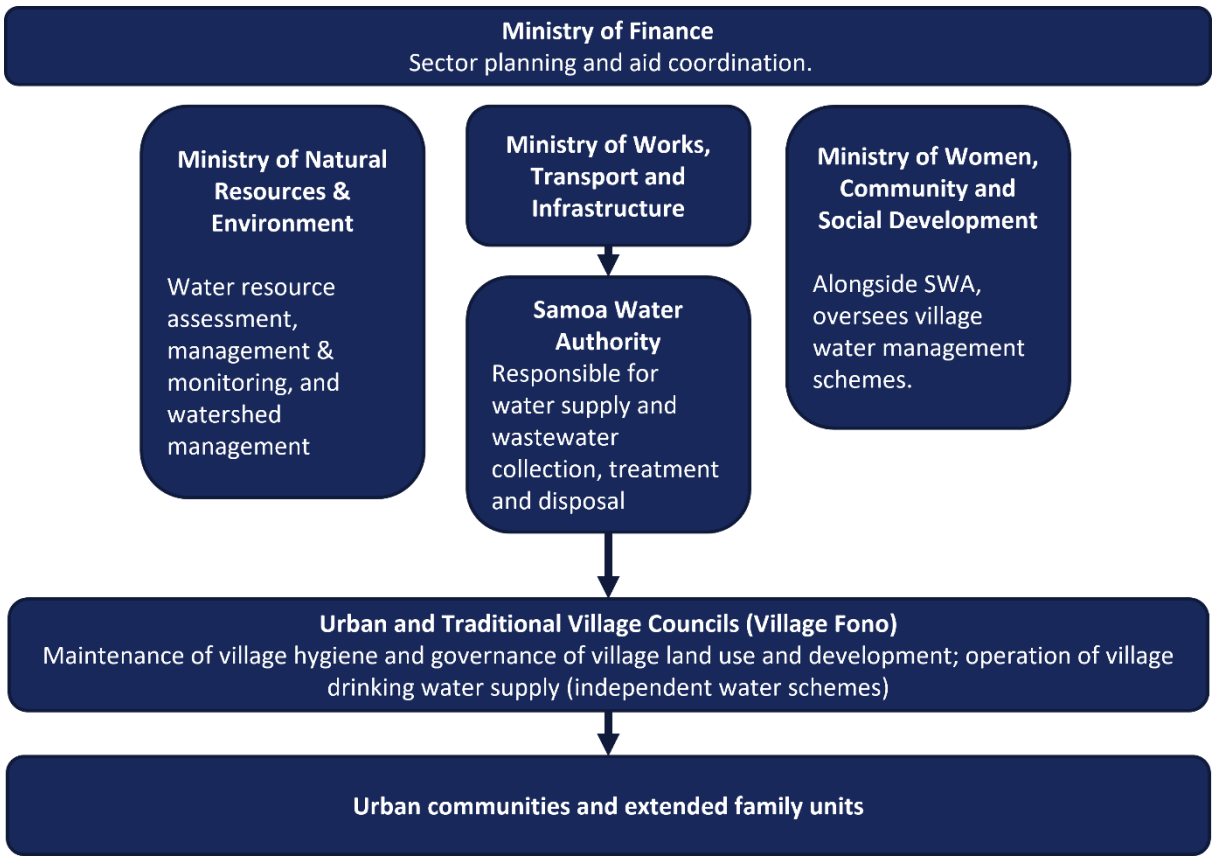


*Figure 7 Key ministries and authorities relating to water and climate change for Samoa*

The Ministry of Natural Resources and Environment (MNRE) is responsible for the implementation of the *Water Resources Management Act 2008.* The MNRE is also responsible for Samoa's Climate Change Policy (Samoa, 2020).[16] Importantly, Samoa's Prime Minister is also the Minister for MNRE, providing some political weight to the Ministry. A Climate Change Bill (2017) has been drafted.

Management and provision of water services, however, comes under the mandate of the Samoa Water Authority (SWA) – a state owned enterprise that sits under the responsibility of the Ministry of Works, Transport and Infrastructure.

The SWA provides core services of water supply to approximately 88% of the national population and wastewater collection, treatment and disposal from the CBD of Upolu. There are 14 water treatment plants to treat water from river offtakes. In addition, the SWA manages water supply from 45 bores across Savai'i and Upolu islands (SWA, 2021). Groundwater is a major expense because of electricity costs and fees which are payable to landholders.

[16] While the nation's Climate Change Policy creates an expectation that climate change and disaster risk 'are integrated into all sector plans and ministry and implementing agency corporate plans.' (p. 8), in reality this is still an ongoing process.

Local government administration is conducted through 286 traditional village councils and 26 urban village councils, authorised under the *Village Fono Act 1990*, with responsibilities for village hygiene, use of village land and economic development. Land is held by extended families or 'aiga' within each village. Any heir of the aiga is entitled to own and use family land, but the entitlement is only realised on the rendering of service to the chief ('matai') and on continuing residency on family land. The matai may allocate lands for family members to build a house on, to plant and to harvest. Depending on the closeness of kinship and the service to the matai, the rights to occupy and use the land are different among the members of the family (Ye, 2009).

## Key challenges and emerging responses

### In urban areas

Looking at areas under pressure in Samoa, the Pacific Ridge to Reef programme observed that 'The Vaisigano Catchment behind Apia provides water for three of the five hydropower plants in the country. The lack of natural water storage results in these catchments reaching low flow levels within several weeks. Conversely the lack of storage also results in rapid flooding events, with times to peak estimated at less than three hours for cyclone and tropical storm associated rainfall events.' (Pacific R2R website)

The programme's Annual Performance Report (GCF, 2019) describes progress on flood mitigation activities, commissioning of design work for the Apia Integrated Sewerage System, progress on the scaling-up of the health surveillance system in Samoa to be included in a Climate Early Warning System (CLEWS, which is part of the public health response to a serious measles epidemic from August 2019 – December 2019); hydrological modelling to generate flood scenarios; and investments in training, awareness, advertising and drills for flood early warning response.

The other two areas of action are catchment-wide ecosystem-based protection and rehabilitation measures, and an ecosystem-based adaptation enterprise development programme. A total of 195 small ecosystem-based projects have been approved for funding, including 164 projects implemented by households/families, 26 existing enterprise projects, four CBO projects and one NGO project.

In terms of the threat of climate change, the Samoa Water Authority (2021) has formalised a risk matrix and plan and developed recovery plans for assets and water services following disaster. This includes developing an insurance arrangement for assets. In relation to the risk of more high intensity rainfall in catchments affecting water quality, discussions are underway with MNRE on 'necessary improved catchment management practices' (SWA, 2021, p. 13).

Major investment is occurring via the 'Integrated Flood Management to Enhance Climate Resilience of the Vaisigano River Catchment in Samoa' (UNDP, 2019). This project, worth USD 65 million, is co-funded by the GCF and the Samoan Government (UNDP, 2019) and is 'designed to strengthen the adaptive capacity and reduce the exposure to climate risks of all 31 vulnerable communities and villages, infrastructure and the built environment in the Vaisigano Catchment area.' This project built upon an IWRM project in the same area which applied a ridge to reef approach, tackling technical and socio-economic issues with communities (MNRE, 2007).

Importantly, nearly all the main water pipelines in the urban areas of the island of Upolu have been replaced in the last ten years. These upgrades have also transferred customers in these areas from raw water schemes to treated water schemes.

Samoa does not have extensive peri-urban informal settlements. The SWA continues to extend and improve its coverage within its mandated service areas. This includes the installation of new reticulation networks to cover remote villages, communities and newly established residential areas through new subdivisions and relocation.

These works cover the rural areas such as the Southeast Upolu and Savaii. It also includes the various new settlements around the urban areas such as Afiamalu, Tiapapata, Moamoa Fou and Malololelei. The SWA also plans to extend the wastewater collection network from the CBD towards the towards the Matautu Marina and Wharf.

### In rural areas

The SWA is now focusing on improving the rural networks on Upolu and Savai'i islands, replacing old pipes and building new pipelines and bores to service areas which have not had access to treated water before. Independent village water schemes are being progressively integrated with the water supply network of SWA.

Despite the extensive coverage of Samoa through the water supply network, there are still some areas that do not have 24-hour water supply, and water shortages can occur during periods of drought. The SWA is seeking to address this through increased water storage in areas supplied by groundwater bores (SWA, 2021).

New projects are underway in rural areas to:

- Assess the water quality of rainwater tanks based on national and international drinking water standard, with the Scientific Research Organisation of Samoa (SROS) and
- Develop an Information Management System for all Rainwater Harvesting Infrastructure (MNRE, 2020).

A number of projects that were developed through the National Adaptation Programme of Action (MNREM, 2005) would benefit from further follow-up and support, particularly those relating to securing community water resources and the 'reforestation, rehabilitation and community forest fire prevention'.

### Recommendations

1. Support alignment of overall catchment management with the needs of householders within the catchment, generating mutual benefits and a sense of collective responsibility (Taua'a, 2010). Support processes to develop community consensus and integrate household livelihood needs with improved catchment outcomes.
2. Support business re-design to incentivise household water use efficiency.
3. Support improvement in agricultural on- farm water use management.

4. Contribute to development of a drought plan (SWA, 2021, p.12).

5. Contribute technical expertise to the expressed need to improve operational data collection, recording and review the design and implementation of key performance measurement and linkage to improved decision making.

6. Contribute to finalisation and implementation of the draft Climate Change Adaptation Risk Matrix and Plan (SWA, 2021 p.13).

7. Assist in implementation of Risk Management Plans for Disaster and recovery plan of assets and water services and develop an insurance arrangement for assets vulnerable to disasters (SWA, 2021 p.13).

8. Support improvement in hydrologic modelling and Climate Early Warning System.

9. Coordinate scoping of water supply insurance options and standard documentation to facilitate disaster recovery. This could include innovative approaches to philanthropic foundations to establish a trust fund focused on SDG 6.

10. Investigate innovative energy solutions to reduce power costs of pumping from bores.

11. Work with SROS to expand the Information Management System for all Rainwater Harvesting Infrastructure for use in other countries to improve drought planning.

12. Support improvement in the linkage of integrated catchment management as the mechanism to reduce clearing of trees from watershed areas and contamination of water and soils, referred to in the Samoa Climate Change Policy 2020 and improved catchment management practices (SWA, 2021 p.13).

## Solomon Islands

The population of Solomon Islands is 712,071, the land area is 28,230 km$^2$, population growth rate is 2.24 % and the GDP per capita is USD$2 295 (SPC Statistics for Development Division). Solomon Islands is a constitutional monarchy consisting of 6 major islands and over 900 smaller islands. The unicameral national Parliament comprises 50 members elected for a four-year term under a first-past-the-post voting system (DFAT Solomon Islands Country Brief). Under the national assembly there are nine provinces plus the City of Honiara, further subdivided into wards, based on population size. Area councils were suspended in 1997 and have not been re-instated.[17] The Solomon Islands is quasi-federal and the Provincial Government Act 1997 (the 'PGA'), governs the nine provincial governments.

There is no climate change legislation. A National Climate Change Policy (2012-2017) has not been replaced, but climate change is encompassed in the National Development Strategy 2016 – 2035.

### Climate projections for Solomon Islands

Climate projections for Solomon Island (ABOM and CSIRO, 2014) for the period to 2100 indicate that:

- There is very high confidence that annual mean temperatures and extremely high daily temperatures will continue to rise. Annual maximum and minimum temperatures have increased in Honiara since 1951. Maximum temperatures have increased at a rate of 0.15°C per decade since 1951.
- Annual rainfall is projected to increase slightly (low confidence), and the frequency of extreme rain events is also projected to increase (high confidence).
- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.
- Tropical cyclones are projected to become less frequent but more intense in the Southwest Pacific, including in Solomon Islands. Tropical cyclones result in flooding and wind damage in the Solomon Islands. There have been severe floods on Guadalcanal, Malaita, Makira and Santa Isabel with severe damage to agriculture and infrastructure. The number of cyclones varies widely from year to year, with none in some seasons but up to five in others. Over the period 1969–2010, cyclones occurred more frequently in El Niño years (SIMS, 2011).
- Sea level-rise: Satellite data indicate the sea level has risen near the Solomon Islands by about 8 mm per year since 1993. This is larger than the global average of 2.8–3.6 mm per year. This higher rate of rise may be partly related to natural fluctuations that take place year to year or decade to decade caused by phenomena such as the El Niño Southern Oscillation (SIMS, 2011).
- Future projections suggest that global mean sea level will continue to rise for the foreseeable future, reaching perhaps 1.65 m (above the 1986-2005 baseline) by the year 2100: possibly over 5 m by 2300 (Horton et al., 2020). How exactly this might be expressed in the central

[17] CLGF Country Profile 2017-18 The local government system in the Solomon Islands. Commonwealth Local Government Forum. Accessed 20/5/2021.

Solomon Islands is uncertain as it depends on understanding how the drivers of the currently very rapid rates of sea-level rise there will alter and affect (+ or -) future global sea-level rise.

## Compounding issues

- Solomon Islands has a high population growth rate of 2.24%, increasing the need to maintain infrastructure growth (SPC Statistics for Development Division)
- There is rapid urbanisation. The nation's last census (SINSO, 2011) recorded an average annual urban growth rate of 4.7% between 1999 and 2009. It is expected that today's urban growth rate is much greater than that of the 2011 census.
- Rainfall and river flows are highly variable in certain areas; drinking water supplies may be short. There are particular problems in the nation's outer atolls where only limited supplies of groundwater exist (SOPAC, 2007). In the smaller islands (where groundwater is limited to hand-dug wells), rainfall is varied, causing a shortage of drinkable water within two weeks of the start of the dry period (Dorevella, 2021).

## Institutional framework

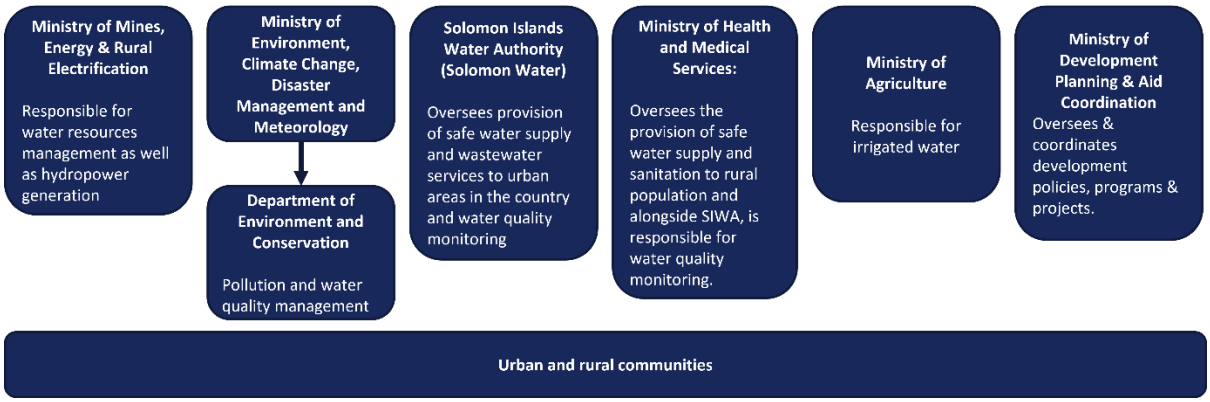


*Figure 8 Key ministries and authorities relating to water and climate change for Solomon Islands*

The Ministry of Mines, Energy and Rural Electrification (MMERE) is the ministry responsible for minerals, petroleum, energy, water resources and rural electrification.

Within the MMERE, the Water Resources Division is responsible for water resource governance, hydrology and drilling. According to Wairiu & Powell (2006) there are another three organisations who contribute to water governance. They are:

- Ministry of Health and Medical Services; involved in the provision of providing safe water supply and sanitation to rural population.
- Solomon Islands Water Authority (SIWA); involved in the provision of providing safe water supply and wastewater services to urban areas in the country.
- Department of Environment and Conservation; involved in pollution and water quality management.

SIWA is responsible for water supply to Honiara, Noro and Gizo in Western Province, Auki in Malaita

province and Tulagi in Central province. The Honiara water supply system currently supplies approximately 55% of the population in Honiara city and the surrounding peri-urban centres in Guadalcanal. Currently only 9% of population within the SIWA service area is connected to wastewater systems in Honiara, 0% for other provincial centres (SIWA, 2017).

The country's legislation is out of date, yet the government has expressed an intention of developing a water law to focus on the management of water resources. A draft Water Resources Bill has been extant since at least 2006 but has not been enacted. Legislation is scattered through various Acts relating to River Waters, the Environment, Forestry and the Water Authority. Some of these responsibilities can be devolved to the Provincial Assemblies through the Provincial Government Act 1997.

The National Water and Sanitation Policy and associated Implementation Plan (2017-2033) has provided the foundation for attracting donor funding for the Solomon Islands Urban Water Supply and Sanitation Sector Project, described below.

The Climate Change Policy 2012-2017 (Solomon Islands, 2012) puts improved resilience of water resource management as its second priority after improved food security, but the policy is yet to be updated.

The World Bank Group noted the need for strengthening coordination among the country's relevant institutions, including augmentation of technical and financial capacity of existing institutions to better meet the needs of remote islands in particular (World Bank Group Climate Change Knowledge Portal)

## Key challenges and emerging responses

Water availability is a key challenge in Solomon Islands and water resource availability varies considerably from overabundance to scarce water resources in small islands and low-lying atolls.[18] Activities such as uncontrolled logging, which is currently widespread in the country, and the traditional slash and burn practices of farming have negatively affected surface water resources quality and quantity, exacerbating the threat to communities who are dependent on those water sources.

Governance challenges, including limited financial resources, weak and unclear authority, and a heavy reliance on external funding for capital works, renewals and senior management roles only exacerbate the above challenges (SIWA, 2017; Wairiu & Powell (2006).

### Urban and peri-urban areas

Urban water supply demands are forecasted to increase significantly by as early as 2022.[19] In Honiara, the population connected to the water supply system is projected to increase from 57,999 in 2017 to 83,832 in 2022, and to the wastewater supply system from 5,656 to 12,253 for the same time period. This change will take place despite wastewater management in Honiara still being very weak.

[18] Solomon Islands Program for Water Governance Provincial Consultation Brochure. Water is Everybody's Business. Water Resource Division, MMERE, SIWA & Environment Health RWSS. 2020.

[19] SIWA forecasts based on existing demands, future connections, and demand reduction measures. SIWA, 2017, p.14.

Options for simplified sewerage systems and pay-as-you-go water supply in Honiara were outlined by Souter and Orams (2019). These types of scaled connection approaches have been trialled by Live & Learn in Honiara, with varying degrees of community ownership and input.

Further pilot studies were recommended by Souter and Orams, particularly for areas that were not yet formalised as settlements. They observed that 'although there is a preference for water-based sanitation, the promotion of dry-based sanitation options should be encouraged as a more water conservative option for those who choose it (which may also relate to lower costs to operate), and to give more consumer choice.'

While community-led total sanitation approaches can work well for rural communities where there is stronger social cohesion, informal settlements frequently have diverse communities and consideration needs to be given to the public benefit in minimising water borne diseases in determining contributions to establishment of sewerage systems in peri-urban settings, even if these are only temporary until more robust planning and design is implemented.

With urban and peri-urban populations in Solomon Islands projected to increase over the next 30 years, significant implications for current water supply and wastewater systems are projected, including (SIWA, 2017):

- Increased health, environmental and water quality impacts of wastewater discharge
- The need for additional water sources due to increased water supply demand
- The need to extend reticulation systems and improve the capacity of transfer systems.

The Strategic Plan recognises the vulnerability of key water and wastewater assets to extreme events and climate change, which will affect the availability of potable water and proposes the need for increasing storage, diversifying water sources, and improving water use efficiency.

The Urban Water Supply and Sanitation Sector Project will increase people's access to piped water supply and sanitation services, especially among poor households; reduce reliance on well water and rainwater harvest; and ensure more efficient water usage.[20] The project will rehabilitate and expand water production and treatment systems across Honiara, Auki, Gizo, Noro and Tulagi; develop a new water supply system in Munda; and connect an additional 40,000 of Honiara's most in-need people to a more efficient water supply network.[21]

The Lungga River is the preferred long-term primary supply source for Honiara. To support effective protection and management of the wider Honiara catchment, the Global Environment Facility (GEF) is financing the Honiara Catchment Management Project (HCMP) and SIWA is initiating stakeholder engagement of catchment communities (SIWA, 2020). The key issue here is that extractive logging activities have increased over the past five years, causing a number of adverse impacts to watersheds,

[20] ADB website. Funded by an Asian Development Bank (ADB) USD$28 million loan and a $9 million grant, a European Union (EU) $20.35 million grant, a World Bank $15 million loan, the national government $11.47 million, and Solomon Water with $9 million, totalling a $92.82 million project. Accessed 4/5/2021.

[21] World Bank Media Release. 16/5/2019. Safer, Cleaner Water and Sanitation for Solomon Islanders.

including greater turbidity and sediment loads, higher rates of runoff and landslides during rainstorms, and changes in seasonal flow regulation. Extreme rainfall is the main climate-related cause of worsening flooding.

### Rural areas

The focus is on providing adequate drinking water infrastructure and improving sanitation. UNDP funded a USD$6.8 million Solomon Islands Water Sector Adaptation Project (SIWSAP) through MMERE Water Resources Division. The project from 2015-2019, used a climate vulnerability assessment process to drive the priorities. Water sector climate change adaptation response (WS-CCAR) plans were envisaged to be developed for six provinces (Choiseul, Makira, Malaita, Rennell and Bellona, Temotu, and Western) and the water governance was improved, recognising that institutional capacity at the provincial level was limited. One of the objectives was to 'improve governance and knowledge management for Climate Change Adaptation in the water sector at the local and national levels', including a national water and adaptation forum. The mid-term review (Lenoci & Vaike, 2017) suggested that SIWSAP would struggle to fully deliver its objectives. Since then, work has continued to rehabilitate, improve and operate Gizo water supplies and identify new water supply sources for Munda, Choiseul Bay, Kirakira and Lata and undertake maintenance operations at the Fiu community desalination plant.[22]

UNDP also funded the SWOCK project, focused on resilience in agriculture and food security, which initiated community-based land use planning in 19 communities across the Solomon Islands to raise awareness of the need to protect water supplies and catchments.[23]

WASH has been undertaken in multiple communities by UNICEF, Live & Learn, Plan International and World Vision in a program from 2011-2016 that operated in three provinces (Isabel, Makira and Temotu) reaching 39 communities with drinking water programs and 15 schools.[24] Water for Women is partnering with Plan International and Live & Learn SI to deliver "New Times, New Targets" to improve WASH services, access and practice in 60 rural communities, eight rural health clinics and 22 schools of western Guadalcanal Province in the Solomon Islands, targeting an estimated 14,600 people.[25]

White (2016), addressing a need recognised in the National Adaptation Programme of Action (NAPA, Solomon Islands, 2008), undertook an initial analysis of drought preparedness and response planning looking at local rainfall data and areas where households depended upon rainwater harvesting. He observed that 'the typical household rainwater harvesting system in SI supplying an average-sized household with all their water needs has the risk of failing after only about 10 days without rain'. This significant work contains recommendations for improved data collection and further analysis, particularly through refining the 'pseudo-water balance method' with a small number of ground-based

[22] R. Molea pers. comm. 6/5/2021.

[23] UNDP website. Accessed 5/6/2021.

[24] Live & learn website Accessed 6/5/2021.

[25] Water for Women website. Accessed 6/5/2021.

rainfall measurements and aggregated monthly rainfall data, using improvements available through the Global Precipitation Measurement (GPM) network of satellites.[26]

### Remote and outer islands

The atoll islands of Solomon Islands face issues common to other atolls in the Pacific: small land areas; undeveloped soils; and a groundwater lens that is highly vulnerable to saline intrusion and pollution.

Consequently, programs have focused on establishing rainwater harvesting infrastructure and developing systems to protect gardens. Strengthening community knowledge and decision-making systems are critical to achieving effective long-term management of water supplies and natural resources (Bayliss-Smith et al., 2010).

### Recommendations

1. Support for community-based land use planning processes to protect catchments and mitigate floodwater run-off that causes soil loss and pollution through damage to inadequate sanitation.
2. Strengthen of community processes and inclusion of women for equitable decision-making around water, sanitation and natural resource management in rural and outer islands will enable communities to progressively adapt to changing conditions, using resources and approaches such as those of the sanitation learning hub, for example the Community-Led Total Sanitation approach. Reinforcing of good community processes with opportunities for social enterprise development will support maintenance.
3. Support business development to recycle nutrients from sewerage back into agricultural areas through biosolid production combined with agroforestry to prevent nutrient leaching into water tables.
4. Support revision of water resources legislation. This would benefit from a renewed framing around integrated water resource management and systems for measuring and modelling catchment and community water use.
5. Long-term investment in IWRM and catchment management will strategically assist in managing water-related disasters, including analysis of the effects of uncontrolled logging on the hydrology and water security of individual catchments and islands
6. Water-borne pollution solutions include continued training, promotion and support for solutions such as waterless composting toilets (Leney, 2017) and biodigesters to manage livestock wastes and provide home energy solutions[27].
7. Support drought preparedness planning by assisting with the design and implementation of

[26] Global Precipitation Measurement website. Accessed 7/6/2021.

[27] An example of the technology is the system promoted by ATEC. ATEC website. Accessed 7/5/2021

improved rainfall monitoring[28] and water balance monitoring. This may include improved evapotranspiration measurement throughout the Solomon Islands, deployment of GPM satellite data on rainfall, supporting analysis of all rainfall records in SI to identify orographic and locational influences on rainfall. White (2016, p. 5) also recommended 'further examination of the inter-relations between the intensity of ENSO events and rainfall extremes in SI, particularly in the dry season.'

8. Support a national survey be carried out of the characteristics of rainwater harvesting systems in SI together with demand and uses to better understand water scarcity (White, 2016, p. 5). This should include data on the roof catchment areas, rain tank capacities and guttering, particularly in areas that rely on rainwater harvesting such as Rennel and Bellona, Western Province, Choiseul and Temotu.
9. Improved hydrological modelling in SI would enable an improved estimate of sustainable yield of surface and groundwater sources in the Henderson-Honiara region to be determined, as well as other catchments.
10. Support review of current stresses on water supplies and design of mechanisms to increase flexibility and robustness of the water supply system in anticipation of climate change (MECM, 2008, p. 34), with a particular focus on gender equity and social inclusion in the assessment of current stresses.
11. Support strengthening of the linkage of an updated climate change policy and development of a National Implementation Plan that specifically addresses the needs of the water sector and improved catchment management.

[28] See also the recommendations of the World Bank Group Climate Change knowledge portal, *Solomon Islands Adaptation Options for Key Sectors*. Accessed 14/9/21.

## Tonga

The population of the Kingdom of Tonga is 99,780, the land area is 749 km$^2$, population growth rate is -0.28% and the GDP per capita is USD 5,081 (SPC SDD statistics from 2020).

The Tongan archipelago consists of 176 islands; 36 of which are inhabited. The islands are divided into four main groups – Tongatapu, Ha'apai and Vava'u and the Niuas.

The unicameral legislative Assembly comprises twenty-six members, seventeen People's Representatives, nine Noble Representatives elected from among the holders of Tonga's 33 noble titles, and up to four additional members. Tonga has a form of local government which features district and town officers elected every three years in local elections similar to the parliamentary elections. There are 23 district officers and 156 town officers elected across the country.[29]

Tonga has no climate change legislation. The key policy is the 2016 Tonga Climate Change Policy - A Resilient Tonga by 2035 (Tonga Climate Change Policy - A Resilient Tonga by 2035). The national climate change policy and Joint National Adaptation Plan (2018-2028) align with the Tonga Strategic Development Framework II (2015-2025) and the Pacific Framework for Resilient Development in the Pacific (2017-2030) (SPC, 2016).

### Climate projections for Tonga

Climate projections for Tonga for the period to 2100 indicate that:

- Annual and November–April mean and minimum temperatures have increased at Nuku'alofa since 1949. Maximum, minimum and mean temperatures have increased in the November–April period. Minimum temperatures have increased in the May–October period.
- El Niño and La Niña events will continue to occur in the future (very high confidence),
- It is not clear whether mean annual rainfall will increase or decrease and the model average indicates little change (low confidence in this model average), with more extreme rain events (high confidence).
- Drought frequency is projected to decrease slightly (low confidence)
- Sea level will continue to rise (very high confidence).

### Compounding issues

- Reliant predominantly on fresh groundwater lenses and rainwater harvesting for water supply.
- Risk of contamination of groundwater from household sanitation systems, and the need to increase availability of sanitation services to reduce groundwater pollution.
- Increasing urbanisation.

[29] CLGF Country Profile 2017-2018 The Local Government System in Tonga. Commonwealth Local Government Forum.

## Institutional framework

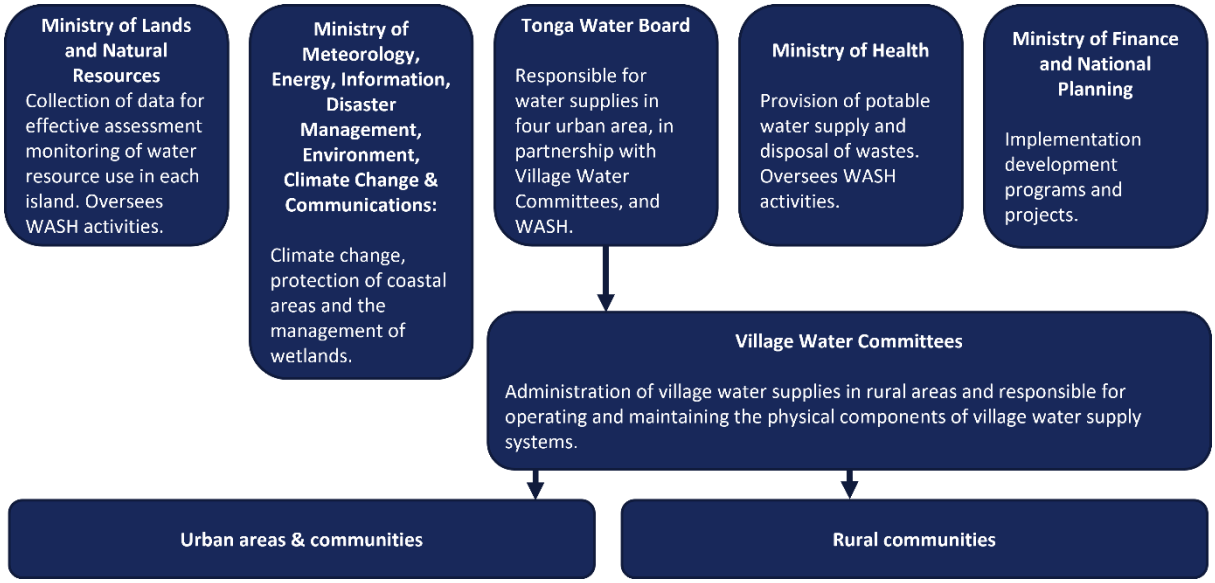


*Figure 9 Key ministries and authorities relating to water and climate change for the Kingdom of Tonga.*

The Water Resources Act 2020 creates legislation for a National Water Resources Committee responsible to the Ministry of Lands and Natural Resources (MLNR). The Committee has responsibilities to collect data for effective monitoring of water resource use in each island.[30]

The Committee is also responsible for projection of future water demand by domestic, commercial, industrial, and agricultural users, considering the impacts of climate change. The Committee may also recommend new water source protection zones. It is also responsible for monitoring construction and sealing of bores, wells and galleries constructed for accessing groundwater. Significantly, the Committee is mandated to address contingency plans to be used in the event of disasters or threats to the quality and quantity of water resources to reduce vulnerability and increase resilience.

Tonga's Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC) has responsibilities for climate change, protection of coastal areas and the management of wetlands, while its Ministry of Health retains oversight of provision of potable water supply and disposal of wastes.

The Tonga Water Board is responsible for water supplies in the four urban areas (Nuku'alofa, Pangai-Hihifo, 'Eua and Neiafu); with Village Water Committees, which sit under the mandate of the Ministry of Health, tending to administer village water supplies in rural areas.

While the Ministry of Health, the Tonga Water Board and the MLNR have a tripartite mandate over water and WASH, the skills do not necessarily lie in the right place, so there is still some improved alignment to be achieved.

[30] Including average quantity of water extracted on a daily, monthly, and annual basis; average quantity of water consumed on each island by the domestic, commercial, industrial and agricultural sectors and the wastewater produced by each of these groups.

The Ministry of Finance and National Planning (MOFNP) is the primary implementing partner for major international funding initiatives such as the GCF's Readiness and Preparatory Support program. It is therefore a key government ministry in terms of both national development and climate change action. Elevation of water into the increasingly powerful climate change arena appears to be assisting both in better influencing water resource management from a functional environment point of view, but also in terms of the human aspects of supply and sanitation.

The new Water Resources legislation was only passed in December 2020 and the implementation arrangements are currently being put in place to support the National Water Resource Committee. This will require some senior managerial appointments and the recruitment of some graduate positions.

The Tonga Climate Change Policy (2016) nominates 'Well managed water resources and sufficient water for all in times of shortage' as a target.

## Key challenges and emerging responses

### Urban areas

Nuku'alofa, Tonga's capital, has a population of 34,058 (34% of the national population) and is forecast to grow to 45,000 (or about 40% of Tonga's population) by 2030. Migration to Nuku'alofa from Tonga's outer islands is significant. About 98% of households in Nuku'alofa have access to the piped water supply provided by the Tonga Water Board. Water for the Tonga Water Board water supply is pumped from the Mataki'eua Tongamai well field and is chlorinated prior to distribution. Despite this, most households in Nuku'alofa rely on individual septic tank systems for wastewater disposal (ADB, 2011).

Tonga's water infrastructure, both large and small, is highly vulnerable to extreme weather conditions. When Tropical Cyclone Tino hit Tonga in January 2020, for example, it caused significant damage to public water infrastructure. Part of the response since then has been to develop a program to deliver water tanks to all households which do not currently have a water tank. This is being funded through the Climate Change Trust Fund, funded by the ADB Climate Change Resilience in the Pacific program. This envisages a total delivery of about 6,000 locally manufactured water tanks.

### Rural areas

In rural communities, water supplies have a distribution pipe network using water from surface or groundwater and normally use gravity flow pipelines to tanks or standpipes in the villages. This type of water supply often uses petrol, diesel or solar pumps to supply water to a storage tank feeding standpipes within the village. Village water committees often manage rural water systems with a small fee charged to households for the operation expenses (Tonga, 2019, p. 20).

Donor funds for the water sector are primarily used to address demand for increased water storage capacity requested by communities. This includes donations from Korea, India and China (Budget Statement 2020-21, Ministry of Finance, Kingdom of Tonga).

## Recommendations

Some recommendations are drawn from the Tonga Climate Change Policy (TCCP, 2016). The Objective

and page number are given where relevant). However, the Policy only focussed on actions to 2020 and did not address all of its own targets.

1. Support NGOs to further improve gender equity and social inclusion through the composition of village water committees, and improved access to funding to support women, youth and vulnerable groups in community development planning (Obj. 5.4, p. 19). This could be undertaken through the lens of improved budgeting for village WASH activities and planning for maintenance.

2. Support increased training and skills of women to design and implement WASH programs, including assisting households to plan, design and budget for water supply improvements.

   Training processes can be used to build the sense of communal ownership and household ownership of systems and empower communities to monitor and manage their own water resources.

3. Contribute to the coordination of messaging around water resource management and WASH, with many different agencies producing their own version of best practices.

4. Support and holistic water management database that would store supply and demand data and water balance data to enable prediction of water shortages. (Obj.5.2, p.17).

5. Support improved drought planning through improved awareness of rainwater harvesting infrastructure and better data on rainwater use.

6. Support the evolution of the National Water Resources Committee under the Water Resources Act 2020 and the policies, plans and procedures for Tonga's next phase of water resource planning, particularly with improved integration of issues relating to the particular needs of women, girls, the disabled and other vulnerable groups.

   Technical assistance will assist rapid advancement of Tonga's water security planning through investment in policies, planning, implementation workplans, development of Terms of Reference, the design of integrated databases and manuals and assisting senior MLMR staff with legacy planning.

## Tuvalu

The population of Tuvalu is 10,580, the land area is 26km$^2$, population growth rate is 0.81% and the GDP per capita is USD 4,223 (SPC SDD statistics from 2020). Tuvalu became independent in 1978 and is a constitutional monarchy with a 15-member unicameral parliament elected every four years. Local government is managed by eight *kaupule*, which are island councils.

Tuvalu's climate change legislation is the Climate Change Resilience Act 2019. The national policy is Te Kaniva Tuvalu Climate Change Policy 2012-2021. This policy sits under the National Sustainable Development Strategy 'Te Kete' 2021-2030 (Tuvalu, 2021).

### Climate projections for Tuvalu

Climate projections for Tuvalu for the period to 2100 indicate that:

- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence).
- Frequency and intensity of extreme rain events will increase (high confidence).
- The risk of coral bleaching will increase in the future (very high confidence).
- Sea level will continue to rise (very high confidence).
- Temperature on extremely hot days is expected to increase by about 0.5$^o$C by 2030 and the frequency of these days is expected to increase.
- Surface wind-wave driven processes, which impact to cause coastal flooding during storm wave events and coastal erosion, both during episodic storm events and due to long-term changes in integrated wave climate.
- During La Niña years, waves are more strongly directed onshore and wave power is stronger.

High year-to-year variability in rainfall is mostly due to the impact of the ENSO and is the greatest current challenge for Tuvalu, with droughts in 1999 and 2011 causing water scarcity in a number of communities.

While the scientific modelling may be unclear, the national development strategy (Tuvalu, 2016) notes that 'rise in global temperature has shifted rainfall patterns that are changing freshwater supplies, thus affecting the quality and quantity of water availability in Tuvalu, with adverse effects on agriculture.'

### Compounding issues

- Tuvalu is defined by coastline and is subject to tidal swamping, causing saline intrusion into groundwater.
- More public and private water catchment and storage is needed on Funafuti, to meet rising water demand and to be better able to cope with droughts or periods of low rainfall, which can last 3-6 months or longer in duration (Tuvalu, 2016, p.51).
- Enforcement of hygiene standards is a problem and there is poor social consensus around

water and knowledge of the water balance of the islands.

- On the outer islands further work is needed to upgrade water storages and catchments.
- Pollution control is critical. The widespread use of flushing toilets and associated septic tank infrastructure is problematic for protection of scarce groundwater and protection of onshore reefs and lagoons.

## Institutional framework

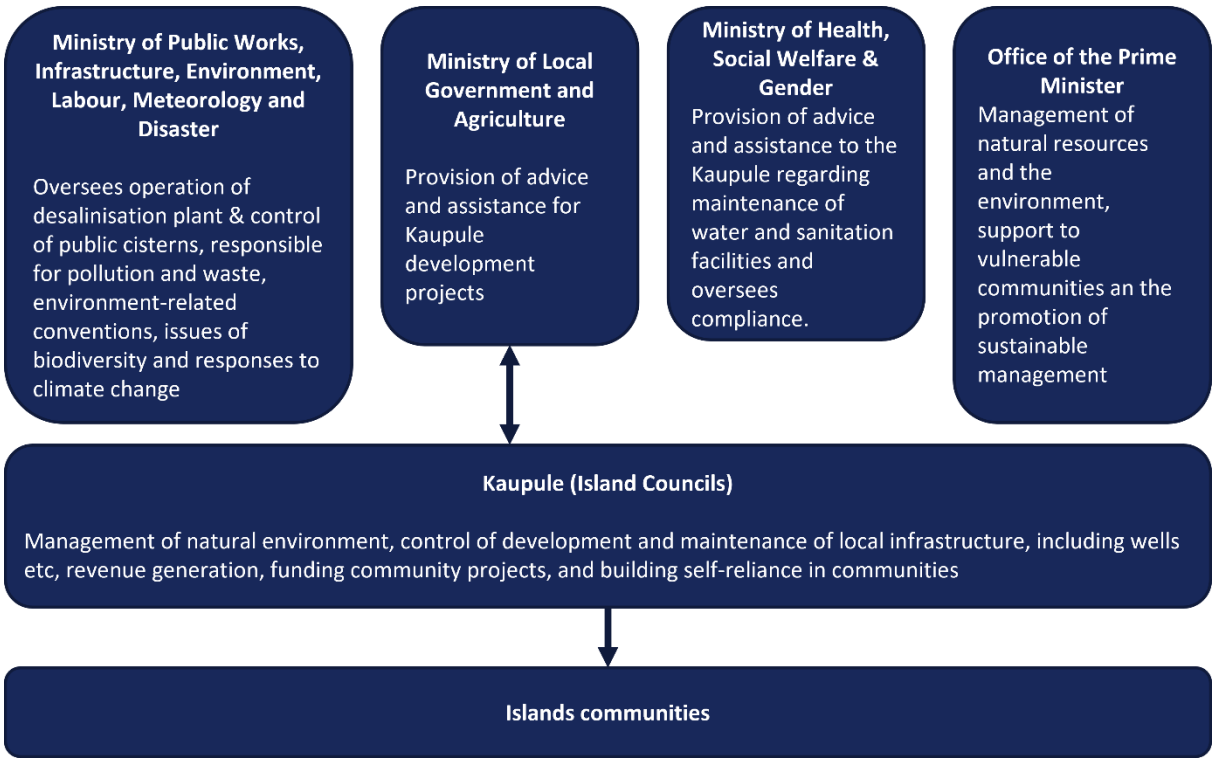


*Figure 10 Key ministries and authorities relating to water and climate change for the Kingdom of Tuvalu.*

Key acts are the Environment Act 2008 which covers regulation and control of pollutions and wastes and matters related to climate change; and the Falekaupule Act 1997 which creates the local government structure of eight island councils (the executive arm of the falekaupule, known as the 'kaupule') for the eight main inhabited islands. The island councils ('falekaupule') have responsibilities for maintaining water supply according to the Water Act 1967, and public health according to the Public Health Act 2008, and also for environmental matters of coastal erosion and tree planting.

National development is guided by the Te Kakeega III National Strategy for Sustainable Development 2016-2020 (Tuvalu, 2016). A Sustainable and Integrated Water and Sanitation Policy 2012-2021 (SIWSP) provides specific direction within the National Strategy.

## Key challenges and emerging responses

### Urban areas

ADB (2020) observed that Funafuti has 'inadequate water supply and sanitation services, and an increasingly high rate of communicable diseases. The groundwater is unsuitable for drinking because of saltwater intrusion and anthropogenic contamination. Rainwater harvesting is the primary source

of drinking water all over the country. Despite high average annual rainfall (3,483 millimetres), Funafuti frequently experiences short dry periods. Dry periods longer than 10 days typically result in water shortages, which require desalinated water to be delivered via trucks to household and community tanks.

The desalination plant, operated by the government through the Public Works Department (PWD), a division of the Ministry of Public Utilities, Infrastructure, Environment, Labour, Meteorology, and Disaster, has a capacity of 100 cubic meters per day. Importantly, this capacity cannot meet demand during severe droughts and the existing water storage capacity in Funafuti limits resilience to prolonged drought.

Data collected from the Population and Housing Mini-Census 2017 shows that about 86% of households have flush toilets with septic tanks, 7% have pour-flush pit latrines, and 3% have composting toilets (ADB, 2020). However, most septic tanks are poorly constructed with no desludging, and are breached during flood events.

Lal et al. (2006) analysed options for renovation or replacement of current household sanitation systems and concluded that an ecological sanitation system based on the composting toilet is the only option that is both economically viable and does not rely on water availability. They also observed that there were social barriers to acceptance. As shown by the census results, these problems have persisted, despite coining a Tuvaluan word for composting toilets ('*falevatie*') and promoting the concept extensively (SPC, 2013). Souter and Orams (2019) recognised this problem in Honiara too, and proposed options including sub-contracted maintenance of household or communal septic tanks, and inclusion of composting toilets as a cost-saving option for households.

ADB (2020) anticipates designing and building 'resilient, sustainable, and affordable water supply and sanitation services in Funafuti from 2020 to 2040.'

### Remote areas and the outer islands

With less households on the outer islands (Vaitupu, the second largest, has 187 compared with Funafuti's 849), the pressures may be less, but the problems are similar – dependence on rainwater, public health risks from polluted water, expensive transport and high risk of the need for supplementary water supplies. There is a need for increased public water catchment and storage (Tuvalu, 2016 p. 54).

### Recommendations[31]

1. Improved planning and geospatial tools need to be brought together to assist communities to manage their own aquifers and support appropriate local governance with technical advice.
2. Similarly, better water budgeting and quality monitoring tools and training will assist community decision making processes around public health and WASH options.
3. Support improved integrated land management through improved planning processes (Tuvalu

[31] Te Kete. National Strategy for Sustainable Development 2021-2030. Government of Tuvalu.

2021, p.5, KSA 1.5.6 and KSA 2.6.5) and emphasis on improved awareness, training, and partitioning of waste streams to maximise circular economy options (KSA 1.5.4).

4. Support Adoption and implementation of an Integrated Geospatial Information Framework (IGIF) to measure, monitor, quantify and manage Tuvalu's natural environment (Tuvalu, 2021 p. 5 KSA 1.5.5 and KSA 2.7.4) to better anticipate changes to the natural environment caused by climate change.
5. Support the Tuvalu Government's direction for implementation of Multi-Hazard Early Warning Systems (MHEWS) using improved meteorological data and modelling and increased meteorological service capacity to respond to climate change and disaster risk (Tuvalu, 2021 p.5, Key Strategic Action (KSA) 1.5.2 and 1.5.3).
6. Continue to support scale-appropriate energy solutions such as bio-digesters and improved solar powered reverse osmosis water production.
7. Support development and implementation of improved waste management strategies with local communities and the private sector (Tuvalu 2021, p5.), including consideration of alternative ownership and operation models to better scale the operation and maintenance of septic tanks, septage and sanitation with renovation of existing household septics but management by Public Works.
8. Support improved land management and food and water security through agricultural initiatives that contribute to climate change adaptation, including KSA 2.8.2 implementation of a national integrated coconut replanting scheme (recently funded by the EU) KSA 2.8.4 Develop a greater level of local food production and use of traditional food preservation knowledge. Support initiatives already operating that are referenced under KSA 2.8.3 Develop agricultural commercial activities including agribusiness.
9. Facilitate effective grassroots support for communities, working through the Tuvaluan Falekaupule local councils and strengthening these traditional governance mechanisms (KSA 4.16.1, 4.16.2 and 4.16.3).

## Vanuatu

The population of the Republic of Vanuatu is 294,688, the land area is 12 281 km$^2$, population growth rate is 2.27 % and the GDP per capita is USD$3,223 (SPC SDD statistics from 2020). The unicameral parliament has 52 members, comprising individual Members of Parliament and the Presidents of the six Provincial Councils.[32]

Key legislation for Vanuatu is the Meteorology, Geological Hazards and Climate Change Act 2016. Relevant policies are the National Policy on Climate Change and Disaster-Induced Displacement 2018, and the National Sustainable Development Plan 2016 to 2030.

### Climate projections for Vanuatu

Current climate trends show that maximum and minimum air temperatures increased at Port Vila) from 1948–2011 as did November– April and May–October maximum temperatures at Aneityum (in the south of the Vanuatu archipelago). Annual and half-year rainfall trends show little change and extreme daily rainfall trends also show little change.

Climate projections for Vanuatu for the period to 2100 indicate that:

- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.
- Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence).
- Mean annual rainfall could increase or decrease with the model average indicating little change (low confidence), with more extreme rain events (high confidence).
- Incidence of drought is projected to decrease slightly under the high emission scenario and stay approximately the same under the other emissions scenarios (low confidence).
- Ocean acidification is expected to continue (very high confidence).
- The risk of coral bleaching will increase in the future (very high confidence).
- Sea level will continue to rise (very high confidence).
- Wet season wave heights and periods are projected to decrease slightly (low confidence), with no significant changes projected in the dry season (low confidence).

### Compounding issues

- Vanuatu's population is distributed relatively evenly across its islands but there is increasing urban and peri-urban growth around Port Vila, Luganville and, to a lesser extent, Norsup on Malekula. The processes for expansion of municipal council areas to accommodate service provision for these areas are unclear, as are the enabling additional funding.

[32] CLGF Country Profile 2017-2018 The Local Government System in Vanuatu. Commonwealth Local Government Forum.

- In addition to multiple recent tropical cyclones that have caused extensive damage, Vanuatu's disaster management arrangements were also tested by the eruption of the Manaro volcano and the evacuation of the entire population of Ambae in 2018-2019. This meant a dramatic and abrupt increase in populations of a number of urban centres and neighbouring islands (particularly Luganville), with many evacuees settling more permanently.
- Orographic rainfall patterns mean that a number of remote communities (such as the west coast of Espiritu Santo) experience more frequent droughts but have very little resilience to water shortage. To the north, in Torba province, water scarcity and drought are increasing in frequency. In conjunction with cyclone damage, these events limit investment in household water infrastructure to increase security.

## Institutional framework

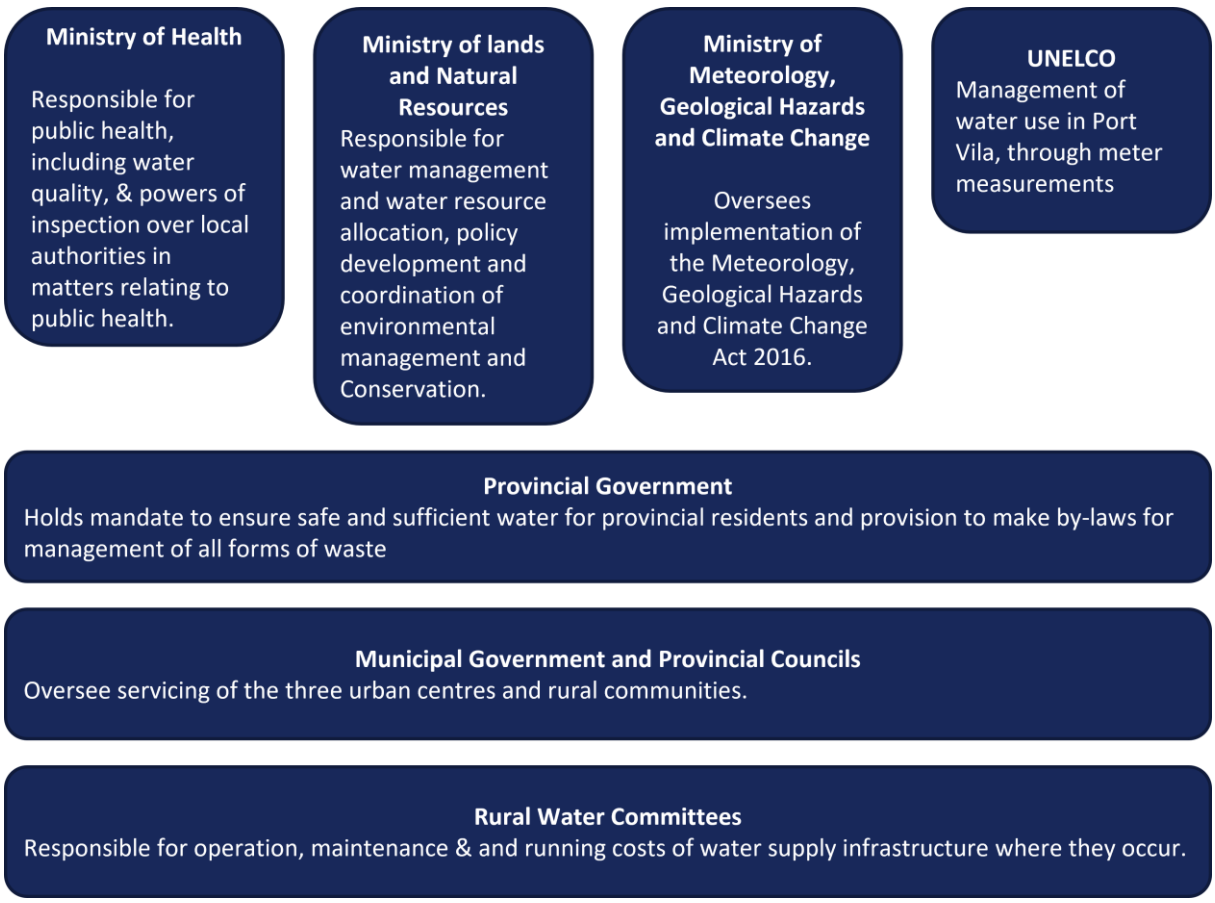


*Figure 11 Key ministries and authorities relating to water and climate change for the Republic of Vanuatu*

The Ministry of Lands and Natural Resources (MLNR) is responsible for Vanuatu's water management under three Acts: The Water Resource Management Act 2002, the Water Supply Act 1985 and the Public Health Act 1994. The guiding policies are the National Water Policy 2017-2030 and the Sanitation and Hygiene Policy 2017-2030.

The Ministry of Climate Change and Natural Disasters (MOCC) is responsible for the implementation of the *Meteorology, Geological Hazards and Climate Change Act 2016*.The MOCC's National Policy on Climate Change and Disaster-Induced Displacement (Vanuatu, 2018) outlines a strong rights-based

approach to providing displaced Ni-Van citizens with access adequate fresh water, sanitation, energy and infrastructure and recognizes the significant challenge of informal settlements located on marginal land susceptible to hazards. The National Environment Policy and Implementation Plan (Vanuatu, 2016) also within MOCC, proposes targets of declaration of 6 Water Protection Zones and 6 Watershed Management Plans, as well as 100% of community water supply systems with Drinking Water Safety and Security Plans by 2030.

The National Water Policy observes that 'the impacts of climate change on agriculture, energy, industry and urbanization will be primarily mediated by changes in water patterns' (National Water Policy, p. 9).

Below the national government, municipal councils govern the three main urban centres, while six provincial councils serve the provincial rural communities. Each Provincial Council has a central administration. Within each Province local areas have been designated, which are headed by an area secretary who reports to the secretary general of the provincial council (CLGF, 2018). While provincial governments have the mandate to ensure safe and sufficient water for all, they, in fact, play a negligible role in service provision.

In Vanuatu's rural areas, Rural Water Committees (RWCs) are responsible for operating and maintaining the water supply infrastructure where they occur, as well as the collection of monthly fees from households to support costs. Under the Water Resource Management Act 2002 Any landowner, or group of landowners, can establish, and the Director can promote, a RWC for any water resource on or under land for the purpose of implementing water supply conservation measures or a management scheme. However, registration of RWCs can only take place if at least 40% of its members are female (clause 20H) – acknowledging that women tend to be at the forefront of detecting water resource issues and scarcity, so that the performance of RWCs tends to improve where there is a greater role for women. There are 4,090 water supply schemes in Vanuatu with rainwater systems constituting the vast majority with 2,793 schemes.

Relevant legislation is summarised in Annexes 2 and 3.

## Key challenges and emerging responses

### Urban areas

Urban water supplies are provided by UNELCO (a private company) in Port Vila and Public Works in Luganville, Isangel and Lakatoro (SPC, 2012).

Urbanisation is stressing local supplies. Droughts and issues of water quality can also compromise supply especially for available potable water (SPC, 2012). UNELCO manages water use in Port Vila through meter measurement of all customers. It reports that network efficiency is 78-80%.[33]

The sanitation system in greater Port Vila was recently improved with construction of a faecal sludge treatment facility with a capacity of 28 cubic meters per day which was commissioned in August 2017.

[33] UNELCO website. Accessed 4/6/2021.

This enables the safe treatment and disposal of all domestic and commercial septic faecal sludge in Port Vila (ADB, 2020b). This system is operated by the Port Vila Municipal Council.

The Department of Water Resources (DWR) provides the water supply service in Luganville, supplying 3,030 customers. However, it only covers 51% of households in Luganville Municipality and only 10% in peri urban Luganville. Luganville' s water supply is sourced from a shallow well at Sarakata which was developed in 1943 and has been poorly maintained ever since (ADB, 2019). There are water safety issues due to contamination of groundwater, primarily from surrounding houses. Production from the Sarakata water source exceeds the sustainable aquifer yield and drawdown is increasing (ADB, 2019)

Luganville does not have a sewerage system. In 2016, about 68% of Luganville households had improved sanitation, mainly pit toilets and septic tanks (ADB, 2019). DWR, with support from the ADB, is developing a plan to upgrade Luganville' s water supply and sanitation.

### Peri-urban areas

Many of the issues experienced in Vanuatu's peri-urban areas are described in the National Policy on financing Climate Change and Disaster-Induced Displacement (Government of Vanuatu, 2018).

Areas where informal settlements are expanding around Port Vila include: Blacksands, Mele and Mele Maat, Freshwota, Seaside town and Eratap. Around Luganville there are areas that are outside the Municipal area (such as Ban Ban) and areas inside, mostly in the Western Ward (Bebepon and along the Belaru road).

One key finding from Schrecongost and Wong (2015) was the need for government to establish 'clear national mandates for service delivery, clarify the organizational authority and their obligations to implement services, and set clear service level targets for settlements' (Schrecongost & Wong, 2015). Although these mandates are established in legislation in Vanuatu, as noted above, provincial and municipal governments are inadequately resourced to deliver these services.

### Rural areas

While the larger islands of Vanuatu have significant surface and ground water resources, smaller islands such as Mataso and Buninga in the Shepherd's Group, all of the Torres Group, and small islands off Malekula and Santo have neither significant ground nor surface water, relying on rainwater harvesting. During times of national disaster such as cyclones the National Disaster Management Office has provided a desalination plant to these islands as a temporary measure (SPC, 2012).

No country-wide assessment of Vanuatu's water supplies has been undertaken (Sleet, 2019) apart from the SPC (2012) assessment of river systems; finer scale hydrological modelling would facilitate planning of water supply and sanitation.

### Recommendations

The National Water Policy makes a number of explicit and pragmatic recommendations under six headings. There are therefore clear and important opportunities for development partners to contribute to key elements which will have a direct influence on the resilience of the water supply system in the face of climate change. These components of the policy are featured here.

1. Strengthen water safety and security (1.1 of National Water Policy).
    a. Support drinking water safety and security planning to all drinking water asset owners (i.e., departments, private, communities, schools, health facilities, households) to ensure that adequate water reserves are available for days of high temperature and extended dry seasons.
    b. Support increased community-led drinking water testing which will increase community awareness of water quality risks and communal management of pollution sources.
    c. Support improved water resource data management to identify priority areas to invest in the diversification, storage and regulation of water resources
    d. Review existing water resource areas, buffer zones and enforcement mechanisms.
2. Water supply markets (1.2)
    a. Analyse and review existing market-based incentives for water resource management by private operators and consumers, seeking to align market behaviour to improve overall system operation and generation of the revenues necessary to operate, maintain and upgrade public urban water assets.
    b. Support the design of, and reward communities that develop efficient management systems for the operation and maintenance, billing and collection, replacement, and expansion of public rural water assets.
    c. Support the training and business capability of skilled service personnel (i.e., engineers, plumbers, drillers, desalination technicians), products (i.e., tanks, pipes, meters) and techniques (i.e., drilling rigs, HDPE welding).
    d. Support design of improving access to finance for households (i.e., via loans, rebates, consumer cooperatives) to access higher quality drinking water products (i.e., water supply meters, first flush systems, rainwater tanks).
3. Water services compliance and formalising Water Service Providers (1.3 & 1.4)
    a. Support structures to improve planning and accountability for compliance to 'quality of service' standards by seeking to vest public water asset ownership with a legal entity and upskilling water committees.
4. Provincial Council By-laws (1.6)
    a. Support the creation of model by-laws and provide technical assistance to provincial water resources advisory committees to adapt them for local needs.
5. Secure water future (1.7)
6. Improve planning and coordination with other sectors and partners to understand, predict, design, and invest to secure Vanuatu's water future. Investment is desirable to:
    a. Improve mapping and modelling of water resources (ground, surface, rain) to enable

investments in diversified water sources and increase storage giving priority to rain / ground water for drinking and surface water for agriculture and industry.

b. build on local knowledge to improve the protection of water supplies

c. Improve data management and build pathways for knowledge management to improve disaster recovery to be able to build back better and integrate renewable energy sources where possible.

7. Support improved linkage of improved management of WASH and IWRM to the Vanuatu Climate Change and Disaster Risk Reduction Policy • 2016-2030, recognising that the first and most profound effects of climate change and disasters often relate to water, too much, too little or polluted.

# Conclusion

This report has attempted to provide an overview of the effects of climate change on Pacific water security and governance, highlighting the challenges confronted by water agencies, actors and communities.

The climate science is clear that increased temperature, increased rainfall intensity and sea-level rise are all unavoidable. Therefore, efforts to build resilient infrastructure and systems to manage water scarcity, while protecting food systems, are critical. Good planning and strategic, equitable consideration of needs will help to protect the cohesiveness of these societies.

Although only eight countries have been considered, many of the issues that have been raised are present in other countries: Slow implementation of improved drinking water, lack of adequate sanitation for increasingly urban populations and urgent need to adopt ecosystem or whole-of-catchment approaches to protect rivers, minimise pollution and enable water to enter and recharge groundwater aquifers.

Supporting communities to manage their water resources requires knowledge and facilitation within existing power structures, using both formal governance and traditional governance. While respecting these systems, it is critically important to augment the voices in the room and ensure that women, diverse gender, disabled and other vulnerable or marginalised groups can contribute to decision making. Their perspectives, properly heard and implemented, will improve water management for all.

Support for high quality science and knowledge management, Pacific-based water training, and implementation of good governance and decision making at all levels, will help to mitigate the challenges ahead.

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# Annex 1: Key regional programs working on SDG 6 in the Pacific

| Regional Program or Initiative (and primary donor) | Objective and intersection with climate change/water issues | Intersection with climate change | Timeframe |
|---|---|---|---|
| **Water for Women, DFAT** | A WASH program focusing on improved health, gender equality and wellbeing of communities in the Asia-Pacific region through strengthened national and subnational WASH sector systems, increased equitable, universal access to and use of sustainable WASH services, and strengthened gender equality and social inclusion in households, communities, and institutions. | **Limited but increasing:** Limited intersection at the program level, although a small number of WASH and research projects are integrating climate vulnerability and climate risk into project re-designs | 2018-2022 |
| **Global Water Security and Sanitation Partnership (World Bank)** | Provides technical and resource support to countries to meet the targets related to water and sanitation under the Sustainable Development Goals, namely SDG6. The program covers the entire water landscape, including water resources management (WRM); water supply, sanitation, and hygiene (WASH); water and agriculture; and water and the economy. | **OK and increasing:** The program has a strong focus on the intersection of water services and climate change. – increasing reorientation towards climate change and resilience. | 2017-2030 |
| **Water Finance Partnership Facility (ADB)** | To strengthen water and sanitation development outcomes across Asia and the Pacific. Provides support to project preparation and implementation in Water supply, sanitation and wastewater management, irrigation and drainage, flood management, water resources management, wetlands, and watershed protection, and hydropower generation. | **Good:** Tackling climate change, building disaster resilience, and enhancing environmental sustainability is an operational priority under ADB's strategy 2030 [34] and a priority under ADB's Water Sector Group. All water programs of the ADB integrate climate change to some degree. | 2019-2022 |

[34] Considerations for climate change adaptation, environmental sustainability, and disaster risk management form a core part of the ADB's Differentiated approach to Small Island Developing States in ADB's Strategy 2030.

| | | | |
|---|---|---|---|
| **The Pacific WASH coalition (Regional coalition, hosted by SPC)** | A regional coalition focusing on issues of access to safe water supply, adequate sanitation, and improved hygiene practices for the people in the Pacific. Comprises multilaterals, regional organisations, and international and national NGOs.[35] | **Good:** The Coalitions' framework advocates for climate risk management to be integration into all water-related programs, and that all infrastructure and other WASH intervention take climate change and variable into account. | |
| **Sanitation and Water for All (SWA) (Multiple donors, including Australia)** | A global multi-stakeholder partnership working in the WASH sector. The partnership focuses on increasing political prioritization of water, sanitation, and hygiene, ensure adequate financing, and build better governance structures, systems and institutions to achieve SDG 6 by the year 2030.<br>In the Pacific, only Fiji and PNG are member countries. | **OK:** Climate change does exist as one of the network's priority areas.<br>SWA partners are information and concrete suggestion on how to include mitigation and adaptation into their activities. | Ongoing |
| **Water, sanitation, and hygiene program (UNICEF)** | Focusing on WASH and working across 14 PICs, this program aims to strengthen national systems and capacity through construction of WASH facilities for communities, schools, and health centres, providing WASH assistance during emergency responses, and strengthening national level legal systems and policies for WASH. | **Limited:** Limited consideration for climate change, other than through provision of WASH assistance during emergency responses. | 2018-2021 |
| **Water Scarcity Program (FAO)** | Focuses on practical aspects of water accounting, water allocation processes, and adaptation of agricultural water management to water scarcity, better water scarcity management and the development of a Regional Collaborative Platform.<br>Fiji is included in the first stage analysis and it is envisaged that there will be a core program on water scarcity in the Pacific[36]. | **Good:** Climate change is a core component of the program. Program design recognises that climate change will increase demand and reduce or make supply more variable, depending on the precise context. | 2022- |

[35] *Framework for the Pacific WASH Coalition.* Accessed 14/5/2021.

[36] *FAO Water Scarcity Program* (WSP) for Asia-Pacific 2021. Accessed 14/5/2021.

| | | | |
|---|---|---|---|
| **Closing the loop between agriculture and wastewater discharge: A novel technique for turning wastewater into fertiliser in the Pacific (ACIAR)** | A research initiative assessing the suitability and community acceptability of different waste streams and treatments in order to determine the feasibility and uptake of recovered wastewater nutrients for agriculture in the Pacific.<br>Currently engaging with key stakeholders in Vanuatu and Tuvalu. | **Limited:**<br>Sole focus on wastewater, agriculture, and social susceptibility. | 2020-2021 |
| **Pacific Ridge-to-Reef program (GEF)** | Aims to support and address national priorities and development needs while delivering global environmental benefits in line with GEF focal area strategies - biodiversity, land degradation, climate change adaptation and mitigation, international waters, and sustainable forest management. USD$90 M. | **Good:**<br>A strong focus on climate resilience and climate adaptation as solutions to maintaining and enhancing water resources. | 2015-2022 |
| **Small Islands Food and Water Project (USAID, multiple donors, and philanthropic organisations)** | Focuses on improving food, nutrition (enhanced agricultural production) and water security and livelihood opportunities in the small island communities.<br>The program focuses on the Pacific small island states of FSM, Kiribati, Marshall Islands and Tuvalu. | **OK:**<br>Advocated for the mainstreaming of climate change adaptation measures into agricultural production. | 2010 - |
| **Global Climate Change Alliance Plus – Scaling up Pacific Adaptation (GCCA+ SUPA) (European Union)** | GCCA+ SUPA is a climate change initiative focusing on strengthening the implementation of sector-based, but integrated, climate change and disaster risk management strategies and plans, including in the water and agriculture sectors. € 14.89 M. | **Good:**<br>This program is primarily climate change, which is being integrated into key sectors, including water. | 2018-2023 |

# Annex 2: Overview of key national legislation governing water security, climate change and disaster management - Keywords

The legislation is classified according to whether it addresses key areas of water policy and governance: Rights and allocation, Climate Change, Forestry, Catchment Management, Disaster Risk, Salinity, Sustainability, Fires, Environment, Sanitation & Sewerage.

| Country | Legislation | Climate Change | Forestry | Catch-ment Manage-ment | Disaster Risk | Salinity | Sustain-able | Fires | Environ-ment | Sanit-ation or Sewage/ Hygiene |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fiji** | Rivers and Streams Act 1882 | | | | | | | | | |
| | Public Health Act 1936 | | | | | | | | | |
| | Land Conservation and Improvement Act 1953 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | | |
| | Forest Decree 1992 | | ✓ | | | | | ✓ | | |
| | Water Authority of Fiji Promulgation 2007 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | | | |
| | Irrigation Act 1973 | | | | | | | | | |
| | Drainage Act 1961 | | | | | | | | | |
| | Environment Management Act 2005 | | | | | | ✓ | | | |
| | Natural Disaster Management Act 1998 | | | | | | | | | |
| | iTaukei Lands Act 1940 | | ✓ | | | | | ✓ | | |
| | Agricultural Landlord and Tenant Act. | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Land and Water Resources Management Bill 2016 | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ | ✓ | | |
| **Kiribati** | Public Utilities Ordinance 1977 | | | | | | | | | ✓ |
| | Environment Act 1999 | ✗ | | ✗ | | ✗ | ✓ | | ✓ | |
| | State Lands Act 2001 | | | | | | | | | |
| **PNG** | United Nations Paris Agreement (Implementation) Act 2016 | | | | | | | | | |
| | Climate Change (Management) Act 2015 | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✗ | ✓ | ✗ |
| | National Water Supply and Sanitation Act 2016 | ✗ | | | | | | | | ✓ |
| | Public Health Act 1973 | | | | | | | | | |
| | | | | | | | | | | |
| | Environment (Water Quality Criteria) Regulation 2002 | | | | | | | | ✓ | |
| | Environment Act 2000 | | ✗ | ✗ | ✗ | | ✓ | ✗ | ✓ | |
| **Samoa** | Water Resources Management Act 2008 | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Samoa Water Authority Act 2003 | | | ✗ | | | | | | ✓ |
| | Samoa Water Authority (Sewerage and Wastewater) Regulations 2009 | | | | | | | | | ✓ |
| | Forestry Management Act 2011 | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | |
| | Taking of Land Act, 1964. | | | | | | | | | |
| | Village Fono Act 1990 | | | | | | | | | ✓ |
| **Solomon Islands** | Environment Act 1998 | ✗ | ✗ | ✗ | ✗ | ✗ | | | | |
| | Water Authority Act 1992 | ✗ | ✗ | ✓ | ✗ | ✗ | | | | |
| | River Waters Act 1996 | ✗ | ✗ | ✗ | ✗ | ✗ | | | | |
| **Tonga** | Water Resources Act 2020 | ✓ | ✗ | ✗ | ✓ | ✓ | | | | |
| | Environmental Management Act 2010 | ✓ | | ✗ | | | ✓ | | ✓ | |
| | Public Health Act 1992 (amended 2005) | | | | | | | | | ✓ |
| | Tonga Water Board Act 2000 | | | | | | | | | |
| | Emergency Management Act 2007 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ | ✓ | |
| **Tuvalu** | Water Supply Act 1967 | | | | | | | | | |
| | Environment Protection Act 2008 | ✓ | | | ✓ | | ✓ | | ✓ | ✓ |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Falekaupule Act 1997 | | ✓ | | ✓ | | | | ✗ | ✓ |
| | Public Health Act 2008 | | | | | | | | ✗ | ✓ |
| | Climate Change Resilience Act 2019 | ✓ | | | ✓ | | ✓ | | ✓ | |
| **Vanuatu** | Meteorology, Geological Hazards, and Climate Change Act 2016 | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ | |
| | Water Resources Management Act 2004 | ✗ | ✓ | | | | | | | |

# Annex 3: Scope of key national legislation and relevant national ministry

| Country | Ministry / Authority | Legislation | Scope | Definitions / Powers |
|---|---|---|---|---|
| **Fiji** | **MLMR** | **Rivers and Streams Act 1882** | Defines public rights in the rivers and streams of Fiji | |
| | **Ministry of Health and Medical Services (MHMS)** | **Public Health Act 1936** | Includes provisions about sewerage, sanitation, and water supply | |
| | **Ministry of Agriculture (MOA)** | **Land Conservation and Improvement Act 1953** | To make provision for the conservation and improvement of the land and water resources of Fiji". Sections 4-5 establish a Land Conservation Board to supervise land and water resources and to promote public interest in conserving and improving land and water resources.<br>to exercise general supervision over land and water resources;<br>(b) to stimulate, by propaganda and such other means as it may deem expedient, public interest in the conservation and improvement of land and water resources;<br>(c) to recommend to the Minister the nature of legislation by it deemed necessary for the proper conservation and improvement of land and water resources; | Conservation orders can cover prohibition, regulation or control of land clearing, cultivation, grazing and the lighting of fires and burning of vegetation. |
| | **Ministry of Forestry** | **Forest Decree 1992** | Provides for 'forest and nature reserves' to be declared by the Minister, upon recommendation of the Forestry Board, on land which has already been reserved for public<br>purposes. Forest reserves shall be managed as permanent forest in order to provide, on a permanent basis, the optimum combination of benefits of protection and production of which they are capable (from Freund, 2011).<br>Part VII provides the legislation for the control of fires in forest reserves, nature reserves or declared fire hazard areas. | |

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| | **WAF** | **Water Authority of Fiji Promulgation 2007** | Key functions:<br>(a) to harvest, treat and reticulate water for supply to its customers;<br>(b) to comply with standards in relation to the supply and quality of water in its Water System;<br>(c) to collect, transport, treat and discharge waste water<br>(d) to establish, operate and maintain systems for the provision of water and sewerage services;...<br>(g) to progressively achieve economic viability in the provision of water supply and sewerage services;<br>(h) to be environmentally responsible<br>(i) to assist in protecting, managing and conserving water resources; | The authority has the power to control or ration the supply of water, whenever necessary. |
| | **MOWE** | **Irrigation Act 1973** | The Act makes provision for the irrigation of land and various matters related to irrigation, particularly for the construction, improvement and maintenance of irrigation works and establishment and administration of irrigated cultivation. | |
| | **MOWE** | **Drainage Act 1961** | To construct, maintain and improve drainage within declared areas. | |
| | **MOWE** | **Environment Management Act 2005** | To apply the principles of sustainable use and development of natural resources.<br>The Act establishes a National Environment Council with powers to:<br>- Approve a National Environment Strategy<br>- Facilitate a forum for discussion of environmental issues<br>- Ensure compliance with international treaties, conventions and agreements relating to the environment<br>- Advise the government | |
| | **Ministry of Disaster Management** | **Natural Disaster Management Act 1998** | This Act makes provision for measures to better manage the state of calamity caused by a natural disaster. It provides for the establishment of the National Disaster Management Council. The Ministry of Agriculture in liaison with Public Works Department – flood control and water-shed management programmes. | |
| | **Ministry of iTaukei Affairs** | **iTaukei Lands Act 1940** | Establishes the mandate of the TLTB to administer native land for the benefit of native Fijians. The Act grants powers for the Minister to authorise entry for ' maintaining or improving the flow of water in any river, stream, spring, lake or swamp and for that purpose may construct dams and divert any river, stream, spring, lake or swamp.'<br>The Act also stipulates the obligations of tenants to 'maintain in good condition to the satisfaction of the Board all drains, ditches and | |

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| | | | watercourses' and 'measures to check soil erosions as may be required by the Board'. | |
| | **Ministry of Lands and Mineral Resources** | **Agricultural Landlord and Tenant Act.** | | |
| | **MOWE** | **Land and Water Resources Management Bill 2016** | This bill proposed a Board with functions to:<br>initiate the development of land and water use plans through co-ordination with all relevant stakeholders, including the landowners;<br>Every land and water use plan for a land and water conservation area shall involve<br>(a) integrated land and water resources planning for the purposes of the management of catchments and sub-catchments;<br>(b) floodplain management;<br>(c) river and stream management; and<br>(d) water use allocation for the flows and reserves in a river, stream or aquifer for the management of any area of land for which integrated land and water resource management planning is deemed necessary. | |
| **Kiribati** | | **Public Utilities Ordinance 1977** | This Ordinance creates a Public Utilities Board with powers to construct, control, manage, maintain, operate, and supervise waterworks and provide in water supply areas an adequate supply of water for the use of the public. | |
| | | **Environment Act 1999** | This act covers pollution of water including the sea and underground water. The Act aims to reduce risks to human health and prevent the degradation of the environment by all practical means; to protect and conserve the natural resources threatened by human activities, particularly those resources of national and ecological significance. | |

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| | | **State Lands Act 2001** | The State is the owner of land in the Republic, and some of these lands should be made available for development including permanent settlement of citizens and their families, who otherwise have no or limited access to land. The objectives of this Act are on the one hand to provide a framework for the tenure and alienation of such land and on the other hand to provide for the planning and sustainable development of such land in accordance with certain principles. This Act covers the use of land-based resources without specifically mentioning water. | |
| **PNG** | | **United Nations Paris Agreement (Implementation) Act 2016** | To the develop and implement measures to combat climate change in accordance with the Paris Agreement | |
| | | **Climate Change (Management) Act 2015** | Creates a framework for the development and implementation of measures in Papua New Guinea to combat climate change in accordance with the Kyoto Protocol and other international agreements and programmes including agreements between the Authority, the customary owners of the land and forest resources and the project proponent relating to an Agreement on REDD, REDD+, CDM or other Voluntary Carbon Offset Projects and any future climate change emission reduction mechanisms agreed to. | |
| | | **National Water Supply and Sanitation Act 2016** | to provide for co-ordinated water supply and sanitation services and for the planning, design, construction and management of water supply and sanitation systems in the country; and (b) to levy charges in respect of these services and systems, to make provision for the establishment of Water Papua New Guinea Limited as a company replacing the Waterboard; and (c) to repeal the National Water Supply and Sewerage Act 1986, | |
| | | **Public Health Act 1973** | This Act makes provision with respect to matters public health in Papua New Guinea including the handling of food and the supply of potable water. It includes rules for the prevention of the pollution of natural watercourses and the maintenance of the purity of water supply. | |

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| | | **Environment (Water Quality Criteria) Regulation 2002** | Specifies the water quality criteria for protection of freshwater aquatic life and marine aquatic life and establishes standards with respect to the maximum permitted levels of ammonia–nitrogen in freshwater aquatic life. The Regulation prohibits discharge that causes a deterioration of water quality below the prescribed water quality criteria. | |
| | | **Environment Act 2000** | This Act makes provision for the protection of the environment, in particular of water resources, air and soil. The Act covers rights in relation with water and in particular the right of the public to take water, rights of an owner or occupier of land near a watercourse, acquisition of land for public purposes in relation with waterworks and the control of use of water, authorization of investigations of water resources, protection of water resources and measures against drought, | |
| **Samoa** | **Ministry of Natural Resources and Environment** | **Water Resources Management Act 2008** | The Act sets out the principles of sustainable management of water resources, defines rights to control and manage water resources, regulates the taking and use of water, establishes the Samoa Water Resources Board, provides for the protection of watersheds, provides for community involvement in water resources management, provides for enforcement and defines offences. | |
| | **Ministry of Works, Transport, and Infrastructure.** | **Samoa Water Authority Act 2003** | An Act to enable the Samoa Water Authority. The Act has an emphasis on promoting its financial independence and its role as a provider of economically viable services through an accountable management structure. | |
| | **Ministry of Works, Transport, and Infrastructure.** | **Samoa Water Authority (Sewerage and Wastewater) Regulations 2009** | | |
| | **Ministry of Natural Resources and Environment** | **Forestry Management Act 2011** | | |
| | | **Taking of Land Act, 1964.** | The Act concerns taking of private land by the State for public purposes, including "forestry, the control of coasts and rivers, the safeguarding of water, soil and forest resources, water supply, drainage, etc." | |

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| | **Ministry of Women, Community and Social Development (MWCSD).** | **Village Fono Act 1990** | This Act regulates the functioning and powers of village assemblies called Village Fono. This grants the Fono the power to make rules for the maintenance of hygiene in the village and the power to make rules governing the development and use of village land. | |
| **Solomon Islands** | | **Environment Act 1998** | | |
| | | **Water Authority Act 1992** | To manage urban water supply and waste.<br>To manage catchment areas for the purpose of protecting Honiara's water quality. | |
| | | **River Waters Act 1996** | To protect rivers, riverbeds and banks and regulate diversions of water.<br>The Act provides the legal mechanism to manage and control river water for the equitable and benefit use for all.<br>The Act provides a specific order for the management of the use of water and activities associated with six specific rivers systems located on Guadalcanal including the Mataniko, White, Mbalasuna, Ngalimbui, Lungga and Mamara rivers. | |
| **Tonga** | | **Water Resources Act 2020** | Objectives: a) the sustainable management of the water resources;<br>(b) the avoidance of overdrafts;<br>(c) the improvement of the chemical, physical and biological integrity of the water resources;<br>(d) control of pollutant discharges;<br>(e) implementation of urban and rural planning regimes that take account of water management; and<br>(f) assessment of the impacts of proposed developments on the water resources. | Surface and ground waters in aquifers, lakes, streams, and springs; and excludes domestic and communal rainwater storages for private and communal use.<br>Impact of climate change referred to in definition of 'vulnerability'. |
| | | **Environmental Management Act 2010** | Creates the Ministry of Climate Change and defines functions in relation to: (a) climate change; (b) ozone depletion; (c) the movement or disposal of hazardous wastes and chemicals; (d) desertification and drought relief; (e) the preservation of wetlands and the management and protection of coastal areas; (f) the conservation of endangered | |

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| | | | species; (g) the preservation of biological diversity, including management of living modified organisms; | |
| | | **Public Health Act 1992 (amended 2005)** | Includes provision relating to wrong construction of wells or water storage, pollution of pools, lagoons, ditches or watercourses, and obstruction of watercourses. Part V makes provision for the control of (potable) water supply. Part VI concerns the collection and disposal of waste. Notwithstanding the repeal, all: arrangements made for the collection, transport, and disposal of wastes under section 91, arrangements for the cleaning and efficient functioning of latrines, cesspits and other receptacles for sewage under section 92 and other specified arrangements shall continue to have full force | Solid wastes managed under the Waste Management Act |
| | | **Tonga Water Board Act 2000** | The Act creates the TWB to provide water supply services for domestic, stock, horticultural, industrial, commercial, recreational, environmental, and other beneficial uses, in any area in which it may be appointed to do so. | |
| | | **Emergency Management Act 2007** | Creates the National Emergency Management Committee to manage events such as cyclones, storms, storm surges, fire. | |
| **Tuvalu** | **Ministry for Public Utilities & Environment** | **Water Supply Act 1967** | Makes provision for dealing with the country's water supplies. The provisions of this Act relate exclusively to matters of water supply. No provision is made in relation to issues of management, conservation, or quality. | |
| | **Ministry for Public Utilities & Environment** | **Environment Protection Act 2008** | the regulation and control of pollution and wastes;<br>· all matters concerning the implementation of international environment related conventions;<br>· the protection of the biodiversity; and<br>· responses to climate change | |

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| | **Ministry for Home Affairs & Agriculture** | **Falekaupule Act 1997** | The Falekaupule Act provides authority for local area management by island councils (the 'Kaupule') within designated local areas ('falekaupule') in Tuvalu. The functions of the Falekaupule are:<br>- to ensure the proper management and use of the physical and natural resources in the Falekaupule area<br>- related to land: prevent and control erosion of land by the sea or other cause; and<br>- related to public utilities: to make, alter, divert and maintain roads, streets, parking areas, paths, culverts, causeways, bridges, drains and water-courses.<br>- to safeguard public health in accordance with the Public Health Act<br>- to provide, erect and maintain a public water supply, and impose water<br>rates in accordance with the Water Supply Act;<br>- to establish, maintain and control public wells, springs, bathing places, wash houses and swimming pools;<br>- by bye-laws to regulate or prohibit the sinking of wells and provide for the closing of wells;<br>- to prevent the pollution of any water, and by bye-laws to prevent access<br>to any polluted source of water; | |
| | **Ministry for Health, Social Welfare & Gender** | **Public Health Act 2008** | Covers pollution control; water supply; sewerage | |
| | **Department of Climate Change and Disaster, office of the Prime Minister** | **Climate Change Resilience Act 2019** | To manage Tuvalu's natural resources, environment, ecosystems and biodiversity to promote their resilience to the impacts of climate change;<br>- to support vulnerable communities and populations and promote social justice and intergenerational equity;<br>- promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems. | |

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| **Vanuatu** | **Ministry of Meteorology Geological Hazards and Climate Change** | **Meteorology, Geological Hazards, and Climate Change Act 2016** | | |
| | | **Water Resources Management Act 2004** | | Includes all natural sources of freshwater from aquifers, lakes, streams, springs and excludes domestic and communal rainwater storages for private and communal use; |

## About us

The Partnership addresses critical gaps in climate information services, governance, gender, and social inclusion, and boosts technical capacity in Australian aid investment sectors.

## Contact

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## About us

The Partnership addresses critical gaps in climate

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