Annex 2: Feasibility Study

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Version 1

This feasibility study has been prepared by E Co. for The Pacific Community (SPC), as a background document for the Green Climate Fund (GCF) Funding Proposal titled: *Enhancing Adaptation and Community Resilience by Improving Water Security* in Vanuatu. This project will focus on delivering adaptation action for increased climate resilience of Vanuatu's water infrastructure and increased water security for communities.

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Abbreviations

Acronym	Definition
CAP	Community Assistance Programme, which is part of the National Implementation Plan for Safe and Secure Water
DOWR	Department of Water Resources
DSSPAC	Department of Strategic Policy, Planning & Aid Coordination
DWSSP	Drinking Water Safety and Security Plan
ECCE	Early Childhood Care and Education
EHU	Environmental Health Unit
GCF	Green Climate Fund
HCF	Heath Care Facility
IWC	International Water Centre
IWM	Integrated Water Management
MOH	Ministry of Health
NDMO	Natural Disaster Management Office
NDSP	National Development Sustainability Plan
NGO	Non-Government Organisation
NHRDP	National Human Resources Development Plan
NIP	National Implementation Plan for Safe and Secure Water
NSDP	Vanuatu National Sustainable Development Plan
NWRAC	National Water Resources Advisory Committee
PMU	Project Management Unit
PSET	Post-Secondary Education and Training
PWRAC	Provincial Water Resources Advisory Committee
QGIS	Quantum Geographical Information System - An open source Geographical Information System software package
RWC	Rural Water Committee
SDG	Sustainable Development Goals
SOP	Standard Operating Procedure
SPC	The Pacific Community
TAP	Technical Assistance Plan, which is part of the National Implementation Plan for Safe and Secure Water
UNICEF	United National Children's Fund
VEMIS	Open Vanuatu Education Management Information System
VETSS	Vanuatu Education and Training Sector Strategy
WASH	WAter, Sanitation and Hygiene
CR-WASH	Climate Resilient WAter, Sanitation and Hygiene
WHO	World Health Organisation
WIP	WASH in Schools Improvement Plan

1. Introduction to the study

1.1 Objective

This feasibility study (FS) has been developed to support the design of the proposed Green Climate Fund (GCF) programme *'Enhancing adaptation and community resilience by improving water security'* in Vanuatu, for which the Pacific Community (SPC) is the Accredited Entity (AE). The objective of this study is to assess the factors supporting the relevance of the project's proposed interventions for GCF investment, with focus on technical design, cost and benefit analysis, social and environmental impacts, legal and regulatory environments.

The study will analyze the context influencing and supporting the water security in Vanuatu (particularly for the climate-resilient water, sanitation and hygiene i.e., the CR-WASH sub-sector)[1], expand on programme activities identified in the approved Concept Note (CN)[2], and analyze the capacity of national and devolved governments to implement these activities under the following in the Section E of the Funding Proposal.

- **Component 1:** Communities are empowered to plan and manage climate-resilient water resources
- **Component 2:** Communities have enhanced climate-resilient rural water infrastructure
- **Component 3:** Provincial and national institutions are strengthened to address climate risks associated with water security.

Further, the study demonstrates the timely need for GCF investment for managing observed and future climate changes and their impacts on water security and infrastructure across rural communities in Vanuatu. The Intergovernmental Panel on Climate Change (IPCC) reconfirms that continued global warming and climate change is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.[3] Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions[4], introducing unpredictability in current rainfall patterns of Vanuatu. It is very likely that rainfall variability related to the El Niño – Southern Oscillation (ENSO) is amplified by the second half of the 21st century[5] – projecting increased climate-induced hazards for Vanuatu.

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[1] GCF (x). Technical Guidelines: Water Security. Guides. Accessed at: https://www.greenclimate.fund/sites/default/files/document/sap-technical-guidelines-water.pdf
[2] Concept Note for the project can be accessed here: https://www.greenclimate.fund/sites/default/files/document/21860-enhancing-adaptation-and-community-resilience-improving-water-security.pdf
[3] IPCC – Sixth Assessment Report (B3): https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf
[4] IPCC – ibid.
[5] IPCC – ibid.

Another factor is the rising and accelerating global mean sea level:[6] this will increase the vulnerability of coastal – primarily rural – communities, particularly in Vanuatu (where over 60% of the population live within 1 km of the coast).[7]

These observed and predicted changes in the climate are heightening risks in Vanuatu[8], elaborated further in Section 3 of this FS. Water, in effect, is one of the primary mediums through which these effects of climate change are currently manifesting and will continue to in Vanuatu:

- Droughts, caused by higher evapotranspiration and unpredictable ENSO, directly impacts rain-fed subsistence agriculture and human health. This has already been observed in Vanuatu's southern islands, which experienced a meteorological drought in early 2020. [9] ENSO impacts combined with dry season to delay the arrival of expected rain, impacting the Tafea Province (Tanna and Aniwa islands). The spillover effects included heightened water insecurity, cattle deaths and crop failures in these areas.

- Climate impacts on availability and distribution on rainfall, river flows and groundwater deteriorate water access and quality. Reduced availability of water will combine with projected increase of water temperature will lead to the disruption aquatic ecosystems and increase the vulnerability of communities (about 75 – 80% in Vanuatu)[10] that are primarily dependent on natural resources and ecosystems goods and services.

- Tropical cyclone, bringing damaging winds, heavy rain, flooding, and storm surges, are the most significant natural hazard for Vanuatu. The country experiences an average of 2 to 2.4 cyclones per year, mainly between November and April.[11] Storm surges associated with cyclones, and flooding due to heavy rains, are common occurrences. Landslides are also occasionally triggered by precipitation from cyclones. The average annual losses sustained due to cyclones has been estimated at 5.0% of GDP.[12] Cyclones impede water security during and post-disaster, by displacing populations to other islands or underserved emergency shelters in the short term, and also by contaminating water sources in the longer term. In the aftermath of TC Pam, for example, about 110,000 people had no access to safe drinking water and in

[6] IPCC – Special Report on the Ocean and Cryosphere in a Changing Climate https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

[7] Andrew, Neil L. et al (2019). "Coastal proximity of populations in 22 Pacific Island Countries and Territories". Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0223249#abstract0

[8] Risk: The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species. (IPCC definition of risk - https://www.ipcc.ch/site/assets/uploads/2021/02/Risk-guidance-FINAL_15Feb2021.pdf)

[9] Radio New Zealand International update: https://reliefweb.int/report/vanuatu/vanuatus-southern-islands-drought

[10] Leathers, A. (2008). Common property resource management in Vanuatu, available at: https://core.ac.uk/download/pdf/41335685.pdf

[11] State of the Climate (2014) – report from the Australian Bureau of Meteorology and CSIRO, 0

[12] PCRAFI (2015). Country Note : Vanuatu. Available at: https://www.gfdrr.org/sites/default/files/publication/country-note-2015-pcrafi-vanuatu.pdf

some communities, all sanitation facilities were destroyed, particularly in the most affected provinces of Tafea and Shefa.[13]

- Coastal inundation in Vanuatu is also a risk factor. Satellite data indicate that sea level has risen near Vanuatu by 6 mm per year since 1993, as compared to a global average of 2.8 – 3.6 mm.[14] This has been projected to have a direct impact on drinking water: saltwater inundation and intrusion of groundwater sources and shallow aquifers.[15] Additionally, this has a sectoral impact on agriculture and agroforestry, as coastal inundation reduces freshwater availability for crop production and animal husbandry.

Water-related climate risks in Vanuatu, therefore, are multivariable and will cascade through food, energy and urban and environmental systems, covered in greater detail in this study in Sections 4 and 5. These risks will also combine with existing capacity issues of the water sector in the country, which the study covers at length as well

Given the compounding effects of climate change on the water sector, there is an urgent need to support the Department of Water Resources (DoWR) for reinforcing government-owned processes, and establishing credible community-based management systems (such as the rural water committees – RWCs), policies and legal systems that can facilitate transfers of water through strengthened infrastructure that benefit vulnerable groups and service providers. Vanuatu has passed progressive legislation on improved rural water management since 2015: roles and responsibilities have been clarified, communities have been encouraged to take ownership and manage their water supply systems, and there has been concerted effort to devolve powers to local authorities (with the recent separation of the rural and urban water departments through these legislations). The breadth of climate risks in the country requires resilience-building and strengthening of water sources, infrastructure and the supply chain to limit the impact of extreme weather events and rainfall variability. Additionally, the DoWR has also experienced several years of understaffing and inadequate technical support (including a period without an in-house engineer), despite a broad responsibility structure that has competing rural and urban priorities, compounded with climate risks.

Local planning, decision-making and water management processes, in light of water-related climate risks, at national and devolved levels require urgent improvement and strengthening in Vanuatu. Additionally, there is a need to invest in available water infrastructure and provide new, climate-resilient infrastructure to rural communities to enhance water security in remote areas. The study, therefore, identifies critical gaps and the investment pathways for the project to improve institutional capacities at the national and provincial level as well as contribute towards improved water infrastructure and management processes in the rural areas of Vanuatu.

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[13] OCHA (2015). Press release available at: https://reliefweb.int/report/vanuatu/vanuatu-one-month-thousands-remain-need-water-food-and-shelter
[14] PCCSP (2011). Current and future climate of Vanuatu, available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2013/06/15_PCCSP_Vanuatu_8pp.pdf
[15] Global Groundwater Region 36: Islands in the Pacific, available at: https://www.un-igrac.org/sites/default/files/resources/files/Global%20Overview%20of%20Saline%20Groundwater%20Occurences%20and%20Genesis.pdf

1.2 Methodology

Research for this feasibility study was conducted from June – October 2021. The study was kicked-off by an in-person workshop held on 30th June 2021 in Port Vila, Vanuatu. This workshop, organized by The Pacific Community (SPC) and the DoWR, set the scene by introducing the different stakeholders involved in Vanuatu's WASH sector. The DoWR introduced the mechanisms of National Implementation Plan for Safe and Secure Water (NIP)[16] and the Drinking Water Safety and Security Plan (DWSSP) [17] – which are the target processes of this project.

From July – September 2021, national stakeholder engagement experts interviewed relevant government ministries and departments (in addition to the DoWR, this included: the Department of Environment and Conservation, the Department of Forestry, the Department of Livestock, the National Disaster Management Office, Department of Women's Affairs, the WASH Cluster), as well as key international non-governmental organizations (INGO) and United Nations (UN) actors on the ground such as: Global Green Growth Institute, Red Cross Vanuatu, World Vision Vanuatu as well as United Nations International Children's Emergency Fund (UNICEF). A full list of stakeholders consulted is available as an appendix in the Annex 7 – Stakeholder Consultations and Engagement Plan.

A second leg of provincial consultations was carried out from the end of September to mid-October 2021. Participants and stakeholders were identified using a combination of purposive and snowball sampling during the mission led by the DoWR and the national stakeholder engagement experts, and consulted according to their levels of knowledge, exposure and access on climate change, water infrastructure, and gender as well as socioeconomic issues to prioritize and vet information and data received. These consultations yielded grey literature, recent policies that have been enacted and existing project documents and policy guides from current and closed programmes.

The primary literature generated from the stakeholder consultations were reviewed by the international consultants in lieu of in-country missions, which could not be organized due to COVID-19 restrictions. Lastly, an extensive desktop review collated documents from different climate sector and development sector actors, focusing on: climate change issues in the Pacific SIDS, water security and CR-WASH, and Vanuatu's socioeconomic and gender baseline. Additionally, post-disaster assessments on Cyclone Pam (2015) and Cyclone Harold (2020) were reviewed to assess climate impacts on Vanuatu's water structure, with particular focus on available localised studies on Sanma, Torba and Tanna. The literature review also focused on climate resilience and water security as a broader topic, drawing from Global Water Partnership – GWP, Global Facility for Disaster Reduction and Recovery – GFDRR, United Nation's International Children's Emergency Fund – UNICEF, United Nations Development Programme - UNDP, UN Environment, and the World Bank, as well as donor agencies such as Australian Aid - AusAID, Ministry of Foreign Affairs and Trade of the government of New Zealand - MFAT-NZAID, and United States Agency for International Development – USAID.

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[16] More information on the NIP can be found here:

Vanuatu National Implementation Plan for Safe and Secure Community Drinking Water (2018), see: https://mol.gov.vu/images/News-Photo/water/DoWR_File/Management_Plans/Vanuatu-NIP-Guide-annual-CAP-210818.pdf

[17] More information on the DWSSP can be found here:
Facilitator's Guide to the DWSSO - https://mol.gov.vu/images/News-Photo/water/DoWR_File/Monitoring_Evaluation/190529_-_DWSSP_Facilitators_Guide.pdf

2. In profile: Vanuatu

2.1 Geography and demographics of Vanuatu

Vanuatu is an irregular “Y” shaped archipelagic nation of 83 islands, 65 of which are inhabited, extending over 1,000 kilometres in a north-south direction between the equator and the tropic of Capricorn. The archipelago, which is of volcanic origin, is 1,750 kilometres east of northern Australia, 540 kilometres northeast of New Caledonia, and to the west of Fiji. The country lies between latitudes 13°S and 21°S and longitudes 166°E and 171°E. Port Vila, on the island of Efate, is the capital of the country.

Vanuatu is divided administratively into six Provinces and each province is administered by a provincial council (responsible for promoting regional autonomy). There are three municipal councils for the cities of Port Vila (Shefa), Luganville (Sanma), and Lenakel (Tafea). Each province is further divided into Area Council administrative units, with Area Administrators and Provincial Water Officers, who have devolved mandates from the DoWR.

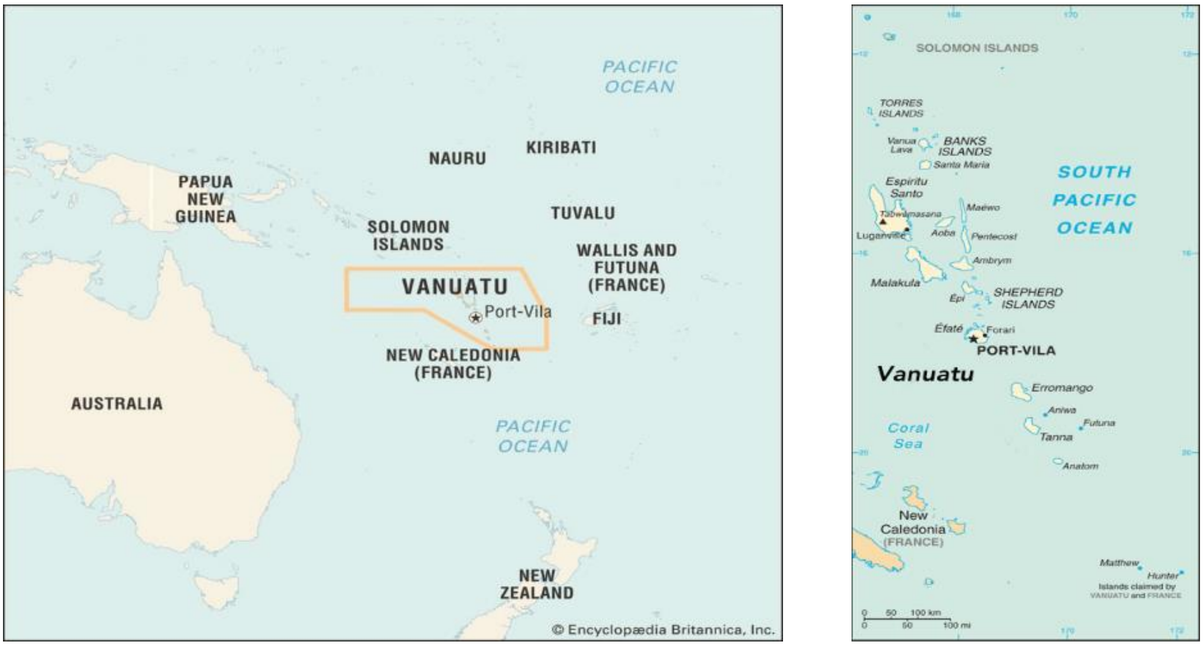

Figure 1: Map of Vanuatu (Encyclopædia Britannica, Inc.)

A diverse topography[18] – ranging from rugged mountains and high plateaus to rolling hills and low plateaus, with coastal terraces and offshore coastal reefs – characterizes the islands of Vanuatu. Sedimentary and coral limestones and volcanic rocks predominate the landscape – with the islands experiencing frequent earthquakes. Active volcanoes are found on several islands, including Séréama on Vanua Lava, Manaro on Aoba, Garet on Santa Maria, the twin volcanic vents of Benbow and Marum on Ambrym, and Yasur on Tanna. There are also submarine volcanoes in the group, and some islands have solfataras or fumaroles. The highest point is Tabwémasana at 1,879 metres on Espiritu Santo, the largest island.

[18] Adapted from the Encyclopædia Britannica, accessed at: https://www.britannica.com/place/Vanuatu

According to the preliminary results released by the Vanuatu National Statistics Office (VNSO), the census completed in 2021 estimates the population to be at 316,000.[19] As the population pyramid (Figure 1) demonstrates, the ni-Vanuatu peoples are a young populace, however the sex ratio at birth is skewed towards male births (currently at 104 : 100 as a national average).[20]

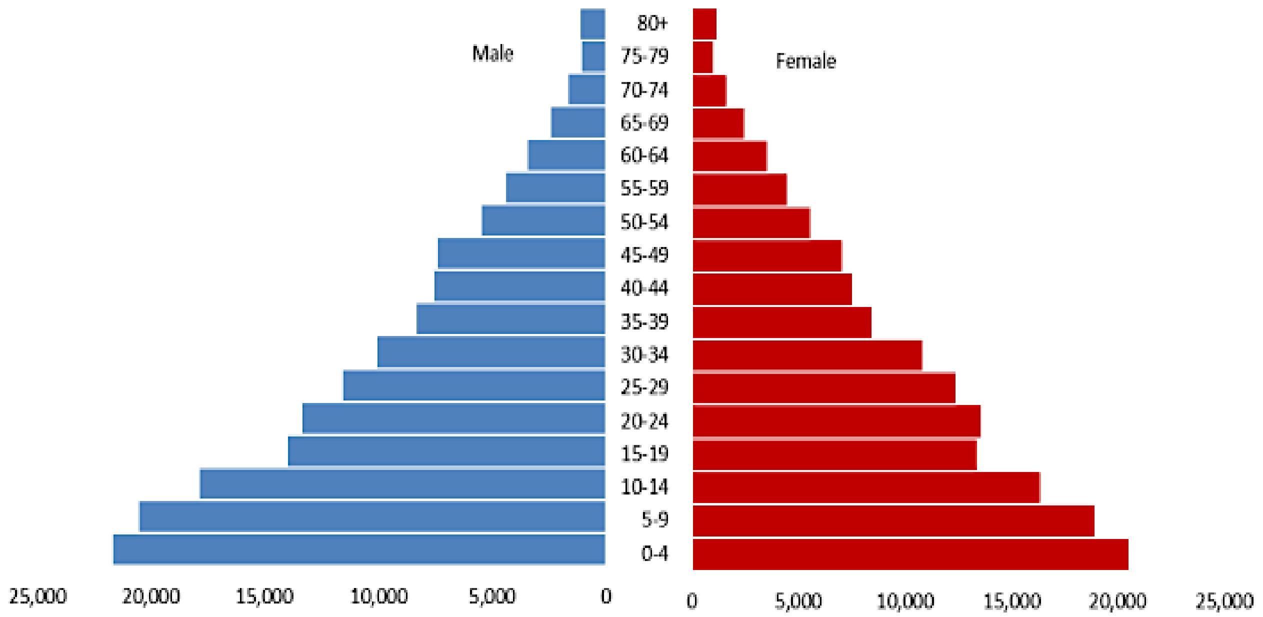

Figure 2: Population pyramid by 5-year age group and sex (VNSO, 2020)

The country is highly homogeneous – 99% of its population are the indigenous, Melanesian ni-Vanuatu peoples. Around three-quarters of the people live in rural areas, although Port Vila – and the surrounding capital region – account for about 21% of the total population. There are over 100 languages and dialects, of which approximately 80 are actively spoken, making it one of the one of the most linguistically diverse countries in the world. There are three official languages: Bislama, English and French. Table 1 presents population by province, sex and number of households, which illustrates the spatial distribution of the ni-Vanuatu peoples.

Table 1: Population by province, sex and number of households (VNSO, 2021)[21]

PROVINCE	HOUSEHOLDS	SEX	
		MALE	FEMALE
Torba	2,390	5,726	5,691
Sanma	12,696	31,536	29,992
Penama	7,812	18,004	17,470
Malampa	9,664	21,437	20,939

[19] Information on demographics available at: https://vnso.gov.vu/index.php/en/

[20] Sex ratio at birth refers to male births per female births. The data are 5-year averages. (World Bank, 2019)

[21] VNSO Population and Housing Census Preliminary Results (2020) – released on June 2021, available at: https://vnso.gov.vu/images/Public_Documents/Census_Surveys/Census/2020/Preliminary_Results/VANUATU_National.pdf

Shefa	22,100	52,857	52,479
Tafea	8,214	22,785	22,849

2.2 Constraints and opportunities of Vanuatu's economy

Vanuatu's economy is characteristic of small Pacific Island nations: small size, remoteness from major markets and internal dispersion. These factors combine to push up the costs of private production and public administration, lower the return on market activities and narrow the feasible set of economic opportunities.[22] Currently, the total Gross Domestic Product (GDP) of the country is valued at USD 934.2 million World Bank, 2019) and the most recent value of GDP per capita is USD 2,783 (World Bank, 2020)[23]. The share of economic sectors in GDP (2014 values) are: agriculture (28.2%); industry (9.1%); and, services (62.7%).

Vanuatu is classified as a Small Islands Developing States or SIDS[24], which are a distinct group of developing island countries facing specific social, economic and environmental vulnerabilities. As in many other SIDS, Vanuatu's repeated exposure to climate events and natural disaster phenomena presents a major obstacle to the sustained eradication of poverty and undermines progress on gender equality and socioeconomic indicators. This is compounded by common SIDS characteristics such as: remoteness and deprivation from the benefits of scale, low income and assets, small domestic markets and heavy dependence on a few external markets and international support, high volatility of economic growth, fragile natural environments, and socioeconomic as well as gendered vulnerabilities.[25] Additionally, until December 2020, Vanuatu was a Least Developed Country (LDCs).[26] During its graduation from the LDC list, United Nations Conference on Trade and Development (UNCTAD) recognized consistent strides made by the country to improve its social and economic development indicators but that the exposure to environmental and economic vulnerabilities remain high, particularly in the face of climate change and other external shocks.[27]

One such external shock has been the COVID-19 pandemic. Although stringent border controls have protected Vanuatu from widespread community transmission, these have pushed its tourism-reliant economy into a deep recession in 2020.[28] A vaccination drive that began in mid-2021 will

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[22] World Bank Group. (2016) *Systematic Country Diagnostic for the Eight Small Pacific Island Countries : Priorities for Ending Poverty and Boosting Shared Prosperity, available at: https://openknowledge.worldbank.org/handle/10986/23952*

[23] World Bank data portal, see: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=VU

[24] SIDS were recognized as having special status both for their environment and development at the Earth Summit, held in Rio de Janeiro, Brazil in 1992. Updated list of SIDS can be found on: https://www.un.org/ohrlls/content/list-sids.

[25] UN-OHRLLS – Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries, and Small Island Developing States (2015). Small Island Developing States in Numbers: Climate Change Edition 2015. Report. Available at: https://sustainabledevelopment.un.org/content/documents/2189SIDS-IN-NUMBERS- CLIMATE-CHANGE-EDITION_2015.pdf

[26] UNCTAD LDC list (2020), see: https://unctad.org/news/vanuatu-graduates-least-developed-country-status

[27] UNDESA. Vanuatu LDC profile, see: https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/LDC_Profile_Vanuatu.pdf

[28] Economist Intelligence Unit, see: http://country.eiu.com/Vanuatu/ArticleList/Updates

permit a phased border reopening from 2022, but widespread vaccination will take several years. The graph in Figure 3, from the Asian Development Outlook Update (September 2021), presents GDP forecasts, displays the pandemic dip experienced in 2020 and the recovery forecasted for 2021 and 2022.

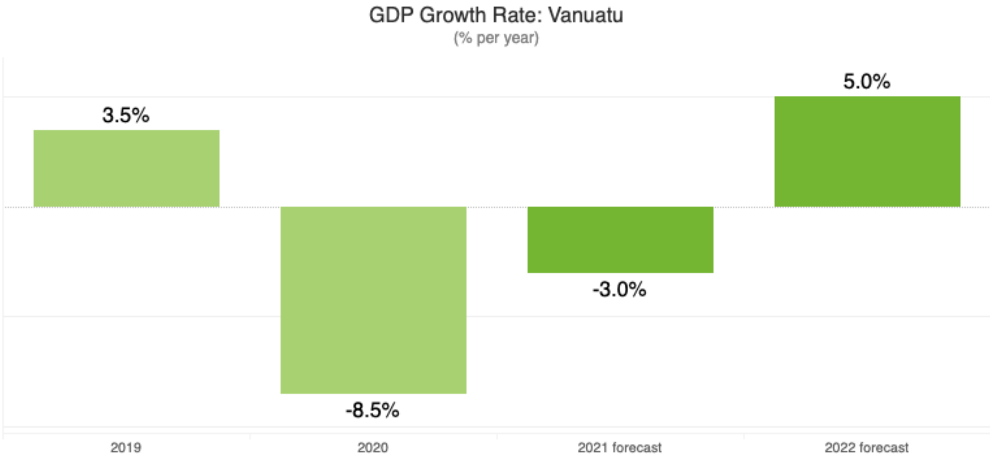

Figure 3: GDP growth rate: Vanuatu (% per year, ADB 2021)

The World Bank Systematic Country Diagnostic for Vanuatu (which was conducted in 2016 with 7 other Pacific Islands) also emphasizes that while public expenditures tend to be high in relation to the size of the economies of these island nations, the absolute size of the public sector is still very small and often lacks the financial and human resources needed to provide adequate public services such as regulation or economic management. The assessment identifies that technical assistance and upstream design support play an important role in filling these capacity gaps – which are important to deliver effective climate change adaptation for the water sector in Vanuatu.

Indeed, in-country consultations with water management experts and stakeholders of the WASH industry in Vanuatu identified that current capacities of WASH service delivery are limited, and are progressively being strained by climate impacts. These issues are interconnected with not only Vanuatu's geographical specificities but also trends of historically-inadequate WASH infrastructure and service delivery capacities (this is explored in Section 2.3 – the WASH baseline) as well as socioeconomic indicators (this is explored in 2.4 – the socioeconomic and gender baseline).

2.3WASH baseline in rural Vanuatu

The primary challenge for water safety and security in Vanuatu is that: while access to a proximate source of drinking water is high (94% access to an improved drinking water source and 86% access on the premises)[29], the safety and reliability of the water consumed by most people in Vanuatu is unknown. This has short- and long-term health impacts on the ni-Vanuatu: unsafe drinking water can lead to diarrhoea and other water-borne sicknesses, while (in the longer-term) inhibiting the ability of the body to absorb nutrients and contributing to chronic undernutrition.

Water plays an important role in ensuring equitable, sustainable and productive rural economies globally and in Vanuatu. In addition to being an essential element for agricultural production,

[29] UNICEF (2020). Rural water supplies in Vanuatu in need of significant improvements. (WASH Technical Paper/13/2020).

nutrition and human health, water enables economic opportunities in numerous key sectors across the rural landscape in Vanuatu. In rural settings, water is a public good – although climatic and environmental conditions as well as resilience of infrastructure largely determine access to this essential utility. The DoWR recognizes that, particularly in these rural (often remote) areas, the absence of market signals (such as prices and permits), as well as inadequate planning and incentive structure can impact upon water security. The DWSSP has been designed to address this issue: by establishing a planning and prioritization structure to improve water supply management, to identify infrastructure needs (and delivery, if the DWSSP is funded for implementation) and ensure overall maintenance.

Rural communities in Vanuatu use a combination of groundwater, surface water and rainwater, depending on availability and accessibility. Out of these, rainwater systems were most common, as reflected through the 2014 – 2016 data, as over 66% of all surveyed water supplies drew from such infrastructure, and made up over 75% of water supplies in Malampa and Penama.[30] Additionally, significant portion of the population is reliant on rainwater as either primary or secondary supply – while the national average is around 36% of households, in rural areas this figure rises to 44%.[31]

Groundwater-based water points are less common, comprising only 13% of surveyed systems. Likewise, piped systems made up just 11% of the surveyed water systems – of these 54% were fed by springs, 32% by surface water, and 14% by groundwater from boreholes and wells. The assessments finds that only 1/3rd of households have access to water 24 hours per day, every day of the year. In more remote areas, using water from unprotected sources is common: while the national average hovers around 12%, in certain area councils (such as Erromango and Tanna), this indicator is as high as 70%, according to the VNSO.

The Vanuatu Water Resources Management Act mandates that a full water resources inventory be conducted every five years: in preparation for the 2020/2021 inventory, an assessment on more than 4,700 water sources across 44 islands, with the following findings:[32]

- Approximately a 3rd of piped supplies were not providing a 24-hour supply
- 52% of water systems were not providing a year-round supply;
- Fewer than a 3rd of water committee members were women, but those with female members saw increased functioning and reliability of water services;
- Sanitary inspections indicate spring-fed systems and rainwater collection systems were at risk of microbial contamination;
- Water testing carried out by the government and research partners have revealed that about 60% of sources have bacterial contamination in the immediate aftermath of climate and weather events.[33]

In terms of sanitation, the household living (dwelling) conditions analysis of the 2020 Census reveals that outside urban centres and provincial hubs (where flush toilets are available), people rely on shared or private pit latrines or have no toilets at all. This is particularly true in Penama – where between 83 – 100% of ni-Vanuatu living in Pentecost, Maewo and Ambae rely on these types

[30] UNICEF (2020). Ibid.
[31] Ibid.
[32] Foster, T., Kohlitz, J., Rand, E. (2018) Rural water supply in Vanuatu: assessment of coverage and service levels. UNICEF: Port Vila
[33] UNICEF (2020). Rural water supplies in Vanuatu in need of significant improvements. (WASH Technical Paper/13/2020).

of sanitation infrastructure.[34] Water rationing, both for household use and sanitation, and water shortages are common during the dry season within families. The DoWR Water Resources Inventory (WRI) indicates that many of the water sources are not available or have inadequate yields during the dry season. Meanwhile, rainfall patterns have been affected by climate change, and can often manifest as intense periods of extreme rainfall, leading to floods – which further exacerbate the WASH baseline.

The direct effects of limited water supply and water security, drinking contaminated water, and inadequate WASH infrastructure are well known: increased morbidity (diarrhea, stunting and other illnesses) and increased mortality, among both children and adults. Significant improvements in the management, operation and maintenance of rural water systems are needed to ensure water services are managed safely.

Safely managed WASH services are critical for preventing diseases and protecting human health during infectious outbreaks, including the current COVID-19 pandemic. Water insecurity also has secondary impacts on food security, as most ni-Vanuatu peoples rely on rain-fed, subsistence agriculture in the different islands. Food insecurity and increased stress, and poor health can lead to reduced performance on socioeconomic indicators (explored in the next section) such as economic opportunities, poor school attendance and reduced educational achievement.

The maps (Figure 4, 5 and 6) demonstrate the variations and trends in drinking water sources as well as sanitation infrastructure in the island nation further:[35]

- Figure 4 demonstrates that in Vanuatu, the national average of households with the main source of drinking water coming from wells (unprotected) or river/lake/spring is 11.7%. However, regional and intra-island group variation is high: in West Santo (Sanma Province), South Erromango and Middle Bush Tanna (in Tafea Province), the number of households ranges from 53.2% - 73.8%. This discrepancy demonstrates how community vulnerabilities to climate-induced risks are a spectrum, and must be addressed through localized interventions.
- Figure 5 shows that in Vanuatu, the national average of households sourcing drinking water primarily from household or shared tanks is 34.3%. However, over 13 districts fall in 0.0% - 11.4% category (primarily Tafea Province, Maewo in Penama Province, parts of Malampa and Sanma Provinces), demonstrating inequity in water access in the islands. This posits that climate burden relating to water security risks are also shared unequally in the country.
- Figure 6 covers the regional variation of households with main toilet facility being a pit latrine (private or shared) or none – the national average is 48%. However, most of the Penama Province falls in the 82.7% - 100% category, along with Sanma, Malampa and Tafea Provinces showing limited access to sanitation infrastructure. Climate change affects and threatens this limited baseline of sanitation infrastructure, with long-standing setbacks faced during hazards (as experienced during recent TCs Harold and Pam).

[34] Vanuatu National Statistical Office; World Bank. 2014. Vanuatu : Socio-Economic Atlas, available at: https://openknowledge.worldbank.org/handle/10986/18669

[35] World Bank (2014). Vanuatu: Socioeconomic Atlas, available at: https://documents1.worldbank.org/curated/en/827661468098051596/pdf/876750WP0P1336089B00PUBLIC00Vanuatu.pdf

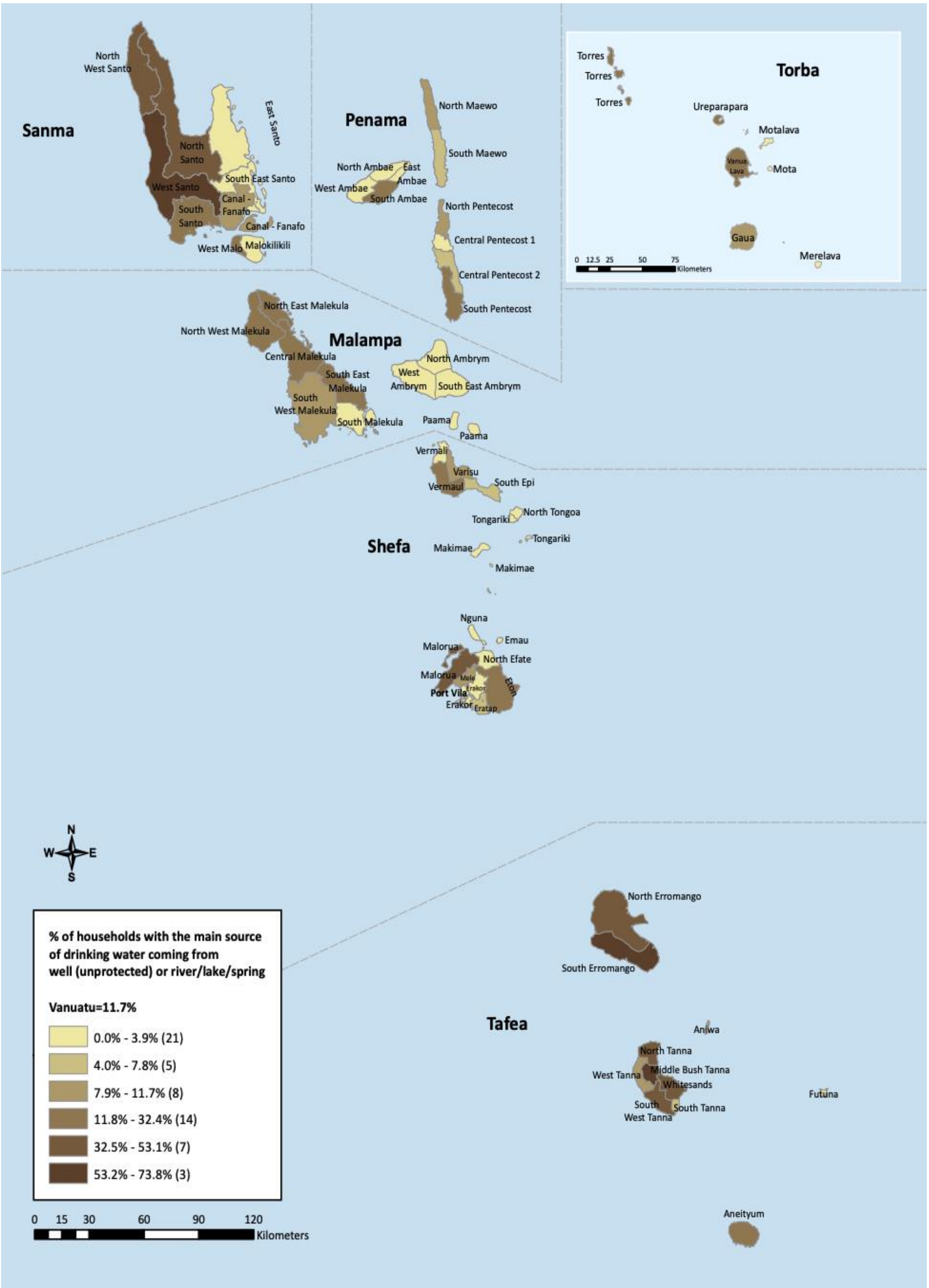

Figure 4: Percentage of households with main sources of drinking water, unprotected wells or open-source (World Bank, 2009)

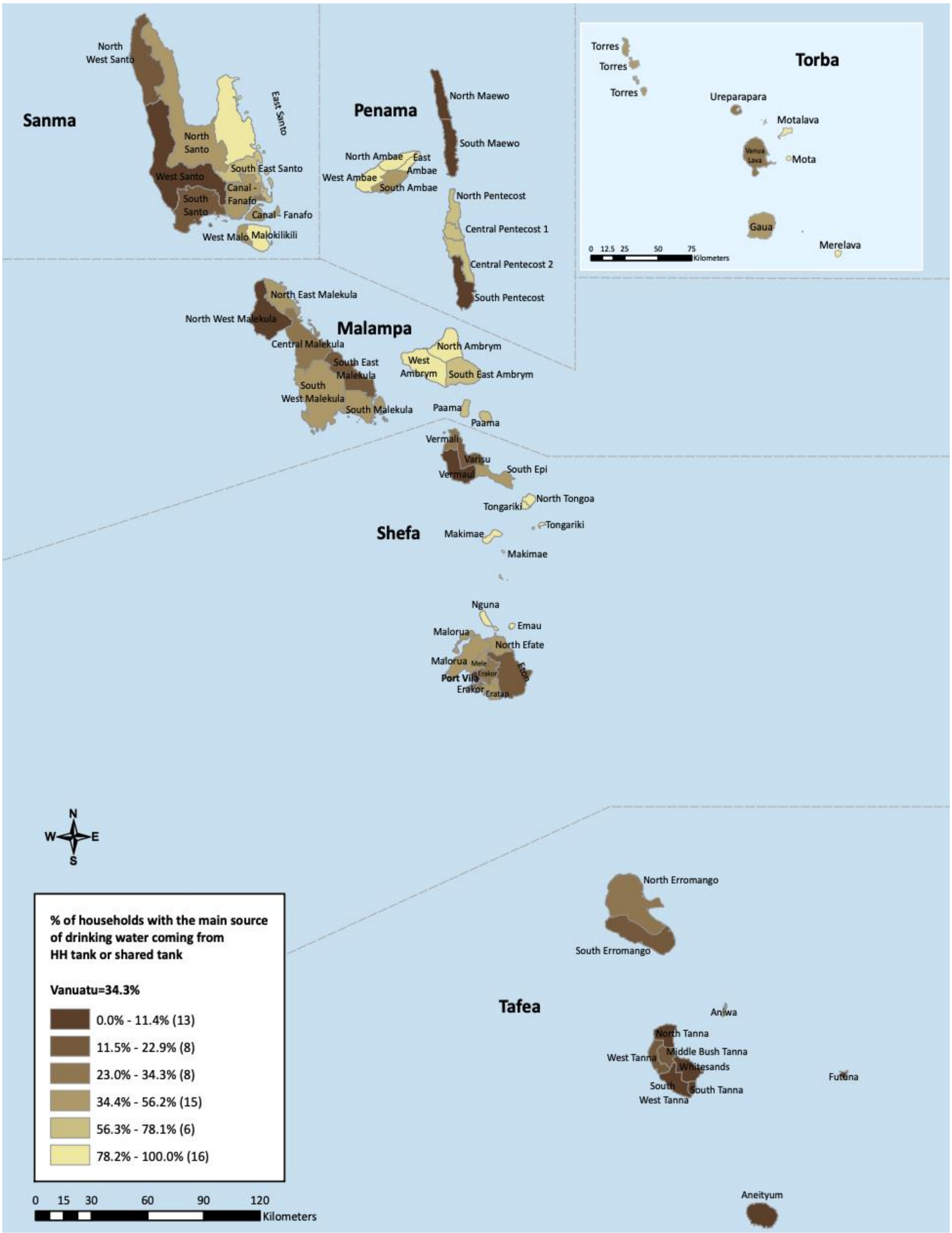

Figure 5: Percentage of households with main source of drinking water coming from HH tank or shared tank (World Bank, 2009)

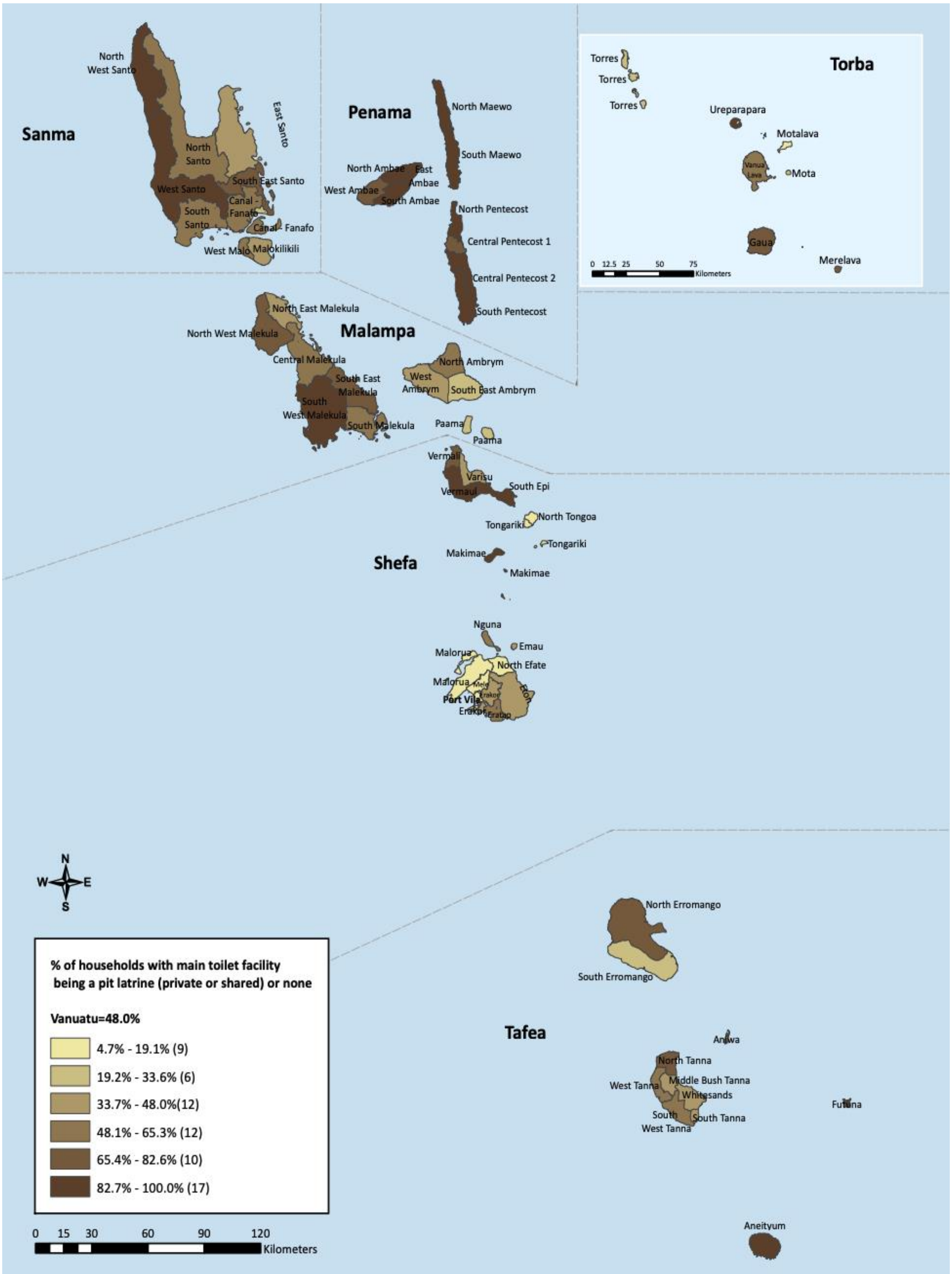

Figure 6: Percentage of households with main toilet facility being a pit latrine (private or shared) or none (World Bank, 2009)

2.4Socioeconomic and gender baseline in Vanuatu

Vanuatu's limited WASH service delivery and infrastructure – as described in the previous section - affect women and men differently. Traditionally, gender roles typically involve women and girls putting in more labor and spending more time than men and boys in managing the household's water, sanitation and hygiene.[36] Increased walking times during dry seasons or climate-induced emergencies to source water can increase instances where women and children are further exposed to gender-based violence (GbV). Vanuatu is an endemic region (with the broader Pacific SIDS) for high-GbV levels in the world. Adaptive capacity to external shocks, including climate change, in the WASH sector, therefore, crosscut with existing gender vulnerabilities. These are explored in the Gender Assessment and Action Plan (Annex 8 of the Funding Proposal) and summarized in Section 11 of this study. WASH-related gender and socioeconomic issues must be mainstreamed to ensure the project benefits are inclusive and accrue to all members of communities, who risk being left further exposed to climate and weather events, which have occurred in the islands with more intensity in recent times.

Site-specific data has not been collected as the project will select sites during the implementation phase through the National Implementation Plan (NIP) process. In lieu, this section presents national aggregate statistics and composite indices available for Vanuatu. These data points have been chosen to nuance the primary and secondary research on climate resilience and the WASH baseline in the country. Drawn from primarily VNSO, and different UN entities, these speak to the issues identified by the GCF in its *Mainstreaming Gender* toolkit as crucial socioeconomic indicators that can impact upon the performance of the project and therefore, are being mapped and mainstreamed in the project design stage.

National aggregate statistics

The national-level data points are divided into four categories (poverty and hardship, education, labour and health), and presented alongside their corresponding Sustainable Development Goal (SDG). These indicators include: **SDG 1**; **SDG 3**; **SDG 4** and **SDG 8**.

SDG 1	CHOSEN INDICATORS	VALUES
	• % of population below international poverty line	• 13.2% (2010)
	• % of population below national poverty line	• 12.7% (2010)
	• % of population below lower middle income poverty line	• 39.4% (2010)
	• % of population in severe multidimensional poverty	• n/a
	• % of population vulnerable to multidimensional poverty	• n/a
	• % of male-headed households (HHs)	• 76% (2009)
	• % of female-headed households	• 24% (2009)

Vanuatu's relatively high per-capita incomes combine with reasonably widespread land access for subsistence agriculture and informal, community-based social safety nets to keep the incidence of

[36] Halcrow G, Rowland C, Willetts J, Crawford J and Carrard N (2010), Resource Guide: Working effectively with women and men in water, sanitation and hygiene programs, International Women's Development Agency and Institute for Sustainable Futures, University of Technology Sydney, Australia, available at: http://www.genderinpacificwash.info/system/resources/BAhbBlsHOgZmIj4yMDExLzAxLzI0LzE5LzA0LzI3LzIwMi9XQVNIX1JFU09VUkNFX0dVSURFX2ZpbmFsNHdlYi5wZGY/WASH%2520RESOURCE%2520GUIDE-final4web.pdf

extreme poverty low. However, these high per-capita incomes overshadow the fact that Vanuatu (along with the Federated States of Micronesia, Kiribati and Marshall Islands) has higher than 10% extreme poverty (the regional average for the Pacific is around 3%). Vanuatu (along with the FSM, Kiribati and Marshall Islands) collectively hosts over 90% of people in poverty in the southern Pacific.

- National and International Poverty Line:[37] National poverty lines are defined according to each country's specific economic and social circumstances, and the International Poverty Line is pegged at US$ 1.90 or 210 VATU. Since Vanuatu is a lower middle-income country, it is also important to measure poverty using the Lower Middle Income Class Poverty Line (US$ 3.20 or 354 VATU) – 39.4% of the population is below this line, according to the latest available statistics.

- Multidimensional poverty[38]: Currently, due to a paucity of data, the MPI is not calculated for Vanuatu. Like peer Melanesian SIDS, with large proportions of the population living semi-subsistence lifestyles in rural areas, consumption poverty is difficult to measure, however vulnerabilities are widespread – which are exacerbated by multivariable risks, including compounding climate hazards.[39]

- Gender-disaggregation of households: [40] In Vanuatu, due to the presence of multigenerational households, it is difficult to assess how household heads are designated and such roles adhered to. However, gender-disaggregation of private households, is available from a monograph published by the VNSO on the 2009 National Population and Housing Census – revealing that MHHs are the norm (76% compared to 24% of FHHs). The overriding factor influencing WASH in Vanuatu is rural versus urban location, according to the VNSO monograph. However, analysing the data by the sex of the household – lone MHHs have slightly better access to improved sanitation facilities compared to FHHs. FHHs also tend to have shared toilet facilities, possibly reflecting a lower standard of housing for women in particular cases and areas.[41]

[37] World Bank data portal, see: https://databank.worldbank.org/data/download/poverty/33EF03BB-9722-4AE2-ABC7-AA2972D68AFE/Archives-2019/Global_POVEQ_VUT.pdf

[38] Multidimensional poverty: In the post-2015 SDG and Agenda 2030 Framework, SDG 1 targets poverty elimination – in all forms and dimensions. This mandate requires tools to enumerate (quantitatively) and assess (qualitatively) poverty levels in different countries. The Multidimensional Poverty Index, calculated by UNDP and Oxford Poverty and Human Development Initiative (OPHI), is an important tool as it complements the international poverty line statistics by showing the nature and extent of overlapping deprivations for each person. Currently, due to a paucity of data, the MPI is not calculated for Vanuatu.

[39] Feeny, M & MacDonald, L. (2014) Vulnerability to multidimensional poverty – findings from Melanesia, available at: https://www.tandfonline.com/doi/abs/10.1080/00220388.2015.1075974

[40] Micro data analyses, with consideration for macro, population and demographic factors, reveals the importance of introducing heterogeneity in household poverty figures as well as contextualizing how FHHS and MHHs function, conditional upon location, age, number of members, marital status, economic access, and other indicators. It is an imperfect metric but is currently one of the only viable option for exploring how gender impacts on household characteristics. See: https://data.worldbank.org/indicator/SP.HOU.FEMA.ZS?locations=Z4-VU

[41] MJCS (2009). Gender monograph on the Vanuatu Census, see: https://mjcs.gov.vu/images/research_database/2009_Vanuatu_Census_Gender_Monograph.pdf

SDG 3	CHOSEN INDICATORS	VALUES
	• % exposure to gender-based violence (lifetime probability)	• 60% (2011)
	• # adolescent fertility rate, (modeled estimate, births per 1000 women)	• 48 births (2019)
	• # maternal mortality ratio (modeled estimate, per 100,000 live births)	• 72 deaths (2019)
	• # infant mortality rate (modeled estimate, per 1000 live births)	• 22 deaths (2019)
	• # children under five mortality (modeled estimate, per 1000 births)	• 26 deaths (2019)

Despite producing insignificant greenhouse gas emissions populations in SIDS (including the ni-Vanuatu) are on the frontline of climate change impacts, including having a high burden of climate-sensitive diseases. Furthermore, the government highlights the threats climate change poses to human health in its Nationally Determined Contribution (NDC), which also recognizes the vulnerability of the country to climate change and the need to improve access to basic health services.[42] The importance of SDG 3 is underwritten by the scope of this project: investment in climate resilience and water security of communities can have diffuse and direct impacts on health outcomes of the population (particularly, in light of the ongoing COVID-19 pandemic).

- Maternal mortality ratio (MMR), infant mortality rate (IMR) and under-five mortality rate:[43] MMR, IMR and under-five mortality statistics are collected through the census to demonstrate the access and efficacy of health services and family planning in Vanuatu. Child mortality, for example, has fallen in Vanuatu, but remains high compared to other Pacific countries. Poor water security and WASH infrastructure is one of the leading contributors to enteric and other infectious disease burdens, which remains high in Vanuatu.

- Additionally, Vanuatu – like peer economies and SIDS, is vulnerable to tropical disease outbreaks. Climate change could affect the seasonality of such outbreaks, as well as the transmission of vector-borne diseases, underwriting the importance of robust WASH in the country.[44] For example, the seasonality and prevalence of dengue transmission may change in future climate change scenarios, and is modelled for different RCPs in Figure 7: Dengue projections based on different RCPs in Vanuatu (WHO, 2020)Figure 7:

[42] UNFCCC (2020). Country profile: Vanuatu, see: https://cdn.who.int/media/docs/default-source/climate-change/who-unfccc-cch-country-profile-vanuatu.pdf?sfvrsn=451e1b3b_2&download=true
[43] The World Health Organisation (WHO) identifies MMR or complications during pregnancy and childbirth as a leading cause of death and disability among women of reproductive age in developing countries. This was an MDG and is now an SDG 3 indicator. Similarly, the IMR under-five mortality rates take stock of preventable child deaths at birth and below the age of 5.
https://data.unicef.org/country/vut
[44] UNFCCC (2020) – ibid.

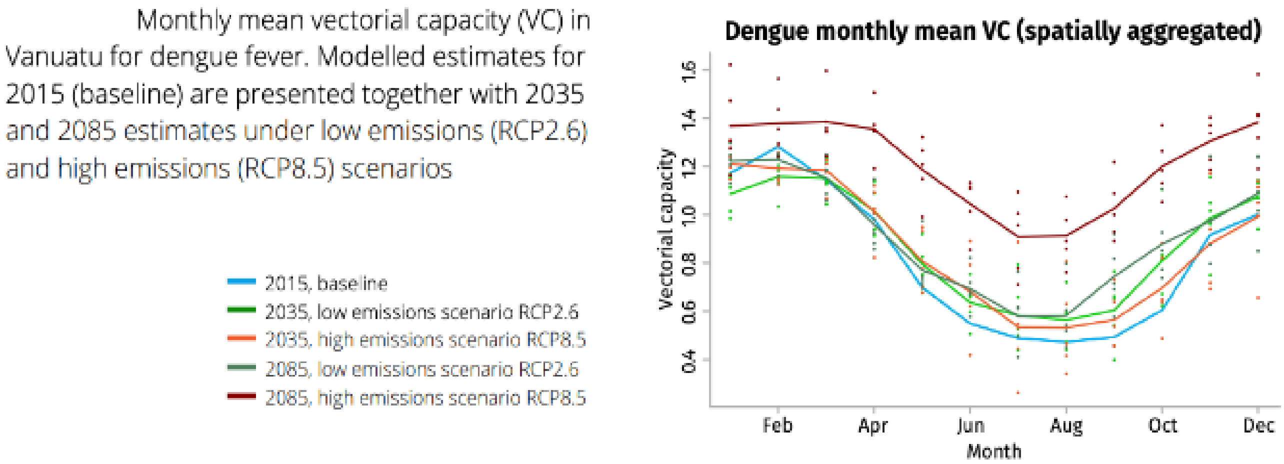

Figure 7: Dengue projections based on different RCPs in Vanuatu (WHO, 2020)

SDG 4	CHOSEN INDICATORS	VALUES
4 QUALITY EDUCATION	• % literacy rate, adult female	• 86.7% (2018)
	• % literacy rate, adult male	• 88.3% (2018)
	• % literacy rate, youth female	• 96.5% (2014)
	• % literacy rate, youth male	• 95.0% (2014)
	• # children out of school, primary, female	• 1503 (2015)
	• # children out of school, male	• 1797 (2015)
	• % progression to secondary, female	• 45.6% (2000)
	• % progression to secondary, male	• 44.2% (2000)

The education system of Vanuatu is atypical in that it represents an amalgamation of two disparate systems, the British and the French, that co-existed within the country. Additionally, the church plays an important role in the establishment and functioning of schools. Government expenditure on education (as a percentage of total government expenditure) is 12.6% and the sector is the largest government service deliverer and employer.

Overall, there is no statistically significant difference between the performance of boys and girls, from available data. However, the Vanuatu Education and Training Sector Strategic Plan 2020 – 2030 identifies the importance of developing the capacities to identify further gender inequalities and address them through the Ministry of Education and Training (MoET). Particularly, a module on GbV has been developed by the Vanuatu Education Sector Program (VESP) in collaboration with the MoET as an awareness-raising exercise and for broader use in the education sector.

- WASH performance in Vanuatu's schools (per the UNICEF/WHO Joint Monitoring Project indicators) has been found to be limited. A baseline study of Penama province's 78 schools found that 63% had access to basic water, 26% had basic sanitation, and 27% with basic hygiene facilities.

- A Wash in Schools (WinS) program funded by the Australian Government (Western Pacific Sanitation Marketing and Innovation Program) in the broader region found that maximising girl children attendance can be achieve through the creation of 'girls' space' with dedicated bathrooms and reliable water supply.[45] Dignity kits are important to access in schools – with sensitization training for WASH in the national curriculum as well as for teachers' training syllabus. In Port Vila, through the said project, this is being encouraged through School Improvement Officers (SIO), who are now monitoring WASH as one of the fifteen school quality indicators.

SDG 8	CHOSEN INDICATORS	VALUES
	• % labor force participation rate, female	• 43% (2019)
	• # labor force, total	• 129,602 (2020)
	• % vulnerable employment, female	• 70.6% (2019)
	• % vulnerable employment, male	• 65.6% (2019)
	• % wage and salaried workers, female	• 29.7% (2019)
	• % wage and salaried workers, male	• 33.8% (2019)
	• % employment in agriculture, female	• 56.7% (2019)
	• % employment in agriculture, male	• 56.7% (2019)
	• % of time, unpaid care work, female	• n/a
	• % of time, unpaid care work, male	• n/a

Vanuatu's economy is still primarily based on subsistence or small-scale agriculture, which provides a living for more than 70% of the population.[46] Since the early 2000s, tourism, land sales and high commodity prices for copra and coffee, and donor funding have driven the economy.[47] Major impediments to the economy include: undiversified economic base, constraints from poor transport infrastructure and a small domestic market.

- Although the gender differences are minor, it is telling that, according to World Bank statistics, about 70.6% of the active female labour force and 65.6% of the active male labour force are engaged in vulnerable employment. Roughly 20% of the workforce in Vanuatu is engaged in formal sector employment, and the formal economy only offers some hundreds of jobs each year. Consequently, the social protection system in Vanuatu is limited to formal sector employees – a miniscule minority of workers in the country.

- Given trends of low growth and limited employment opportunities, migration and remittances have been a critical driver of increased living standards in Vanuatu (and other Pacific Island Countries). However, although out-migration has significantly increased household incomes, such processes are affected by external shocks (such as climate change). Due to COVID-19, seasonal worker schemes have been affected in Australia and New Zealand, and the broader Pacific region, causing broad-based and significant reductions in employment and earnings.[48] About 8.1% of the ni-Vanuatu workforce rely on

[45] More information on WinS is available at: https://livelearn.org/projects/western-pacific-sanitation-marketing-innovation-program; and was collected during the stakeholder consultations that have informed the Feasibility Study.
[46] ILO (undated). The ILO in Vanuatu, available at: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-suva/documents/publication/wcms_366547.pdf
[47] ILO – ibid.
[48] World Banj (2020). Interim Report: Pacific Labor Mobility, available at: https://documents1.worldbank.org/curated/en/430961606712129708/pdf/Pacific-Labor-Mobility-Migration-and-Remittances-in-Times-of-COVID-19-Interim-Report.pdf

such programmes (Australia’s Seasonal Worker Program – SWP and the Pacific Labour Scheme - PLS; New Zealands’s Recognized Seasonal Employer Scheme – RSE), which indicates the precariousness of employment opportunities in the country.

Composite indices

Designing a climate resilience-based WASH service delivery system requires situating the project’s results framework on a thorough and context-driven baseline, which this feasibility study collates through various data sources. A collation exercise of scores and rankings from composite indices, especially due to paucity of updated, decentralized, nationally available data, has been included in this assessment to reflect Vanuatu’s overall performance on different indicators. These indices have differing methodologies, and are being employed as indicative (and *not* conclusive) measures of current levels of development, gender equality, poverty, and labour force participation.[49]

This baseline, at the outset, uses scores of three different UNDP composite indices: Human Development Index (HDI), Gender Inequality Index (GII) and Gender Development Index (GDI) as points of departure. The latter two are currently unavailable for Vanuatu, but has been included to display the paucity of data characteristic of Pacific island contexts. Secondly, the baseline collates scores from the World Economic Forum (WEF)’s Global Gender Gap Index (GGGI), where Vanuatu was recently included.

Table 2: Composite Indices – Vanuatu’s ranks and scores

INDEX (SCALE, ORGANIZATION)	RANK / SCORE
Human Development Index, out of 189 countries (UNDP)	**141**
Gender Inequality Index, out of 162 countries (UNDP)	**n/a**
Gender Development Index clustered with group (UNDP)	**n/a**
Global Gender Gap Index out of 153 countries (WEF)	**126**

Vanuatu’s HDI value is 0.609 – which puts the country in the medium human development category – positioning it at 141 out of 189 countries and territories in the 2018 index.[50] This can primarily be linked to the SID-specific challenges that the World Bank identifies for the Vanuatuan economy:

[49] As Booysen’s research shows, composite indices present both challenges and advantages. For example, numerous fallacies have been identified in the methodologies employed in composite indexing. These indices are mainly quantitative, and present empirical and aggregate measures of complex development phenomena, making values apparently objective, at the cost of subjective nuances. Yet, these also remain invaluable as useful supplements to income-based development indicators, understanding relative degrees of development, simplifying complex measurement constructs as well as providing access to non-technical audiences.
Booysen, F. (2002). An Overview and Evaluation of Composite Indices of Development in Social Indicators Research, (Vol. 59 No. 2). Journal Article.
[50] UNDP (2019). Briefing note for countries on the 2019 Human Development Report: Vanuatu in the Human Development Report 2019. Research brief. Accessed online: http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/VUT.pdf

small size, remoteness from major markets and internal dispersion.[51] The country's geographical location, undiversified economic structure, and high import dependence makes it vulnerable to external shocks, especially climate change-induced disasters and natural hazards.[52] Such shocks greatly impact hard-earned development gains and threaten food, water and energy security – this project will address particularly water security issues.

Currently, the GII and GDI remain unavailable for Vanuatu due to the paucity of relevant and quality data.[53] The 2020 GGGI (WEF) includes four new countries, including Vanuatu for the first time. It is ranked 126 out of 153 countries and territories, on an aggregate score that combines performance in Economic Participation, Educational Attainment, Health and Survival and Political Empowerment.[54] Female representation in political spheres in Vanuatu displays a vast gender gap, there has never been a female head of state in the past 50 years, and there is currently no women in parliament or in ministerial positions, as evinced by the findings of the Beijing +25 report. Women's hardship trends, despite scant data, can be inferred from their dependence on lower skilled and remunerative activities such as subsistence agriculture as well as natural resource-based livelihoods.[55] On trend with the Pacific region, Vanuatu experiences a high incidence of gender-based violence and intimate partner violence.[56]

These indices are important to consider in the context of WASH and climate change, as they signal potential hurdles towards inclusive application of proposed alternatives towards resilience and water security in the country. However, this project attempts to mitigate these expected hurdles by locating the change paradigm after a thorough safeguards assessment, presented in the Environment and Social Management Plan (Annex 6), extensive stakeholder consultations presented in the Stakeholder Engagement Plan (Annex 7), and gender analysis collated in the Gender Assessment and Action Plan (Annex 8).

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[51] World Bank (2017). Systematic Country Diagnostic: Republic of Kiribati, Republic of Marshall Islands, Federated States of Micronesia, Republic of Palau, Independent State of Samoa, Kingdom of Tonga, Tuvalu, Republic of Vanuatu (PIC8 – 8 Pacific Island Countries). Multi-country report. Accessed online: http://documents.worldbank.org/curated/en/313021467995103008/pdf/102803-REPLACEMENT-SecM2016-0025.pdf

[52] World Bank (2017). Systematic Country Diagnostic: PIC8. Ibid.

[53] UNDP (2019). 'Briefing note for countries on the 2019 Human Development Report: Vanuatu' in the Human Development Report 2019. Ibid.

[54] WEF (2020). The Global Gender Gap Report. Ibid.

[55] World Bank (2017). Systematic Country Diagnostic: PIC8. Ibid.

[56] The World Bank reports that based on the best-available data, women in the PIC8 suffer from either partner or non-partner violence at higher extents than any other part of the world. See API-GBV website for more.

3. Technical assessment: climate modelling for CR-WASH in Vanuatu

3.1Climate profile: Vanuatu

Vanuatu was ranked as being at the highest risk level in the 2019 World Risk Index for disaster exposure and has consistently featured among the top 10 most climate-impacted countries in the world.[57] The 80-odd islands in the archipelago are highly heterogenous in geographic, topographic and climatic conditions. For example, some of the larger, more mountainous islands have good ground- as well as surfacewater resources, whilst others have either ground or surface water or rely entirely on rainwater catchment. However, steep catchments and narrow coastal plains are ubiquitous in these islands and are vulnerable to flooding and sea-level rise. Water resources in the country, therefore, vary and are influenced by climatic and geographic factors. Concomitantly, the island nation is prone to multivariable water-related climate risks coupled with underlying social and economic vulnerabilities.

Since Vanuatu's population is also concentrated along the coasts, the balance of freshwater and saltwater (coastal) ecosystems also plays a vital role in the subsistence and commercial life of the population. The islands have uniquely fragile water resources due to its small scale, lack of storage and limited freshwater reserves – which are increasingly exposed to climate impacts. Climate impacts particularly destabilize natural resource-dependent livelihoods of rural communities (pegged at 75% of the population)[58], who continue to rely on subsistence farming in the different islands.

Vanuatu's climate varies from wet tropical in the north to subtropical in the south. From May through September, south easterly winds support fine sunny days and cooler nights. November to April is the wet season with higher temperatures, heavy rain and occasional cyclones. The wettest months are from January through March. Average temperatures range in Port Vila from 27 degrees Celsius in February to 22 degrees Celsius in July.

Rainfall is also affected by latitude and altitude. The northern higher islands in the Banks and Torres groups receive an annual average of 4,000 mm rainfall, while the southern and lower islands may receive only half of such figures, showing regional disparity in the water sources available.

The hot or wet season in Vanuatu, which typically extends from November to April of the following year, is the tropical cyclone season. The geographical location of the archipelago in the southwest Pacific means that tropical cyclones occasionally traverse the country wind speeds of at least 62 km/hr. According to the Vanuatu Meteorological and Geo-Hazard Department statistics, the area of Vanuatu (land and sea) receives about two to three cyclones per season. The most significant frequency of these events is in January and February. On average, Vanuatu, and its marine economic zone experience 20 to 30 cyclones per decade, between three and five causing severe damage. Tropical cyclones can affect any island of Vanuatu, with several impacts: heavy rainfall, flash flooding, flooding of low-lying areas, coastal flooding, riverine flooding, storm surge,

[57] World Risk Report 2021, see: https://reliefweb.int/sites/reliefweb.int/files/resources/2021-world-risk-report.pdf
[58] The Pacific Community (SPC) – see more details on https://sdd.spc.int/vu.

landslides, and very rough seas. These events regularly cause damage to life, infrastructure and public goods, as well as property in the islands – and also have direct and indirect impacts on water security and WASH infrastructure in the country.

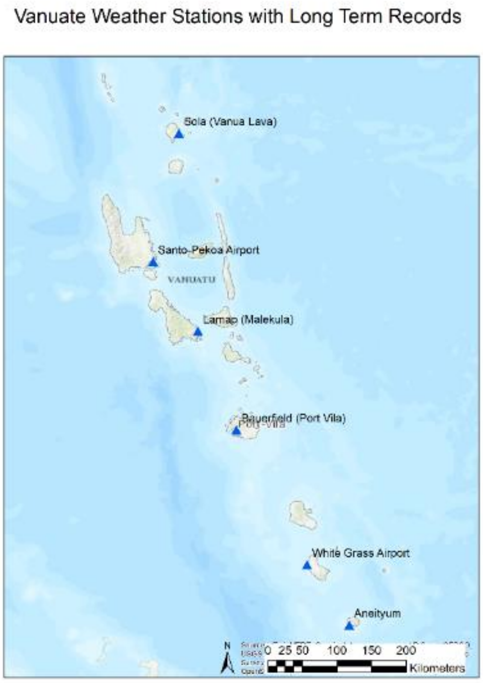
3.2 Climate rationale: increased resilience for WASH infrastructure in Vanuatu

Given the multiplicity of factors and barriers affecting the WASH baseline in Vanuatu, a climate modelling study was conducted for this feasibility study (detailed outputs are attached as Annex A and summarized below) based on primary data to map water and climate risks, and their interconnectedness, in the country. The objective of this effort is to help Vanuatu's decision-makers incorporate WASH and water-related climate risk information into decisions across sectors, and to illuminate water resources management challenges linked with climate change.

The primary conclusion of the study – which informs the design of this project – is that observed changes in the climate of Vanuatu can impact and compound common challenges associated with water and sanitation services and water resource management. Storms and floods, made more intense and frequent by climate change, will have increased potential to damage water utilities, pipes, and community-based systems in the baseline scenario. Floods can increasingly overwhelm drains, wastewater treatment plants, and latrine pits, resulting in stagnant, contaminated water that puts the health and wellbeing of the ni-Vanuatu at risk. Droughts, caused by higher evapotranspiration and unpredictable ENSO, also directly impacts rain-fed subsistence agriculture and human health in Vanuatu. This has already been observed in the southern islands, which experienced a meteorological drought in early 2020.[59] ENSO impacts combined with dry season to delay the arrival of expected rain, impacting the Tafea Province (Tanna and Aniwa islands). The spillover effects included heightened water insecurity, cattle deaths and crop failures in these areas.

Historical data were analyzed based on six weather stations with reasonable data quality and quantity in Vanuatu. Ten populated locations in Vanuatu were selected for climate change scenario analysis: Port Vila, Luganville, Norsup, Port-Olry, Isangel, Sola, Lakatoro, Melsisi, Lamap, and Aneghowhat (see map on page 33).

[59] Radio New Zealand International update: https://reliefweb.int/report/vanuatu/vanuatus-southern-islands-drought



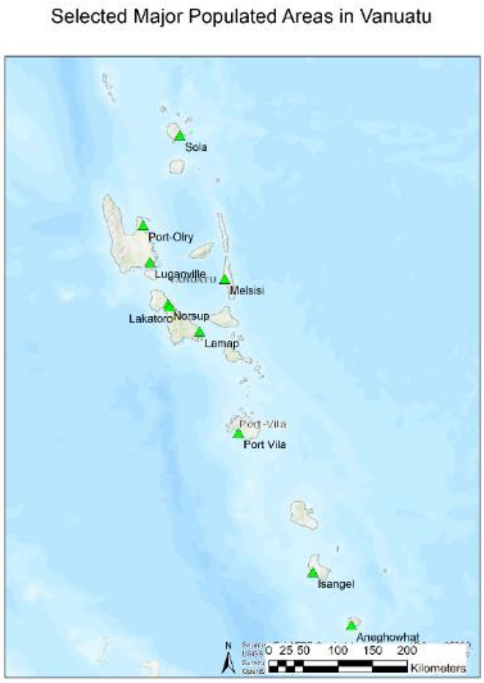


Figure 8: Weather station and selected sites for analysis in Vanuatu

Key outputs relevant for the project design are presented in the following section, with Annex A detailing the data sources, methodology and key modelling outputs.

3.3 Key outputs of climate data modelling: past, observed and projected changes

- The analysis revealed that climate change has manifested in the historical observational data, especially in the temperature data with an increasing trend. However, annual precipitation shows no significant change in the trend and the variability of total rainfall continues to be considerable on a seasonal and annual basis. Tropical cyclones and ENSO are the main driving forces for the seasonal and annual variations in Vanuatu.

- Climate change analysis was carried for baselines and the year 2050, under RCP4.5 and RCP8.5 scenarios, applying CMIP5 22 CORDEX AUS Domain RCM and 40 GCMs ensemble approaches and other historical climate data sources, with outputs for the median, 5th and 95th percentiles.

- Daily extreme precipitation was calculated based on the six meteorological observation stations data and average recurrence intervals (ARI) of 2, 5, 10, 25, 50, 100, 200, 300 years. The extreme daily precipitation for all stations is high due to the occurrence of tropical cyclones. For example, the 100-year ARI for daily rainfall is 504.8mm at Port Vila. The other five stations range between 300 and 500mm.

- Extreme wind speeds are high for all ten sites, with ARI 50, 100, 500 and 1000 year values modelled. For example, in Port Vila, the 100-year ARI extreme wind speed could reach 168.2km/hr with other locations at similar intensity. Under climate change scenarios, the median change indicates increase in intensity.

- Tropical cyclone induced extreme wind and precipitation are the major meteorological hazards for Vanuatu. They cause extensive damage to all types of infrastructures, and climate change will continue to exacerbate these impacts if intensification of events is not factored into designs. Historically the TC season has fallen from early 1st November to 30th April, however in recent years there are indications of cyclones falling outside of the season (notably Liua Sept 2018 and Donna May 2017)[60]. This indicates increasingly unpredictable cyclone events outside of season. Additionally, TC tracks in recent years have been shown to be more irregular and looping rather than curvilinear) mean impacts can be over a wider area of the country causing greater destruction. Overall, in comparison to the 1970-1990 reference period, TC events over 1990-2010 showed a slight decrease in total events but a 9% increase in the chance of a TC falling int a severe category[61]. Future climate projections, particularly from data analysed by the Pacific Catastrophe Risk Assessment and Financing Initiative, indicate there will be a slight increase in maximum wind speeds of tropical cyclones, increasing potential for future losses as well increasing the proportion of population affected in Vanuatu.[62] The data is unclear on whether the number of cyclones crossing Vanuatu will increase, however, extreme precipitation and wind speeds brought on by these events are expected to increase. Even with climate-proofing, it is essential to note that some extreme events may overwhelm the best intentions in engineering for resilience. Therefore, disaster preparedness must coincide with adaptation planning and infrastructure design, particularly in the context of a fragile WASH baseline in Vanuatu.

- Drought frequency and intensity was analyzed based on the Standardized Precipitation Evapotranspiration Index (SPEI). A slightly increasing trend for a drought over time was found in all 10 locations. Meteorological droughts have already been observed in the south of Vanuatu's archipelago.[63] ENSO impacts combined with dry season to delay the arrival of expected rain, impacting the Tafea Province (particularly Tanna and Aniwa islands). Therefore, drought and its implications will need to be considered carefully in the infrastructure design and planning for water security in Vanuatu.

- Mean sea-level rise was analyzed. By 2050, an increase of between 40 and 60cm in mean sea level is projected under RCP4.5 and RCP8.5 scenarios with only slight variation from location to location.

- In the coastal areas, where Vanuatu's population is concentrated, high-water levels in the historical period for 50, 100, 200, 300 year return period are presented. The 100-year ARI extreme water level for the ten locations is around 0.7 to 1.0 meter. By 2050, the extreme still high-water level could reach 1.4 to 1.8 meters. These values include mean

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[60] https://www.vmgd.gov.vu/vmgd/images/climate-media/docs/Tropical_Cyclone_Seasonal_Outlook_2019_2020.pdf

[61] Saverimuttu, V. and Varua, M.E., 2016. Seasonal tropical cyclone activity and its significance for developmental activities in Vanuatu. Environmental & Economic Impact on Sustainable Development, p.8.

[62] Data outputs summarized here: https://www.terranova.org.au/repository/paccsap-collection/current-and-future-tropical-cyclone-risk-in-the-south-pacific-country-risk-profile-vanuatu/current-and-future-tropical-cyclone-risk-in-the.pdf

[63] Radio New Zealand International update: https://reliefweb.int/report/vanuatu/vanuatus-southern-islands-drought

sea level rise, indicating that increased salinity and inundation could become issues for freshwater and groundwater sources.

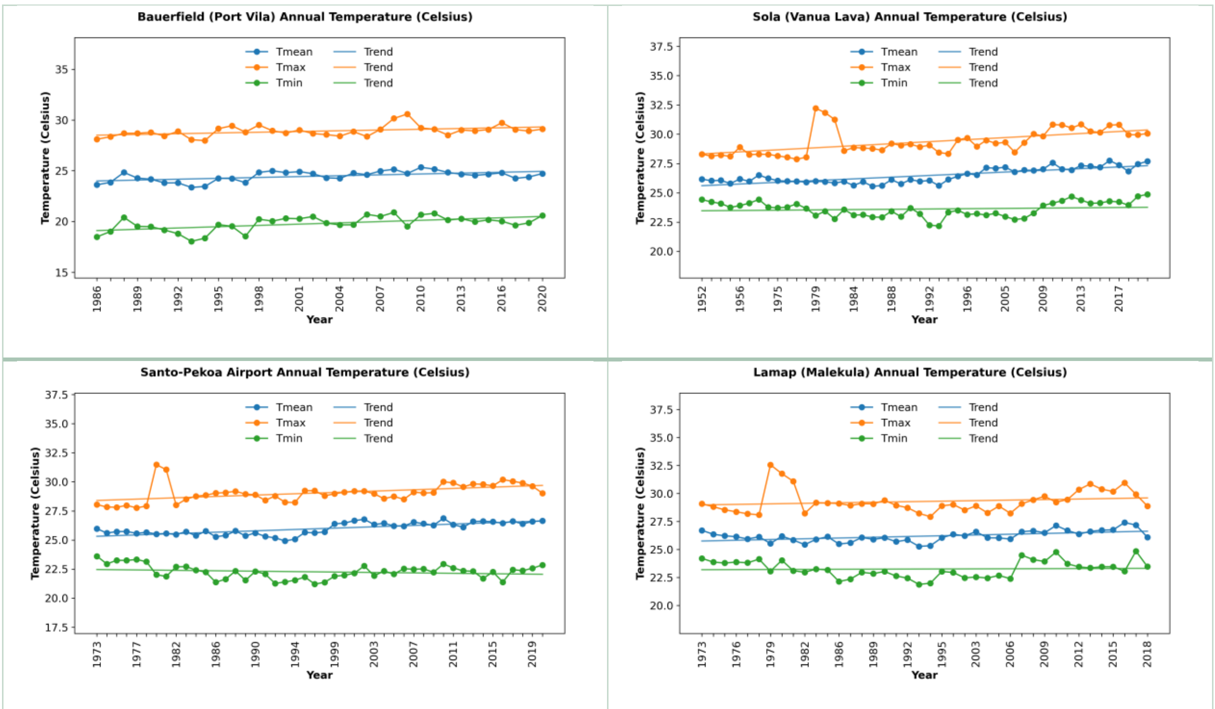
- The velocity of acute risks caused by extremes precipitation, wind, and heat events could occur at any time. Even a 1 in 100-year event, while only representing a 1 per cent risk of an event on any one year, over, for example, a 30-year lifecycle of an infrastructure project, would over that lifespan have a 26% chance of having to withstand a 1 in 100-year event. As increasingly apparent around the world, uncertainties in extremes beyond climate model scenario prediction are possible.

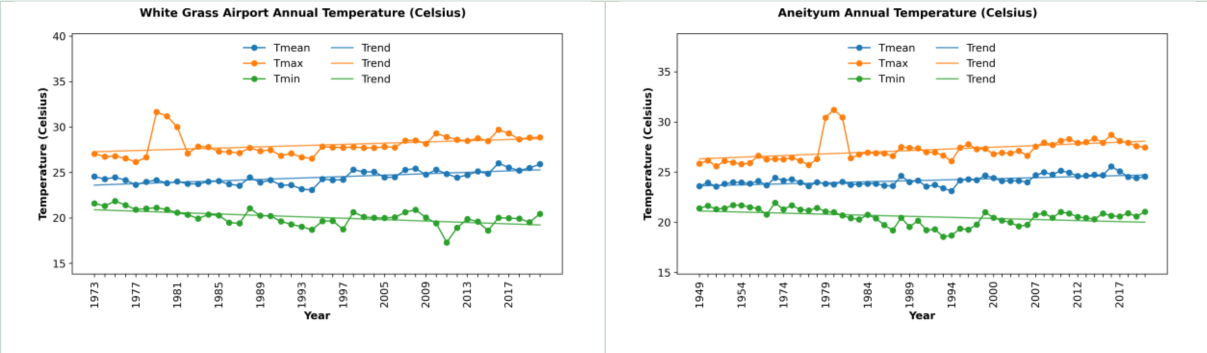
- Geohazards, including landslides, earthquakes, and extreme ocean waves, are beyond this project's scope but need to be included in design considerations, where they are relevant, to ensure installed WASH infrastructure are resilient to the extent possible to these events.

Historical annual mean, maximum and minimum temperature trend analysis: mean temperature increasing in all selected stations

Mean temperature showed increasing trends in all the selected stations. However, minimum temperature has a slower increasing trend, and showed a decreasing trend in the White Grass Airport and Aneityum station. The trend and data quality need to be further checked with further analysis.

Table 3: Historical temperature trends by study site

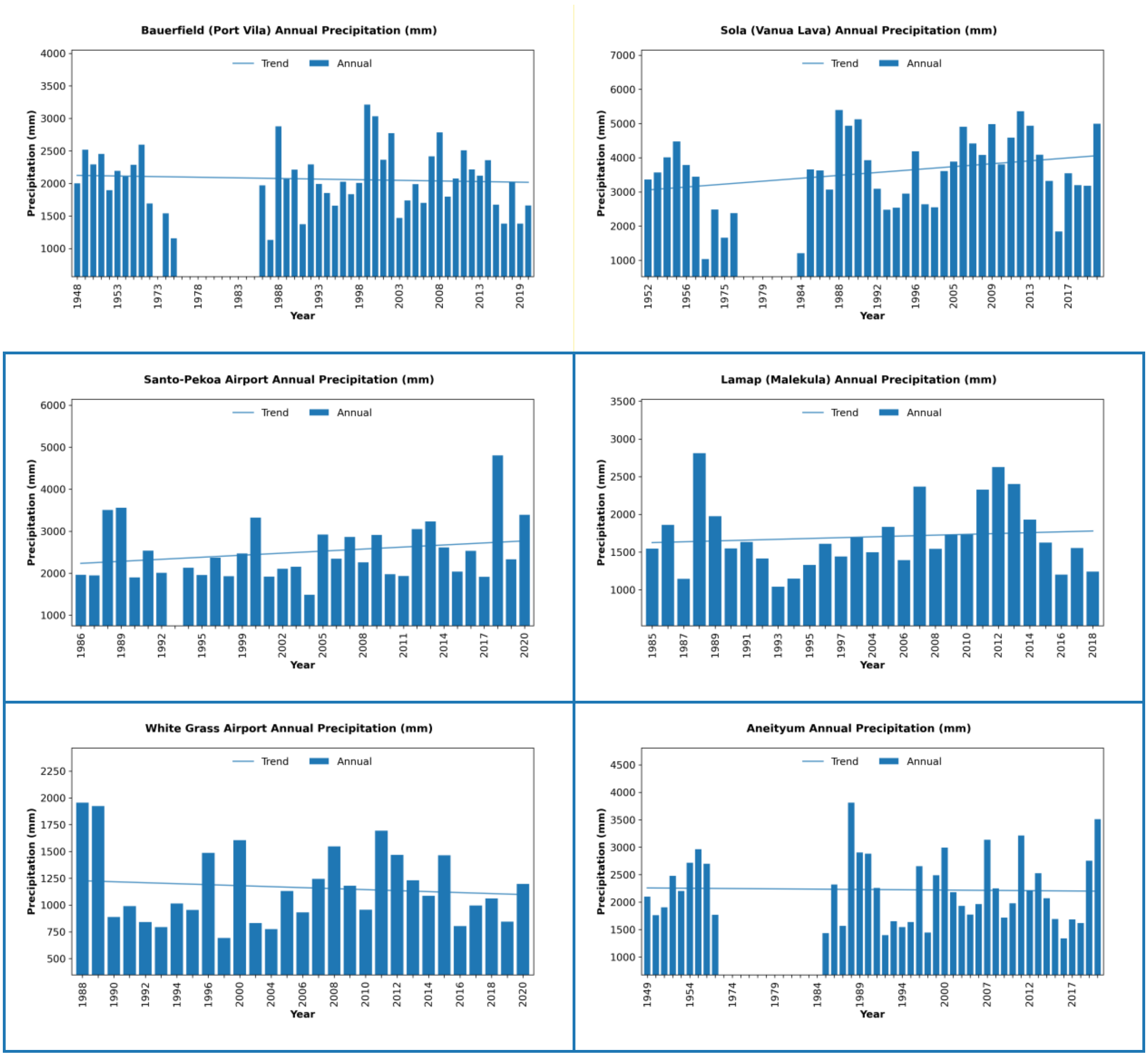




Historical annual total precipitation trend: no clear signal of systemic changes

The historical annual precipitation variabilities are significant in Vanuatu. Stations have no clear signal of systemic changes. Data quality may need further investigation to cross-check the projections.

Table 4: Historical annual precipitation changes



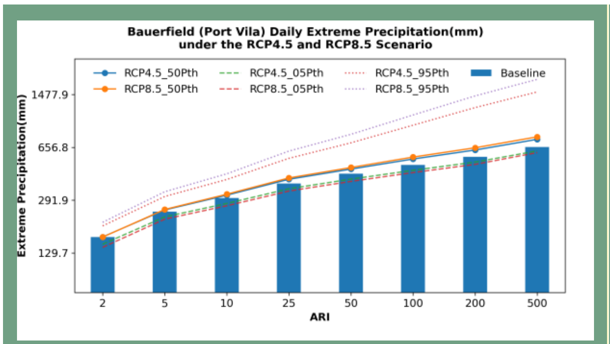
Historical and projected daily extreme precipitation based on 6 observation stations: predicted increase in extreme precipitation, with slight decrease in annual total precipitation

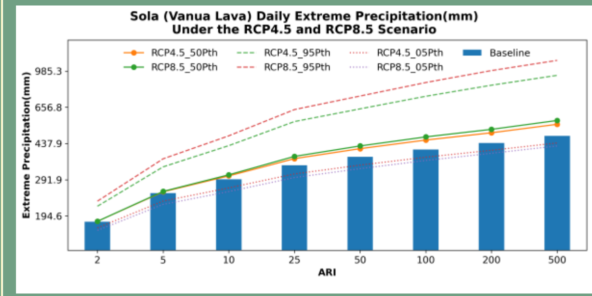
Mainly accounted for through tropical cyclones, the extreme precipitation in Vanuatu is quite high. For 100-year return, daily precipitation in Santo Pekoa Airport can reach 479.4mm, other stations range from 361.7 to 475.6mm. The extreme precipitation causes floods and landslides in the natural and built environments in Vanuatu. With climate change, the extreme precipitation would increase significantly in contrast to the slight decrease in annual total precipitation. In Port Vila, 2050 RCP4.5 the daily extreme precipitation increases 8.8 (-8.4, 83.0) %, and 12.1 (-11.6, 114.0) % under RCP8.5. Shorter return periods have a smaller increase in percentage; longer return periods have a higher increase percentage. The uncertainty range in extreme precipitation changes looks very high, such as 114.0% for the 95th percentile of the ensemble. However, extreme events in recent years showed that the precipitation could exceed the climate model projections. Detailed results are shown below.

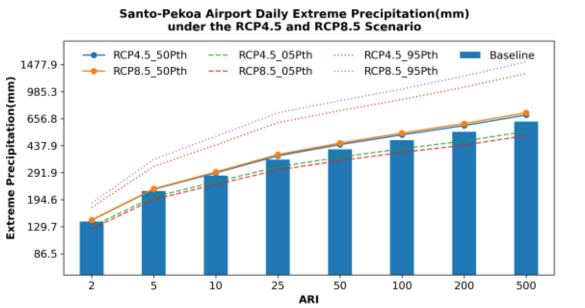
Table 5: Vanuatu observation station historical daily extreme precipitation (mm)

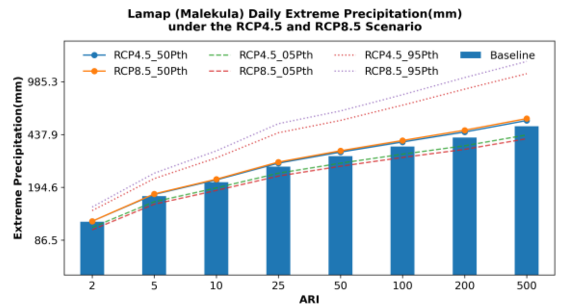
Station Name/ Return Year	Lamap (Malekula)	Sola (Vanua Lava)	Bauerfield (Port Vila)	Santo-Pekoa Airport	White Grass Airport	Aneityum
2	115.51	183.17	167.06	141.34	99.36	155.05
5	171.20	252.45	246.79	223.61	154.91	231.51
10	212.32	294.85	303.61	281.24	196.94	285.59
25	269.67	344.76	380.35	357.85	256.88	358.13
50	316.48	379.32	441.08	417.56	306.87	415.14
100	366.89	411.68	504.75	479.36	361.70	474.59
200	421.35	442.11	571.75	543.57	422.02	536.79
500	500.27	479.64	665.92	632.47	511.31	623.63

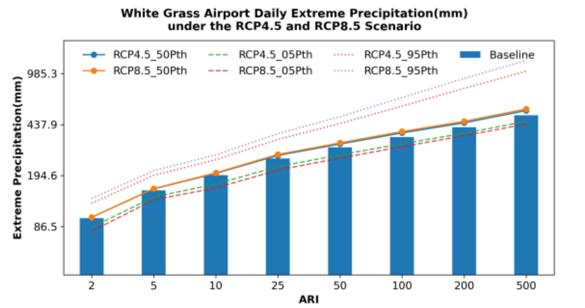
Table 6: Baseline and future scenarios of extreme precipitation by weather station











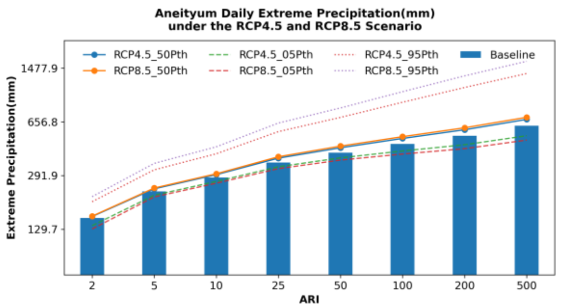


Table 7: Vanuatu Stations Extreme Precipitation 2050 24Hrs Change (%) RCP4.5 50Pth Scenario with the 5Pth-95Pth Range

Name/ Return Year	2	5	10	25	50	100	200	500
Aneityum	1.4 (-11.7, 26.8)	3.2 (-6.3, 37.5)	3.6 (-6.5, 42.1)	6.0 (-6.9, 58.4)	7.1 (-8.1, 69.4)	7.8 (-10.8, 86.2)	8.7 (-13.4, 105.8)	9.4 (-14.5, 118.8)
White Grass Airport	0.7 (-14.1, 26.2)	1.5 (-10.6, 26.1)	2.3 (-13.7, 27.1)	4.4 (-12.6, 34.5)	4.7 (-11.9, 45.0)	6.1 (-10.8, 62.5)	6.7 (-9.5, 84.5)	7.1 (-10.0, 99.9)
Bauerfield (Port Vila)	-0.6 (-11.1, 17.8)	1.9 (-8.4, 25.2)	3.9 (-8.5, 32.2)	5.9 (-8.5, 46.0)	6.8 (-8.5, 59.7)	8.8 (-8.4, 83.0)	10.4 (-8.4, 111.6)	11.6 (-6.5, 131.3)
Lamap (Malekula)	0.1 (-8.9, 17.8)	2.0 (-8.9, 30.0)	2.8 (-9.2, 44.1)	4.6 (-10.3, 66.9)	5.7 (-10.9, 71.9)	6.5 (-11.7, 87.4)	8.1 (-12.5, 108.7)	8.6 (-13.0, 123.0)
Santo-Pekoa Airport	1.1 (-8.0, 22.3)	1.8 (-9.2, 43.3)	3.5 (-9.5, 57.5)	5.1 (-11.0, 73.0)	6.6 (-11.8, 77.5)	7.5 (-12.7, 82.8)	8.9 (-13.6, 93.8)	9.8 (-14.2, 104.8)

Sola (Vanua Lava)	0.1 (-7.0, 18.5)	1.1 (-8.9, 33.6)	3.4 (-9.6, 45.1)	7.3 (-9.6, 62.4)	9.0 (-9.3, 70.2)	10.6 (-8.7, 80.5)	11.7 (-8.1, 90.3)	13.2 (-8.1, 95.8)

Table 8: Vanuatu Stations Daily Extreme Precipitation 2050 Change (%) RCP8.5 50Pth Scenario with the 5Pth-95Pth Range

Name/ Return Year	2	5	10	25	50	100	200	500
Aneityum	2.0 (-16.0, 36.9)	4.4 (-8.7, 51.5)	5.0 (-8.9, 57.9)	8.3 (-9.5, 80.2)	9.7 (-11.2, 95.3)	10.7 (-14.9, 118.5)	11.9 (-18.3, 145.4)	12.9 (-20.0, 163.2)
White Grass Airport	1.0 (-19.3, 35.9)	2.1 (-14.6, 35.8)	3.2 (-18.9, 37.2)	6.0 (-17.4, 47.4)	6.5 (-16.3, 61.8)	8.3 (-14.8, 85.9)	9.2 (-13.0, 116.1)	9.8 (-13.7, 137.3)
Bauerfield (Port Vila)	-0.8 (-15.3, 24.5)	2.6 (-11.6, 34.7)	5.4 (-11.7, 44.3)	8.1 (-11.7, 63.2)	9.3 (-11.6, 82.1)	12.1 (-11.6, 114.0)	14.2 (-11.5, 153.4)	16.0 (-8.9, 180.4)
Lamap (Malekula)	0.1 (-12.2, 24.5)	2.7 (-12.2, 41.3)	3.9 (-12.6, 60.5)	6.4 (-14.2, 91.9)	7.9 (-15.0, 98.8)	8.9 (-16.1, 120.1)	11.1 (-17.2, 149.3)	11.8 (-17.9, 169.0)
Santo-Pekoa Airport	1.6 (-11.0, 30.7)	2.5 (-12.7, 59.5)	4.8 (-13.0, 79.1)	7.1 (-15.1, 100.3)	9.1 (-16.1, 106.4)	10.3 (-17.4, 113.8)	12.3 (-18.7, 128.9)	13.5 (-19.5, 143.9)
Sola (Vanua Lava)	0.1 (-9.6, 25.4)	1.5 (-12.2, 46.2)	4.6 (-13.2, 61.9)	10.0 (-13.2, 85.8)	12.4 (-12.8, 96.5)	14.6 (-12.0, 110.6)	16.1 (-11.2, 124.1)	18.2 (-11.1, 131.6)

Historical monthly mean temperature and precipitation, and future projections for the populated areas

The annual mean temperature over Vanuatu varies from 24.2 in Aneghowhat, the southern island, Aneityum, to 26.4 in Sola, a northern island, Vanua Lava. The seasonal temperature variations are 2 to 4 degrees, and the daily temperature range is around 6-7 degrees Celsius. Located the South Pacific, the temperature increase speed in Vanuatu is slower than the global average. They are 0.81-0.83 (0.6-1.2) Celsius by 2050 under RCP4.5 and 1.09-1.11(0.8-1.6) Celsius under an RCP8.5 scenario. Maximum, minimum, and mean temperature changes are very close to each other.

Northern islands are projected to get more annual precipitation: 3333 mm in Sola, and 2149 mm in Aneghowhat. The precipitation in Vanuatu has seasonality; the wet season is from November to April, getting 59% of the precipitation; the dry season is May to October, receiving the remaining precipitation. However, the annual variabilities are high in Vanuatu. Projected by the GCM and RCM models, the annual precipitation in Vanuatu shows the possibility of a slight decrease in all places, from -0.81% to 1.25%, with a wide range of uncertainties, from -21.57% to 29.56% in 2050 RCP4.5. And a more considerable decrease with a wider range of confidence intervals. The following tables and figures present the detailed monthly and annual temperature and precipitation over ten selected areas.

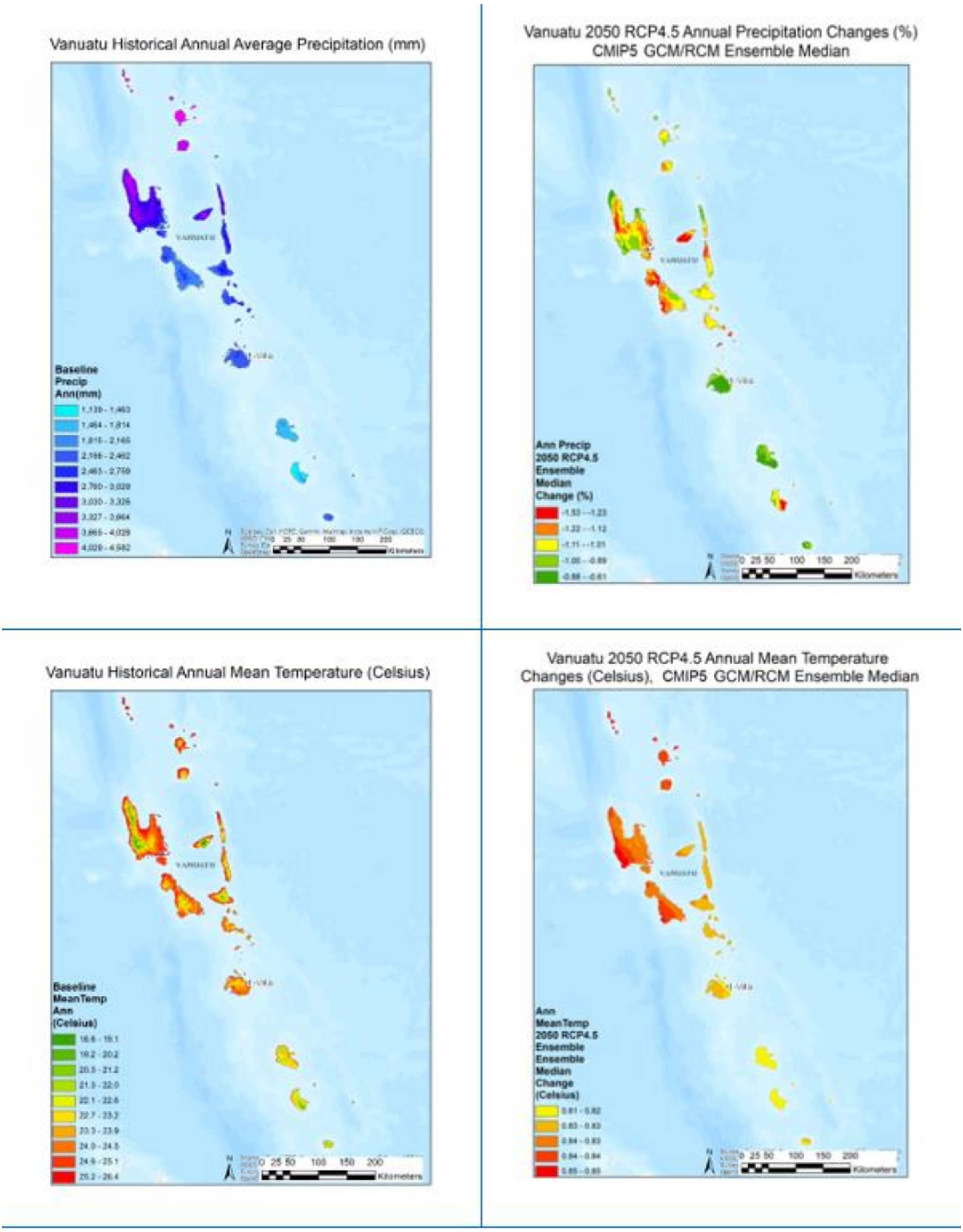


Figure 9-: Sample maps for the historical (1981-2010 average) and RCP4.5 2050 annual precipitation and mean temperature for Vanuatu. The baseline annual precipitation and temperature were based on the adjusted WorldCLIM2 data, and RCP4.5 changes were based on the CMIP5 GCM/RCM ensemble median data. (Data and map source: authors)

Table 9: Vanuatu Monthly Mean Temperature Baseline (1981-2010 average) (Celsius)

Name/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Port Vila	26.7	26.8	26.6	25.6	24.4	23.5	22.6	22.6	23.1	24.1	25.2	26.0

Luganville	27.0	27.0	27.0	26.5	25.8	25.2	24.6	24.5	24.9	25.6	26.2	26.8
Norsup	26.9	27.0	26.9	26.4	25.5	24.8	24.2	24.1	24.5	25.2	26.0	26.6
Port-Olry	26.4	26.5	26.4	26.1	25.4	24.9	24.5	24.6	24.8	25.2	25.8	26.3
Isangel	26.3	26.4	26.1	25.2	23.8	22.8	21.9	21.8	22.5	23.5	24.6	25.6
Sola	27.0	27.1	27.1	26.9	26.4	25.9	25.5	25.5	25.7	26.2	26.6	27.0
Lakatoro	26.6	26.7	26.5	26.1	25.3	24.6	24.0	24.0	24.3	25.0	25.7	26.3
Melsisi	26.1	26.1	25.9	25.4	24.5	23.8	23.3	23.4	23.6	24.3	25.0	25.7
Lamap	27.0	27.0	26.9	26.3	25.4	24.7	24.1	23.9	24.3	25.1	25.9	26.6
Aneghowhat	25.9	26.0	25.8	25.1	23.9	23.0	22.4	22.3	22.6	23.5	24.4	25.3

Table 10: Vanuatu Monthly Maximum Temperatures Baseline **(1981-2010 average)** (Celsius)

Name/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Port Vila	29.9	30.0	29.8	28.8	27.6	26.7	26.3	26.2	26.8	27.8	28.9	29.7
Luganville	30.1	30.0	30.0	29.6	28.9	28.2	28.2	28.1	28.5	29.1	29.8	30.3
Norsup	29.9	30.0	29.9	29.4	28.6	27.8	27.9	27.7	28.1	28.9	29.6	30.2
Port-Olry	29.4	29.4	29.3	29.1	28.4	27.8	28.2	28.3	28.4	28.9	29.4	29.9
Isangel	29.6	29.8	29.5	28.5	27.1	26.1	25.8	25.7	26.4	27.3	28.5	29.5
Sola	29.9	29.9	29.9	29.7	29.2	28.7	28.9	28.9	29.1	29.5	30.0	30.4
Lakatoro	29.5	29.6	29.5	29.1	28.2	27.5	27.6	27.6	27.9	28.6	29.3	29.9
Melsisi	29.3	29.4	29.2	28.7	27.7	27.0	27.0	27.1	27.3	27.9	28.7	29.4
Lamap	30.0	30.0	29.9	29.3	28.4	27.7	27.6	27.5	27.9	28.6	29.4	30.1
Aneghowhat	29.0	29.1	28.9	28.2	27.0	26.1	26.1	26.1	26.4	27.3	28.2	29.1

Table 11: Vanuatu Monthly Minimum Temperatures Baseline **(1981-2010 average)** (Celsius)

Name/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Port Vila	23.5	23.6	23.4	22.4	21.2	20.3	19.0	18.9	19.4	20.5	21.6	22.4
Luganville	24.0	24.0	23.9	23.5	22.8	22.1	21.1	20.9	21.4	22.0	22.7	23.2
Norsup	23.9	23.9	23.9	23.3	22.5	21.8	20.6	20.4	20.9	21.6	22.3	22.9

Port-Olry	23.5	23.5	23.4	23.1	22.5	21.9	20.9	21.0	21.2	21.7	22.2	22.7
Isangel	23.0	23.1	22.8	21.8	20.5	19.4	18.0	17.9	18.6	19.6	20.7	21.7
Sola	24.2	24.2	24.3	24.1	23.6	23.1	22.2	22.1	22.4	22.8	23.2	23.6
Lakatoro	23.6	23.7	23.6	23.2	22.3	21.6	20.4	20.4	20.7	21.4	22.1	22.7
Melsisi	22.8	22.9	22.7	22.2	21.3	20.6	19.6	19.7	19.9	20.6	21.3	22.0
Lamap	24.0	24.0	23.9	23.3	22.4	21.7	20.5	20.4	20.8	21.6	22.4	23.1
Aneghowhat	22.8	22.9	22.7	22.0	20.8	20.0	18.6	18.5	18.8	19.7	20.7	21.5

Table 12: Vanuatu Monthly Precipitation Baseline **(1981-2010 average)** (mm)

Name/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Port Vila	274.4	272.4	329.9	234.6	163.6	166.1	131.0	126.5	118.1	128.6	162.7	176.2
Luganville	352.7	324.4	380.3	292.0	188.9	210.3	160.7	160.6	213.6	233.4	217.0	224.4
Norsup	255.4	307.7	300.0	250.2	268.9	181.3	138.4	157.4	91.7	89.1	225.0	185.9
Port-Olry	332.7	344.9	356.5	329.9	202.2	259.8	154.5	146.6	184.8	148.5	247.7	207.7
Isangel	263.6	256.0	287.2	209.4	161.2	133.2	127.9	127.6	106.0	97.2	159.1	164.9
Sola	394.0	385.1	410.4	331.1	244.1	225.0	200.1	156.1	206.3	237.2	240.2	303.8
Lakatoro	376.7	309.6	311.3	235.6	274.7	135.5	144.5	154.8	97.7	109.8	184.6	225.4
Melsisi	342.1	352.6	342.6	324.3	243.4	238.4	189.0	168.9	169.0	219.3	218.6	264.7
Lamap	318.8	296.3	309.7	224.0	157.2	130.0	136.9	83.4	111.4	140.0	216.9	181.7
Aneghowhat	253.5	240.2	281.8	230.6	182.6	156.5	111.7	147.6	115.7	104.6	165.2	158.9

Table 13: Summary of annual temperature and precipitation baseline **(1981-2010 average)** and changes for the 10 populated areas (with 5th and 95th of the model ensembles)

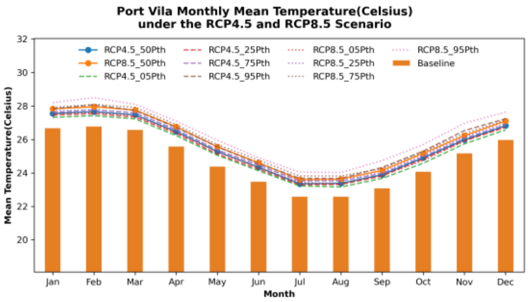
Name	Mean Temperature (Celsius)	Maximum Temperature (Celsius)	Minimum Temperature (Celsius)	Precipitation (mm)
Port Vila	24.77	28.21	21.35	2284.10
Luganville	25.93	29.23	22.63	2958.30

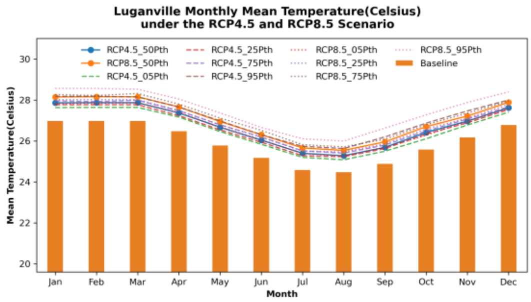
Norsup	25.68	29.00	22.33	2451.00
Port-Olry	25.58	28.87	22.30	2915.80
Isangel	24.21	27.82	20.59	2093.30
Sola	26.41	29.51	23.32	3333.40
Lakatoro	25.43	28.69	22.14	2560.20
Melsisi	24.76	28.22	21.30	3072.90
Lamap	25.60	28.87	22.34	2306.30
Aneghowhat	24.18	27.62	20.75	2148.90

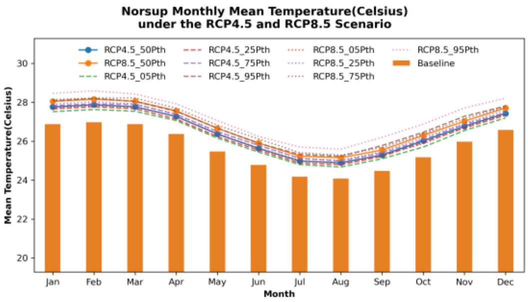
RCP4.5 Changes				
Name	Mean Temperature (Celsius)	Maximum Temperature (Celsius)	Minimum Temperature (Celsius)	Precipitation (%)
Port Vila	0.82 (0.59 - 1.17)	0.81 (0.59 - 1.16)	0.83 (0.60 - 1.18)	-0.81 (-20.57 - 23.84)
Luganville	0.83 (0.61 - 1.19)	0.83 (0.61 - 1.19)	0.83 (0.62 - 1.20)	-1.12 (-19.67 - 20.84)
Norsup	0.83 (0.61 - 1.18)	0.83 (0.60 - 1.18)	0.83 (0.61 - 1.19)	-1.25 (-19.89 - 22.57)
Port-Olry	0.83 (0.61 - 1.19)	0.83 (0.60 - 1.19)	0.83 (0.62 - 1.20)	-0.95 (-19.39 - 19.51)
Isangel	0.82 (0.59 - 1.16)	0.81 (0.58 - 1.15)	0.83 (0.59 - 1.18)	-0.95 (-20.17 - 27.89)
Sola	0.83 (0.60 - 1.20)	0.83 (0.60 - 1.19)	0.84 (0.61 - 1.20)	-1.02 (-17.91 - 18.71)
Lakatoro	0.83 (0.60 - 1.18)	0.83 (0.60 - 1.18)	0.83 (0.61 - 1.19)	-1.09 (-19.87 - 21.97)
Melsisi	0.82 (0.61 - 1.19)	0.82 (0.60 - 1.19)	0.82 (0.61 - 1.20)	-1.21 (-20.54 - 21.08)
Lamap	0.83 (0.61 - 1.18)	0.83 (0.60 - 1.18)	0.83 (0.61 - 1.20)	-1.11 (-19.90 - 23.36)
Aneghowhat	0.82 (0.59 - 1.16)	0.81 (0.58 - 1.14)	0.83 (0.59 - 1.17)	-0.84 (-20.27 - 29.56)

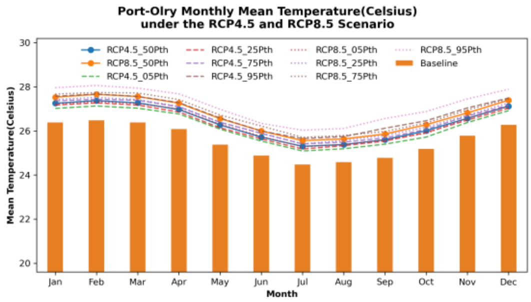
RCP8.5 Changes				
Name	**Mean Temperature (Celsius)**	**Maximum Temperature (Celsius)**	**Minimum Temperature (Celsius)**	**Precipitation (%)**
Port Vila	1.10 (0.79 - 1.56)	1.08 (0.78 - 1.54)	1.10 (0.79 - 1.58)	-1.08 (-27.37 - 31.72)
Luganville	1.11 (0.81 - 1.58)	1.10 (0.80 - 1.58)	1.10 (0.82 - 1.59)	-1.49 (-26.17 - 27.73)
Norsup	1.11 (0.80 - 1.57)	1.10 (0.80 - 1.57)	1.11 (0.81 - 1.59)	-1.66 (-26.47 - 30.04)
Port-Olry	1.10 (0.81 - 1.58)	1.10 (0.80 - 1.58)	1.10 (0.82 - 1.59)	-1.26 (-25.80 - 25.96)
Isangel	1.09 (0.78 - 1.54)	1.08 (0.77 - 1.53)	1.10 (0.79 - 1.57)	-1.26 (-26.84 - 37.11)
Sola	1.11 (0.81 - 1.59)	1.10 (0.80 - 1.59)	1.11 (0.82 - 1.60)	-1.36 (-23.83 - 24.90)
Lakatoro	1.10 (0.80 - 1.58)	1.10 (0.80 - 1.57)	1.11 (0.81 - 1.59)	-1.45 (-26.44 - 29.24)
Melsisi	1.09 (0.81 - 1.58)	1.09 (0.80 - 1.58)	1.10 (0.81 - 1.59)	-1.61 (-27.34 - 28.05)
Lamap	1.10 (0.80 - 1.57)	1.10 (0.80 - 1.57)	1.11 (0.81 - 1.59)	-1.48 (-26.48 - 31.08)
Aneghowhat	1.09 (0.79 - 1.54)	1.08 (0.78 - 1.52)	1.10 (0.79 - 1.56)	-1.12 (-26.97 - 39.34)

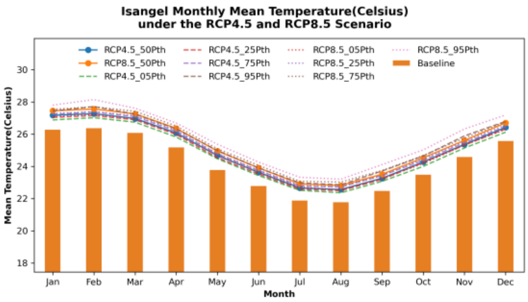
Table 14: Baseline (1981-2010 average) and future scenarios of monthly mean temperature by populated area

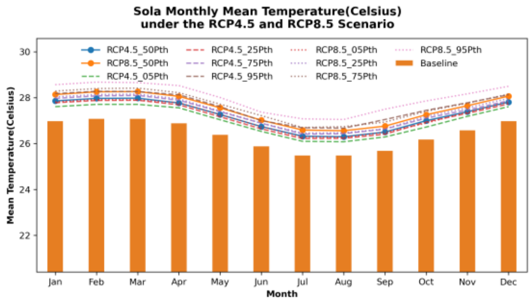


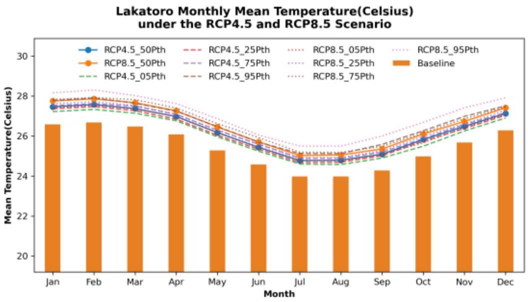


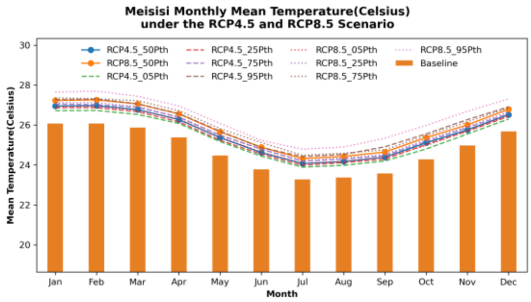


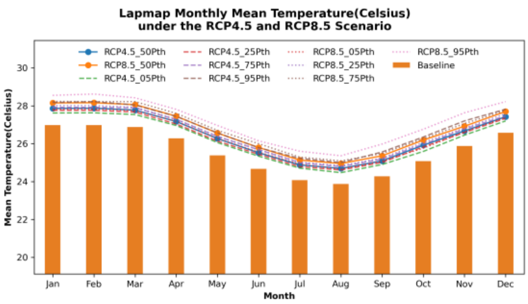












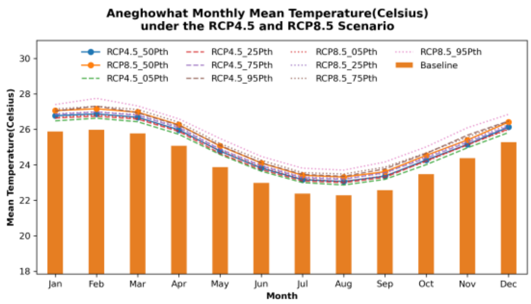
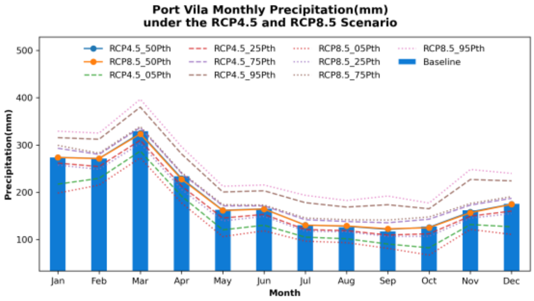
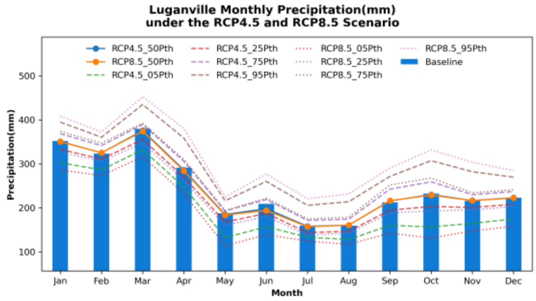
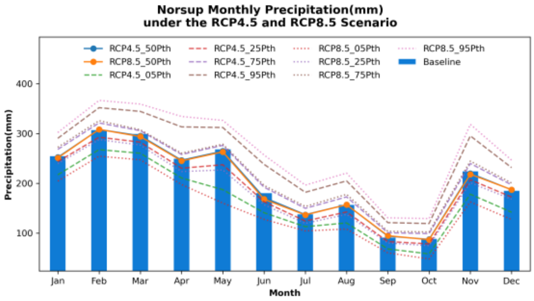
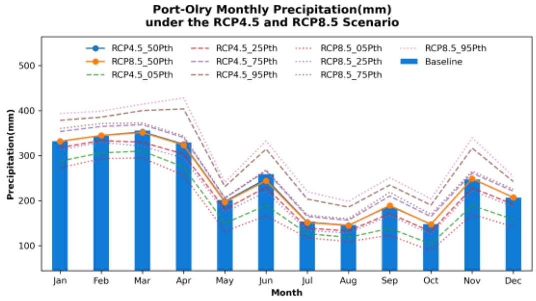


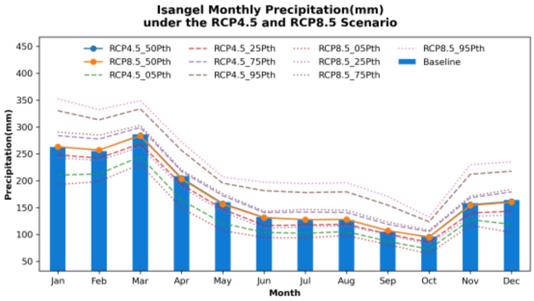
Table 15: Baseline (1981-2010 average) and future scenarios of monthly precipitation by populated area

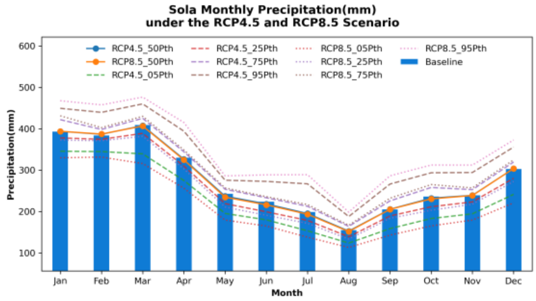


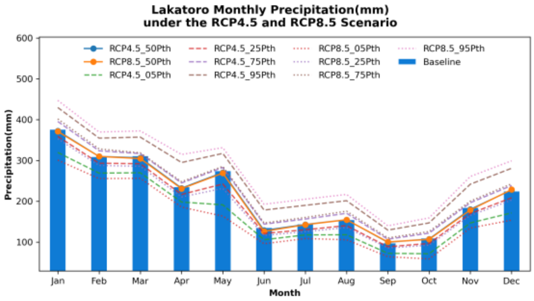


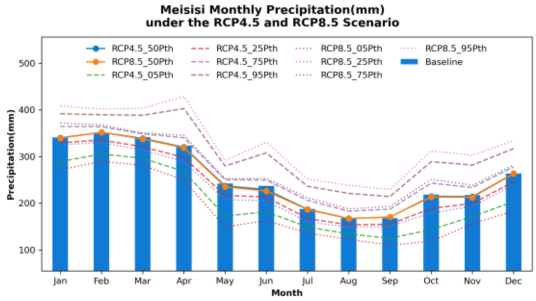


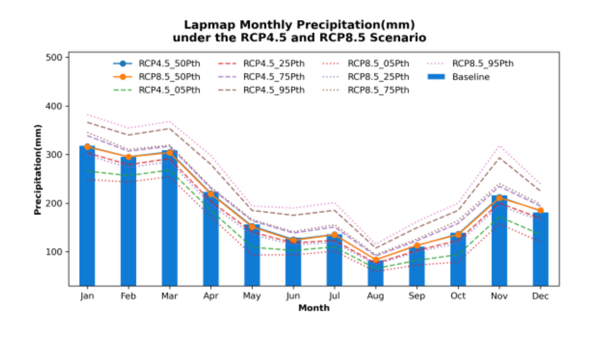


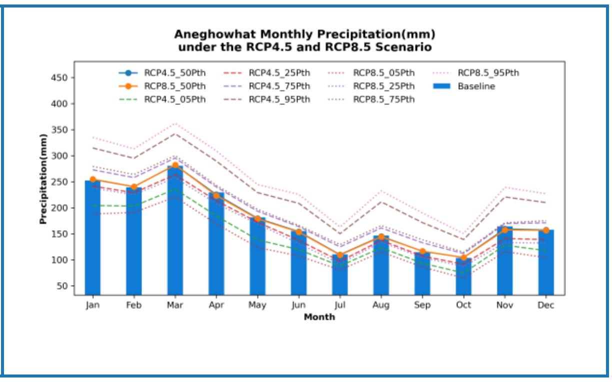












Extreme wind speed analysis output: projected to increase in climate change scenarios

The extreme wind speed in all the Vanuatu locations is very high. Based on the GAR15 data, the 100-year return wind speed can range across the country of 165.5 to 175.8 km/h, and 1000 year return is around 240-260 km/h, which are in the range of category five (252 km/h) of the Saffir-Simpson scale. Under climate change scenarios, the extreme wind speed is projected to increase between 1 and 5% in the ensemble median but reach more than 10% in the 95th percentile.

Table 16: Vanuatu Extreme Wind Speed Baseline **(depending on the data availability time ranges from 1949-to 2020)** (km/h)

Name/ Return Year	50	100	500	1000
Port Vila	140.67	168.19	217.05	241.39
Luganville	140.20	167.01	220.37	247.09
Norsup	139.97	166.97	219.66	245.97
Port-Olry	142.14	169.04	223.67	251.35
Isangel	146.16	174.10	224.16	249.77
Sola	148.46	175.84	234.52	265.07
Lakatoro	140.08	166.97	219.17	245.16
Melsisi	138.00	165.49	217.78	243.54
Lamap	139.19	166.53	217.66	242.99
Aneghowhat	141.50	170.54	221.13	246.66

Table 17: Vanuatu Extreme Wind Speed 2050 Change(%) RCP4.5 50Pth Scenario with the 5Pth-95Pth Range

Name/ Return Year	50	100	500	1000
Port Vila	3.5 (-3.3, 5.6)	4.1 (-3.4, 6.2)	4.9 (-3.9, 7.1)	5.3 (-3.9, 7.7)
Luganville	3.3 (-4.5, 6.6)	3.7 (-4.8, 7.4)	4.2 (-5.8, 8.7)	4.4 (-5.9, 9.3)
Norsup	3.5 (-4.2, 7.3)	3.9 (-4.5, 8.1)	4.5 (-5.5, 9.3)	4.7 (-5.7, 10.1)
Port-Olry	3.1 (-4.6, 6.0)	3.5 (-4.9, 6.8)	3.9 (-5.8, 8.0)	4.1 (-6.0, 8.7)
Isangel	2.2 (-2.7, 4.0)	2.6 (-3.1, 4.6)	3.2 (-3.5, 5.7)	3.5 (-3.5, 6.3)
Sola	4.0 (-5.1, 6.0)	4.5 (-5.6, 6.5)	5.2 (-6.9, 7.3)	5.5 (-7.0, 8.0)
Lakatoro	3.5 (-4.2, 7.4)	3.8 (-4.5, 8.2)	4.4 (-5.5, 9.4)	4.7 (-5.6, 10.2)
Melsisi	2.2 (-4.3, 7.6)	2.3 (-4.6, 8.3)	2.7 (-5.9, 9.6)	2.8 (-6.1, 10.5)
Lamap	3.0 (-4.0, 7.3)	3.3 (-4.3, 8.0)	3.7 (-5.4, 9.0)	3.9 (-5.6, 9.8)
Aneghowhat	2.3 (-2.6, 3.7)	2.6 (-3.2, 4.2)	3.1 (-4.4, 5.3)	3.4 (-4.3, 5.9)

Table 18: Vanuatu Extreme Wind Speed 2050 Change (%) RCP8.5 50Pth Scenario with the 5Pth-95Pth Range

Name/ Return Year	50	100	500	1000
Port Vila	2.5 (-7.7, 9.4)	2.9 (-8.1, 9.9)	3.7 (-9.1, 11.5)	3.8 (-8.8, 11.7)
Luganville	2.3 (-5.5, 10.0)	2.6 (-6.0, 10.3)	3.3 (-7.3, 11.7)	3.4 (-7.2, 11.6)

Norsup	2.0 (-6.6, 9.4)	2.1 (-7.1, 9.8)	2.5 (-8.5, 11.3)	2.6 (-8.4, 11.5)
Port-Olry	2.7 (-4.3, 9.9)	3.2 (-4.7, 10.4)	4.3 (-5.8, 11.8)	4.4 (-5.8, 11.6)
Isangel	2.1 (-8.2, 10.0)	2.3 (-8.5, 10.6)	3.0 (-9.4, 12.8)	3.0 (-9.0, 13.2)
Sola	1.8 (-6.1, 9.6)	2.0 (-6.5, 10.0)	2.8 (-7.6, 11.6)	2.9 (-7.5, 11.7)
Lakatoro	2.0 (-6.7, 9.3)	2.1 (-7.3, 9.8)	2.3 (-8.7, 11.5)	2.3 (-8.6, 11.7)
Melsisi	0.7 (-7.2, 9.7)	0.8 (-7.8, 10.3)	1.1 (-9.1, 12.4)	1.1 (-8.9, 12.7)
Lamap	1.2 (-7.4, 10.3)	1.4 (-8.1, 11.0)	1.7 (-9.6, 13.2)	1.7 (-9.5, 13.5)
Aneghowhat	1.1 (-7.3, 11.6)	0.9 (-7.4, 12.5)	0.8 (-7.9, 15.1)	0.8 (-7.5, 15.5)

SPEI drought intensity and duration analysis: increase in drought expected, owing to decrease in precipitation and increase in temperature

The tables in this section include the drought severity and duration probability for the historical period and future projection. Drought severity and duration probability have a similar increasing trend for all the locations across the country and have the same increase in the majority of the locations, in RCP4.5 and RCP8.5 2050, while others have a higher increase under the RCP8.5 scenario. The increase of drought is caused by a slight decrease in precipitation and an increase of temperature. The results indicated that the probability of extreme drought would change in all the locations. Consultations held with the National Disaster Management Office (NDMO) revealed that the primary WASH response is towards climate change-induced droughts in large parts of Vanuatu, due to low rainfall and unpredictability. There is increased requirement for coordination of water logistics to be delivered to affected areas. For details, see stakeholder consultations in Annex 7.

Table 19: Port Vila: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration	

Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	56.25	28.12	18.75	14.06	11.25
Severe (-1.5 to -1.99)	9.38	4.69	3.12	2.34	1.88
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	68.75	34.38	22.92	17.19	13.75
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	68.75	34.38	22.92	17.19	13.75
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 20: Luganville: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	100.00	53.12	35.42	26.56	21.25
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	100.00	57.81	38.54	28.91	23.12
Severe (-1.5 to -1.99)	18.75	9.38	6.25	4.69	3.75
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	62.50	41.67	31.25	25.00
Severe (-1.5 to -1.99)	18.75	9.38	6.25	4.69	3.75
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 21: Norsup: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes.

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	84.38	42.19	28.12	21.09	16.88
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	93.75	46.88	31.25	23.44	18.75
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	51.56	34.38	25.78	20.62
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 22: Port-Olry: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month

Moderate (-1.00 to-1.49)	100.00	57.81	38.54	28.91	23.12
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	100.00	59.38	39.58	29.69	23.75
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	62.50	41.67	31.25	25.00
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 23: Isangel: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	71.88	35.94	23.96	17.97	14.38
Severe (-1.5 to -1.99)	9.38	4.69	3.12	2.34	1.88
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	78.12	39.06	26.04	19.53	15.62
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					

Moderate (-1.00 to-1.49)	84.38	42.19	28.12	21.09	16.88
Severe (-1.5 to -1.99)	21.88	10.94	7.29	5.47	4.38
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 24: Sola: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	56.25	28.12	18.75	14.06	11.25
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	75.00	37.50	25.00	18.75	15.00
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	75.00	37.50	25.00	18.75	15.00
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 25: Lakatoro: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	84.38	42.19	28.12	21.09	16.88

Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	93.75	46.88	31.25	23.44	18.75
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	51.56	34.38	25.78	20.62
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 26: Melsisi: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	90.62	45.31	30.21	22.66	18.12
Severe (-1.5 to -1.99)	12.50	6.25	4.17	3.12	2.50
Extreme (<-2.0)	6.25	3.12	2.08	1.56	1.25
2050 RCP4.5					
Moderate (-1.00 to-1.49)	100.00	54.69	36.46	27.34	21.88
Severe (-1.5 to -1.99)	18.75	9.38	6.25	4.69	3.75
Extreme (<-2.0)	6.25	3.12	2.08	1.56	1.25
2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	54.69	36.46	27.34	21.88

Severe (-1.5 to -1.99)	25.00	12.50	8.33	6.25	5.00
Extreme (<-2.0)	6.25	3.12	2.08	1.56	1.25

Table 27: Lamap: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	90.62	45.31	30.21	22.66	18.12
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	96.88	48.44	32.29	24.22	19.38
Severe (-1.5 to -1.99)	18.75	9.38	6.25	4.69	3.75
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP8.5					
Moderate (-1.00 to-1.49)	100.00	50.00	33.33	25.00	20.00
Severe (-1.5 to -1.99)	21.88	10.94	7.29	5.47	4.38
Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62

Table 28: Aneghowhat: Historical (1981-2010 average) and 2050 RCP4.5, RCP8.5 drought duration frequency based on SPEI and GCM/RCM ensemble median precipitation and temperature changes

Drought Severity (SPEI range)	Drought Duration				
Historical	1 month	2 month	3 month	4 month	5 month
Moderate (-1.00 to-1.49)	50.00	25.00	16.67	12.50	10.00
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12

Extreme (<-2.0)	3.12	1.56	1.04	0.78	0.62
2050 RCP4.5					
Moderate (-1.00 to-1.49)	53.12	26.56	17.71	13.28	10.62
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	6.25	3.12	2.08	1.56	1.25
2050 RCP8.5					
Moderate (-1.00 to-1.49)	56.25	28.12	18.75	14.06	11.25
Severe (-1.5 to -1.99)	15.62	7.81	5.21	3.91	3.12
Extreme (<-2.0)	6.25	3.12	2.08	1.56	1.25

Mean sea level rise analysis: 40 cm and 60 cm rise projected under RCP4.5 and RCP8.5

Mean sea-level rise was analysed. By 2050 an increase of between 40 and 60cm in mean sea level is projected under RCP4.5 and RCP8.5 scenarios with only slight variation from location to location.

Table 29: Mean sea-level rise (**reference year: 1981-2010 mean sea level**) (unit: cm) in the populated area in Vanuatu, RCP4.5 and RCP8.5 2050

Name	RCP4.5 05Pth	RCP4.5 50Pth	RCP4.5 95Pth	RCP8.5 05Pth	RCP8.5 50Pth	RCP8.5 95Pth
Port Vila	45.7	**54.2**	62.9	49.0	**57.9**	67.2
Luganville	40.6	**49.2**	57.9	43.9	**52.8**	62.2
Norsup	42.3	**50.8**	59.5	45.6	**54.5**	63.9
Port-Olry	39.3	**47.8**	56.5	42.6	**51.5**	60.8
Isangel	38.9	**47.4**	56.0	42.2	**51.0**	60.3
Sola	37.7	**46.2**	54.8	41.0	**49.8**	59.1
Lakatoro	42.4	**51.0**	59.7	45.7	**54.6**	64.0

Melsisi	42.5	**51.1**	59.8	45.8	**54.7**	64.1
Lamap	43.7	**52.1**	60.7	46.9	**55.8**	65.1
Aneghowhat	34.7	**43.2**	51.8	38.0	**46.8**	56.1

Coastal extreme water level analysis: 1.4m - 1.8m range expected by 2050

Coastal extreme still high water levels in the historical period for 50, 100, 200, 300 year return period are presented. The 100-year ARI extreme water level for the ten locations is around 0.7 to 1.0 meters. By 2050, the extreme still high-water level could reach 1.4 to 1.8 meters. These values include mean sea level rise.

Table 30: Extreme water level (reference year: 1981-2010 mean sea level) (unit: meter) in the populated areas in Vanuatu, RCP4.5 and RCP8.5 2050

ARI 50									
Name	Baseline 05Pth	Baseline 50Pth	Baseline 95Pth	RCP4.5 05Pth	RCP4.5 50Pth	RCP4.5 95Pth	RCP8.5 05Pth	RCP8.5 50Pth	RCP8.5 95Pth
Port Vila	0.77	0.78	0.80	1.42	1.50	1.63	1.46	1.54	1.66
Luganville	0.94	0.96	0.98	1.46	1.55	1.66	1.50	1.59	1.70
Norsup	0.72	0.73	0.75	1.26	1.34	1.45	1.29	1.38	1.49
Port Olry	0.93	0.94	0.96	1.44	1.52	1.63	1.48	1.56	1.67
Isangel	0.82	0.84	0.86	1.39	1.47	1.58	1.42	1.51	1.63
Sola	0.99	1.00	1.02	1.47	1.56	1.66	1.50	1.59	1.70
Lakatoro	0.75	0.76	0.77	1.29	1.37	1.47	1.32	1.41	1.51
Melsisi	0.99	1.00	1.02	1.54	1.62	1.72	1.57	1.66	1.76
Lamap	0.78	0.79	0.80	1.33	1.41	1.51	1.36	1.45	1.55
Aneghowhat	0.80	0.82	0.85	1.28	1.36	1.46	1.32	1.40	1.51

ARI 100									
Name	Baseline 05Pth	Baseline 50Pth	Baseline 95Pth	RCP4.5 05Pth	RCP4.5 50Pth	RCP4.5 95Pth	RCP8.5 05Pth	RCP8.5 50Pth	RCP8.5 95Pth
Port Vila	0.77	0.79	0.81	1.43	1.54	1.64	1.47	1.58	1.67
Luganville	0.94	0.96	0.98	1.48	1.57	1.66	1.51	1.61	1.70
Norsup	0.72	0.74	0.75	1.27	1.36	1.45	1.30	1.40	1.49
Port Olry	0.93	0.95	0.97	1.46	1.55	1.64	1.49	1.59	1.68

Isangel	0.82	0.84	0.87	1.40	1.50	1.59	1.43	1.54	1.64
Sola	0.99	1.01	1.03	1.48	1.58	1.67	1.51	1.62	1.71
Lakatoro	0.75	0.76	0.78	1.30	1.38	1.48	1.33	1.42	1.52
Melsisi	0.99	1.01	1.03	1.55	1.64	1.73	1.58	1.68	1.77
Lamap	0.78	0.79	0.81	1.34	1.42	1.52	1.37	1.46	1.56
Aneghowhat	0.81	0.83	0.85	1.31	1.39	1.46	1.34	1.43	1.51

ARI 300									
Name	Baseline 05Pth	Baseline 50Pth	Baseline 95Pth	RCP4.5 05Pth	RCP4.5 50Pth	RCP4.5 95Pth	RCP8.5 05Pth	RCP8.5 50Pth	RCP8.5 95Pth
Port Vila	0.78	0.80	0.82	1.46	1.55	1.68	1.50	1.60	1.70
Luganville	0.95	0.97	0.99	1.51	1.58	1.68	1.54	1.62	1.72
Norsup	0.73	0.74	0.76	1.30	1.36	1.46	1.33	1.41	1.50
Port Olry	0.94	0.96	0.98	1.49	1.56	1.66	1.52	1.60	1.70
Isangel	0.83	0.85	0.88	1.44	1.52	1.63	1.47	1.56	1.68
Sola	0.99	1.01	1.03	1.49	1.59	1.69	1.52	1.62	1.73
Lakatoro	0.75	0.77	0.79	1.32	1.39	1.49	1.35	1.44	1.53
Melsisi	0.99	1.01	1.04	1.57	1.64	1.76	1.60	1.68	1.79
Lamap	0.78	0.80	0.82	1.36	1.44	1.54	1.39	1.48	1.57
Aneghowhat	0.81	0.83	0.87	1.32	1.40	1.50	1.35	1.44	1.55

3.4Key impacts: climate risks for water security and WASH infrastructure

The data analysis conducted for the pre-feasibility study and project design phase revealed implications of different variables for the WASH sector, as well as potential impacts on climate resilience of infrastructure and communities. This is summarized in the following table.

Table 31: Water sources, WASH infrastructure and climate change variables

Variable	Impact on water sources, infrastructure and the WASH sector
Sea-level rise	▪ Reduction in availability and quality of water supply due to saltwater intrusion and increased salinity of groundwater aquifers and distribution networks ▪ Increase in maintenance and repair costs for distribution networks due to saltwater intrusion

	▪ Increase in maintenance, operation, and repair of infrastructure such as desalination plants, exposed to inundation and flooding
Increased intensity of precipitation events	▪ Reduction in capacity of reservoirs due to increased overland flows, soil erosion and sedimentation as well as contamination ▪ Increase in costs for operations and maintenance of treatment plants as inflows will have increasing levels of suspended solids and other contaminants ▪ In the case of rural areas with low access to sanitation facilities, increased inflows will increase disease burden of children and adults ▪ Conflicts between drinking water storage and flood mitigation capacity of water storages ▪ Increase to damage costs to low lying water treatment plants exposed to inundation hazards ▪ Increase in costs to maintain and repair distribution networks due to increasing erosion hazards caused by overland flows ▪ Decrease in groundwater recharge, as heavy precipitation can exceed soil infiltration capacity and, instead, increases surface runoff
Extreme wind speed, tropical cyclones	▪ Damaged power transmission lines, and transportation infrastructure such as roads, culverts, and bridges ▪ Intense cyclones can bring torrential rains and have embedded severe thunderstorms that are accompanied by tornadoes, causing wind damage to limited housing options ▪ Buildings damaged by wind often suffer water damage as well. Water driven by hurricane-force wind can enter buildings through otherwise sealed openings, and rain entering through damaged roof can compromise building interiors, and in some cases, expose the building to dangerous mold ▪ Wind-borne debris often initiates or enhances damage to structures, which are then worsened by extreme precipitation ▪ Heavy rainfall and subsequent inland flooding can also induce extensive damage and, in coastal areas, coastal floods and beach erosion, especially after roof and/or windows or other openings are compromised by wind-borne debris

Drought and decreased precipitation volumes, seasonal patterns changes	▪ Reduction in availability and quality of water supply due to reduced streamflow and increased pollution concentrations in storage ▪ Reduction in groundwater aquifer levels due to limited recharge ▪ An increase in penetration of saline waters into estuaries and aquifers may reduce water supply and quality ▪ Increase in operations, maintenance, and repair costs for water treatment systems due to lower quality inputs ▪ Increase in operations, maintenance, and repair costs for distribution networks as soil moisture decreases and saline intrusion increases ▪ Water service providers need to build greater numbers of capital-intensive rain-independent desalination and recycled water plants to provide adequate water security for coastal populations
Increased air and water temperatures	▪ Reductions in catchment water sources due to increases in evapotranspiration ▪ Increase in water treatment costs as quality of inflows decreases due to lake stratification and fewer destratification (mixing) events; post-bushfire runoff of dissolved materials into receiving waters; changes in turbidity and chemistry of water ▪ Increased occurrence of eutrophication and toxic algal blooms in rivers, reservoirs and lakes ▪ Reductions in groundwater levels due to improved growth conditions increase biomass and increased evapotranspiration. ▪ Increase in operations, maintenance and repair costs for distribution networks as saline intrusion increases.

3.5In comparison: findings of similar studies

The analysis and results obtained from the climate data modelling for the feasibility study were also reviewed and compared with existing literature. These include:

- PACCSAP Country Reports, which provide an overview of the climate variability, extremes and different changes in trends in the Western Tropical Pacific, including a specific report for Vanuatu. The findings of the climate study conducted for this pre-feasibility study are consistent with the comparable variables of the PACCSAP reports, including mean precipitation, temperature, and mean sea level rise. It is noted that the climate study conducted for this project provides longer historical climate records and more stations than included in the PACCSAP report, along with detailed outputs for extreme value analysis for precipitation, wind speed and extreme still high-water level.
- This climate study applied SPEI for drought analysis, which including evapotranspiration. SPEI could be a better drought indicator in a climate change context; evapotranspiration could change the drought situation as temperatures increase. On the other hand, the PACCSAP applied SPI, which could distort the drought changes due to increased evapotranspiration.

- The Republic of Vanuatu Third National Communication (2020) essentially adopted the PACCSAP country report. Therefore, the climate modelling conducted for this pre-feasibility study is consistent with Vanuatu's TNC to the UNFCCC. Additionally, Port Vila Climate Vulnerability Assessment – Abridged Report (2015) was reviewed to cross-check the findings for the area, however, that report did not include concrete historical trends. Similarly, risk profiles for climate change and geohazards developed by key line ministries in Vanuatu provided similar results as this report for extreme precipitation and sea-level rise, as similar data and methodologies were applied.
- Therefore, the climate modelling exercise[64] conducted for this feasibility study has demonstrated results that have been reflected elsewhere and garner general consensus among practitioners and policymakers in the WASH sector of Vanuatu. The next section explores these linkages further.

[64] Please see Annex A for detailed analysis and relevant figures, maps and tables.

4. Technical review: rural water supply and the WASH sector in Vanuatu

This report presents discussion and findings resulting from a review of the rural water supply and Water Sanitation and Hygiene (WASH) sector in Vanuatu. It reviews the policy and governance framework of rural water supply, the implementation of safe drinking water in rural communities, and capacity of the relevant agency.

Legal, strategy and policy framework for rural water management has recently had numerous changes and improvements, strengthening roles and responsibilities of various government bodies, enabling communities to take ownership and management of their own water supply systems, and decentralising roles to provinces.

The National Implementation Plan for Safe and Secure Water (NIP) and the Drinking Water Safety and Security Plan (DWSSP) are the key processes to deliver safe and secure water to rural communities, directly addressing water security and improving community resilience. DWSSP are also required for School and Healthcare Facility water supply systems. The processes have been generally well received, supported through resources and training, and existing methodology to improve rural communities' water supply systems.

The Department of Water Resources (DoWR), Ministry of Health (MoH) and Ministry of Education and Training (MoET) have worked together to update the core DWSSP to strengthen climate change, vulnerability and sanitation considerations. The MoH and MoET have included the core DWSSP with their own requirements of HCF and WASH in Schools requirements.

The current form of the DWSSP considers climate change and disaster vulnerability sufficiently. The NIP guides communities and facilitators through the processes. The CAP targets the most at-risk communities through an equitable prioritisation scheme. Strengthening these could be further investigated, however it may hamper the rollout of the already sufficient and well accepted processes.

Climate change, disaster readiness and sanitation considerations are considered in the DWSSP development and system design, and therefore inherently included in NIP processes and CAP prioritisation / ranking. An investigation explicitly including these factors in the ranking is recommended but not essential for a successful programme. Any changes should not affect the current equity of the processes or DWSSP already assessed by PWRAC/NWRAC, and may need partnership from other departments.

Existing and/or implemented DWSSP should be reviewed to ensure they meet standards set in the current DWSSP. For DWSSP already implemented, the review should consider if improvements can be retrofitted for climate change robustness and water supply infrastructure resilience. To avoid this becoming an onerous task, a strategic approach should be considered, such as prioritising developed DWSSP not yet supported by CAP, and look at implemented DWSSP beginning with oldest first.

Skill levels across the nation vary but tend to be insufficient. The nation-wide systemic technical skill issues are being addressed through the MoET and the Post-Secondary Education Training (PSET) sector. The mid- to long-term aim is to enable sustainable water supply training needs through national planning, including higher-education and technical training.

Training courses are mostly classroom based, without direct in-field application to reinforce learnt skills, leading to ineffective training. A survey of water staff skills self-assessment indicated lack of, or under confidence, in a range of skills, from basic water engineering skills, data management and computer skills.

National and provincial DoWR staff skill levels can be addressed through mentorship, on-the-job skills training, and improving delegation and confidence in subordinates or provincial staff to perform tasks adequately. Long-term mentorship at provincial levels will greatly improve provincial skill level, improve national delegation, and promote development of local skills and trades. Within the proposed project, it is recommended that per province, two Engineers Without Borders delegates (or similar agency) are engaged.

The DoWR has experienced a period of reduced staff levels, including a period without in-house engineers, or dedicated Project Management Unit. This, combined with competing urban water resource tasks, has burdened staff and hampered progress of rural water supply improvements.

The DoWR’s rural and urban water resource roles and responsibilities are separating into two governmental departments. The restructure will be accompanied with a significant number of new posts being created, greatly increasing staffing levels in provincial offices. This, as well as stronger management, is expected to see efficiencies and improvements with rural water improvements. Government funding is not currently sufficient to fill all new posts, leaving opportunity to fund staff through this programme. The roles and responsibilities of posts within the new DoWR structure should be assessed against recent WASH capacity assessments.

The new DoWR structure and their recruitment drive is opportunistic timing which can be leveraged by the proposed programme to greatly improve knowledge of CR-WASH, climate change and water supply adaptation methodology, with ongoing reinforcement through practical applications.

Effective delivery of the existing DWSSP processes is required, directly improving water security of at-risk communities, enhancing their adaptation and resilience to climate change and other impacts. Further, supporting the existing DWSSP can accelerate its current implementation, develop capacity of national and provincial governments, and enable private sector growth in water supply sector. The scale of the DWSSP programme can also support long-term skills training and education through on the job application at a local and national level.

The following key recommendations are presented for the proposed programme:

- Support the current policy and governance framework.
- Leverage the current DWSSP and NIP processes to efficiently implement climate resilient water resources and increasing rollout of the DWSSP.
- Fast-track development of DWSSP beyond the rate of implementation.
- Use the implementation for on-the-job training, practical application and for mentorship for capacity building and skills development, centralised around climate change and vulnerability awareness and adaptation.
- Deliver training or skills as single sex events to encourage participation and to mitigate possible concerns of gender-based violence.
- Increase awareness of the NIP and DWSSP to wide range of sectors.
- Investigate the feasibility of a fast-track funding mechanism which may bypass NWRAC, delegating decision to a provincial level, or for use in emergency settings.
- Investigate implications of changing NIP prioritisation ranking.
- Use GCF funding to employ staff not covered by first round of recruitments. This can be done on a contract basis until GoV can provide sufficient funding.

- Engage two external engineers through humanitarian engineering organizations for each Province to work with existing and new staff, improving capacity, developing skills, providing mentorship. Ideally, this would include minimum one woman per Province.
- Undertake a thorough capacity / needs assessment on restructured DoWR, focussing on provincial staff skills needs through a development plan.
- Use this DWSSP as a mechanism to build capacity across all levels, from national government to the pursuit of improved community resilience.

5. Governance and policy framework for water governance and WASH in Vanuatu

5.1Water supply and WASH governance

Vanuatu's water resources and WASH activities are governed by national and provincial government departments, committees, local public works bodies, and community water committees. The aid and development sector, and WASH Cluster have important roles supporting the official bodies.

The delivery of water supply and other WASH related services, activities and objectives are the responsibility of three main GoV agencies: the DoWR, MoET and MoH. These agencies are supported by aid and development agencies, donors, NGOs, and the private sector. The Ministry of Climate Change is involved in water-related projects through renewable energy, water and climate change nexus. The Ministry of Agriculture, Livestock, Forestry, Fisheries, and Biosecurity are invested in rural water supply through agricultural and livestock water demands.

Department of Water Resources

The DoWR within the Ministry of Lands and Natural Resources oversees the provision of safe, secure and sustainable management of community water supplies, protection of water resources, catchment management, and WASH disaster programs. The DoWR coordinated assessment of rural water supply scheme improvement plans is driven through the National Implementation Plan for Safe and Secure Community Drinking Water (NIP). The NIP process and integrated plans is the principal mechanism to which water systems must comply, and through which efficient and effective delivery of improvement services is motivated.

Department of Climate Change

Mandated by the Meteorology, Geological Hazards and Climate Change Act, 2016, the Department of Climate Change (DoCC) is responsible for the coordination and implementation of all Adaptation, Disaster Risk Management and Mitigation to climate change impacts throughout Vanuatu. It is the government focal point for achieving resilient development across all sectors, as well as being GCF's National Designated Authority.

Ministry of Education and Training

The Ministry of Education and Training (MoET) is responsible for ensuring adequate water and sanitation facilities in schools. Their core contribution to WASH activities is through the WASH in Schools (WinS) Improvement Planning (WIP), and Schools Strategic Plan, which set and implement minimum facility requirements. Furthermore, school facilities used as emergency evacuation centres must meet further facility, management and behavioural requirements.

Beyond the delivery of WASH in Schools Program, the MoET have acknowledged their essential services to Vanuatu's long-term water security through sustainable Post-Secondary Education Training (PSET) delivery across trade, polytechnic and university courses.

Ministry of Health

The MoH, specifically the Environmental Health Unit therein, oversee household sanitation and hygiene practices, such as water treatment and storage, sanitation and hygiene promotion and compliance to applicable standards/requirements. They are also responsible with the WASH practices in Healthcare Facilities and for WASH in emergencies.

The Environmental Health Unit includes a Compliance Officer and a Sanitation Officer in each Health Zone. These officers work with local nurses, village health workers, communities and provincial governments to promote safe drinking water, hygiene, food safety, legislation and standards and occupational health.

WASH Cluster

DoWR is the lead coordinator of the Vanuatu WASH Cluster, with DOWR acting as secretariat and chair during emergencies and UNICEF acting as co-chair.

The Vanuatu WASH cluster is very active due to the high number of emergencies that the country experiences. Monthly preparedness and coordination meetings are often replaced by active cluster meetings. MoH leads Sanitation and Hygiene working group.

In 2019 a WASH Sector Human Resource Development Plan was developed by IWC (2019) [65]. The underlying WASH sector capacity and training assessment identified a wide range of needs in all levels of WASH actors (see IWC (2019).WASH Capacity Assessment Vanuatu).

Inter-Department and Cross-Sectoral Working

Historically, as IWC (2019) suggests, there has been limited coordination between the government departments regarding water supply and WASH activities, beyond the provision of requirements and some training.

Recent development of the WIP programme and the WASH in HCF plans were support through coordinated effort between the DoWR, MoET and MoH. The WinS steering committee bought together numerous agencies for regular and multi-sector meetings. The National Health Promoting Schools Committee includes members from MoET, MoH, UNICEF and various NGOs.

The WASH cluster inherently relied on collaboration between various GoV agencies and NGOs to deliver WASH and Disaster related activities. DoWR coordinates the WASH Cluster, working closely with MoH and UNICEF, and with the MoET and Gender and Protection.

The DoWR, MoET and MoH are working to share relevant water quality monitoring data. The MoET use a centralized Open Vanuatu Education Management Information System (VEMIS) to report on education facilities' assets.

Rural Water Committees

Rural Water Committees (RWC) are local community-based bodies responsible for protecting water source and infrastructure, developing a DWSSP, managing waters supply system, and representing the community. A RWC must be approved and registered for to submit a DWSSP. For eligibility for CAP funding, the RWC must have minimum 40% women representation.

NGOs

UN agencies, NGOs, civil societies, donors and church groups are active in Vanuatu's water resources and WASH sector. UNICEF, who works in close collaboration with DoWR, plays a leading role in the delivery of WASH services. For instance, World Vision, Care and Hexagon, who are

[65] IWC (2019).WASH Capacity Assessment Vanuatu. Accessed at: https://mol.gov.vu/images/water/WASH_Capacity_and_Training_Needs_Assesment_for_Vanuatu_280219.pdf

active in local community outreach programmes, have facilitated several communities through development of their DWSSP. Church groups and organisations, such as ADRA, have provincial/local presence, working closely with communities in a range of services, including WASH and DWSSP development. In the past, the Vanuatu Red Cross Society have been active in the WASH sector particularly implementing water supply projects during reconstruction periods, but have shifted their operational focus onto Disaster Risk Reduction and Management.

Private Sector

Vanuatu's private rural WASH service industry is limited to mostly retail supply of resources and materials, and trade/skills hire. Some sanitation construction cooperatives have been established, which where contractors can be engaged. Some private parties are active during emergency response and by progressing solar water pumping implementation. Beyond these, there has been little effort to enable, facilitate or engage the private sector.

5.2Legislation, strategies and policies

Vanuatu's water resources are governed by national and provincial government departments, committees, local public works bodies, and community water committees, with the aid and development sectors and WASH Cluster playing large roles supporting the government bodies and committees. Water resource and WASH responsibilities are guided and supported by a series of policies, strategies and plans, as summarised in Table 1.

Table 32: Legislation, policies, and plans relating to the WASH delivery for the DoWR, MoET and MoH (updated from IWC, 2019[66])

	Sustainable Development Goals - SDG 6	National Sustainable Development Plan 2016-2030	Decentralisation Act 2013
Key Agency	**DoWR**	**MoET**	**MoH**
Act(s)	Water Resources Management Act 2002 / 2016 Amendment	Education Act 2014	Public Health Act 1994 / 2018 Amendment
	Water Supply Act 1988 / 2016 Amendment		
	Vanuatu National Drinking Water Quality Standards 2016		
Strategies	Vanuatu National Water Strategy 2018-2030	Vanuatu Education and Training Sector Strategic Plan	

[66] IWC (2019). WASH Capacity Assessment Vanuatu. Accessed at: https://mol.gov.vu/images/water/WASH_Capacity_and_Training_Needs_Assesment_for_Vanuatu_280219.pdf

		National WinS Strategy 2019 - 2029	
Policies	Vanuatu National Water Policy 2017-2030		National Sanitation Hygiene Policy
			Vanuatu National Environment Policy and Implementation Plan 2016-2030

Nationally Determined Contributions[67]	Vanuatu's NDCs developed targets and indicators for the water sector were broad but with a focus on ensuring water availability during average rainfall amount as well as drought by means of appropriate infrastructure. The overarching goal for the water sector was identified as: "The water management system is able to support water needs for all communities in a changing climate". In contributing to the achievement of this goal, two targets were established: • Target Wa1: By 2030, 100% of water-climate vulnerable rural communities in the six provinces have developed DWSSP and are able to address water needs in normal and (climate, disaster and environmentally) stressed times. • Target Wa2: By 2030, 6 climate-resilient water protection zones declared and sufficiently provides urban water supply needs in normal and (climate, disaster and environmentally) stressed times

	Drinking Water Safety and Security Plan		
Safe Water Planning	National Implementation Plan for Safe and Secure Community Drinking Water	WASH in Schools Improvement Plan	WASH in Healthcare Facilities

Climate Change	Vanuatu Climate Change and Disaster Risk Reduction Policy 2016-2030

Standards, Guidelines	Design and Construction Standards for Rural Water Supply	WinS Facilities Guide WinS 3-star indicators	Sanitation and Hygiene Guidelines

To address Climate Change and vulnerability impacts, the GoV has made commitments to improve water, WASH and disaster preparedness security through legislation, strategies and policies, and developed relevant implementation plans.

[67] See Vanuatu's NDC: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Vanuatu%20First/Vanuatu%E2%80%99s%20First%20Nationally%20Determined%20Contribution%20(NDC)%20(Updated%20Submission%202020).pdf

Fundamental to all development undertakings are the SDGs and the Vanuatu National Sustainable Development Plan (NSDP) 2016-2030 (The People's Plan) goals. Specifically, SDG 6: *Ensure access to water and sanitation for all*, and the following NSDP 2016-2030 goals:

ENV 3: *A strong and resilient nation in the face of climate change and disaster risks posed by natural and man-made hazards.*

ENV 4: *A nation which utilises and sustainably manages our land, water, and natural resources.*

The proposed programme interventions of targeting 600 communities for water and CR-WASH improvements align strongly with the SDG and NSDP goals and provide Vanuatu with a basis / framework from which these goals can be achieved.

By targeting water supply and sanitation improvements through Climate Resilient-Water Sanitation and Hygiene (CR-WASH) practices, this project will directly address SAP Key Areas 1 and 2, as well has sets foundations for Key Area 3.

Table 33 presents the relevant acts, strategies and policies with which the proposed programme is aligned.

Table 33: Policy, Strategy and Programme Alignment

Policy / Programme	**Related Sections**	**Programme Alignment**
Sustainable Development Goals	International 2030 Agenda SDG 6: Ensure access to water and sanitation for all	Through implementation of infrastructure, awareness and training interventions.
National Sustainable Development Plan 2016-2030[68]	Vanuatu's People's Plan, setting national cross cutting goals ENV 3 addresses Climate and Disaster Resilience with the goal of: A strong and resilient nation in the face of climate change and disaster risks posed by natural and man-made hazards. ENV 4 addresses Natural Resource Management with a goal of: A nation which utilises and sustainably manages our land, water and natural resources.	This programme will assist in strengthening through infrastructure interventions, capacity development, awareness and training.
Vanuatu National Water Policy 2017-2030[69]	Guides implementation of various Acts. Establishes seven priority areas to strengthen the accountability of the institutions necessary to secure a safe and sufficient,	This programme will work on directly implementing community-level safe and secure water supply, whilst acknowledging and

[68] National Sustainable Development Plan 2016-2030. Accessed at: https://rti.gov.vu/images/PDFs/NSDP/National_Sustainable_Development_Plan.pdf
[69] Vanuatu National Water Policy 2017-2030. Accessed at: https://mol.gov.vu/images/News-Photo/water/C---Vanuatu-Water-Policy-with-Annexures.pdf

	accessible and affordable, reliable and sustainable source of water for all.	addressing climate change and other vulnerabilities.
Water Resources Management Act 2002 [70] / 2016 Amendment[71]	Overall responsibility for protection, management and use of water. Establishes ownership of water resources. Empowers DoWR to transfer water schemes to Rural Water Committees that meet certain criteria. Mandates that each water supply system must have a drinking water supply safety plan.	This programme will work directly with communities to implement DWSSP for their water supply systems, improve water safety and mitigate or adapt to climate change. The programme will support and promote women leadership in RWC.
Water Supply Act 1988 [72] / 2016 Amendment[73]	Establishes responsibilities of water supply schemes. Allows delegation of water supply systems operation. Requires operators of water supply system to have approved DWSSP	This programme will work directly with communities to implement DWSSP for their water supply systems. The programme will support and promote women leadership in RWC.
Vanuatu National Drinking Water Quality Standards 2016	Sets minimum water quality standards: biological, physical, chemical	Ensure secure water supply, which will lead to a safer supply. Promote water quality training and management.
Vanuatu National Water Strategy 2018-2030[74]	Sets priorities and actions to address the priorities: Water Safety & Security, Water Supply Markets, Water Services Compliance, Formalize Water Providers, Rights of the Pipes, Provincial Council Authority, Secure Water Future, Capacity for Reform	This programme will directly address safety and security of water supply to rural communities.

[70] https://mol.gov.vu/images/docs/Water_Resources_Acts/DoWR_Files_2018/Water-Resources-Management-ACT.pdf
[71] https://mol.gov.vu/images/docs/Water_Resources_Acts/DoWR_Files_2018/Water-Resource-Management-Ammendment-2016.pdf
[72] https://mol.gov.vu/images/docs/Water_Resources_Acts/DoWR_Files_2018/Water-Supply-Act-1955--Revisions.pdf
[73] https://mol.gov.vu/images/docs/Water_Resources_Acts/DoWR_Files_2018/Water-Supply-Act-Ammendment-2016.pdf
[74] https://mol.gov.vu/images/News-Photo/water/DoWR_File/Strategy/national_water_strategy-finalsmall.pdf

Public Health Act 1994[75][76]	Provincial Councils are responsible to ensuring and enforcing sufficient and safe water for all. Requires design and construction of water supply systems to comply with public health standards. Requires occupiers of premises maintain safe drinking water. Prohibits discharge of foul into public drains.	This programme will support improvements to related infrastructure to ensure and secure water and sanitation
Sanitation and Hygiene Guidelines	Sets minimum sanitation infrastructure requirements Set latrine type selection, design, construction, operation, maintenance and safety guidance. Technical specification. Provides resources for implementing sanitation projects.	This programme will support improvements to related infrastructure to ensure and secure water and sanitation
National Sanitation Hygiene Policy[77]	Sets sanitation standards and technical guidelines to address sanitation infrastructure issues. Sets responsibility to the Provisional and Municipal Councils. Requires Provisional and Municipal Councils to monitor and approve partners' sanitation and hygiene promotion activities	This programme will support improvements to related infrastructure to ensure and secure water and sanitation The programme will build provisional and municipal level technical capital with regards to WASH activities
Vanuatu Climate Change and Disaster Risk Reduction Policy 2016-2030[78]	Provides a framework through which risks can be identified, assessed, reduced and managed. Integrates and mainstreams climate change and disaster risk reduction initiatives through a coordinated approach across different government agencies and levels, and ensures stakeholders are aligned to policy direction.	This programme will align to all of the policy's six principles: accountability, sustainability, equity, community focus, collaboration and innovation.
Vanuatu National Environment Policy	Aims to fulfil the Environmental Protection and Conservation Act by setting priority for protection of land water and natural resources. Empowers provincial and municipal level authorities in long-term planning and development decision-making.	This programme will ensure that interventions are aligned with renewable energy requirements, climate change and disaster risk impact minimisation, and

[75] https://mol.gov.vu/images/News-Photo/water/DoWR_File/van88965.pdf
[76] https://mol.gov.vu/images/docs/Water_Resources_Acts/DoWR_Files_2018/Public_Health_Amendment_Sanitation_2018.pdf
[77] https://mol.gov.vu/images/docs/Water_Resources_Acts/Final_Sanitation_and_Hygiene_policy.pdf
[78] https://nab.vu/vanuatu-climate-change-and-disaster-risk-reduction-policy-2016-2030

and Implementation Plan 2016-2030[79]		works towards IWM planning for water catchments.
Vanuatu Education and Training Sector Strategic Plan	Sets out long-term objective and goals for sustainable PSET requirements based on demand	Provides job training opportunities. Provides awareness of career opportunities.

[79] https://environment.gov.vu/images/Reports/NEPIP%202016-2030%20Summary%20ENG.pdf

5.3Conclusion

The above summary of Vanuatu's water and WASH governance and policies is presented to illustrate the well-defined structured framework within which the proposed programme will be firmly established, and the key actors who will constitute stakeholders.

The governance of rural water supply and WASH activities of various actors is well established in legislation and strategies. Coordination between agencies has reportedly been lacking but improvements have been observed through WASH cluster coordination effects, DWSSP revisions and data sharing.

Most relevant legislation, policies and strategies have been updated to strengthen DWSSP implementation, climate change impacts, and skills and training challenges. The policy framework is supportive of the implementation of safe water planning and improvements, including the NIP and DWSSP. The goals within the various strategies and policies set targets for improved water supply to which the proposed programme will contribute.

The recommendation herein is for the proposed programme to accept the current governance and policy framework. The proposed programme should focus on efficient and effective mobilisation and implementation of the policy framework by building capacity of communities, supporting provincial and national DoWR, enabling trade and skills development, and by engaging private sector.

6. NIP and DWSSP processes of the DoWR

The NIP and DWSSP methodology and prioritisation processes are reviewed below with consideration to include climate change and vulnerability impacts, as well as broader WASH practices, including sanitation and hygiene infrastructure.

The review was undertaken via a desktop study referring to relevant documents and reports, as well as feedback from in-country semi-structured interviews and communications. The review encompasses experiences, NIP / DWSSP materials such as guides, DWSSP template, and facilitator guides. It also draws from advancements and updates to education and health specific DWSSP plan development.

6.1Background of the NIP and DWSSP

In Vanuatu, the water safety planning processes began in 2006 by the DoWR and has been progressively developed since that time. Water Safety Plans were adopted as a priority in the Vanuatu National Water Strategy 2008-2018 and the National Environmental Health Policy and Strategy 2012-2016. From 2015/16 onwards, there was a coordinated movement to formally adopt and enforce DWSSPs, realised and enabled through legislative changes, and national strategies, policies and plans.

The National Sustainable Development Plan (NDSP) 2016-2030 – the People's Plan – sets a target of 100% of community water supply systems with DWSSPs by 2030. Water Supply Act 1998, 2016 Amendment mandated that all urban and rural drinking water supply system must have a DWSSP. The 2016 Amendment to the Water Resources Act required every Rural Water Committee to develop, implement and maintain the DWSSP.

Standardising the DWSSSP development, implementation and funding processes, the Vanuatu NIP for Safe and Secure Community Drinking Water was adopted in 2017 following extensive consultation.

The NIP framework, including the Technical Assistance Plan (TAP) and CAP, sets out stages, requirements and eligibility necessary to develop, adopt and implement DWSSPs and associated drinking water improvement throughout Vanuatu. The NIP provides for decentralised decision-making, putting the communities and provincial governments and committees in key decision and action positions. It provides transparent prioritisation and expenditure mechanisms. The NIP process is coordinated through four levels of cooperation: community, local government/council, national government, and donors/NGO/civil societies.

The NIP focusses service delivery and coordination of support to where it is most needed: the most at-risk or vulnerable communities. It was designed for:

- Effective Delivery – through standardised support tools and processes
- Efficient Delivery – by enabling and leveraging provincial agencies and resources to reach as many communities as possible
- Collaborative Delivery – by enabling provision for support from inter-governmental agencies, donors, NGO, technical support agencies and private sector.
- Community Enablement – by supporting communities to develop, implement and own their own plans and infrastructure.

Table 34 presents the NIP and DWSSP stakeholders, along with their main roles and responsibilities.

Table 34: NIP and DWSSP stakeholders, including overview of their roles and responsibilities

Stakeholder	Involvement in NIP Process
Communities	• Beneficiaries and users • Contribute to development of DWSSP
Rural Water Committees	• Maintain DWSSP, systems and services
Department of Water Resources (Rural)	• Coordinate rural water supply scheme improvement planning • Provide NIP and DWSSP certification training
Provincial Water Offices (Rural)	• Link government to communities. • Promotes establishment of Rural Water Committees.
Area/Ward Councils	• Encourage, coordinate and support engagement of communities and provincial governments with the DWSSP
Provincial Water Resources Advisory Committee (PWRAC)	• Check and approve community requests, ensuring they meet CAP eligibility criteria • Prioritise community requests for financial assistance.
NWRAC	• Assesses the prioritization of the DWSSP and decides the improvements to adopt each year. • Through membership, provides linkages with Department of the Environment, Private Sector Utilities, Ministry of Health, Ministry of Climate Change, Public Works, DSSPAC and Department of Forestry
NGOs, Civil Societies	• Supports communities through DWSSP facilitation • Provide skills, trades, resources and training
Private contractors	• Provide construction services and specialized trade and skills

6.2NIP process

The NIP process, as shown in Figure 10 is triggered by a community, which may be coordinated by Area Secretaries, Provincial Water Officers, or via development projects. Irrespective of whether the supporting agency or the source of funding is government or non-government, the DWSSP must be followed. Initial steps of the NIP process include the community registering a mandatory RWC. The RWC membership must be minimum 40% women.

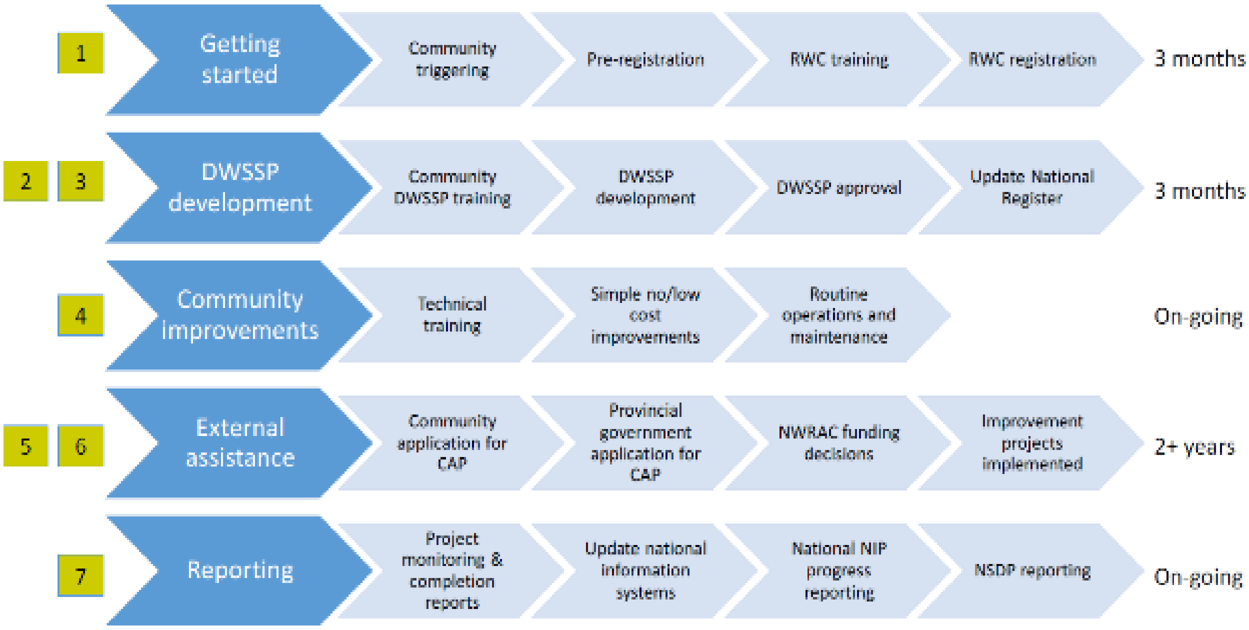


Figure 10: Community Actions and Involvement (Source: NIP, 2018)[80]

Community DWSSPs are developed through facilitation from DoWR, MoH or by NGOs or other groups. The MoET work with schools to create DWSSP for Schools water supply systems, namely WinS Improvement Plans (WIP). The MoH develop DWSSP for Healthcare Facilities. The DWSSP include improvement plans and actions, including mitigation and adaptation actions, maintenance plans, and actions to be completed by the communities. A critical element of improvements is no- or low-cost community improvements.

Once the DWSSP has been developed and training provided, the communities are required to undertake no- or low-cost interventions as identified in the DWSSP. This is an important hold point in the NIP process which the community must complete to be eligible for CAP funding. The implementation of no- or low-cost interventions by the community is intended to promote ownership and preparedness for adoption of a more costly intervention. This process is designed to improve communities' resilience by empowering them to identify and address their own water vulnerabilities and needs. It can also promote local private industry services.

A DWSSP implementation is approved at a provincial/national level only after the community had undertaken no- or low-cost interventions. Provincial DWSSPs are evaluated by PWRAC quarterly,

[80] NIP (2018). Vanuatu National Implementation Plan for Safe and Secure Community Drinking Water - A Guide to the Plan. Accessed at: https://mol.gov.vu/images/News-Photo/water/DoWR_File/Management_Plans/Vanuatu-NIP-Guide-annual-CAP-210818.pdf

prioritized based on greatest needs and nominated to the NWRAC. NWRAC prioritises all PWRAC DWSSP nominations, with the most at-risk communities' systems given to DoWR engineers for detailed design. CAP funding is prioritised to the most insecure and unsafe water sources. The current method of CAP funding prioritisation ensures those communities whose water sources are most at risk are targeted, regardless of cost or location.

DoWR carry out inspections during construction to ensure that they satisfy engineering construction standards. Once the improvement projects are implemented, monitoring and evaluation should be undertaken. However, stakeholder liaison and review of the limited follow-up reports indicates that improvement is needed. Monitoring and evaluation is important for the continuous improvement cycle of DWSSP processes and for reinforcing climate change awareness and adaptation. Inspection and maintenance of systems is essential for resilient and secure water supply. Maintenance plans will be developed through the DWSSP according to system specifications, these could also include self-monitoring and evaluation and reported back to DoWR. DoWR can perform strategically scheduled follow-up inspections, or leverage presence of third parties. DoWR staff should have remote presence through phone calls to committee meetings or directly to committee members.

Where DWSSP implementation is performed by non-DoWR party, the contracts should extend through a period of monitoring and evaluation. This would also act as a warranty period for any required repair and maintenance activities. The costs would be factored into the original contract, and the length of warranty period and other details dependant on the type of system implemented.

Sourced from NIP (2018), provides an estimate of timings for the major components of the NIP process, with the time between triggering to improvement implementation estimated to be at least 2.5 years. This protracted duration may see DWSSP becoming outdated through changes to the systems or processing changes. Indeed, recent changes to the DoWR DWSSP form may have made numerous submitted DWSSP outdated.

In reality, communities may experience a longer delivery period due to a number of reasons. wet should be minimised as it leaves communities exposed to water security and climate change related risks, and have a reputational impact on the NIP processes and implementing actors. Approaches to fast track DWSSP implementation should be adopted.

A key weakness identified through stakeholder engagement is the monitoring, recognition and reward of no- and low-cost improvements. This is confounded by the length of time between community improvements to external assistance being provided, which is often excessive. That is, after two or more years, when externally assisted improvements are implemented, the memory of the DWSSP development and the communities' improvements have faded and links with the development and training of the DWSSP and efforts of the no- and low-cost improvements have been forgotten. Additional stakeholder feedback suggested that DWSSP are becoming a mechanism for accessing external funding, rather than a self-driven improvement. To combat these issues, community driven improvements could be reinforced by leveraging communities' capacity to undertake no- and low-cost improvements, through promoting pre-emptive or immediate improvements.

No- and low-cost improvements can be embedded in or triggered in the DWSSP training. The provision of simple materials could be used as initiation to community led improvements whilst also providing climate change awareness and technical skills training. This may include:

- cement to build tank lids to protect against natural disaster impacts and insects,
- tie-downs to secure tanks during increasing intensity cyclones,

- tap re-seater provision and training to minimise leaks and provide greater water reliability addressing droughts and El Nino,
- simple tools for self repair, or,
- working-bee to build fences or bury pipes to protect against traffic, floods, landslips.

To reinforce self-led improvements, communities could be incentivised to pre-empt, trigger or even develop their own DWSSP through a reward, no-wait, or fast-track DWSSP system. Some communities' capacity to implement no- and low-cost improvements and upgrades pre-emptively can be immediately leveraged through such incentivization.

The community improvements listed above can form a basis for monitoring indicators on follow-up visits. Monitoring between the training and the DWSSP implementation should encourage communities to take ownership of their improvements, capture additional supporting information and data, and provide feedback should context change.

Further indicators will be required to track progress and monitoring from initial DWSSP training and survey, through implementation of water supply solutions, and then regularly over subsequent years.

Monitoring and support approaches may differ across projects to accommodate variation in outreach and effectiveness of facilitators, and communication and internet coverage. It is important that any support approach should be inclusive and support the current equity of the DWSSP and CAP processes. It is therefore recommended to not implement awards through the prioritisation scoring and ranking.

One monitoring approach may be to adopt the three-star indicator approach the "WASH in Schools programme" use for community WASH projects. For schools progress is tracked through through the MoET VEMIS system and showcased on a social media page. A similar approach may be co-opted for this project, with progress indicators kept on a DoWR webpage and facebook.

Facilitating organisations should highlight whole life cycle monitoring and be active in calling the community to encourage them to implement, photograph and post online. Radio announcements and segments can reach areas without adequate telephone or internet access. Other follow up communications should include regular updates and photographs to support self-reporting and remote-monitoring.

Monitoring and reporting immediately after DWSSP implementation will ensure construction is sufficient, operation as expected, and will also inform any construction warranty applicable. It is suggested that follow-up visit or phonecall be undertaken at one month, three months and six months. Following the six months call, further visits or self reporting should be undertaken to reinforce ongoing inspection, maintenance, and ensure any repairs undertaken in a timely manner.

6.3 Progress of DWSSP development and implementation

The NSDP 2016-2030 sets an ambitious target that by 2030, over 2000 communities throughout Vanuatu must have established a Water Committee and developed respective DWSSP for their drinking water supply systems.

The DoWR Information Management Database contains information on various water resource related information, including quality, registered water systems and committees, WASH 4W, and NIP-CAP and DWSSP information. Table 35 presents a summary of basic DWSSP statistics extracted from the DoWR database[81], along with 2016 population. Table 4 presents records of DWSSP developed and implemented annually.

Table 35: Summary of Provincial Population, Registered Water Systems, and DWSSP Rollout Status (2014-2021)

Province	2016 Population[82]	Registered Water Systems[1]	Developed DWSSP Uploaded	Developed DWSSP Remaining	Reported DWSSP Completed
Malampa	40,928	456	44 (9.6%)	412 (90.4%)	38 (8.3%)
Penama	32,534	581	48 (8.3%)	533 (91.7%)	46 (7.9%)
Sanma	54,184	476	37 (7.8%)	439 (92.2%)	30 (6.3%)
Shefa	97,602	345	68 (19.7%)	277 (80.3%)	63 (18.3%)
Tafea	37,050	487	79 (16.2%)	408 (83.8%)	78 (16%)
Torba	10,161	102	25 (24.5%)	77 (75.5%)	22 (21.6%)
Total	272,459	2447	301 (12.3%)	2146 (87.7%)	277 (11.3%)

Based on the data available, 12% of registered water systems have DWSSP registered, and 11% have received system improvement. There is a considerable number of water supply systems which require DWSSP – nearly 90%.

Tafea and Shefa have the highest number of DWSSP and improvements. Per water system, Torba, Tafea and Shefa have the most DWSSP developed and completed. Sanma, Malampa and Penama have the lowest DWSSP rollout across most metrics. It should be noted that this data includes urban and rural water systems, therefore skewing Shefa results due to high population.

Figure 12 presents records of DWSSP developed and implemented from 2014. During 2016 and 2017, significant increase in DWSSP rollout was undertaken in Shefa in 2016 through NIP piloting and in 2017 in Tafea during TC Pam reconstruction. From 2016 to 2020, inclusive, an average of 56 DWSSP were developed and 53 implemented annually. Notably, during 2020 the number of developed DWSSP almost matched some previous years, even with COVID related restrictions in place.

[81] Extracted from https://exchange.riscon.solutions/ - 19/08/2021
[82] 2016 Mini Census: https://vnso.gov.vu/images/Public_Documents/Census_Surveys/Census/2016/2016_Mini_Census_Main_Report_Vol_1.pdf

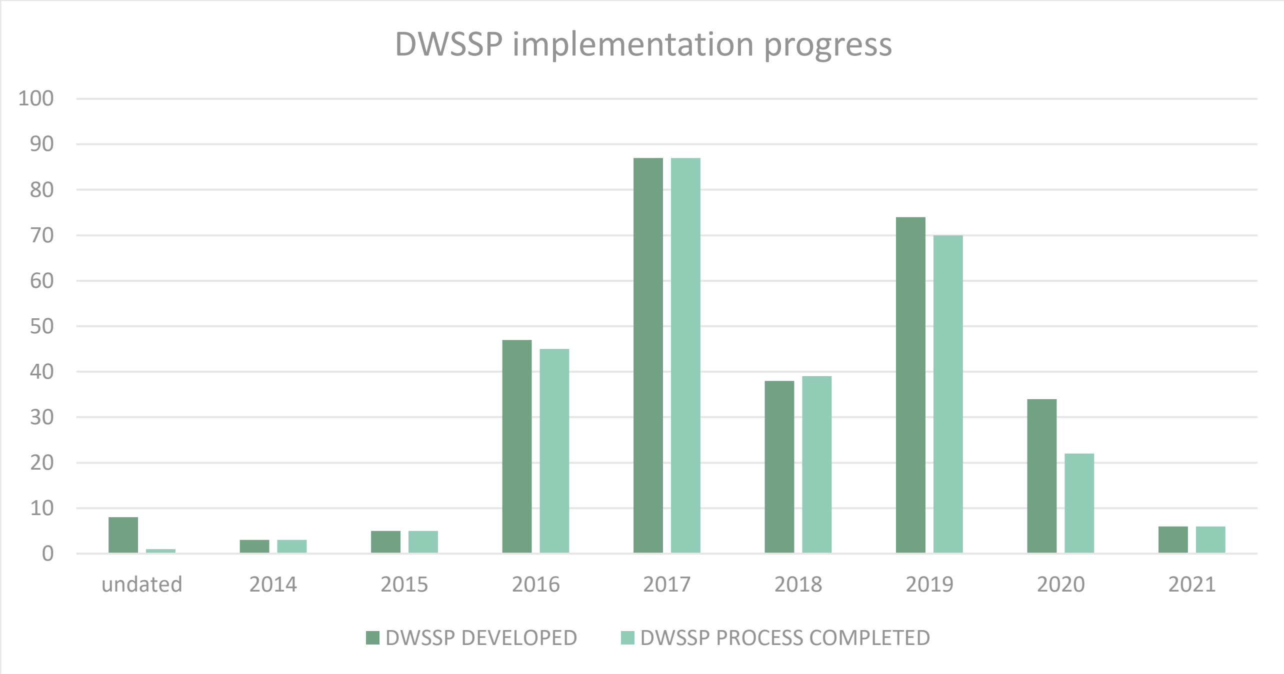


Figure 11: Number of DWSSP submitted and implemented annually (DoWR inventory)

Over 90% of developed DWSSP are registered as being completed. If that data is current and complete, the 90% completion rate indicates developed DWSSPs are almost always prioritised and adopted for intervention by PWRAC and NWRAC. Indeed, the number of developed and completed systems presented in Figure 3 shows that DWSSP are developed and implemented at nearly the same annual rate. Based on that data alone, it brings into question the prioritisation process.

Ideally, DWSSP should be developed at faster rate than subsequent implemented improvements. Having a high number of DWSSP developed would ensure greater coverage and assessment of water supply systems, and their inherent risks. The number of systems presented to the PWRAC should be as high as possible, so that the most at-risk communities are identified.

For the proposed programme, significant effort to develop DWSSP should be made early in the scheduling. Doing so would increase the number DWWSPs developed, communities thoroughly assessed, increase community awareness of NIP, DWSSP and climate change risks, and it will provide opportunity to implement training. For instance, it would assist in training staff in the NIP and DWSSP processes and community facilitation, and for technical and engineering staff in design processes.

Having a high number of DWSSP developed can be crucial information for reference in disaster and emergency settings. Elements of the DWSSP plans can be used for rapid assessment of required resources by the WASH Cluster and used by aid actors for implementation. Caution should be heeded to ensure that that generic DWSSP are not developed for the sake of efficiency.

The NIP and DWSSP sets a framework for decentralised and collaborative engagement through all levels of NIP process. This should be leveraged to streamline the NIP process and minimise delays, requiring efficient communication and coordination across the entire sector.

During stakeholder engagement, it was revealed that the Vanuatu Red Cross Society were not aware of the NIP process, even though that have recently been facilitating development and submitting DWSSP. It is important that broad communication and collaboration is undertaken through this project.

6.4 Climate change, disaster vulnerability and sanitation in DWSSP

At its inception, the DWSSP focussed primarily on water supply security, capturing data on the current status of the communities and the water sources, low- and no-cost community improvements, maintenance plans and improvements plans. It has been incrementally updated to introduce new security and safety metrics, improved clarity, increase supporting information, and significantly to introduce disaster and climate related elements.

In 2019 the core / community DWSSP and its supporting resources underwent a revision which significantly strengthened disaster and climate related risks and interventions; operation, monitoring and maintenance sections; categorisation of intervention complexity; and standardised assessment / quantification. The changes to the core DWSSP have been subsequently adopted by the MoET and MoH. The MoET merged the new DWSSP requirements with specific education facilities requirements for their WIP. Similarly, the MoH combined the DWSSP with specific requirements for the WASH in Healthcare Facilities plans. The change to the core DWSSP will also have implication to emergency evacuation facilities.

This coordinated approach has strengthened the inclusion of climate change and disaster risk considerations across all water supply systems. It has also improved collaboration and shared knowledge between the three departments. However, care must be taken when considering any changes to the DWSSP as it will have follow-on effect to the WIP and WASH in HCF plans.

A review of the DWSSP form indicates there are some changes that could further improve the resilience, safety and security of rural water systems. Minor changes can be incorporated such as increasing storage size of tanks, increasing design population to future proof community growth, or additional consideration of groundwater based on data records. Design considerations should already include size, quality and durability of materials, location of services, ease of repair, availability of parts, and design standards against natural disasters. Climate change and vulnerability maintenance regimes should be considered, including regular system inspections or disaster preparedness practices.

Regarding the already developed DWSSP, a review of the existing and/or implemented DWSSP is recommended to ensure that they meet the required climate change considerations. For DWSSP already implemented, the review should consider if the climate change protections can be retrofitted. For DWSSP not yet implemented, not approved or rejected, the review should determine if climate change and vulnerability adaptation measures can be assessed at the desktop, or if it requires another round of facilitation.

Prioritisation

Risk scores are based on water safety and security risks, infrastructure risk, health risk, and drought risk. Health risks are based on known disease occurrences from the MoH to provide long term context rather than single water sampling. Drought index from the Vanuatu Meteorological Services informs drought risk. Security of water sources is scored to consequence of impact, implicitly including climate change impacts.

The risk scores are informed through the DWSSP community facilitation, which has strengthened climate change considerations in its recent revision. Climate change considerations included in data capture, training and facilitation, engineering design, follow-up visits, monitoring, maintenance, operation, and community engagement.

The prioritisation of DWSSP for adoption and funding through CAP focusses on water safety and security risk imparted onto the source. The ranking lacks consideration of other vulnerabilities and risks, such as social, conflicts, natural disasters, and secondary environmental risks such as erosion, salt intrusion, landslips. Importantly, there is no consideration of funding, nor cost/benefit analysis. This is a significant adoption which ensures that the process is targeted solely on risk, rather than population, location, or cost. Furthermore, it is a transparent method of prioritisation which does not require the PWRAC and NWRAC to have local knowledge to interpret possible impacts climate change or other vulnerabilities.

Should it be deemed necessary, changes to the prioritisation can include further climate change and vulnerability considerations such as secondary water sources, seasonality of supply, location assessment, additional protections and safeguards, and assessment of RWC practices. Any changes should be developed under thorough stakeholder liaison, sensitivity tested on existing and implemented plans, and have supporting resources developed.

However, any changes to the prioritisation should be undertaken with care to ensure that the equity of this risk only based prioritisation is retained. The current ranking presents opportunity to target the most at-risk communities with regards to water safety and security, regardless of other factors. Furthermore, changes to the prioritisation practices may have knock-on effects on the DWSSP form and the plans already developed. Therefore, alteration of the risk ranking is not recommended within this project.

Sanitation

Sanitation and hygiene are considered throughout the core DWSSP and strengthened in the 2019 revision, including a toilet survey recording location to water sources, type and breakdown each toilet's component. Sanitation is also consideration in the improvements; either community led no- or low-cost improvements; or those requiring external assistance for expertise, tools or funding. The community can undertake behavioural and attitude changes, or day-to-day operation or maintenance. The DWSSP encourages communities to implement fee collection to cover low-cost maintenances.

Sanitation consideration is not explicitly addressed in the NIP process, nor included in the CAP ranking / prioritisation, without possible inclusion in the community no- and low-cost improvements. If required, one mechanism to implement sanitation in NIP and/or prioritisation would be the mandating of sanitation based no- and low-cost improvements, including awareness, behavioural and attitude interventions, improved maintenance and management, or improvement of latrines.

Furthermore, indicators could be developed to monitor the implementation and maintenance of community sanitation improvements, which would in turn assist with monitoring, recognition and reward. For instance, infrastructure, maintenance and behavioural change indicators, may assist lead to fast-tracked DWSSP, or separate CAP funding expenditure. Climate change and vulnerability maintenance regimes should be considered, including regular system inspections or disaster preparedness practices.

It should be highlighted that sanitation and hygiene in communities is the responsibility of the Ministry of Health. Therefore, explicit inclusion of sanitation in NIP will oblige MoH to take co-ownership of the NIP.

6.5Conclusion

Beginning in 2006 by the DoWR, Vanuatu's safe water planning has since been consistently developed and standardised to the current NIP and DWSSP processes. The NIP and DWSSP development have increasingly incorporated government agencies at all levels, communities, NGO, and civil societies.

The NIP process standardises the implementation of DWSSP for communities, facilitators, government agencies, and donors. This process is a framework of logical steps required to develop, assess, fund and deliver DWSSP improvements. As such rather than the NIP considering climate change and vulnerability considerations, the components therein should be the mechanisms which climate change awareness, mitigation and adaptation be implemented.

Currently CAP funding prioritisation is based on equity of communities' water supply safety and security. The prioritisation does not consider cost, location or demographics, only the risk to the community. Security rank scores inherently consider climate change impacts to security of a water supply. Prioritisation incorporating sanitation is feasible, however, they are already included in DWSSP maintenance and improvements. Any changes to the current ranking should include thorough investigation and care to ensure that the current equitable ranking is maintained.

The most recent revision of the DWSSP significantly strengthens climate change and vulnerability considerations from training of trainers, community training and facilitation, data collection, improvement planning, to operation and maintenance. The revised DWSSP also establishes a basis for parallel revisions of the MoET's WASH in Schools and MoH's WASH in Healthcare Facility.

The DWSSP have been generally well received, understood and a body of resources support its rollout. The DWSSP developed range in form and quality across various facilitating actors, and the NIP is not well recognised outside of the immediate water supply practitioners. Therefore, repeated awareness to all WASH exponents and community development agencies is required.

Through the investigation and assessment of the NIP, CAP and DWSSP, it is evident that the framework has undergone many revisions. Further changes can be implemented however this may further hamper implementation and mobilisation of the processes. The current statuses of NIP and DWSSP are suitable for rollout and is an ideal mechanism for the proposed programme to address water vulnerability in rural communities of Vanuatu.

Recommendations:

- Use the development of DWSSP as a foundation for on-the-job training, using climate change and other vulnerabilities as central pillars of training.
- Establish monitoring indicators for no/low cost improvements, including sanitation indicators
- Leverage community capacity to perform CR-WASH no/low cost upgrades immediately
- Incentivise communities' self-driven initiatives to trigger or self-development of DWSSP
- Incentivise pre-emptive or immediate low-no cost improvements and upgrades
- Embed no-/low-cost improvement materials and training in DWSSP training and follow-up visits
- Caution needs to be heeded to ensure the DWSSP does not become a generic process which is not led by communities
- Improve monitoring and evaluation through field visits and phone calls throughout and between all stages of the DWSSP/CAP processes, with particular emphasis on the lengthy period between the DWSSP development and its implementation.

- Enable communities to perform self-monitoring and evaluation as part of their maintenance and evaluation plans
- Include a monitoring and evaluation / warranty period into third party contracts

7. Capacity Assessment of Rural Water Management

7.1Capacity of the DoWR

The capacity needs assessment given below was undertaken through a mixed methodology of remote consultations, and desktop review of recent studies and surveys. The main sources are the *Vanuatu WASH Sector Analysis* (UNICEF, 2018) and the *WASH Capacity Assessment Vanuatu* (IWC, 2019). Key stakeholder consultation was undertaken from July – September 2021 with various national departments, and via remote communication to department and NGO staff. Provincial travel was undertaken by stakeholder consultations, and details can be found in the Stakeholder Consultations and Engagement Plan.

The DOWR is the governing body for water resources, overseeing the provision of safe, secure and sustainable management of community water supplies, protection of water resources, catchment management, and WASH disaster programs. Their staff have been organised in three units: Monitoring and Evaluation, Technical Services, and Projects and Operations, supported by an administrative department.

In 2016 the DOWR had 41 of 58 positions filled, with two of three Section Heads in acting capacity and with little management experience (UNICEF, 2018). Women held only administrative positions. This study identified that some staff worked without pay at the start of their employment. In 2018, only 5 of 16 planned recruitments were successfully completed.

The organisational structure from 2019 shows 47 positions filled. Two Section Heads remained in acting in their duties. One staff nominated in two positions. Little personnel changes had occurred between the 2018 and the reviewed organisation chart. A new position has been created and one removed. One new staff member is added. Some previously acting posts are no longer reported as such. The Port Vila based Head Office had 40% vacant positions.

The capacity of key DoWR staff was reduced during a period without in-house engineers, brought on by retirement. These departures would have had a fundamental staffing gap which will have a current and lasting impact of the Department’s functions. In the short term, design work could be outsourced to limited in-country private firms or NGO engineers, or supported through Engineers Without Borders engagement. In the longer term the lack of permanent Department engineers would have had an affected recruitment, support and development of junior engineers or technical staff. The on-going mentorship and knowledge sharing is critical not only for the department’s functions but also to provide supportive and fulfilling culture, which if established can be perpetuating. During stakeholder engagement in August 2021, the DoWR indicated that they had successfully recruited civil engineers and a number of other posts, but highlighted that some gaps still remained.

Staff in DoWR are responsible for a broad range of urban and rural water resource tasks, from which urban revenue tasks are typically focused upon. Further, they are required to prioritise WASH Cluster activities during the frequent emergency settings. The reduced DoWR capacity and the competing tasks leaves the rural water sector underprovided, including DWSSP development and auditing, associated training, and monitoring and evaluation. The reduced prioritization of NIP progress has been further exacerbated by lack of a project management office which has meant that administration staff have been required to undertake procurement activities, which often are delayed.

Stakeholder liaison determined that staff are often undertaking duties below their post, e.g. national engineers undertaking assessments in place of CDOs. The cause was deemed to be due ineffectiveness of classroom-based training, lack of confidence in provincial staff, and lack of provincial skills.

DoWR restructure

The DoWR has been challenged with competing tasks, staff shortages, increased roles and responsibilities, and increasing scope of skills required. Recognising these challenges were impeding on rural water improvements, a restructure was required. The new structure will see separate urban responsibilities be moved to another department, leaving the DoWR to focus and specialise on rural water resources.

Annex A presents an interim list of posts desired for the restructured DoWR. Of the 34 existing posts, 26 are filled, 8 are vacant posts (24%). A significant number of 39 new posts are presented, reflecting the significant roles and responsibilities of the DoWR. A considerable number of new posts are set to strengthen staffing levels and skills in the provincial offices.

Due to the Government of Vanuatu (GoV) budget limitations, funding for a current, initial tranche of recruitment will be submitted by the DoWR to the GoV. Funding for the remaining posts will be sought in a future, second tranche.

Funding for the proposed programme could be allocated to recruit some posts for the second tranche on a contract basis until they can be funded by the Government of Vanuatu. This approach would reduce the burden of DoWR with ongoing recruitment, enable the department staff to focus on DWSSP delivery, and maximise the workload. It would be beneficial for the proposed programme to be initiated with the fullest possible complement of DoWR staff, so to make training and initial project setup efficient and effective.

The DoWR restructure, details on the staff level, and their roles and responsibilities close to finalisation. Therefore, a detailed capacity assessment of the DoWR has not been undertaken. Instead, the two recent WASH capacity assessments, UNICEF (2018) and IWC (2019), were considered.

7.2Gap analysis of available skillset

The International Water Centre's WASH Capacity Assessment (IWC, 2019) sought to undertake capacity and training needs assessments of Vanuatu WASH sector, develop a Human Resources Development Plan for relevant agencies, and develop a workplan for relevant staff capacity building. The assessment included 22 semi-structured interviews of mostly national staff, reviewed institutional framework to clarify department and other WASH actor roles, identified skills required, and assessed existing skills against those needed. The assessment interviews focused on national level stakeholders, and lacked discussions provincial actors, such as Area Secretaries or School Improvement Officers.

Section 8.2 presents 26 priority gaps identified by (IWC, 2019), which fall into the following distinct areas:

- Coordination at all levels
- Data collection, monitoring

- Training
- Technical skills
- Staffing roles and responsibilities
- Knowledge and skills awareness and sharing
- Mentorship

To address these gaps, the IWC recommend that nation-wide training delivered throughout the provinces, mentorship, and courses.

Lack of technical training and skills development has been recognised as a systemic issue throughout Vanuatu's PSET sector. The education sector recognizes WASH, climate change and disaster reduction challenges which Vanuatu face, and their critical position in supporting the country achieve a sustainable and long-term solution. Therefore, the Vanuatu Education and Training Sector Strategy (VETSS) 2020-2030 (MoET, 2020) provides long-term direction for the sector as a whole, as well as for various departments and work units. VETSS aligns with SDG and NSDP objectives, stating "The MoET is a key agent through schools to plan, support, prepare and educate its citizens about the hazards."

VETSS ambitions are supported by the National Human Resources Development Plan 2020-2030 (NHRDP). Amongst other findings, the research backing Plan found:

- a gap between skills and qualifications of current labour force, to the skills and qualifications required
- a gap in managers, professionals and technical/associate professionals
- interests of students, not the national objectives or labour market demand, dictated courses offered and scholarships taken

The process of developing long-term strategy and plans mean that PSET investments are now focused on in-country resources, increasing scholarships delivered in Vanuatu, increasing accessibility to more ni-Vanuatu, keeping capital in country, and strengthening national capability.

To achieve this the NHRDP, envisaged a new polytechnic institute be established in the short- to mid-term, which would be able to deliver technical water resources and WASH related courses and training. However, the NHRDP recognizes Vanuatu's PSET providers currently lack qualified staff with current skills and industry experience. The long-term plan to develop in country expertise and knowledge include policy changes, courses and possibly the creation of national university.

Vanuatu faces a systemic technical education and training issue which directly impacts the Water Resources and WASH sectors in the short- to mid-term. The lack of in-country expertise will have a knock-on effect on departments, mentorship and training opportunities.

From desktop reviews of rural water supply systems undertaken, there appears to be a lack of integrated water management within the sector. Systems are scoped, designed, implemented and operated in isolation, and water resources considered separate. Individual components of integrated water management are applied in Vanuatu although not integrated. Linking these components could uncover new or revitalise existing opportunities to increase water resilience against climate change.

7.3Training requirements

In early 2021 a short survey on training indicated DoWR staff have received broad ranging training on water supply and sanitation activities, however they self-identified need for more fundamental skills in system design and construction, and general project management skills. It is deemed that many training sessions delivered are ineffective as they are not followed with practical or feasible application.

Training courses are frequently classroom based, without direct in-field application to reinforce learnt skills, leading to ineffective training. A survey of water staff skills self-assessment indicated lack of, or under confidence, in a range of skills, from basic water engineering skills, data management and computer skills.

Skill levels throughout all levels are deemed to be below required levels. For DoWR, at both national and provincial levels, a cause for diminished skill levels can be linked to post vacancy, lack of mentorship, lack of on-the-job skills training and awareness, and lack of confidence in subordinates or provincial staff to perform tasks adequately.

Fundamental to all training should be the consideration of climate change and other vulnerabilities. Simple data capture, monitoring and analyses can be used to raise awareness of weather patterns. Critical review of existing systems in light of climate change can provide insight. Staff and stakeholder seminars of findings will reinforce and share learnings.

This programme, with the number of interventions proposed, can assist in addressing these deficiencies and opportunities through field training sessions, applied implementation, study tours and knowledge sharing. Training for provincial staff and female only training session will also have broaden the benefits of typical centralised, classroom sessions.

7.4DoWR position descriptions

Due to COVID restrictions, in-country liaison limitations and present structural changes in the DoWR, a thorough review of staff skills and their roles and responsibilities was not undertaken. Instead, a rapid review of the position descriptions was undertaken to identify climate related activities.

Position descriptions for existing DoWR staff are available in the DoWR Standard Operating Procedure (SOP) (DoWR, 2018)[83]. The SOP, along with all recently adopted strategies and policies, relates directly to, and discusses climate change and disaster vulnerability. The existing DoWR posts (see DoWR SOP) and restructured DoWR posts (Annex A) do not have dedicated climate or disaster focal points, outwith the WASH Cluster Coordinator and the WASH Cluster activities.

The roles and responsibilities of existing DoWR posts do not explicitly identify climate change, disaster preparedness or other vulnerabilities tasks or skills. The exception being WASH Cluster Coordinator and the WASH Cluster activities. The roles and responsibilities also do not reference NIP and DWSSP. The DoWR, and the water industry as a whole, would benefit from a water resource climate change specialist. However, such a post may be better placed in water authority should it exist, or in the existing Department of Climate Change.

[83] DoWR Standard Operating Procedure (2018). Accessed at: https://events.gov.vu/4w/docs/procedural-documents/DoWR%20Standard%20Operating%20Procedures.pdf

Engineers, technical staff and facilitators involved in the development of DWSSP and survey of potential water supply sources and systems, have an implicit consideration of climate change impacts through the DWSSP cycle. This is indicated through DWSSP training packages and inferred through review of standards and system scoping. For instance, the facilitators highlight climate change variability and other vulnerabilities through DWSSP training. Also, system scoping considers climate impacts on water source, such as reduced/changing rainfall patterns and spring/stream flow, as well as consideration of additional backup sources.

It is at design and construction stages of water supply systems where engineers, technical staff and contractors will have the greatest influence on resilience against climate change and other vulnerabilities (See Section 7.5 for a discussion on design elements). Once again, climate change and vulnerabilities are not explicitly referenced in the position descriptions. From an engineering point of view climate change adaptation design measures should be included in design standards and procedures, therefore implicit in the relevant position responsibilities.

Due to the present restructure and the expected increase of staff levels, it is recommended that the project include a review of individual staff skills, their roles and responsibilities, and update position descriptions during the programme scheduling. Therein, analysis of the skills gap can be determined, and individual capacity building planning developed.

Since NIP and DWSSP are a key mechanism directing a significant portion of DoWR duties and programmes, it is deemed that the inclusion of NIP and DWSSP in individual position descriptions will not be of benefit. Instead, the inherent tasks required to achieve the NIP and DWSSP should be aligned and encompassed within staff roles and responsibilities. For instance, awareness tasks should involve NIP and DWSSP, as well as water cycle, catchment management, IWM, etc. From the rapid review of the provided roles and responsibilities, this is generally the case.

Similarly, climate change and disaster considerations are not explicitly stated in position descriptions, although it should be guiding principles fundamental to the DoWR and many of its posts. It is recommended, to reinforce the importance, that climate change should be explicitly stated in key staff position descriptions. Should climate change and other vulnerabilities be included in the position descriptions, two approaches can be taken:

1. A general statement establishing climate change and vulnerabilities as key considerations in contracts, SOP or in each posts' roles and responsibilities.
2. Adding or amending individual tasks to include climate change and vulnerabilities. Limited examples of changes for the Technical Service Manager and the Principle Engineer roles and responsibilities are given in **Error! Reference source not found.**:

Table 36: Potential Additions or Amendments for Climate Change and Vulnerability Considerations in Key Post Roles and Responsibilities

Post	**Additions or amendments**
Technical Service Manager	Ensure the latest climate change and disaster readiness considerations are implemented throughout designs, standards, operations, and capacity building.
Principle Engineer	Co-ordinate compliance of water supply maintenance with environmental, climate change, disaster readiness, social and poverty issues related to water infrastructure developments through liaison with Community Development Coordinator for all new water supplies

Post	Additions or amendments
	Participate in reviews and advice on such aspects as the safety, security, reliability, structural adequacy, and economy of solutions proposed for water infrastructure projects problems arising during planning, design, construction and maintenance

Additional skill gaps were revealed through stakeholder feedback, including the need to improve oversight on contractors delivery of services so that satisfactory work is completed, improving efficiency and of DWSSP delivery. This is a critical element that will ensure that construction standards are adequate to withstand climate change and other vulnerabilities.

The SOP and position descriptions lack inclusion and responsibility of integrated water resource management. It is recommended that the DoWR develop understanding and skills of integrated water resource management.

7.5Design considerations

A sample of DWSSP and their water supply designs were reviewed from an engineering perspective, whilst considering climate change and other vulnerabilities to secure water infrastructure.

Design standards, procedures and choices of water systems and their components will provide greatest amount of resilience against climate change and other vulnerabilities. Due to limitations of available data, ongoing finances and/or resources, and skills and experience, some climate resilient technologies are not suitable for a given community / location. This is already recognised by system designers who focus on implementing simple yet effective solutions such as gravity fed systems and rainwater harvesting systems. The reviewed designs imply consideration of water resource security hierarchy, and threats such as saltwater intrusion.

Although the designs are to standard and typically optimised sufficiently, they do not extend beyond the minimum requirements of water supply for individuals. Nor do they provide backup or fail-safe mechanisms which could maintain water reliability during flood, drought or natural disasters. It was noticed that some designs are downscaled to minimum standards due to cost concerns; this should be avoided. The additional costs of a larger tank or pipe could greatly increase water security now and into the future.

This GCF programme can directly address this short fall in conventional design and increase climate impact resilience by implementing simple changes to the design criteria, providing staff exposure and experience to climate change impact design mitigation. Some examples are provided below:

- Increasing system storage to mitigate water shortages during expected longer dry periods, droughts or El Nino events. This can be done by simple upsizing tanks from 6kL to 10kL, increasing the design litres per person per day or a multiplication factor on serviced population.
- Using modular tank network where tanks are linked to share excess water and maximise the volume of water attenuated for later use in dry periods. Tanks should be connected so that damage to one tank will not empty the whole system.
- Utilising / rehabilitating concrete tanks to reducing greenhouse gas emissions from building new tanks/slabs and logistics.

- Increasing cement cover on reinforcement to protect the steel from oxidisation and add additional bulk to mitigate against cyclone events which are expected to become more intense and frequent.
- Tank overflows to discharge into soakaways or infiltration basins. This may increase rechange to and capacity of groundwater resources

These and other climate resilient adaptation methods do not need to be highly technical. Indeed many will be a design consideration or maintenance practices. Such simple adaptation would be within the current staff ability, albeit not currently in their skillset. Additionally, the scale of the task to increase Vanuatu's water resilience.

As discussed in Section 7.2, Vanuatu is lacking integrated water resource assessment and management practices. Adopting such practices could make feasible exploitation of new water resources or revitalise existing opportunities. It can increase communities water resilience against climate change, whilst also offsetting climate change impacts on water resources. It is therefore recommended that the DoWR move towards a regional approach to water resources and use be adopted, considering:

- water balance between various resources,
- the abstraction and discharge of water for human consumption as only one component of a larger water cycle,
- efficiencies of strategically linking water supply systems,
- discharged/overflow water as a resource,
- annual or longer water cycles,
- groundwater recharge and borrow.

7.6Conclusions

In general, Vanuatu has lacked capacity in water supply engineering, and climate change and vulnerability assessment and impact mitigation throughout all levels and sectors. The systemic skills gap has been recognized and is being addressed nationally by the PSET sector, and through decentralization and delegation of responsibilities, and tasks to lower agencies or committees.

DoWR have undergone a challenging period of under-staffed, competing priorities and poor management or delegation of duties. Present structural changes are focussing on increasing staff levels, decentralising tasks, and separating core functions, with the aim to allow focus and deliver on rural water supply priorities. The DoWR will undertake a significant recruitment drive to fill ~50 positions, which includes 30 provincial based staff. Due to funding restrictions, recruitment will be undertaken in two tranches, with the second tranche occurring when funds are available.

Despite these DoWR challenges, COVID-19 restrictions and budget limitations, the NIP and DWSSP processes have been ongoing and successfully implemented. However, the current rate of delivery will fall far short of the ambitious target of 2000 community DWSSP by 2030.

As discussed in Section 0, the relevant legislative and policy frameworks for safe and secure water supply and sanitation services delivery in rural communities is well defined and understood. The NIP and DWSSP are well accepted and implemented, and have been enhanced through updates to include climate change risks and disaster risk evaluation.

The proposed programme of targeting 600 communities for water supply improvements is an excellent mechanism to increase capacity in awareness, mitigation and adaptation of climate change and other vulnerabilities. The project will strengthen delivering of training, skills development and application throughout the nation. At a national and provincial government level, the significant number of projects will provide working applications reinforcing training and skills development. The expected increase of DoWR staff will improve adaptation knowledge sharing possibilities, broaden training reach, and increase monitoring and evaluation of DWSSP development and implementation. The increase of monitoring and evaluation will ensure that designs and construction target and maintain improved water security through improved construction standards. Relieving funding concerns will ensure that design choices do not compromise resilience in wake of limited budget.

Recommendations:

- Use the DWSSP as a mechanism to build capacity across all levels, from community to national government, focussing on climate change considerations, improved construction standards, and monitoring and evaluation
- Support the DoWR restructure by assisting to fund posts on a contract basis
- Support engagement of two external water resource experts per province to assist with development of new staff, local DWSSP community engagement, and provide mentorship
- Engage with PSET to use DWSSP as applied learning mechanisms
- Encourage skills sharing, provincial office knowledge and talent swaps, and study tours
- Encourage climate change related seminars, presented by staff on projects/tasks they have performed
- Instil mentorship attitude within DoWR to promote learning, improve skills and confidence, and increase delegation
- Maximise local labour use, avoid large plant hire where community members can be hired
- Enforce simple adaptation practices to encourage and normalise climate change considerations
- Improve oversight of contractors delivering DWSSP
- Build capacity of DoWR and DWSSP facilitators to maximise value and efficacy of development and implementation DWSSP
- Adopt integrated water management methodologies

8. Overview of the interim DoWR and IWC gap assessment

8.1 Interim Department of Water Resources

The table below in an indicative list of desired positions for the restructured DoWR. Not all of these posts can be funded immediately. The DoWR will submit these posts to the Government of Vanuatu for funding under two phases. The Status column indicates vacant or new posts. New posts are nominated ‘Phase 1’ or ‘Phase 2’.

Table 37: Department of Water Resources positions

#	Title	Status
5300	Director	Contract
5301	Deputy Director	New Post - Phase 1
5302	Manager (Rural Services)	Not Known
5303	Manager (Water Resources Management Unit)	Permanent
5304	Principal Engineer (RWS)	Permanent
5305	Principal Projects Officer	New Post - Phase 2
5307	Principal Officer Provincial Water (Sanma)	Permanent
5308	Principal Officer Provincial Water (Penama)	Permanent
5309	Principal Officer Provincial Water (Malampa)	Permanent
5310	Principal Officer Provincial Water (Tafea)	Permanent
5311	Principal Officer Provincial Water (Torba)	Permanent
5312	Principal Officer Provincial Water (Shefa)	Permanent
5314	Senior Engineer	Permanent
5315	Senior Officer (Projects)	Permanent
5316	Senior Officer (Water Quality)	Permanent
5317	Senior Officer (Hydrology)	Vacant
5318	Senior Officer (Hydrology Geologist)	Permanent
5319	Senior Officer (Compliance)	Permanent
5320	Senior Officer (Procurement)	New Post - Phase 1
5321	Senior Officer (Contracts)	New Post - Phase 1
5322	Senior Officer (Finance)	New Post - Phase 1
5323	Senior Officer (WASH Coordinator)	Permanent
5324	Senior Officer (Information Management)	Permanent
5325	Outreach & Awareness Officer	Permanent
5326	Data Base Officer	Vacant
5327	Compliance Officer (Environmental)	New Post - Phase 2
5328	Water Engineer (North)	New Post - Phase 1
5329	Water Engineer (South)	New Post - Phase 1
5328	Water Engineer	New Post - Phase 2
5329	Water Engineer	New Post - Phase 2
5328	Water Engineer	New Post - Phase 2
5329	Water Engineer	New Post - Phase 2
5334	Information Management Officer (Sanma)	New Post - Phase 2
5335	Information Management Officer (Tanna)	New Post - Phase 2
5336	Project Planning Officer	Permanent

#	Title	Status
5337	Community Development Officer	Vacant
5338	Foreman Mobile Team	New Post - Phase 2
5339	Drilling Rig Supervisor	New Post - Phase 2
5340	Drilling Rig Supervisor	Perm
5341	Provincial Compliance Officer (Sanma)	New Post - Phase 2
5342	Provincial Compliance Officer (Tafea)	New Post - Phase 2
5343	Desalination Officer	Not Known
5344	Driller	Not Known
5345	Driller	New Post - Phase 2
5346	Laboratory Technician (Water Quality)	Permanent
5347	Water Technician	Permanent
5348	Executive Secretary	Permanent
5349	Provincial Field Officer (Sanma)	Renamed Migrated
5351	Provincial Field Officer (Penama)	Renamed Migrated
5353	Provincial Field Officer (Malampa)	Renamed Migrated
5354	Provincial Field Officer (Malampa)	New Post - Phase 1
5355	Provincial Field Officer (Tafea)	Renamed Migrated
5356	Provincial Field Officer (Tafea)	New Post - Phase 1
5357	Provincial Field Officer (Torba)	Permanent
5358	Provincial Field Officer (Torba)	New Post - Phase 1
5359	Provincial Field Officer (Shefa)	Permanent
5660	Provincial Field Officer (Shefa)	New Post - Phase 1
5361	Administration & Finance Officer (Sanma)	New Post - Phase 1
5362	Administration & Finance Officer (Penama)	New Post - Phase 2
5363	Administration & Finance Officer (Malampa)	New Post - Phase 2
5364	Administration & Finance Officer (Tafea)	New Post - Phase 2
5365	Administration & Finance Officer (Torba)	New Post - Phase 2
5366	Assistant Driller	Permanent
5367	Assistant Driller	New Post - Phase 2
5368	Mechanic	Vacant
5369	Mechanic	Vacant
5370	Logistics Officer	Permanent
5371	Contracts Monitoring Officer	Vacant
5372	Finance Officer	Vacant
5373	Receptionist Filing Clerk Cleaner	Vacant
5374	Procurement & Assets (Sanma)	New Post - Phase 2
5375	Procurement & Assets (Penama)	New Post - Phase 2
5376	Procurement & Assets (Malampa)	New Post - Phase 2
5377	Procurement & Assets (Tafea)	New Post - Phase 2
5378	Procurement & Assets (Torba)	New Post - Phase 2
5379	Procurement & Assets (Shefa)	New Post - Phase 2
5380	Maintenance/Gardener/Driver	Not Known
5381	Receptionist/Cleaner/Filing Clerk (Sanma)	New Post - Phase 1
5382	Receptionist/Cleaner/Filing Clerk (Penama)	New Post - Phase 1
5383	Receptionist/Cleaner/Filing Clerk (Malampa)	New Post - Phase 1
5384	Receptionist/Cleaner/Filing Clerk (Tafea)	New Post - Phase 1
5385	Receptionist/Cleaner/Filing Clerk (Torba)	New Post - Phase 1

8.2 IWC Skills Assessment

The following list was prepared for the WASH Capacity Assessment Vanuatu (IWC, 2019). The assessment consisted of 22 semi-structured interviews discussing WASH outcomes for the next 5 years, institutional framework assessment to clarify department roles and other WASH actors, identify operational and enabling requirements, identify skills and knowledge required to undertake the aforementioned tasks, assess existing capacities against required knowledge and skills, and suggest best approaches.

- DoWR - Communities will need support to manage and monitor water supplies and infrastructure.
- DoWR - Communities will need support in how to maintain effective Water Committees; managing finances for operation and maintenance; strengthening supply chains for spare parts; and building local technical skills and water safety monitoring.
- DoWR - Area Secretaries will need support in liaising with Community Water Committees and Provincial DoWR staff to develop suitable DWSSP
- MoET - Current and future teachers will need training in how to deliver WASH in schools, including menstrual hygiene management, handwashing behaviours and sanitation promotion activities.
- MoET - School Improvement Officers and Mobile ECCE Officers will need training on the use of national guidelines or standard designs to assist with identifying and installing appropriate WASH facilities in schools.
- MoH - Village Health workers will need training in the construction and use of improved WASH facilities, as well as hygiene practices as part of food safety training.
- DoWR - Formal training in plumbing and water supply systems from source to end user.
- DoWR – Water source protection, including risk analysis of water sources, and use of water quality guidelines.
- DoWR – Provincial staff to work with Area Secretaries, Community Water Committees and Contractors to develop and deliver DWSSP.
- DoWR - Supervising installation of desalination systems and solar pumps.
- MoET - Training in WASH guidelines and standards as well as menstrual hygiene management, handwashing behaviours and sanitation promotion activities for Provincial trainers.
- MoH - Environmental Health Officers and Compliance Officers will need training in hygiene, food safety, legislation and standards to support Sanitation Officers, nurses and village health workers at the community level.
- All agencies - Skills for oversight, coordination and development of plans and policies.
- All agencies - Developing an understanding of roles and responsibilities within and between Ministries at national and provincial level and improving linkages between agencies.
- All agencies - Planning, budgeting and project management.

- All agencies - Procurement skills including use of standard operating procedures for tendering processes and structured systems for financial management.
- All agencies - Managing Human resources – to manage staff training and capacity building programs, as well as hiring of appropriate new staff at all levels.
- All agencies - Administration, logistics and organisation skills for mid-level professionals.
- All agencies - Information management for reporting and planning. Collecting and using data effectively.
- All agencies - Skills for monitoring, compliance and enforcement with relevant policies, Acts, regulations and standards at national and provincial levels
- All agencies - Integrating climate change mitigation and disaster risk reduction into WASH planning.
- All agencies - Gender mainstreaming and social inclusion considered in plans and programs.
- MoH and MoET - Improved linkages between technical and behavioural aspects of WASH programs (through deeper understanding of modern WASH behaviour change).
- DoWR - Skilled hydraulic engineers for developing water system designs and conducting surveys, who can then teach some of these skills to provincial level staff.
- DoWR - The use of QGIS for collecting and managing field data to design appropriate water supply systems.
- MoET - Technical expertise in appropriate standards and processes to develop national guidelines or standard designs (minimum quality standards) for WASH facilities in all types of schools (drinking-water, and sanitation, and pre-approved infrastructure designs for schools).

9. Description of the proposed project

9.1Project concept

The project aims to achieve a paradigm shift towards climate resilient water security for rural communities across Vanuatu, by enhancing community-based planning and adaptation for climate-resilient water management, developing climate-resilient rural water infrastructure, and creating an enabling environment at provincial and national level to better address climate risks associated with water security.

This project is listed as the priority intervention in Vanuatu's draft GCF Country Programme[84] and is being fully co-developed with the NDA, the DOWR and UNICEF, alongside other stakeholders which guarantees full country-ownership. By addressing increasing risks and impacts from climate change on water resource management, and by working directly with vulnerable rural communities (incl. community-based adaptation activities), the project is fully aligned with the Government of Vanuatu's climate change strategies and policies, including the Climate Change and Disaster Risk Reduction Policy 2016-2030 (e.g. strategic priority 7.4.3) as well as the National Adaptation Programme of Action (NAPA) and the NDC (which both make reference to water resource management as a top priority). In addition, the project is fully in line with Vanuatu National Sustainable Development Plan 2016 (e.g. objective ECO2.2) and the Vanuatu National Water Policy 2017–2030.

The project will increase the adaptive capacity of rural communities to better cope with the additional burden of climate change on water security and safety, by improving climate-resilient water management, community- based planning, providing explicit capacity building, and fostering adaptation actions through improved local management practices and resilient infrastructures. Water safety and security is particularly vital for community long-term resilience and in the immediate aftermath of climate-induced disasters.

600 communities will be direct beneficiaries as part of Component 1 (through which communities will be empowered to plan and manage climate-resilient water resources), of which 220 will also benefit from improved climate-resilient water infrastructure as part of Component 2 (through which communities will have enhanced climate-resilient infrastructure). An additional 50 communities with existing DWSSPs will be targeted under Component 2 during the first year of the project. This makes a total of 650 communities directly benefiting from component 1 and 2. A preliminary estimate, of direct beneficiaries is therefore 74,230 (including 37,115 women), that is around 24% of the total population in Vanuatu. Indirect beneficiaries include the entire rural population in Vanuatu (228,400 individuals and 75% of the total population), mostly through enhanced institutional capacities and processes toward climate-resilient water security for rural communities (Component 3 – provincial and national institutions are strengthened to address climate risks associated with water security).

[84] Available at: https://www.greenclimate.fund/document/vanuatu-country-programme

9.2Barrier analysis

Barriers for this project has been identified through a review of primary and secondary sources, as well as through a DoWR-led stakeholder engagement process. Primary sources include Vanuatu's draft GCF Country Programme, the Vanuatu Water Policy 2017 - 2030, and in-country consultations with water management experts at national level and provincial level. Consultations were conducted during the CN stage, as well as during the preparations stage.

The secondary review included an extensive desktop review, which collated documents from different climate sector and development sector actors, focusing on: climate change issues in the Pacific SIDS, water security and CR-WASH, and Vanuatu's socioeconomic and gender baseline. Additionally, post-disaster assessments on Cyclone Pam (2015) and Cyclone Harold (2020) were reviewed to assess climate impacts on Vanuatu's water infrastructure, with particular focus on available localised studies on Sanma, Torba and Tanna. There are many root causes that contribute to increased water insecurity, with climate change compounding levels of exposure[85] and risk[86], building on existing vulnerabilities[87]. The main barriers include:

Capacity barrier at local and community levels

Resilience at the community level is key for ensuring beneficiaries receive sustainable water and sanitation services that can adapt to external shocks and processes of change – particularly climate change. The national/sub-national-level processes support coordination and service provision to the WASH sector, but it is the infrastructure and the capacity of communities to manage their system that can either deliver the needed health impacts and increased water security in Vanuatu or prove to be a hurdle in achieving the project goals.

Capacity barrier for climate-resilient WASH in Vanuatu, at local and community levels, has two features:

- inadequate access to evidence-based planning among communities for climate-resilient water management; and,
- limited awareness, knowledge and skills on climate change issues and climate-resilient water resource management at community level.

The stakeholder consultations highlighted these observations: Red Cross Vanuatu (RCV) identified limited capacity to provide backstopping at the provincial offices and community level prior, during and after the implementation of project activities, as a key gap. World Vision (WV), similarly, identifies that at the community and operator level, training and project intervention need to support design capacities, as well as deployed quicker and efficiently.

Infrastructure barriers at local and community level

This project is premised on challenges in the water sector, which are further exacerbated by climate change, resulting in increasing temperatures globally and in Vanuatu, changes in

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precipitation patterns and extreme weather events, leading to excessive flooding and droughts and threatening water and food security, health and the environment.

One of the primary barriers in Vanuatu is limited WASH infrastructure and water supply sources. The DoWR conducted an inventory of water systems, as part of an MFAT-funded Water and Sanitation Sector Strengthening Programme – which found only 79% of systems functional.[88] Shefa Province, which hosts the capital city – Port Vila – had the best functionality at 98%.[89] Meanwhile, Torba, the most remote province in the north, had only 72% of systems functioning.[90] It is also important to note, that even operational systems, did not necessarily have water supply all day, every day. Further analysis revealed that only 37% of systems were reported as providing water 24h/day, every day of the year.[91]

Data collected from rapid assessments of 230 rural water supply systems, as well as inspection of 57 rainwater harvesting systems, following Tropical Cyclone Harold, revealed that –in the immediate aftermath, the only source of clean water for communities were coconuts.[92] With extensive damage to water infrastructure, the WASH Cluster was quickly activated to send in contingency supplies, such as liquid chlorine and chlorine tablets, to stem chances of water-borne diseases.

Given this baseline, infrastructure barriers have the following features in Vanuatu:

- insufficient or lack of WASH infrastructure, with sub-national variations;
- vulnerable WASH infrastrucuture (poorly maintained and not climate-resilient); and,
- no alternative water supplies in case of emergency (shelters are also ill-equipped).

Technical and capacity barrier at provincial and national levels

The legal hinterland provided by the National Sustainable Development Plan (2016 – 2030)[93], provisions for capacity and technical assessments to ensure a dynamic public sector in Vanuatu. Capacity assessments were conducted in the DoWR as recently as October 2019 and reported in February 2020, with a further training survey conducted in February 2021 (focused primarily on Port Vila staff, and Provincial Water Supervisors).

The DoWR have experienced reduced staffing, including a period without in-house engineers, or dedicated Project Management Units. This, combined with competing urban water resource tasks, has burdened staff and hampered progress of rural water supply improvements. Civil engineers in NGOs were generally only available for collaborative projects. Indeed, the DoWR does currently have civil engineers, however, vacant posts still exist.

Stakeholder engagement, conducted during the preparation of this Feasibility Study, demonstrated that DoWR staff often undertake duties at a level below their appointment. Training courses are frequently classroom-based, without direct in-field application to reinforce the absorption of skills, leading to ineffective outcomes. The training survey (self-assessments)

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[88] UNICEF WASH Sector Analysis

[89] UNICEF WASH Sector Analysis

[90] UNICEF WASH Sector Analysis

[91] UNICEF WASH Sector Analysis

[92] WEDC

[93] https://www.gov.vu/index.php/resources/vanuatu-2030

conducted in February 2021, indicated the lack of (or under) confidence for a range of skills: from basic water engineering skills, technical and project management, data processing and computer skills. The survey returned few responses on climate change, which could indicate a gap in understanding of climate risks interlinkages with water security and WASH infrastructure, generated likely from the well-established status quo of siloed action on these sectors.

Water governance in Vanuatu, demonstrably is kneecapped by technical and capacity barriers, amounting to the following features:

- limited technical capacity, human resources, and financing at provincial and national levels to establish and maintain climate-resilient infrastructure;
- limited technical capacity, human resources, and financing on climate-resilient water management at area council, provincial and national level; and,
- insufficient awareness, knowledge and skills on climate change issues and climate-resilient water management at provincial and national level;

Institutional barrier at the Department of Water Resources and associated water governance architecture at devolved levels

The DoWR underwent an institutional assessment primarily dispensed through the Office of the Public Service Commission’s Framework for Institutional Capacity Assessment and Development (available as Annex C), which was designed to clarify the capacity needs, and assessment and development approach. The assessment has 9 rubrics, with several indicators within each (I: Legal Framework, Purpose and Mandate; II: Strategic Plans and Budgets; III: Organisational Function and Design; IV: Operational Systems and Procedures; V: Human Resource Management; VI: Management Processes; VII: Performance; VIII: Workplace Culture and Leadership; IX: Infrastructure). Several of the indicators were pegged at basic or below moderate levels of capacity, such as: planning within the institution; operational procedures; service delivery standards. Few indicators were highlighted as requiring immediate capacity development or attention, such as: staff retention; and, change management and project implementation.

The lacuna in institution building and capacity development, hence, is an important barrier that the project will contribute towards. Particularly, the following features of the barrier will be dealt directly with the project:

- inadequate institutional capacities on climate-resilient water management at the provincial and national level; and,
- paucity of robust and accessible data for integrated and climate-resilient water management.

Based on this barrier analysis, a Theory of Change (Section 9.3) has been developed with outputs geared towards delivering improved water security and water governance as well as climate-resilient WASH infrastructure in Vanuatu.

9.3Theory of Change

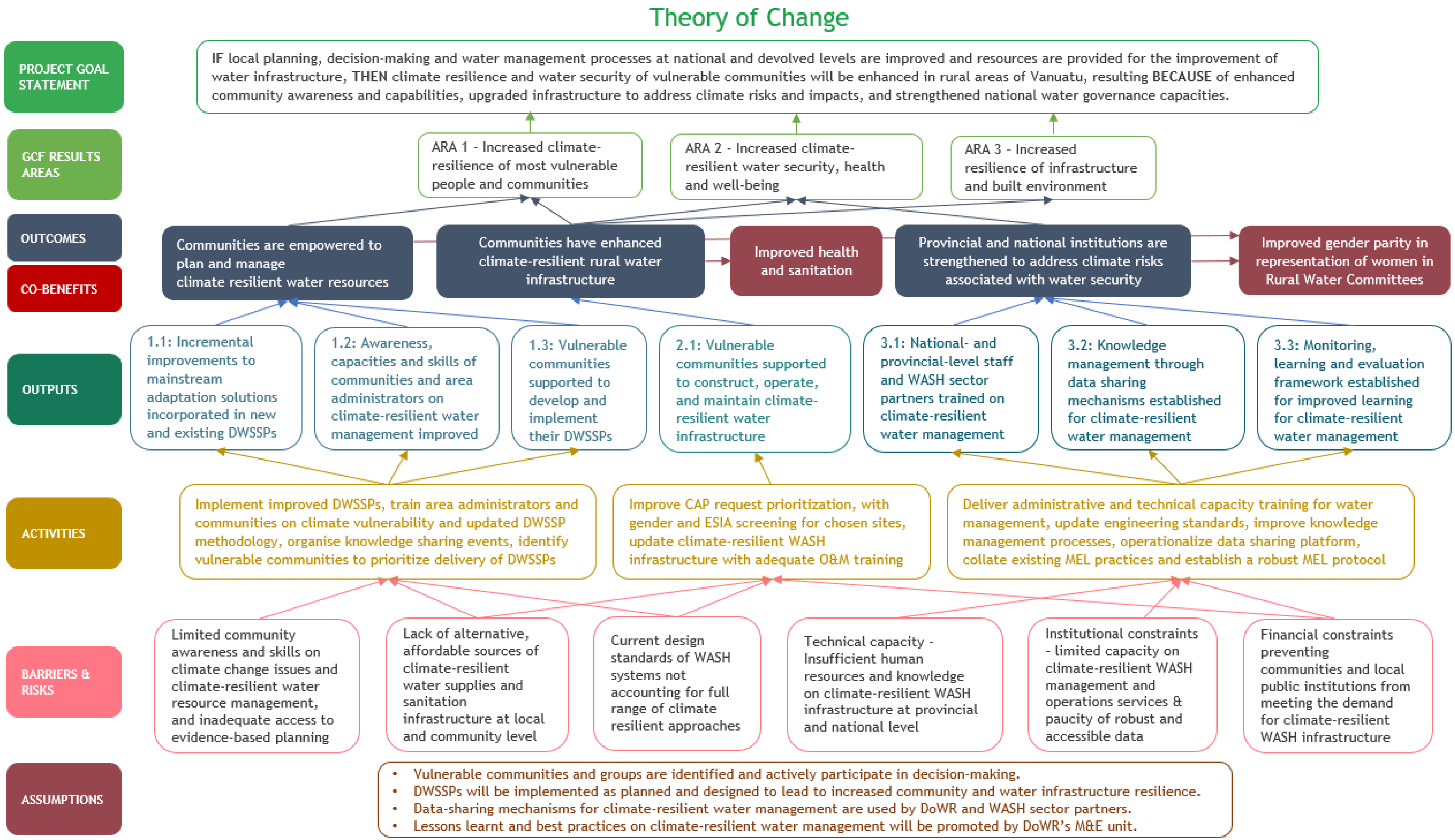


Figure 12: Theory of Change

The above Theory of Change demonstrates the relevant GCF Integrated Results Framework indicators and how the project will contribute towards a paradigm shift in the CR-WASH sub-sector of Vanuatu. The fund-level impact will be A2.0 (increased resilience of health and well-being, and food and water security with the A2.3 indicator (number of males and females with year-round access to reliable and safe water supply despite climate shocks and stresses). This is expected to have the following fund-level outcome: A7.0 (strengthened adaptive capacity and reduced exposure to climate risks), which will be measured with the A7.1 indicator (use by vulnerable households, communities, businesses, and public-sector services of Fund-supported tools, instruments, strategies and activities to respond to climate change and variability).

The project goal statement explains the causal linkages between the project outputs, outcomes and the goal that the project will contribute towards (in this case, increased water security and climate resilience of communities in Vanuatu). The statement states that if local planning, decision-making and water management processes at national and devolved levels are improved and resources are provided for the improvement of water resources, then climate resilience and water security of vulnerable communities will be enhanced in the rural areas of Vanuatu, resulting because of enhanced community awareness and capabilities, upgraded infrastructure to address climate risks and impacts, and strengthened national water governance capacities.

The project will be delivered through three components (expected results):

- Component 1: Communities are empowered to plan and manage climate-resilient water resources;
- Component 2: Communities have enhanced climate-resilient rural water infrastructure; and,
- Component 3: Provincial and national institutions are strengthened to address climate risks with water security.

Component 1: Communities are empowered to plan and manage climate resilient water resources

This component will deliver on two aspects of community resilience towards climate change: firstly, through increasing the number of DWSSPs, while also introducing climate adaptation measures in these plans. It will also aid in retrofitting existing DWSSPs with a climate change perspective. Additionally, this component will focus on building the institutional capacity for CR-WASH at area and community levels.

This component has been designed to create a paradigm-shift towards implementing CR-WASH in a scalable and sustainable way at the community level, building on UNICEF research that this can only be achieved by providing tailored and required assistance to communities. The TAP component, for example, which is implemented through the DWSSP process, provides a risk-based training method to communities in order to aid them in managing their systems and understanding required infrastructure to meet defined WASH targets. Using these plans to both manage community systems and apply for capital assistance provides both the management capacity and infrastructure – and importantly, ownership – to rural communities. The expected outputs, along with activities, are listed below:

Output 1.1: New and existing DWSSPs incorporate incremental improvements to mainstream adaptation solutions

The DWSSP methodology has been updated recently with significant overhaul towards climate mainstreaming.[94] It is expected that the methodology will be further updated - with annual improvements, through this output.

In the new DWSSPs developed with communities, the updated methodology will be used to ensure climate risks are mainstreamed. For the existing DWSSPs – workshops and technical assistance will be provided to ensure these plans are retrofitted to better reflect climate risks and adaptation solutions.

The importance of this Output stems from the reality that although Vanuatu has seen ODA-driven investments in the WASH sector, these are often ad-hoc in nature and have not been made in a climate-resilient way. The updated, existing DWSSPs and the new DWSSPs, will therefore provide a framework for incom

ACTIVITY	SUB-ACTIVITIES
1.1.1 - Implement DWSSPs processes that incorporate incremental improvements to mainstream adaptation solutions and update existing DWSSPs. Please refer to section 6.3 of Annex 2 Feasibility Study for details on DWSSP status across Vanuatu.	1.1.1.1: Review uptake and delivery of updated methodologies, making incremental improvements annually. Incremental improvements will be made by reviewing and updating the DWSSP template and process on a yearly basis to incorporate climate resilient design standards and design criteria in the risk assessment and improvement plan sections of the DWSSP. There will be small improvements made each year taking into consideration additional data and lessons learnt from implementation of DWSSPs and CR WASH infrastructure during the year. International and local consultants will be recruited to work with a National Project Engineer (NPE) to, carrying out a gap analysis on the current methodology and analysing lessons learned from ongoing DWSSPs. Following the above assessments, the consultants and the NPE will update the methodology to mainstream climate resilience factors into the documentation and ensure all DWSSPs moving forward account for climate risks and impacts. Updated methodology will be presented to the Project Steering Committee (PSC) for approval at regular intervals to enable incorporation of lessons learned over the projects 5 years of implementation. This will ensure that by completion of the project the DoWR and DWSSP methodologies are strengthened based on international best practice and tailored through evidence-based feedback to account for local contexts. 1.1.1.2: Integrate updated methodology into DWSSP processes. The NPE will provide training to DWSSP Facilitators at the national level. This will be conducted twice to accommodate facilitators covering all provinces. 1.1.1.3: Update existing DWSSPs, when appropriate. DoWR staff and provincial DWSSP facilitators will identify the 100 DWSSPs (of the 301 developed to date, please see Annex 2) most vulnerable to climate change through climate analysis and identification from the original documentation for updates to enhance the DWSSPs with new climate resilient factors. For cost efficiency this will be done through provincial level engagement with Provincial Area Councils at 3 intervals over the project. The remaining 201 DWSSPs will be updated by the DoWR through national processes post project. Upgrades will include enhancing the hazard risk assessments and improvement and preparedness plans as well as upgrading the climate

[94] Update date?

	change risk and improvement plan sections in alignment with the new DWSSP climate resilient methodologies.

Throughout the project cycle, the AE will partner with the DoWR to conduct an annual review and stocktaking of the DWSSPs being updated and formulated, tabulating the progression in climate-resilient planning through this important process.

Output 1.2: Awareness, capacities and skills of communities and area administrators on climate-resilient water management improved

Resilience at the community level is key to ensuring beneficiaries receive sustainable water and sanitation services that can adapt to shocks and processes of change. The national/sub-national-level processes support coordination and service provision to the WASH sector, but it is the capacity of communities to manage their system that delivers the needed sanitation and security impacts in Pacific communities. Awareness and empowerment, as well as capacity and skill-building will improve the climate-resilience and sustainability of community WASH services and infrastructure in rural Vanuatu. The Output's activities will be synergistic with, and build on, Output 1.1 activities by carrying out community level awareness and knowledge sharing campaigns to specifically enhance understanding of the importance of climate resilience and its incorporation into the DWSSP methodology. Further, climate vulnerability technical capacity training for area administrators within the government extension structure on climate resilient practices in the DWSSP processes will be held. This will enhance Area Council level technical understanding for development of new DWSSPs following the updated methodology in Output 1.3. Through this process the three outputs are seen as fully complimentary, providing in Output 1.1) relevant updates to methodologies, in 1.2) relevant awareness raising and technical capacity building on climate resilient, and in Output 1.3) actively engaging and providing support in the development of DWSSPs.

ACTIVITY	SUB-ACTIVITIES
1.2.1: Train area administrators and develop material for communities on climate vulnerability, risks and updated DWSSP methodology	1.2.1.1: Conduct training targeting area administrators on climate vulnerability and risks and updated DWSSP methodology. This will carried out at the provincial level by facilitators, who will provide tailored training on climate vulnerability and its relevance to building climate resilience through the updated climate resilience updates in the DWSSP methodologies. 1.2.1.2: Conduct training targeting communities on DWSSP processes, with interactive content and WASH advocacy materials. Technical knowledge on the impacts of climate change and solutions for climate resilience will be synthesised into appropriate learning material to be shared with communities by Area Councils, including easily comprehensible written documents (pamphlets and flyers for RWC to distribute) as well as through social media, and popular media (TV and radio) campaigns.
1.2.2: Organize knowledge sharing events	1.2.2.1: Organize community level knowledge sharing events to ensure widespread dissemination among communities. The Monitoring, Evaluation and Learning Officer (MEL) and Environmental and Social Safeguard (ESS) officers will establish a community of practice for knowledge sharing and dissemination. This will include provincial forums held at intervals over the project to enhance the profile of climate resilience and showcase success stories and lessons learned.

These activities will include formative research to identify the target audience in the different communities, adhering to frameworks of gender inclusion and inclusion of marginalized communities, as well as map their capacity/knowledge gaps in terms of water safety and security (as well as climate-resilience). For Activity 1.2.1, targeted trainings will be provided through technical assistance. Area administrators, if relevant, can be paired with DWSSP facilitators to ensure that trainings are not duplicated (this activity will tie in with 1.2.1). For Activity 1.2.2, interactive training material and learning notes will be developed. This could be done in partnership with UNICEF which already has tried and tested community-led efforts in Vanuatu. This activity will bring together communities, area administrators for peer-to-peer learning and knowledge-sharing events and provide a platform for greater collaboration at the grassroots CR-WASH management and service delivery levels.

The AE will develop two completion reports for this Output: one, consolidating the evaluations of the trainings provide to area administrators and communities on CR-WASH using the following indicators (number of participants – gender disaggregated; number and mapping of training courses delivered). The other report will consolidate interactive training material and learning notes for knowledge management purposes.

Output 1.3: Vulnerable communities are supported to develop and implement their DWSSPs (600 DWSSPs by the end of the project cycle)

The majority of WASH systems in the Pacific are isolated from government service provision and are managed by community committees, according to UNICEF research. This is also the case for Vanuatu – therefore, establishing strong governance structures that are grassroots and accountable, with decision-making mandates and have community participation are key to managing water resources safely in the country. The DWSSPs will provide for a framework through which community-owned WASH infrastructure (new and/or improved) can be sustainably managed, localizing both priorities and interests. Through this output, the project will deliver the 600 targeted DWSSPs, identified and delivered through the country-owned (DoWR-mediated) NIP process. For a full description of the process please refer to Annex 23. In summary, a community request (triggering) is received at the Area Council or Provincial Government. Support to communities to develop DWSSPs is provided with a priority to the most vulnerable communities climate threats impacting their water security. This takes into consideration drought maps and local knowledge from Area Councils, National Disaster Management Office, Ministry of Health and other Water, Sanitation and Hygiene (WASH) partners. Once a community is selected the support is provided to conduct a DWSSP with the Rural Water Committee and other community members. Following this a vulnerability analysis to quantify climate risks in relation to water quantity and safety is carried out by the Provincial Water Resources Advisory Committee (PWRAC) to prioritise the sites. After communities have completed low cost improvement plan developed during the DWSSP workshop they will be eligible for CAP funding. RWC's will be registered under the national and provincial RWC register (provincial RWC register to be established in this Output to filter into the National RWC register).

As presented in Annex 2 section 6.3, approximately 2000 DWSSPs must be developed by 2030. To reach this target a minimum of 200 DWSSPs are required to be developed per year up to 2030. This exceeds the DoWR current capacity. This project will therefore provide resources to enhance the capacity of the DoWR over the project cycle to target an additional 600 DWSSPs. This Output will be conducted in years 1-3 of the project. This will enable the 600 developed DWSSPs to access the resources as described in Outcome 2 to carry out the required infrastructure works over the remaining implementation period for communities most in need under the context of climate vulnerability.

The technical capacities provided by the project in terms of technical knowledge and human resources will be continued by the DoWR post project creating an enhanced enabling environment to carry out required operations at the scale needed. This in conjunction with institutional improvements also provided by the project (Outcome 3) will enhance efficiency in the process. This combined impact will enable the DoWR to have a long-term strategy and capacity to meet the 2030 target.

ACTIVITY	SUB-ACTIVITIES
1.3.1 Identify vulnerable communities through the NIP process to prioritize delivery of DWSSPs	1.3.1.1: Recruitment of provincial engineers – these positions will be embedded in the DoWR and will provide centralised technical support at the provincial level to assist with monitoring contractors facilitating the community DWSSP workshops, assist with provincial level climate resilient trainings, assist with detailed assessments to create designs and bills of quantities for CR-WASH infrastructure improvements and complete construction monitoring of contractors implementing CR-WASH infrastructure improvements (refer to CAP, Outcome 2) 1.3.1.2: Refresher for community DWSSP facilitators halfway through the project to serve as a refresher training and to incorporate the various incremental improvements over the intervening implementation period incorporated under Output 1.1. 1.3.1.3: Development of 600 DWSSPs informed by best-available climate science, local information and traditional knowledge. This includes a five day workshop/training at the community level, conducted by DWSSP facilitators, to engage with RWCs and community members to develop DWSSPs in an inclusive and representative manner. This is in alignment with the requirements under the Water Resources Management Act and shows alignment with national legislation and policies. The ESS Officer and Provincial Engineers will monitor the community DWSSP facilitator contractors to ensure DWSSPs are to standard including the climate risk assessments, ESS assessments and improvement plans and that communities are well trained to improve community climate resilience. 1.3.1.4: Establish and register local water committees. Currently, there is no register at the provincial level. The project will establish an online register with the provincial governments to deliver this process.

	1.3.1.5: Support provided by Provincial Engineers and Provincial DoWR officers to implement no and low-cost measures in communities.

Activity 1.3.1 will involve PWRAC identifying vulnerable communities who request DWSSPs through the NIP process, followed by recruitment of new DWSSP facilitators.
For the new DWSSP facilitators – and existing staff – training will be provided on the updated DWSSP methodology (with focus on CR-WASH and climate change adaptation through local). This will focus on climate risks and how these can be adapted to through the DWSSPs. Rural water committees will be established through the DWSSPs – with a mandatory quota of 40% women, ensuring equitable gender participation. Climate vulnerability assessments and community engagement will be undertaken to ensure 600 DWSSPs developed during the project cycle are informed by the observed climate impacts and are able to withstand impacts, particularly, of fast-onset disasters (such as extreme precipitation and flooding, or tropical cyclone and storm surges).

The AE will develop one annual review (so 5, in total) for this Output: this annual review will review and stocktake of the DWSSP process, particularly tabulating and mapping new and updated DWSSPs in specific communities achieved per year. Processes and success stories around women's participation is expected to be documented through these annual reviews as well.

Component 2: Communities have enhanced rural water infrastructure

This component represents the core investment envisioned for a paradigmatic shift towards CR-WASH infrastructure in rural contexts of Vanuatu. The objective of this component is to strengthen water systems in prioritized rural communities (through the DWSSP process) and to address climate variability and change risks and impacts through the existing capital assistance programme (CAP). Investments in rural water supply infrastructure (whether new or improved), such as improved rainwater harvesting, will be at once a private good (providing water supply to households), but when used correctly and consistently, also a wider, public good key to achieving SDG 6 targets.

At least 200 prioritized communities schools or healthcare facilities are expected to be targeted as part of Component 2. GCF funding and co-financing will be mobilized to support climate-resilient infrastructures that will be developed, based on needs identified in the DWSSPs and through DoWR's expanded and improved capacity (delivered through Component 1). It is widely recognized that every drop of water that has to be pumped ,moved, or treated to meet health and food needs requires energy – the Component, therefore, will aim to deliver technology options that ensures effective co-management of water and energy, to ensure systems are reliable and climate-resilient. The expected outputs, along with activities, are listed below:

Output 2.1: 200 vulnerable communities supported to construct, operate, and maintain climate-resilient water infrastructure

This Output will focus on delivering climate-resilient water infrastructure to 200 communities in Vanuatu. Provision of this WASH infrastructure will include: rehabilitation, upgrading, and/or expansion of rural drinking water supply systems to serve at least 200 communities. Collaboration with provincial governments, drinking water providers, and target communities will ensure reliable and sustainable potable water services. To ensure improvements are sustained, the project will aim to achieve two mutually reinforcing intermediate results, through this Output:

- Increase access to safely managed drinking water in rural Vanuatu through the rehabilitation or construction of small-scale infrastructure projects, identified through the country-owned DWSSP and NIP processes
- Increase engagement of communities in management, oversight and accountability of drinking water service points and infrastructure (through, particularly, the RWCs).

In 2020, the national Water Resources Inventory (WRI) under DoWR, and UNICEF conducted a water point mapping that identified 4,097 water systems across 44 islands of which:

- 15% were Indirect Gravity Fed systems,
- 20% Direct Gravity Fed systems and
- 65% Community Rainwater Harvesting systems.

Only 79% of systems were identified as functional and only 37% of these systems were reported as providing water 24h/day daily, every day of the year.

The CAP facility under the NIP does not have capacity to upgrade or build new CR-WASH infrastructure for all of the required infrastructure needs at present. This project aims to enhance CAP and institutional capacities in the DoWR and to contribute an additional 270 CAP investments over the project life cycle. Please see Annex 4's detailed budget notes for a detailed breakdown of planned infrastructure investments based on CAP and DoWR experiences to date. This is deemed the maximum level of support feasible considering the human resource and technical capacities conducting CAP operations at present plus the additional capacity provided by positions planned through this projects PMU. Noting the 270 is additional to the current CAP capacity which completed 100 investments in 2021 expected to increase each year with efficiencies. With the enhanced institutional processes in place from Outcome 3 it is envisioned that this project will also increase capacity of the DoWR to roll out greater than 100 CAP requests a year post project. Targeting the most vulnerable communities to climate change through the improved assessment process.

The 270 communities targeted for this Output will be selected from those DWSSPs developed under Outcome 1 and will be financed by GCF resources through the DoWR managed CAP. DWSSPs will be selected for CR WASH infrastructure projects through the method described in the 'Guide to the Capital Assistance Programme'. Please see Annex 22 sections 2.1 and 3.1 for pre-requisite conditions and list of eligibility criteria.

Once a DWSSP is deemed to meet the prerequisites and eligibility criteria a request for CAP funding will be developed by the RWC with assistance from the Provincial Engineers, DoWR Provincial Officers, Area Councils and PWRAC members. The project is then submitted through the review and approval process, please see Annex 22 for full details. In summary

- Will check that each application contains all of the required documentation (application form and an approved DWSSP).
- Will calculate the overall risk scores (safety and security) for each application (see Section 4.1 Annex 22).

- Will use the overall risk scores to categorise each new application (see Section 4.2 Annex 22).
- Make adjustment to the category for community commitment (see Section 4.3 Annex 22).
- On a quarterly basis, PWARC will prepare a summary report of applications awaiting financial assistance and submit to DoWR all applications for Category 6 and 5 [and possibly Category 4] communities for detailed works design and costing.
- On an annual basis, complete the application form to NWRAC, recommending the priorities for allocation of CAP funds
- NWRAC will, on an annual basis, review and make decisions on which community improvements will proceed, within the annual budget it has allocated to each province. NWRAC will notify provincial government of these decisions.
- DoWR will then administer the funds, contracting relevant suppliers as necessary to implement the constructions and requisite trainings as detailed in Activity 2.1.2 below.

To further support this process the project will assess the CAP criteria and upgrade the risk screening process to be more robust and provide a greater focus on climate vulnerability as described in sub activity 2.1.1.1 below. Further, the ESS Officer will provide technical capacity support to the Provincial Engineers and DoWR Provincial officers to provide technical support to communities in the development of ESS screening and impact assessments (for those projects deemed category B, estimated at <5% of applications based on CAP applications to date) for CAP proposals, as per Activity 2.1.1.2 described below.

Communities / water asset owners not covered by this project will be covered through updated CAP processes with alternative funding to meet the target National Sustainable Development Plan 2030 target of 'Ensur[ing] all people have reliable access to safe drinking water and sanitation infrastructure by 2030' (100% coverage of the population).

ACTIVITIES	SUB-ACTIVITIES
2.1.1: Improve CAP request prioritization, with gender and ESIA screening for chosen sites	2.1.1.1: Assess and update multi-criteria analysis for risk ranking process to prioritize CAP requests to identify sites for infrastructure planning. Additional criteria will be included to those risk criteria presented in Annex 22 to enhance focus on climate vulnerability. The new criteria to be incorporated includes, flood risk, sea level rise, degraded forest areas, groundwater resources and saline intrusion assessments. On approval of the changes by the PSC, 2 trainings will be provided to provincial facilitators to highlight and explain these changes. 2.1.1.2: Conduct relevant surveys, gender, environment and social safeguards screening and impact assessments in chosen sites. The ESS Officer, Provincial Engineers, National Engineer and DoWR provincial officers will assist communities/RWCs to conduct these activities.
2.1.2: Upgrade CR WASH infrastructure, with adequate O&M training	2.1.2.1: Construct and upgrade infrastructure for climate resilient water sources, distribution, and storage. Please refer to Annex 2 Feasibility Study Annex C for indicative list (and pictures) of climate resilient Infrastructure works to be financed through the CAP. This includes technologies such as concrete protection on spring sources, well head aprons, cyclone screws and tie downs, appropriate foundations for tanks, robust river crossing infrastructure, housing around tap and pipe stands, well covers, deep ground water wells (not shallow), relocation of wells from brackish water

	sources. These are a few examples and each CAP proposal will be assessed on an individual basis against proved CR-WASH designs. 2.1.2.2: Train RWCs on operation and maintenance for the CR-WASH infrastructure. The Water Resources Management Act states that the Minister must not establish a Rural Water Committee unless he or she is satisfied that the members of the committee have undertaken a: 1. Community development training - technical training at community level, specifically focused on plumbers training and community mobilisation to understand, operate and maintain infrastructure. 2. Water management and financial training – provided to the RWC to ensure effective and sustainable management of the infrastructure in the long term. These trainings are detailed in the budget and reflect the national regulation under the Water Resources Management Act and subsequent lump costs the DoWR have defined as minimum requirement for adequate training.

Despite being a single output component (tasked with infrastructure delivery), four activities have been identified as a part of Output 2.1 (Component 2). These activities will establish climate-resilient drinking water infrastructure and build capacity among vulnerable communities to maintain and operate these, thus ensuring a paradigm shift from build-neglect-rebuild approach.
Activity 2.1.1 will focus on updating the existing multi-criteria analysis to ensure that CAP requests being processed are more equitable, and focus on remote areas. This will ensure that sustainable drinking water services, which are provided through climate-resilient infrastructure, are available to under-served rural areas. This activity will complement Component 1 (which will invest in improved community governance of the infrastructure introduced through Component 2).
Activity 2.1.2 will mimic funding prioritization processes, and ensure baseline and exploratory assessments (covering gender, environment and social safeguards, impact and risk analysis) are conducted before investments are directed towards targeted communities. This will ensure investments in WASH infrastructure have equitable and gender-responsive outcomes.
The sub-activities will build the groundwork 2 to deliver the climate-resilient WASH infrastructure, while ensuring adequate training is delivered for operationalizing and maintaining these improved and new systems.

The AE will develop two completion reports for this Output: one report on communities supported and infrastructure delivered (with mapping of what was delivered where, which will show how DWSSPs help in prioritizing community-based needs). This deliverable will be merged with the deliverable for 3.1 to ensure consolidated and contextualized reporting. Further, the AE will deliver a consolidated report on operation and maintenance capacity in communities, how and what levels of engagement was ensured during infrastructure delivery, and whether equitable and meaningful gender participation was reflected.

Component 3: Provincial and national institutions are strengthened to address climate risks associated with water security

A key barrier identified in the process of adapting to climate-related water risks in Vanuatu stem from constraints at the institutional level – both provincial and national. Water security is simultaneously impacted by and contributes to climate change – and institutional strengthening is a key aspect in addressing these multifaceted risks effectively. Component 3, therefore, focuses on improving provincial and national institutions in Vanuatu by increasing capacity of governance staff and WASH sector partners, while also provisioning for knowledge management, data sharing mechanisms and M&E framework.

The Government of Vanuatu recognizes that essential to the effective delivery of the national DWSSP are standardised support tools and processes, the foundation being community-level DWSSP. Additionally, it also recognizes that essential to efficient delivery of the National DWSSP is reaching as many communities as possible by devolving responsibility and support to provincial government, coupled with national oversight and coordination of the many government agencies, implementing partners, technical support agencies. Keeping this mandate as context, Component 3 will work towards gearing institutional capacity at provincial and national level to ensure the effective and efficient delivery of the DWSSP and other related water management processes to manage the adverse effects of climate change. The expected outputs, along with activities, are listed below:

Output 3.1: National and provincial-level staff and WASH sector partners trained on climate-resilient water management

This output will focus on providing training to different levels of staff within the water governance structure, as well as to WASH sector partners, to ensure climate change and management of climate risks are mainstreamed within existing processes of water safety and security. In doing so, it will deploy different types of training – from the provincial and key line ministry level, to WASH sector partners – ensuring stakeholders across the board (and in the WASH industry) are better able to deliver on Vanuatu's emerging and ongoing needs related to climate-resilient water management.

The activities identified under Output 3.1 are:

ACTIVITIES	SUB-ACTIVITIES
3.1.1: Deliver enhanced administrative and technical capacity training for water management	3.1.1.1: Train PWRAC and DoWR staff on updated DWSSP, climate risks and water management 3.1.1.2: Host 2 engineers (1 male, 1 female) each in 6 provinces through humanitarian engineering assistance

The AE will develop one completion report for this Output, and will ensure the different types of trainings provided are reflected in separate sections of the report. Additionally, the AE will map the trainings conducted in the different provinces, and manage information collected on stakeholders, interest and influence levels, as well as gender participation.

Output 3.2: Knowledge management through data sharing mechanisms established for climate-resilient water management

This output will focus on knowledge management and monitoring and evaluation of the project, and improve the knowledge management and data sharing mechanisms available to the different stakeholders of the water and climate change sectors. Support, particularly, will be provided to WASH sector partners to be able to employ data for decision-making. One of GCF's paradigm shifting pathways for water security is creating and sharing knowledge to harmonise valuation methodologies with climate risks built into financial decisions for sustainable development – this Output will contribute towards this pathway and indeed pioneer a robust, climate-water- specific KM and M&E system for Vanuatu.

The activities identified under Output 3.2 are:

ACTIVITIES	SUB-ACTIVITIES
3.2.1: Improve knowledge management processes	3.2.1.1: Review existing knowledge management and identify gaps to be strengthened 3.2.1.2: Establish knowledge management protocol through consultative process
3.2.2: Operationalize data sharing platform	3.2.2.1: Integrate data collected through DWSSPs into government knowledge management platforms, such as DoWR data portal 3.2.2.1: Set and disburse relevant data management procedures to ensure data is compatible and aggregable within the system. 3.2.1.2: Engage relevant stakeholders to support effective utilization of data for decision-making by WASH sector partners

These activities are a step-by-step process for setting up a robust knowledge management system through the project. Firstly, through Activity 3.2.1, data will be collected and harmonized through existing platforms. Focus, through this activity, will be on presenting the data in a usable format and to inform decision-making by WASH sector partners. The sub-activities under Activity 3.2.2 will focus on assessing the operational efficiency and monitoring performance available though the NIP process. In case of updates, WASH partners will be trained and brought up to speed on the need to track indicators for improved water safety and climate resilience. Uniquely, this system will also be used to track the progress of this project (keeping in line with the government-led approach) for accountability, as well as for creating opportunities to disseminate lessons learnt and best practices.

The AE will develop one report on the KM mechanism developed, as well as periodical M&E report for tracking the progress of the project (as agreed with the AE, NDA and the DoWR). These progress reports will also be made publicly available through the KM mechanism.

Output 3.3: Monitoring, learning and evaluation framework established for improved learning for climate-resilient water management

This output will establish a MEL system and contribute to the same paradigm shifting pathway for water security as the previous output (creating and sharing knowledge to harmonise valuation methodologies with climate risks built into financial decisions for sustainable development). Having a MEL system, particularly for the sanitation and hygiene sub-sector will measure and ensure that inputs and activities lead to their intended results and outcomes; to adjust course where necessary (during the project lifetime); and to establish whether progress is being made; and lastly, to document lessons learnt and best practices. This will tie in with the DoWR's structure – which includes an M&E unit that keeps track of DWSSP progress and maintenance of system improvements.

ACTIVITIES	SUB-ACTIVITIES

3.3.1: Collate existing MEL practices within water governance structures in Vanuatu, and establish a robust MEL protocol	3.3.1.1: Stocktake existing MEL processes, and collate lessons learnt, case studies, and best practices available 3.3.1.2: Create an inventory of existing reports 3.3.1.3: Introduce robust MEL protocol, identified through a consultative process

The AE will develop periodical M&E report for tracking the progress of the project, and will use existing processes of the DoWR to do so. These progress reports will also be made publicly available and complement the Annual Reporting to the GCF.

9.4GCF investment criteria performance

Paradigm shift: This project will contribute to the second paradigm-shifting pathway identified in GCF's Water Security Sectoral Guide, namely *"strengthening integrated water resources management and water management"*, and will deliver on both sub-areas: (i) preservation of existing water resources; and (ii) development of new water supply sources.

Climate mainstreaming into the government-owned DWSSP process is nascent. While climate considerations are increasingly being integrated in water security and safety management, there remain significant needs for improvements to deliver climate-resilient water security benefits for rural communities in Vanuatu. By scaling up the number of climate-resilient DWSSPs registered (Component 1) and then delivering climate-resilient infrastructure and system improvements through prioritized DWSSPs (Component 2), the project will strengthen a whole-of-government approach to achieving climate-resilient water safety and security through the DoWR with associated decision-making processes that are decentralized, transparent, participatory, community-focused and evidence-based.

In doing so, the project will transition the current precarious water security and safety situation experienced by Vanuatu's rural communities in the face of climate change to one of a reliable and predictable supply of safe water. This will occur through climate-resilient, community-led planning and management practices (Component 1), and through climate-resilient water infrastructure (Component 2). By building and operating climate-resilient water infrastructure, interruption to services during and after disasters will be reduced or avoided. Therefore, this GCF project will reduce the costs associated with continual repairing and rebuilding after disasters, allowing the limited public funds available to be leveraged for investment in new WASH infrastructure and sustainable exploration of water sources.

By empowering and supporting communities to manage and operate their own water supplies in a climate-resilient way (through dedicated activities under Outputs 1.4 and 2.1), this project will help to break the cycle of "*build-neglect-rebuild*" characterising many WASH programmes in Vanuatu in the past. Not only will the project change the knowledge and practices of WASH sector partners, but it will also improve the longevity of the current TAP and CAP's impacts through institutional strengthening (Component 3) at local, provincial and national levels.

The key pillars of the project's transformational impact will be the increased awareness, knowledge, skills and capacities at all levels (Outputs 1.2 and 3.1), the establishment of a community of practice at the local level (Output 1.2), and the mechanisms and systems strengthened for enhanced knowledge management, data sharing and MEL (Outputs 3.2 and 3.3).

The paradigm shift will also support transitioning towards gender-transformational WASH investments,. Vanuatu's currently limited WASH service delivery and infrastructure affect women and men differently. Traditionally, gender roles involve women and girls providing more labour and spending more time than men and boys in managing the household's water, sanitation and hygiene needs[95]. Increased time spent by women and girls to obtain water during dry seasons or after climate-induced emergencies increases their exposure to gender-based violence (GbV). Conversely, improving predictability and location of water sources will reduce exposure to such risks, increasing personal safety and security in addition to the safety and security of water supply. Similarly, the participation of women in water user communities and in decision-making processes under the DWSSPs will ensure that gendered needs are mainstreamed into the design of new and maintenance of existing WASH infrastructure.

Sustainable development: This project will generate significant environmental, social and economic benefits. It will reduce the negative environmental impacts of poor wastewater management by improving the behaviour and practices of communities through the sanitation component of DWSSPs (outputs 1.2 and 1.4). It will also achieve a better protection of water sources and forested water catchment areas (output 1.4) through no and low-cost community improvements. In addition, the project will highly contribute to an equitable access to water as a basic human right in Vanuatu, targeting especially the most vulnerable in rural communities. Other significant social benefits include health improvements (higher water safety and security leading to less stunting and diarrhoea) and an improved situation for women through their role in water committees. Finally, the project will be economically beneficial through avoided health costs (because of improved water security and sanitation practices) and avoided damages in case of disasters (because of resilient infrastructure and maintenance training).

The project responds directly to SDG13 – Climate Action, SDG6 – Clean Water and Sanitation, and SDG5 – Gender Equality through its objective of building climate-resilient and gender-equitable water safety and security in Vanuatu. Finally, by transitioning the water sector towards climate resilience and the management of climate risks, the project contributes towards the objectives of Vanuatu's National Sustainable Development Plan 2016–2030 and the Vanuatu National Water Policy 2017–2030.

Needs of recipients: This project will address some of the vital needs of rural communities in Vanuatu. Over 24,000 households across the country are reliant on either rainwater or surface water for their primary drinking water supply. Also, one third of households have no alternative source of drinking water. These issues have been, and will continue to be, exacerbated by climate change. This project will address the fundamental human right to safe drinking water. Through an already existing prioritization process that the project will also improve, those communities that have elevated levels of vulnerability, low access to WASH services and are exposed to climate risks

[95] Halcrow et al. (2010), Resource Guide: Working effectively with women and men in water, sanitation and hygiene programs, International Women's Development Agency and Institute for Sustainable Futures, University of Technology Sydney, Australia, available at:

http://www.genderinpacificwash.info/system/resources/BAhbBlsHOgZmIj4yMDExLzAxLzI0LzE5LzA0LzI3LzIwMi9XQVNIX1JFU09VUkNFX0dVSURFX2ZpbmFsNHdlYi5wZGY/WASH%2520RESOURCE%2520GUIDE-final4web.pdf will be targeted first. These communities are the most in need of climate-resilient water management interventions. As the project is rolled out, it will ultimately assist all rural communities by strengthening the enabling environment for resilient interventions.

Country ownership: This project is listed as the first priority project in the pipeline presented in Vanuatu's GCF Country Programme[96] and has been fully co-developed with the DoWR, along with other national stakeholders. By addressing climate change risks and impacts on water management, and by working directly with vulnerable rural communities on community-based adaptation activities, the project is fully aligned with the Government of Vanuatu's climate change strategies and policies, including the Climate Change and Disaster Risk Reduction Policy 2016–2030 (e.g. Strategic priority 7.4.3) as well as the NAPA and the NDC, which both reference water resource management as a top priority. In addition, the project is fully in line with Vanuatu's National Sustainable Development Plan 2016–2030 (e.g. Objective ECO2.2) and National Water Policy 2017–2030. The project responds directly to the Government of Vanuatu's goal for every rural community to have a DWSSP by 2030, as outlined in the Water Resource Management Act and the Water Supply Act.

[96] Vanuatu's GCF Country Programme is available here:
https://www.greenclimate.fund/sites/default/files/document/country-programme-vanuatu.pdf

10. Parallel investments relevant to the proposed project

10.1 GEF proposal: Water & Food Security in the Pacific

Context: In December 2020, the GEF-7 project concept “Enhancing water-food security and climate resilience in volcanic island countries of the Pacific” was approved by the GEF Council for design by the Food and Agriculture Organization of the United Nations (FAO - Implementing Agency) in collaboration with SPC (as the Executing Agency).[97] The USD 6 million full-size regional project will be implemented in Fiji, Vanuatu, and Solomon Islands over the period of 5 years. A full project proposal is under development (current status – Concept Approved). Currently, on the GEF Project Details tab – the concept of the project remains approved. The overall project objective is “*to enhance water and food security and climate resilience, sustain ecosystem services, and relieve pressure on over-exploited coastal aquifers by expanding and assessing the role of volcanic aquifers and by introducing sound groundwater governance frameworks in selected volcanic island states of the Pacific.*”

Description: The four components with the main associated activities as identified in the project identification form (PIF) are presented below:

Component 1: Expanding and assessing the role of groundwater resources

In many of the larger volcanic islands in the Pacific there are indications of the presence of large, exploitable groundwater resources at economically reachable depths and resilient to climate variability.

Component 2: Introducing sound groundwater governance frameworks

The main objective under this component is to facilitate the adoption of aquifer management plans following the recommendations and methodologies of the “Groundwater Governance Project” (GEF/FAO/World Bank/UNESCO/ IAH)

Component 3: Tackling hot-spots

Activities include targeted on-the-ground interventions necessary to achieve the Outputs under Components 1 and 2 and other specific objectives under Component 3. “Hot spots” will be targeted to address and potentially resolve priority issues of concern related to groundwater, including groundwater production infrastructure for agricultural and drinking water purposes.

Component 4: Reinforcing institutional capacity

Enhanced institutional capacities in groundwater assessment, management and monitoring in the three project countries.

The project components are closely connected to regional and international agreements (SENDAI framework, SDGs, Framework for Resilient Development in the Pacific), and are consistent with

[97] Project details are available here: https://www.thegef.org/projects-operations/projects/10712

several national goals and strategic targets identified in the “2017-2036 National Development Strategy” for Fiji, the “2016-2035 National Development Strategy” for the Solomon Islands, and the “2016-2030 National Sustainable Development Plan” for Vanuatu. Recognising that water security is an issue relevant to multiple sectors and actors, the project will focus on the development and strengthening of existing and new partnerships with government and non-government organisations at the local, national and regional levels. There is significant opportunity to amplify the benefits of this parallel investment through the proposed GCF project, and such synergies will be identified in the implementation stage.

10.2 GCF proposal: Malekula Water Supply Project

Context: The proposed project, Malekula Water Supply Project: Increase Resilience of Vulnerable and Marginalized Communities of Malekula Island through Integrated Water Resource Management and Ecosystem-based Interventions, is important to be kept on the radar for this proposal. Both are envisioning key interventions to increase water security and safety as well as climate resilience of the marginalized communities in Vanuatu. The project context and description of the Malekula Water Supply project is presented below.

Context: The impacts of climate change are reducing the availability of fresh water in Malekula, with groundwater becoming increasingly saline because of saltwater intrusion and rainfall becoming increasingly erratic. The Government of Vanuatu has prioritised ecosystem-based approaches to adaption in the Vanuatu Climate Change and Disaster Risk Reduction (CCDRR) Policy 2016-2030 to minimise the risks of climate change and disasters while enhancing local livelihoods resilience.[98] This policy is aligned with the National Environment Policy 2016-2030 that prioritises climate change adaptation and disaster risk reduction measures, as well as implementation of the CCDRR policy by 2030.

Description: To address the growing climate risks to water resources, this project will apply an ecosystem-based adaptation (EbA) approach to ensure reliable and sustainable water supply for ni-Vanuatu communities under future climate conditions, specifically by protecting and restoring ecological infrastructure, complemented by introducing new, resilient water supply systems in northern Malekula, to provide communities with a reliable source of potable water. This will shift the development pathway away from small, decentralised systems which are vulnerable to the impacts of climate change, towards larger centralised systems which are resilient to the impacts of climate change, and which can be better monitored. Communities not connected to the centralised system will also benefit through the development of an emergency water supply protocol that will facilitate the provision of water to them both during and after extreme climatic events when local supplies are disrupted.

This project is at the concept note stage and was first submitted in September 2019 by UNEP. The indicative total project cost is $20,1000,000.

10.3 Relevant projects

These are the relevant projects available on the National Advisory Board on Climate Change and Disaster Risk Reduction of the Government of Vanuatu. It should be noted that the status of most

[98] Concept Note is available here: https://www.greenclimate.fund/sites/default/files/document/22710-malekula-water-supply-project-increase-resilience-vulnerable-and-marginalized-communities.pdf

of these are marked current, even if the project timeline has expired. Some of the examples have also been sourced from other WASH partners.

TIMEFRAME	PROJECT	IMPLEMENTING AGENCY	DESCRIPTION
2015	Standardization of WASH in Emergency Information Education and Communication Material[99]	UNICEF and the National Advisory Board, with multiple partners	UNICEF partnered with Adventist Development and Relief Agency (ADRA), an NGO that is a member of the WASH cluster and has expertise in Water, Sanitation and Hygiene Promotion and Emergency Response, to coordinate and manage the preparedness and response efforts of this project. As an implementing partner, ADRA provided technical support, coordination and management of stakeholder consultations, pretesting, production, prepositioning and provide training to stakeholders in Vanuatu to use the WASH in emergency standardized messages and IEC materials developed.
2018-2022	GCF - Vanuatu Klaemet blong Redy, Adapt mo Protekt (Van-KIRAP) Project[100]	SPREP	The project builds the technical capacity in Vanuatu to harness and manage climate data; develop and deliver practical CIS tools and resources; support enhanced coordination and dissemination of tailored information; enhance CIS information and technology infrastructure; and support the application of relevant CIS through real-time development processes, for more resilient outcomes. The project has a focus on addressing information gaps and priority needs of target beneficiaries at national, provincial and local community levels across the five priority sectors.

[99] https://www.nab.vu/project/standardization-wash-emergency-iec-material

[100] https://www.greenclimate.fund/project/fp035

2013-2018	Increasing Resilience to Climate Change and Natural Hazards in Vanuatu (IRCCNH)[101]	National Advisory Board (NAB) on Climate Change and Disaster Risk Reduction	The project development objective is to increase the resilience of communities in Vanuatu to the impacts of climate variability and change, and natural hazards, on food and water security, as well as livelihoods.
2012	Supporting Community Planning for more resilient Vanuatu[102]	Vanuatu Red Cross Society	In the scope of the "Supporting Community Planning" project, the Vanuatu Red Cross Society is targeting 11 communities (2.500 people) in Torba Province as follow: - Torres: Hiu Island: Yagavegemena community : HF radio, improvement of evacuation point; - Torres Toga Island: LIteu & Likwal communities: HF Radio - Vanualava: Vatop community : HF Radio - Gaua: Lemanman & Lemoga communities: Improvement of evacuation point - Gaua: Qwetevaveg community: HF Radio; - Motalava: Rah, Nereningman, Queremagde, Totolag, Avar communities: Gravity fed System (access to safe water)
N/A	Several WASH projects (community level)[103]	ADRA	ADRA's projects for Water, Sanitation and Hygiene are working towards Vanuatu's National Sustainable Development Goal ECO 2.2 to "Ensure all people have reliable and safe drinking water and sanitation infrastructure".

[101] https://www.nab.vu/projects/increasing-resilience-climate-change-and-natural-hazards-vanuatu

[102] https://www.nab.vu/projects/supporting-community-planning-more-resilient-vanuatu

[103] https://adra.org.vu/our-projects/wash/

2011-2014	ADRA Vanuatu Sustainable Development Fund Water, Sanitation and Hygiene Project[104]		These help to educate communities on the importance of safe drinking water and hygiene practices. They are also the first step in improving water infrastructure for the people of Vanuatu. ADRA's WASH projects also include working with communities in hard to reach locations like West Santo to improve their water access and sanitation. This work involves construction of infrastructure such as water tanks, pumps and toilets, along with education of good hygiene practice.
N/A	Several WASH projects (community level)[105]	World Vision Vanuatu	World Vision Vanuatu works with and through different partners to deliver WASH programming, to improve health outcomes and also to target women and people with disabilities.
N/A	WASH Vanuatu (Port Vila and Luganville)[106]	Arup Live and Learn International	This project focused on creating enterprise opportunities based on sanitation improvements in two cities of Vanuatu.

[104] https://www.nab.vu/projects/adra-vanuatu-sustainable-development-fund-water-sanitation-and-hygine-project

[105] https://www.wvi.org/vanuatu/our-work

[106] https://www.arup.com/projects/wash-vanuatu

11. Key findings: gender assessment (Annex 8 - FP)

Annex 8 - the Gender Assessment and Action Plan – presents the gender mainstreaming exercise undertaken during the project preparation stage. The proposed project recognises the lack of a gender-responsive approach in Vanuatu that could limit the potential, inclusiveness and success of the project objective, stemming from:

- Poor or missing gender analysis or assumptions that climate services or adaptation actions are gender-neutral[107];
- Side-lining of gender needs or ethnic vulnerabilities in adaptation design, resilience capacity-building and mitigation services;[108] and
- Lack or scant allocation of financial means, gender budgets and dedicated resources towards mainstreaming gender action[109].

Annex 8, therefore, presents an assessment of the different roles, rights, needs and opportunities of women and men, boys and girls in the project context, and mobilise project resources to tackle gender barriers, and contribute towards improved gender equality in Vanuatu. Using gender as a lens will also help identify the social relationships between women and men, and other marginalized groups in Vanuatu. The adaptation pathway chosen by this project recognizes that access to WASH is fundamental to development, but it can be mobilized as critical climate adaptation strategy for poor and vulnerable communities, as well as marginalized groups within those communities, including women and girls.[110]

Gender barriers identified through stakeholder consultations with Department of Women's Affairs as well as among communities are:

[107] See Butterfield, R. (2018) 'Bringing rights into resilience: revealing complexities of climate risks and social conflict' in Disasters. Journal Article.

[108] Poor or missing gender analysis, or the lack of gender-responsive action, may lead to planners or personnel depending on women to assume a central role in their coping strategies, which may not be the practical reality for many vulnerable communities. Further, this also glosses over the existing burdens on women among such groups. See Nelson. V., Meadows. K., Cannon, T., Morton, J., & Martin, A. (2002) 'Uncertain predictions, invisible impacts and the need to mainstream gender in climate change adaptations' in Gender and Development. Journal Article.

[109] Department of Women's Affairs (2020). Beijing +25 – National Review Report. Available at: https://www.asiapacificgender.org/sites/default/files/documents/Vanuatu%20(English).pdf

[110] Winqvist, E. (ed.) (2020). Feminist Policies for Climate Justice. Stockholm: Concord. Available at: https://concord.se/wp-content/uploads/2020/06/fem-rapport-2020-final.pdf

- Different gender groups, particularly women and girls, have gendered needs, which remain underserved by existing WASH infrastructure and are impacted by humanitarian emergencies;
- Women continue to be underrepresented in water security and climate adaptation-related decision-making bodies, despite registering better performance when represented;
- Insufficient, non-resilient WASH infrastructure continue to be compromised by climate risks, increasing time poverty among certain gender groups; and,
- Water insecurity indirectly and directly combines to exacerbate gender inequality in other sectors (such as limited land rights) and limit adoption of adaptation and resilience strategies.

The project has identified the following co-benefit as a part of its Section E: Logical Framework.

Project/programme co-benefit indicators						
Co-benefit #	Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions/ Notes
				Mid-term	Final	
Co-benefit 1	Improved gender parity in representation of women in Rural Water Committees (RWCs)	Registration of RWCs with members (indicating a minimum of 40% of women)	Women are not well-represented across water governance or devolved utility authorities across Vanuatu - exact figures are currently unavailable.	40% of RWCs registered, with 40% of women in each.	Remaining 60% of RWCs registered, with 40% women in each.	40% RWCs registered by mid-term and 100% expected by project conclusion. There is political will in involving women in different sub-national contexts and in water governance institutions. Women may not be, however, able to participate meaningfully participate due to sociocultural barriers, and demands on their time due to unpaid care work within the household.

This co-benefit will act on the finding[111] that women are underrepresented in water user committees in Vanuatu, and establish Rural Water Committees (RWCs) through the DWSSP

[111] Mommen, B., Humphries-Waa, K., Gwavuya, S. (2017). "Does women's participation in water committees affect management and water system performance in rural Vanuatu?" in Waterlines, v. 2017.

processes that provision for a minimum of 40% representation.[112] Women's underrepresentation is detrimental, as UNICEF research has demonstrated that their meaningful participation can increase the effectiveness of community-based management models. This co-benefit feeds into the legal pre-requisite for the registration of RWCs (40% female representation is mandatory) in Vanuatu, under the Water Resources (Amendment) Act No. 32 of 2016.

This will be measured as an independent indicator and will be delivered in tandem with (primarily) Component 1, which will establish 600 new DWSSPs in Vanuatu, alongside providing policy and climate training. Further, the project will also ensure that infrastructure delivery (through Component 2), and trainings (as well as policy strengthening) provided through Component 1 and 3, incorporate findings from the gender consultations.[113] Participants, at the community-level stakeholder consultations, identified key gender groups and articulated their different needs. These were summarized by a breakout group (which reflected other stakeholder groups in the Sanma and Tafea provinces) in Penama province below.

Gender Group	Needs
Elderly (60+)	▪ Easy access/tap stands to be in close proximity ▪ Taps fitted at a lower level for accessibility ▪ Ball taps for ease of use ▪ Solar lighting in the tap use area
Disability/Disabled	▪ Easy access ▪ Ramp for wheelchair/hand-rail ▪ Solar lighting in the tap use area
Women (menstruating/lactating)	▪ Separate shower facilities with dignity facilities ▪ Safe house for menstrual hygiene ▪ Separate individual tank with RWCs for menstrual hygiene / child-related water use ▪ Solar lighting for security / privacy
LGBTQI	▪ Separate shower facilities ▪ Solar lighting for security / privacy
6-18 years (school students)	▪ Separate water storage for: ▪ bathroom use and kitchen use (to reduce collection burdens)
0-5 years	▪ Safety valves to be fixed before taps are installed
***NB*. There is an urgent need to install gender-responsive signs to specifically assigned facilities at the community level.**	

[112] The Rural Water Committee usually takes overall responsibility for developing their supply-specific DWSSP. However, technical and facilitation support will be needed to develop a DWSSP. A community DWSSP team needs to be established, usually comprising members of the Rural Water Committee, women's, men's, youth and church group representation, local plumbers and carpenters, and the head person. This brings together a variety of perspectives from the people who know the water supply and how it is used. Further detail can be found here: Vanuatu's National Implementation Plan for Safe and Secure Community Plan, available at – https://mol.gov.vu/images/News-Photo/water/DoWR_File/Management_Plans/Vanuatu-NIP-Guide-annual-CAP-210818.pdf

[113] During implementation, these designs will be further defined and specified through further consultations and workshops at the community level. These will be dispensed through the process of developing 600 DWSSPs through Component 1.

The proposed solution recognizes that bridging practical gender needs (e.g. access to water) with strategic gender interests (e.g. changes in power and roles) is critical to achieving transformational changes in gender equality in Vanuatu, where underrepresentation of diverse gender groups limits the efficacy of existing infrastructure and the potential of new investments. Through the planned trainings (where 50:50 gender balanced beneficiary distribution is targeted), alongside this co-benefit to ensure increased, meaningful participation of women in RWCs, the project will also be able to explore five WASH- and climate change-relevant elements of empowerment: participation, decision-making, information, capacity building and leadership.In doing so, the assessment operationalises gender mainstreaming activities through the project's results framework by formulating a Gender Action Plan, based on the project's Logical Framework (Section E of the Funding Proposal). This ensures that the proposed design[114], to deliver improved water security and increased climate resilience at community level, can have climate, environmental and social co-benefits, with identified indicators, timeline and means of verification.

[114] Please refer to Section E for the Logical Framework in the Funding Proposal (FP). The Gender Action Plan (GAP) (Section 8 of Annex 8) provides impact and outcome statement for each component in relation to gender mainstreaming entry points and proposed actions for the project, to be evaluated against a set of indicators and targets as well as delineation of timeline, responsible parties and costing. The paradigm shift potential of the results framework is captured in the Theory of Change, available in the FP as Section B.2 and further described in Section D.

Annex A. Climate study: scope, data and methodologies

Study scope

Scenarios: RCP4.5 (as the focus with examples) and RCP8.5

Time slice: 2050 (or from 2041 to 2070)

1. Site-specific analysis for more than 30 years historical observation station precipitation and temperature data from NCDC daily summary dataset; variations, and trends and future projections were analysed;
2. GCM/RCM ensemble approach: CMIP5 22 CORDEX AUS Domain RCM and 40 GCMs outputs. GCM/RCM model ensemble approach will be applied to show the confidence intervals;
3. Spatial maps were generated to illustrate the large scale background of the climate change risks, could include: annual mean and precipitation historical and future changes use the WorldCLIM2 dataset;
4. Site-specific extreme rainfall was analysed where data was available;
5. Extreme wind speed analysis based on a global dataset;
6. SPEI drought analysis with charts;
7. Sea-level rise and extreme water level change for the coastal area were analysed;
8. Detailed methodologies and data sources are documented;
9. Review of each of the above-listed climate change impacts on the proposed water infrastructure project in Vanuatu;

Table 38: Ten populated areas selected for the study

ID	Latitude	Longitude	Name	Province
1	-17.736	168.314	Port Vila	Shefa
2	-15.52	167.162	Luganville	Sanma
3	-16.065	167.397	Norsup	Malampa
4	-15.042	167.073	Port-Olry	Sanma
5	-19.542	169.282	Isangel	Tafea
6	-13.876	167.552	Sola	Torba
7	-16.1	167.416	Lakatoro	Malampa
8	-15.7372	168.1344	Melsisi	Penama
9	-16.4222	167.806	Lamap	Malampa
10	-20.2351	169.7832	Aneghowhat	Aneityum Tafea

Table 39: Weather station IDs

Station ID	Name	lat	long
915680-99999	Aneityum	-20.233	169.767
915650-99999	White Grass Airport	-19.450	169.217
915570-99999	Bauerfield (Port Vila)	-17.700	168.300
915550-99999	Lamap (Malekula)	-16.417	167.800
915540-99999	Santo-Pekoa Airport	-15.517	167.217
915510-99999	Sola (Vanua Lava)	-13.850	167.550

Data sources

1. Historical observational weather station data was obtained from NCDC for station-specific analysis. There are six stations in Vanuatu that have relatively complete long term records for trend analysis, as shown in the figures.
2. WorldCLIM2 dataset (http://www.worldclim.com/version2) for Vanuatu was applied for precipitation and mean spatial temperature variation and mapping purposes.
3. With the absence of quality observational wind speed data, we applied the following GAR15 cyclone extreme wind speed data for Vanuatu historical extreme wind speed analysis: (https://risk.preventionweb.net/capraviewer/main.jsp?tab=3)
4. Historical extreme water level data was calculated based on the data provided by Muis et al. (2016): Muis, S., Verlaan, M., Winsemius, H. C., Aerts, J. C., & Ward, P. J. (2016). A global reanalysis of storm surges and extreme sea levels. Nature communications, 7, 11969. A global reanalysis of storm surges and extreme sea levels: https://data.4tu.nl/repository/uuid:29614991-345e-4ffd-be22-2930912a2798
5. With the absence of quality data for drought analysis, Gridded data was applied for SPEI drought analysis: Daily precipitation, maximum and minimum temperature, solar radiation data. If local observation data was not adequate, other data sources were applied, such as the Global Meteorological Forcing Dataset for land surface modelling, 0.5 by 0.5 degree, from 1961-2012. For information access: http://hydrology.princeton.edu/data.php.
6. Climate change scenario data were obtained from CMIP5 GCM and RCM data sources: CMIP5 GCM data: https://esgf-node.llnl.gov/search/cmip5/ CORDEX RCM data: https://esg-dn1.nsc.liu.se/search/cordex/ GCM and RCM data lists could be found in the appended lists.

Variable	Models applied (equal weighting was applied for all the model ensembles)
Monthly mean precipitation and temperature	40 GCMs as listed in table A1, and 22 RCMs in table A2
Extreme precipitation	22 GCMs listed in table A3
SPEI drought index	40 GCMs listed in table A1
Extreme wind speed	26 GCMs listed in table A5
Coastal extreme water level	28 GCMs listed in table A6, 26 GCM listed in table A5, and 28 GCMs listed in A4

Methodologies

Monthly mean precipitation and temperature future change analysis

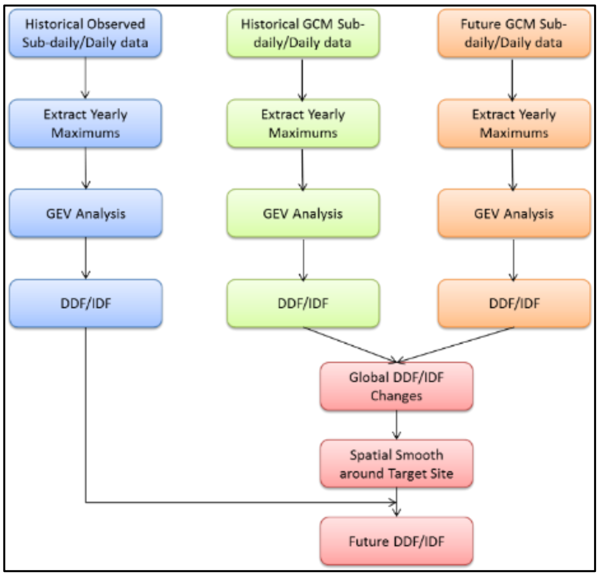
Monthly mean precipitation, temperature future changes were calculated based on a pattern scaling approach. Pattern scaling techniques have been widely used to provide climate change projections for periods and emission scenarios that GCMs have not simulated. The assumption underlying these methods is that the local response of a climate variable is linearly related to the global mean temperature change, with the geographical pattern of change independent of the forcing (Mitchell *et al.*, 1999, and Mitchell, 2003). Thus, the anomaly in variable V, for a particular grid-box (i), month or season (j), year or period (y), and forcing scenario (x) is given by:

$$\Delta V_{xyij} = \Delta T_{xy} V'_{ij}$$

where *ΔT* is the global mean temperature anomaly and V' is the normalised local response patterns derived from GCM/RCM simulations. Climate change scenario data from the SimCLIM 4.0 for Desktop software system data package was applied for this pattern scaling application based on monthly temperature and precipitation data. For details, please visit: http://documents.climsystems.com/SimCLIM%204.0/SimCLIM%204.0%20for%20Desktop%20Data%20Manual.pdf

Extreme precipitation and depth duration frequency analysis

Several components are included in this process as depicted in Figure 1: (1) Historical observation daily or sub-daily extreme event analysis, and depth duration frequency (DDF) calculation; (2) GCM historical data extreme event analysis; (3) GCM scenarios extreme event analysis; (4) GCM extreme event DDF change factor analysis; and (5) Future DDF perturbation which is to add DDF change factors to observed historical DDF.



Historical Observation Depth Duration Frequency (DDF)

Step 1: Derive the rainfall intensity time series of the different durations from historical 3 hourly data time series. The durations include: 3, 6, 12, 24, 48, 72, 120, 144 and 168 hours, then select annual maxima series from the rainfall intensity series. Fit the annual maxima series for each duration to a group of probability distribution functions. Three distribution functions are tested, including: Generalized Logistic (GLO), Generalised Extreme Value (GEV), and Gumbel distribution. Choose the method to deploy for distribution parameter estimation.

Step 2: Assess their goodness of fit with the Anderson-Darling test to follow the method of Viglione (2008). The Anderson-Darling test measures the extent of the departure, in terms of probabilities, between a simulated hypothetical distribution and the frequency distribution for consideration. If the estimated probability is greater than some defined significance level, the test fails. Explore which of the three distributions, provides the best fit. To illustrate, we continue with the presumption that GEV parameters are used for further analysis.

Step 3: Calculate rainfall depths for ar ange of return periods (including 2, 3, 5, 10, 15, 20, 50, 100, 150, 200, 500, 1000 and 10000) for each storm duration using GEV distribution parameters obtained from **Step 1**. The values form the table of depth-duration-frequency (DDF). The intensity-duration-frequency (IDF) table is computed directly from the DDF table by simply dividing the rainfall depths by duration in hours.

Future DDF calculation

The impacts of climate change on historical DDF are evaluated based on climate model data. To reduce the uncertainty of climate change simulated by GCMs, the outputs of as many GCMs as possible should be used. According to the Fifth Assessment Report of IPCC (AR5), there are 40 GCM models developed by various research centres worldwide. Currently, only 22 GCMs out of the 40 GCMs are validated because: i) Not all the GCMs generate selected RCPs for future climate scenarios (i.e., RCPs 2.6, 4.5 and 8.5); and ii) there are some technical issues related to downloading (such as connecting to remote servers or repositories) for some GCM models.

The basic procedure is to employ an equidistant quantile matching (EQM) method to update the DDF and IDF curves under changing climate conditions.

Step 1: GCM 3 hourly output for each grid cell are analysed using extreme value analysis (EVA) to calculate extreme rainfall amounts for the current climate (called the baseline, 1986-2005), and the future periods of interest (2050).

Step 2: DDF change factors for a range of durations (3, 6, 12, 24, 48, and 72, 120, 144 and 168 hours) and return years (2, 3, 5, 10, 15, 20, 50, 100, 150, 200, 500, 1000 and 10000) for each GCM under RCP4.5 and RCP8.5 (or other RCPs) are calculated by applying a pattern scaling approach (Li and Ye, 2011).

Step 3: Interpolate the global DDF change patterns into the same spatial resolutions (0.5^{o} x 0.5^{o}) to construct a global database. Furthermore, a super ensemble method can be applied to derive ensemble statistics at different percentiles (e.g., 25^{th} and 75^{th} percentile of the GCM ensemble), with both RCP4.5 and RCP8.5 change factors for all GCMs being applied equally without any weighting.

Step 4: Perturb the historical estimated precipitation depth/intensity values of each duration and return period using the global DDF change factors for the studied area for the selected future time periods (*e.g.* 2050 RCP8.5). The global DDF changes show high variability around the world. There are also considerable differences among GCM members. To further reduce the impact of natural variability, change factors are applied that are averaged over the studied region.[115]

This approach is applied to perturb the change in extreme event changes, which is crucial for stormwater management. Sørup *et al.* (2017) applied a similar DDF perturbation method, which is a promising way of creating artificially perturbed precipitation time series that can represent a changing climate and be used as input in hydrologic and hydraulic models.

SPEI based drought intensity and frequency analysis

Historical and future drought intensity, frequency, and duration analysis was carried out using the Standard Precipitation Evapotranspiration Index (SPEI) output. SPEI is based upon precipitation and potential evapotranspiration data and has the capacity to include the effects of temperature variability in drought risk assessments. SPEI is based on a water balance; it can be compared to the self-calibrated Palmer Drought Severity Index (PDSI) developed by Vicente-Serrano *et al.* (2010). The SPEI uses the daily or monthly (weekly) difference between precipitation and PET (Potential Evapotranspiration), which is a simple water balance methodology that is calculated at different time scales to obtain the SPEI. The results of an SPEI calculation are represented as positive (wetter than normal) and negative (drier than normal) conditions. Drought is a key concern of this analysis. An example of the SPEI number (0.0 to -0.99) and their relationship with the severity of drought being modelled and the return period likelihood per 100 years are provided in Table 1.3.
Daily precipitation, maximum and minimum temperature, solar radiation data for SPEI calculations were applied. If local observation data was not adequate, other data sources were applied, such as the Global Meteorological Forcing Dataset for land surface modeling, 0.5 by 0.5 degree, from 1961-2012. For information access: http://hydrology.princeton.edu/data.php.

SPEI	Category	# of times in 100 yrs.	Severity of event
0 to -0.99	Mild dryness	33	1 in 3 yrs.
-1.00 to-1.49	Moderate dryness	10	1 in 10 yrs.
-1.5 to -1.99	Severe dryness	5	1 in 20 yrs.
< -2.0	Extreme dryness	2.5	1 in 50 yrs.

A change factor approach was applied for climate change projection of each variable of the future SPEI calculation, including the change factors of monthly precipitation, maximum and minimum temperature, and solar radiation derived from GCM data. For detailed information regarding pattern scaling and change factor methods and GCM information, please refer to the CLIMsystems data manual (http://climsystems.com/simclim/downloads).

The overall change in the incidence of drought is described by the 'percent of the time in drought.' This is calculated by aggregating the durations for drought events in the moderate, severe, and extreme categories during the period of interest. Projections of drought in each category for drought duration and frequency were estimated according to the median of model ensemble projections for each scenario for the selected future period.

Extreme wind speed analysis

A change factor approach is applied for extreme wind speed change analysis. For each GCM, the wind speed change values were derived directly from the GCM data between the future and historical periods. Then, the 75th percentile of the GCM ensemble for both wind speed changes was applied.

Coastal extreme water level

Global extreme coastal extreme water levels at 0.05-degree resolution for every decade from 2030 to 2100. This included the extreme water level Average Return Intervals (ARIs): 10, 50, 100, 250 years, with 5%, 50% and 95% of the GCM ensemble in future projections.

The change factors of extreme water level for the future were derived from the CMIP5 GCM ensemble changes in three components: mean sea level rise, extreme sea level pressure, and extreme wind speed.

The global mean sea level rise of 28 GCMs between 1986-2005 and 2081-2100 is calculated by the pattern scaling method and included in the data package described in (1) above. GCM data are retrieved from the Earth System Grid (ESG) data portal for CMIP5, including the sea surface height ('zos'), the global average thermosteric sea level change ('zostoga') and the global average sea level change (' zosga') under RCP8.5 scenario. For some GCMs, only 'zosga' was available and used instead of zostoga. You can find details on the GCM data in the appendix.

Limitations of data and methodologies

- Constrained by the absence of the quality and density of the observational data, public available gridded climate data sources were applied for spatial and site-specific analysis.
- The climate change projections produced by a pattern scaling approach are the average climate status during a period, such as 2050 is the average climate over 2040-2060. Therefore, it could not reflect the inter-annual variability of climate variables.
- The local climate of Vanuatu cannot be resolved in coarse resolution GCM or RCMs. More careful downscaling approaches could be applied (Mearns et al., 2003). However, given the time and effort constraints, only the readily available GCM and RCM data was applied in this study.
- A super ensemble uses each model as an independent statistical sample and reflects substantial intermodal variability in the GCMs and RCMs. However, this approach could be hampered by a lack of independence among models and systematic sampling of the projections' uncertainties (Tebaldi & Arblaster, 2014).

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Appendix I (Annex A)
GCM and RCM lists for analysis

Table A1: Availability of GCM variables in the CMIP5 monthly database

No	Model	Temp	Precip	SolRad	RelHum	Wind	SLR
1	ACCESS1.3	Yes	Yes	Yes	Yes	Yes	
2	ACCESS1.0	Yes	Yes	Yes	Yes	Yes	
3	BCC-CSM1-1	Yes	Yes		Yes	Yes	Yes
4	BCC-CSM1-1-m	Yes	Yes		Yes		Yes
5	BNU-ESM	Yes	Yes				
6	CanESM2	Yes	Yes	Yes	Yes	Yes	Yes
7	CCSM4	Yes	Yes	Yes	Yes		Yes
8	CESM1-BGC	Yes	Yes	Yes	Yes		
9	CESM1-CAM5	Yes	Yes	Yes	Yes		
10	CMCC-CM	Yes	Yes	Yes		Yes	Yes
11	CMCC-CMS	Yes	Yes	Yes		Yes	Yes
12	CNRM-CM5	Yes	Yes	Yes		Yes	Yes
13	CSIRO-Mk3-6-0	Yes	Yes	Yes	Yes	Yes	Yes
14	EC-EARTH	Yes	Yes			Yes	
15	FGOALS-g2	Yes	Yes				
16	FGOALS-s2	Yes	Yes				
17	GFDL-CM3	Yes	Yes	Yes	Yes	Yes	Yes
18	GFDL-ESM2G	Yes	Yes	Yes	Yes	Yes	Yes
19	GFDL-ESM2M	Yes	Yes	Yes	Yes	Yes	Yes
20	GISS-E2-H	Yes	Yes	Yes	Yes	Yes	
21	GISS-E2-H-CC	Yes	Yes	Yes	Yes	Yes	
22	GISS-E2-R	Yes	Yes	Yes	Yes	Yes	
23	GISS-E2-R-CC	Yes	Yes	Yes	Yes	Yes	
24	HADCM3	Yes	Yes	Yes	Yes	Yes	
25	HadGEM2-AO	Yes	Yes	Yes		Yes	
26	HadGEM2-CC	Yes	Yes	Yes	Yes	Yes	Yes
27	HadGEM2-ES	Yes	Yes	Yes	Yes	Yes	Yes

28	INMCM4	Yes	Yes	Yes	Yes	Yes	Yes
29	IPSL-CM5A-LR	Yes	Yes	Yes	Yes	Yes	
30	IPSL-CM5A-MR	Yes	Yes	Yes	Yes	Yes	
31	IPSL-CM5B-LR	Yes	Yes	Yes	Yes	Yes	
32	MIROC4H	Yes	Yes	Yes	Yes		
33	MIROC5	Yes	Yes	Yes	Yes	Yes	Yes
34	MIROC-ESM	Yes	Yes	Yes	Yes	Yes	Yes
35	MIROC-ESM-CHEM	Yes	Yes	Yes	Yes	Yes	Yes
36	MPI-ESM-LR	Yes	Yes	Yes		Yes	Yes
37	MPI-ESM-MR	Yes	Yes	Yes		Yes	Yes
38	MRI-CGCM3	Yes	Yes	Yes	Yes	Yes	Yes
39	NorESM1-M	Yes	Yes			Yes	Yes
40	NorESM1-ME	Yes	Yes				Yes

Table A2: CMIP5 CORDEX AUS data RCM list

No	RCM name	Resolution (degree)
1	CCCma-CanESM2_UNSW-WRF360J	0.5
2	CCCma-CanESM2_UNSW-WRF360K	0.5
3	CSIRO-BOM-ACCESS1-0_UNSW-WRF360J	0.5
4	CSIRO-BOM-ACCESS1-0_UNSW-WRF360K	0.5
5	CSIRO-BOM-ACCESS1-3_UNSW-WRF360J	0.5
6	CSIRO-BOM-ACCESS1-3_UNSW-WRF360K	0.5
7	MOHC-HadGEM2-ES_CLMcom-HZG-CCLM5-0-15	0.25
8	MOHC-HadGEM2-ES_GERICS-REMO2015	0.25
9	MOHC-HadGEM2-ES_ICTP-RegCM4-7	0.25
10	MPI-M-MPI-ESM-LR_CLMcom-CCLM4-8-17-CLM3-5	0.5
11	MPI-M-MPI-ESM-LR_CLMcom-HZG-CCLM5-0-15	0.5
12	MPI-M-MPI-ESM-LR_GERICS-REMO2015	0.5
13	MPI-M-MPI-ESM-MR_ICTP-RegCM4-7	0.5
14	NCC-NorESM1-M_CLMcom-HZG-CCLM5-0-15	0.25
15	NCC-NorESM1-M_GERICS-REMO2015	0.25

16	NCC-NorESM1-M_ICTP-RegCM4-7	0.25
17	AUS-44i-ACCESS1-0-CCAM	0.5
18	AUS-44i-CCSM4-CCAM	0.5
19	AUS-44i-CNRM-CM5-CCAM	0.5
20	AUS-44i-GFDL-CM3-CCAM	0.5
21	AUS-44i-MPI-ESM-LR-CCAM	0.5
22	AUS-44i-NORESM1-M-CCAM	0.5

Table A3: CMIP5 GCMs with extreme precipitation data available

No	GCM	nlat	nlon
1	ACCESS1-0	145	192
2	BCC-CSM1-1	64	128
3	BCC-CSM1-1-M	160	320
4	CCSM4	192	288
5	CMCC-CM	240	480
6	CNRM-CM5	128	256
7	EC-EARTH	160	320
8	FGOALS-g2	60	128
9	GFDL-CM3	90	144
10	GFDL-ESM2G	90	144
11	GFDL-ESM2M	90	144
12	GISS-E2-H	90	144
13	GISS-E2-R	90	144
14	HadGEM2-ES	145	192
15	inmcm4	120	180
16	IPSL-CM5A-LR	96	96
17	IPSL-CM5A-MR	143	144
18	MIROC5	128	256
19	MIROC-ESM	64	128

20	MIROC-ESM-CHEM	64	128
21	MRI-CGCM3	160	320
22	NorESM1-M	96	144

Table A.4: CMIP5 GCM data for 6 hourly mean sea level pressure change

No	GCM name	nlat	nlon	No.	GCM name	nlat	nlon
1	ACCESS1-0	145	192	**15**	GISS-E2-R	90	144
2	ACCESS1-3	145	192	**16**	HADGEM2-CC	145	**192**
3	BCC-CSM1-1	64	128	**17**	HADGEM2-ES	145	192
4	BCC-CSM1-1-M	160	320	**18**	INMCM4	120	**180**
5	CANESM2	64	128	**19**	IPSL-CM5A-LR	96	96
6	CCSM4	192	288	**20**	IPSL-CM5A-MR	143	**144**
7	CNRM-CM5	128	256	**21**	IPSL-CM5B-LR	96	96
8	CSIRO-MK3-6-0	96	192	**22**	MIROC5	128	**256**
9	EC-EARTH	160	320	**23**	MIROC-ESM	64	128
10	FGOALS-G2	60	128	**24**	MIROC-ESM-CHEM	64	**128**
11	GFDL-CM3	90	144	**25**	MPI-ESM-LR	96	192
12	GFDL-ESM2G	90	144	**26**	MPI-ESM-MR	96	**192**
13	GFDL-ESM2M	90	144	**27**	MRI-CGCM3	160	320
14	GISS-E2-H	90	144	**28**	NORESM1-M	96	**144**

Table A5: CMIP5 GCM data availability for climate change impacts on daily maximum wind speed

No.	GCM name	nlat	nlon	No.	GCM name	nlat	nlon
1	ACCESS1-0	144	192	**14**	GISS-E2-R	90	144
2	ACCESS1-3	144	192	**15**	HADGEM2-CC	144	192
3	BCC-CSM1-1	64	128	**16**	HADGEM2-ES	144	192
4	BCC-CSM1-1-M	160	320	**17**	INM-CM4	120	180
5	CANESM2	64	128	**18**	IPSL-CM5A-LR	96	96

6	CMCC-CM	240	480	**19**	IPSL-CM5A-MR	143	144
7	CMCC-CMS	96	192	**20**	IPSL-CM5B-LR	96	96
8	CNRM-CM5	128	256	**21**	MIROC-ESM	64	128
9	CSIRO-MK3-6-0	96	192	**22**	MIROC-ESM-CHEM	64	128
10	GFDL-CM3	90	144	**23**	MIROC5	128	256
11	GFDL-ESM2G	90	144	**24**	MPI-ESM-LR	96	192
12	GFDL-ESM2M	90	144	**25**	MPI-ESM-MR	96	192
13	GISS-E2-H	90	144	**26**	MRI-CGCM3	160	320

Table A6: Mean sea level GCM patterns for CMIP5

No.	GCM	zos	zostoga	zosga
1	ACCESS1-0	√		√
2	ACCESS1-3	√		√
3	bcc-csm1-1	√		√
4	bcc-csm1-1-m	√		√
5	CanESM2	√		√
6	CCSM4	√	√	√
7	CMCC-CM	√		√
8	CMCC-CMS	√		√
9	CNRM-CM5	√	√	√
10	CSIRO-Mk3-6-0	√	√	
11	GFDL-CM3	√	√	√
12	GFDL-ESM2G	√	√	√
13	GFDL-ESM2M	√	√	√
14	GISS-E2-R	√	√	√
15	GISS-E2-R-CC	√		√
16	HadGEM2-CC	√	√	
17	HadGEM2-ES	√	√	

18	inmcm4	√	√	
19	IPSL-CM5A-LR	√	√	√
20	IPSL-CM5A-MR	√		√
21	MIROC5	√		√
22	MIROC-ESM	√		√
23	MIROC-ESM-CHEM	√	√	√
24	MPI-ESM-LR	√	√	√
25	MPI-ESM-MR	√	√	√
26	MRI-CGCM3	√	√	√
27	NorESM1-M	√	√	√
28	NorESM1-ME	√		√

Appendix II (Annex A) regarding GCM/RCM evaluation

The general practice of GCM evaluation

The evaluation of GCM performance has since the beginning of modelling itself, been an essential part of climate change research. The quality of GCMs has been associated with their ability to reproduce historical climate. Research on methodologies for evaluating aspects of GCM performance is increasing with publicly available CMIP5, and CMIP6 GCM model outputs (Jun et al. 2008; Notz 2015; Baumberger et al. 2017 Altamirano del Carmen, et al., 2021)

Simply comparing simulated and observed climate to assess a model's skill is often inadequate. For example, the future simulations of the CMIP5 experiment were to replicate the response to observed natural and anthropogenic radiative forcing (i.e., the climate signal). However, they were not constrained using climate records to replicate relevant aspects of observed variability, such as the time of occurrence and phase of natural oscillations (Altamirano del Carmen et al., 2021).

Many indicators could be used to evaluate a number of aspects of the model output (Christensen et al. 2010), and new indicators are emerging for this particular purpose (Knutti et al. 2010; Herger et al. 2018). However, there is no objective approach for choosing metrics to evaluate GCMs performance, and there is little consensus on which metrics are helpful to discriminate "good" from "bad" GCMs (Knutti et al., 2010).

A limited set of performance indicators for GCM selection could be compromised by largely unknown model interdependencies (Christensen et al., 2010). Furthermore, objective methods to evaluate GCM performance could be helpful to maximise the value of climate change projections (Knutti et al., 2010). However, at best, empirical evidence supporting this statement is weak, and GCMs with good historical performance could underperform when projecting future climate (Weigel et al., 2010; Notz, 2015).

The usefulness of a GCM output cannot be judged by its degree of agreement with historical data. Instead, the internal variability, the tuning of the model, observational uncertainty, the temporal variations in dominant processes or the uncertainty in the forcing also need to be considered (Notz, 2015).

Data for climate change risk and vulnerability assessment: downscaling and bias correction

Direct output from GCMs and RCMs is often too coarse to directly inform local adaptation decisions (e.g., Wilby and Dessai 2010); more acceptable resolution offered by dynamical downscaling is often limited to a small domain, short length of model integration, or small ensemble size (e.g., d'Orgeville et al. 2014; Prein et al. 2017). Statistical downscaling based on the empirical relationship between local variables and large-scale features is frequently used to downscale GCMs and RCMs projections (of precipitation and temperature, in particular) to local scales that might be more directly usable in a planning context (e.g., Maraun et al. 2010, Ning et al. 2012, Abatzoglou and Brown 2012, Ahmed et al. 2013). The computational efficiency of statistical downscaling makes it possible to downscale a large ensemble of models; it also corrects systematic biases in surface meteorological variables from GCMs and RCMs (Maraun et al., 2010).

Climate change assessments are undertaken in collaboration with decision-makers and other stakeholders to create synergies between the type of questions the assessment can address with the needs of potential users of assessment outputs (Cash et al., 2003, Kirchhoff et al., 2019). Assessments are often used to help decision-makers understand changes in future flood, drought, and other risks, which relies on data for precipitation characteristics defined at short temporal scales (such as precipitation intensity, frequency, and extremes at daily or hourly resolution) that are challenging to downscale and quantify. While the choice of the database used in climate change assessments and adaptation planning often depends on the purpose of the assessment or the question being asked (Kotamarthi et al. 2016). Databases are often chosen with very little consideration of the effect choice has on assessment findings. Uncertainty analyses, if included at all, primarily concerned GCM-dependence and the Representative Concentration Pathways (RCPs).

Compared to the raw GCM ensemble, bias-corrected GCM inputs are correct for systematic errors and can produce high-resolution projections that are useful for impact analyses. Therefore, changes in hydroclimate metrics often appear considerably different in bias-corrected output compared to raw GCM output (Ficklin et al., 2016). Hence, subjective subset choices and commonly use the equally weighted model mean as the best estimate. However, different climate model simulations cannot necessarily be independent estimates due to duplicated code and shared development history (Herger et al., 2018).

Monthly mean and extremes in GCM simulations

Many signs of progress have been made in climate modelling. However, the limitation are significant (Alexander 2016). GCM and RCM resolution can not accurately simulate the local extreme; even better performance at grid scale. While more advanced methods can help constrain future changes in rainfall extremes further, the temperature-scaling approach can be used in practical applications in urban flood risk and design studies for locations where no high-resolution precipitation projections are available (Dahm et al., 2019).

While GCM and RCM evaluations found that models have difficulties simulating the monthly variations of the global climate systems, the demand for climate change risk assessments has to find innovative methods that extract the climate change signals, relying on the best available data.

A critical impact of climate change is the projected increase in the frequency and intensity of extreme rainfall events (Martel et al., 2021). The recording-breaking events have been devasting for local communities, especially in recent years. The GCM and RCMs have the physical mechanisms to simulate the large scale trend of extreme precipitation and the change factors have been applied for the last decade(Li, et al., 2011).

The multimodel ensemble (MME) mean could capture the spatial variability of annual maximum wind speeds over most regions except over the mountainous terrains (Kumar et al., 2015). At the same time, cyclone activities are intensifying with climate in many areas (Emanuel et al., 2021). Various approaches need to be considered to extract the extreme wind speed changes.

Quantile mapping (QM) approaches are practical among bias correction methods (Enayati et al., 2021; Pastén-Zapata et al., 2020). Moreover, by applying various improvement or fine-tuning methods, QM could outperform dynamic downscaling in some respects (Pham et al., 2021).

This report applied the change factor approach for monthly precipitation and temperature variables—quantile mapping techniques to extreme precipitation and wind speed assessment.

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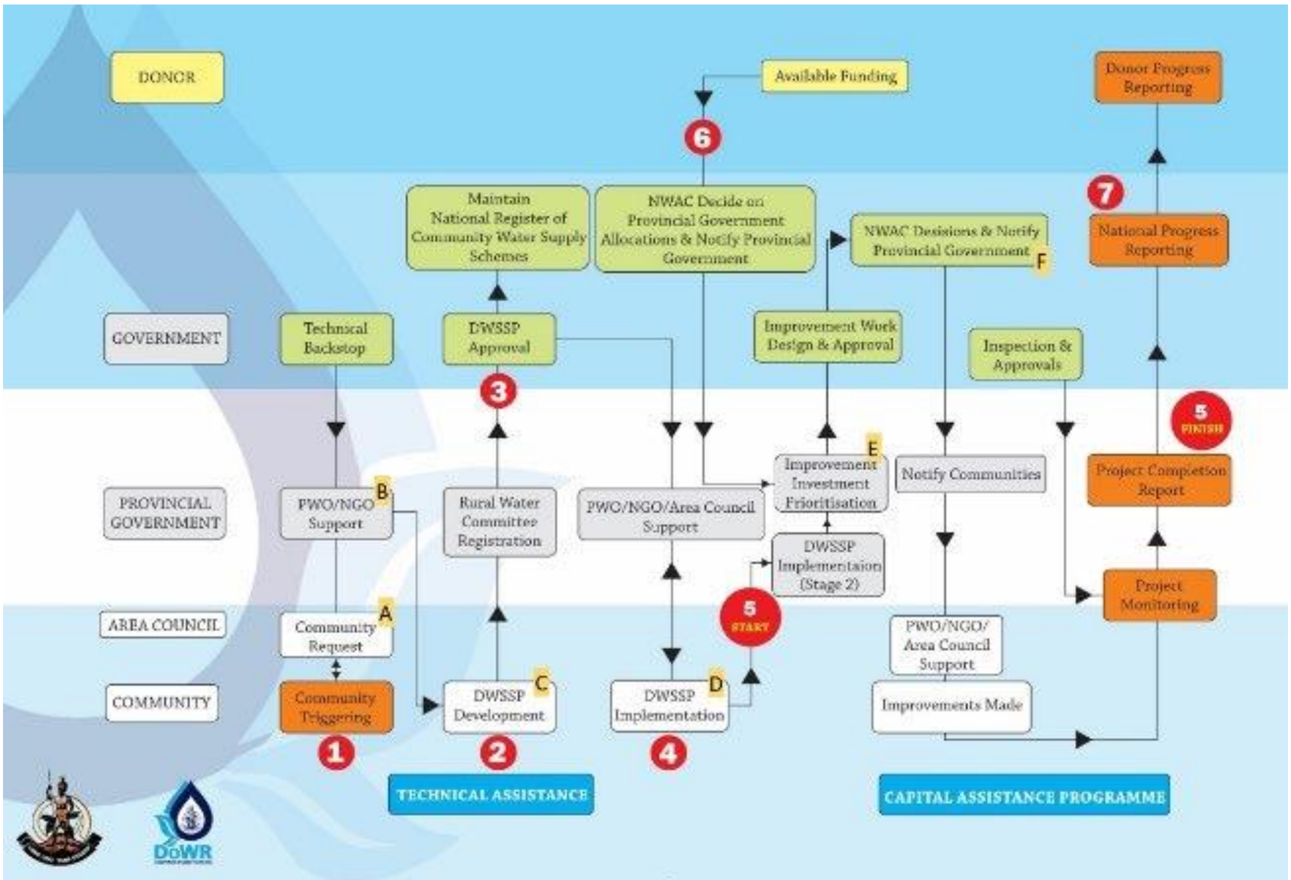
Annex B. Visuals: NIP & CAP processes

Detailed documentation of the NIP and CAP can be found using the given links. Below is a summary showing the flow chart of activities.



Annex C. Examples: infrastructure improvement in Vanuatu

This annex provides a view into the expected infrastructure upgrades that will take place in communities, after the registration of their DWSSPs. Depending on the nature of the investments, these infrastructure upgrades will have no, low, or medium environmental and social impacts. The tables below show: no and low cost community improvements; previous capital assistance; and also presents government standards.

No and Low-Cost Options

The table below shows the different types of no and low cost options, that the DWSSP trainings used to advice communities on, to improve their systems and increase readiness before receiving the Capital Assistance Program (CAP) funding.

Action:	**Before improvement**	**After improvement**
Agreement to protect water source and catchment	 *Unprotected water source*	 *Signing of MoU to protect water source and catchment*
Clear of spring area	 *Spring box covered by vegetation*	 *Spring box, after clearing of vegetation*

Storage	 *No cleaning of storage for a long time*	 *Inside cleaning of storage*
Repair ferrous cement tank	 *Cracked ferro-cement tank*	 *Ferro-cement repaired by plastering*
Bury pipelines	 *Pipelines on the ground surface*	 *Pipelines buried from exposure*
Fix leakages	 *Leakages from the pipelines*	 *Coupling inserted on leakage points*

Build fence around tap stands	 *Figure 19 – Tap stands without fence*	 *Figure 20 - Fencing of tap stands using woods in progress*
Clean gutters	 *Clogged gutters*	 *Cleaned gutters*
Clean first flush system	 *First flush system with cap closed*	 *First flush with cap removed after rainfall to remove debris*
Dig soak-away	 *No soak away around tap stand*	 *Soak away dug for water collected around tap stand*

Disinfect storage containers	 *Dirty container storages*	 *Disinfected container storages (example)*
Prepare site for interventions	 *Site preparation*	 *Collection of aggregates to site*
Upgrade toilets	 *Temporary bush toilet*	 *Upgraded toilet facility, with handwashing facility*

Previous Capital Assistance (with costings)

The table provides the different interventions and estimates of costs, along with dimensions.

	Cost per unite (USD)	Current (sample photo)	Improvement (sample photo)	Max. size
Reduce disruption of water supply and contamination during cyclones				
Build concrete covers to protect spring sources	2,000			2m x 2m
Protect existing hand-dug wells from cyclones with apron and cover	1,000			1.5m diameter
Protect tanks from cyclone debris and wind with proper slabs and tie downs	200			6,000 - 10,000 L poly tank (shown with slab only)
Improve rainwater harvesting roof, gutter and fascia board connection for cyclone resistance	500			12m gutter length, 50 m^2 standard shelter

				
Strengthen road and river pipe crossings	1,000			Average 50m length
Build housing around air release and clean out values to reduce cyclone damage	500			1x1x1m
Upgrade bare pipe standpipes built to government standard with cement and PVC coating to reduce broken pipes from cyclones	100			Standard 3/4" DoWR tapstand
Reduce disruption of water supply and contamination during high rain, flooding and landslides				

Repair broken deep well covers	1,000			3m diameter
Dig deep groundwater to replace shallow wells ($100/meter plus drill rig mobilization)	10,000			shallow approx. <6m, depth >20m
Install closed rainwater harvestin-g tanks to replace rain water collect holes	5,000			6000-10000L polytank or 22,500L ferrous cement tank
Relocate rainwater tanks at risk of landslides from flooding	3,000			n/a
Reduce disruption of water supply and contamination because of rising sea levels				

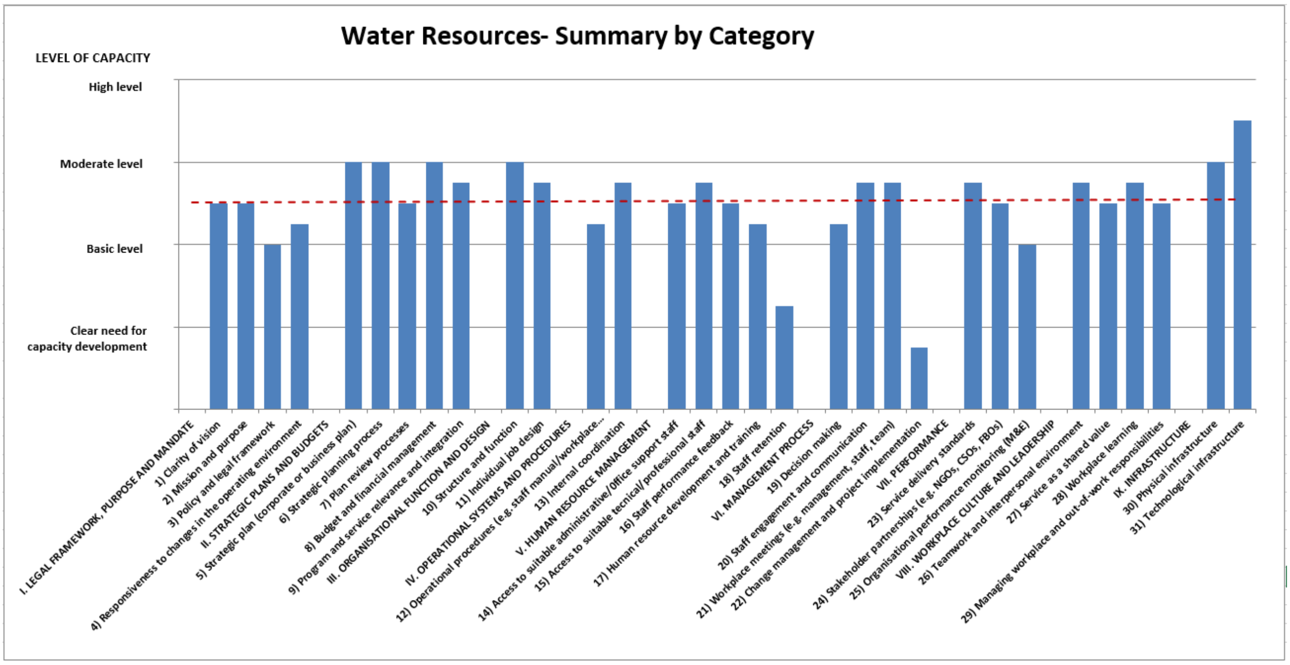
Dig hand dug wells further inland to reduce salt water	1,000			1.5m diameter
Develop new water sources for climate migrants	300,000			N/A
Reduce dependence on fossil fuels that increase climate change				
Replace diesel pump with solar panels and pump	15,000			N/A

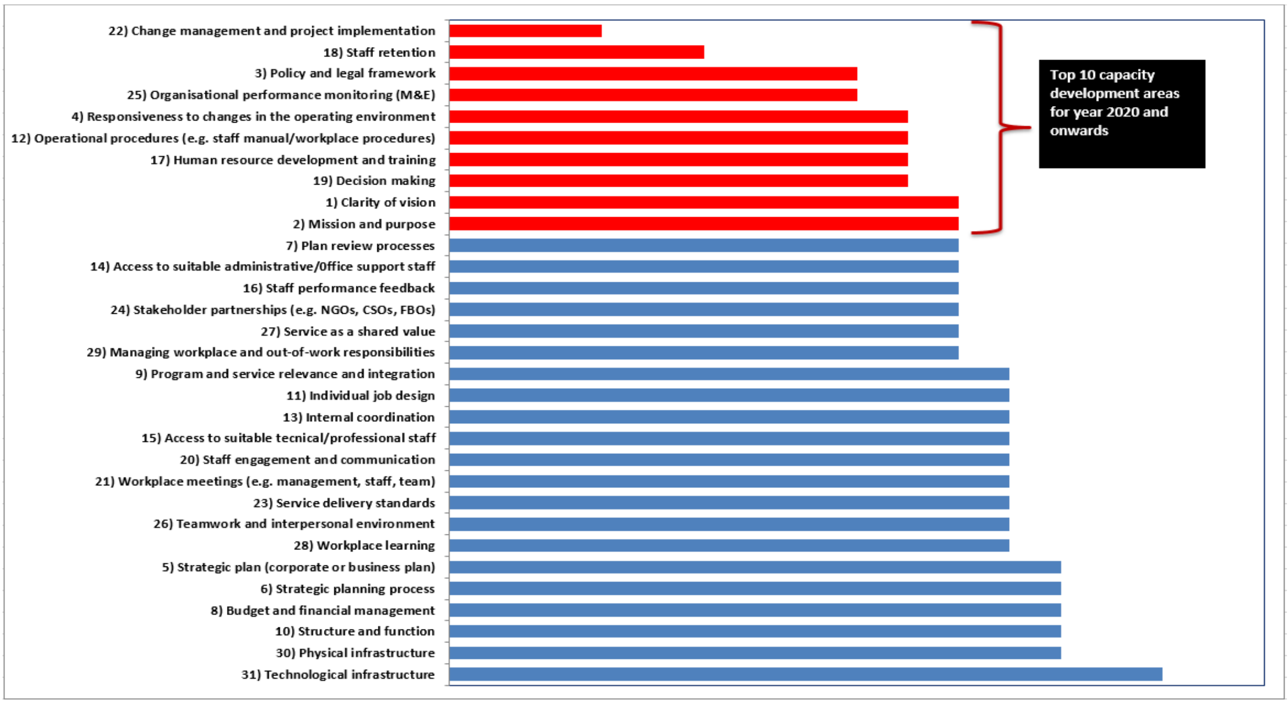
Government Construction Standards

Water Standard Types	Dated	Download PDF File
DGF---1.01---Drawing-Schedule-and-Notes	6th/12/2018	Drawing Schedule and Notes
DGF---1.02---Bill-of-Quantities	6th/12/2018	Bill of Quantities
DGF---1.03---Tap Stand	6th/12/2018	Tap Stand
DGF---1.04---Washout-Valve-Chamber	6th/12/2018	Washout Valve Chamber
DGF---1.05---Air-Valve-Post	6th/12/2018	Air Valve Post
DGF---1.06---Poly-Break-Pressure-Tank	6th/12/2018	Poly Break Pressure Tank
DGF---1.07---6kL-Poly-Distribution-Tank	6th/12/2018	Poly Distribution Tank 6KL
DGF---1.08---10kL-Poly-Distribution-Tank	6th/12/2018	Poly Distribution Tank 10KL
DGF---1.09---Tank-Tie-downs	6th/12/2018	Tank Tie Downs
Design and Construction for Rural Water Supply in Vanuatu	2016 - 2018	Design and Construction for Rural Water Supply
Vanuatu National Drinking Water Quality Standards	2016 - 2018	Vanuatu National Drinking Water Quality Standards

Annex D. Capacity assessment: DoWR

In October 2019, an Institutional Capacity Assessment process was undertaken with DOWR staff and this annex provides the overall outcomes of that process. This assessment was initiated through Vanuatu's National Sustainability Development Plan's (NSDP) society pillar Goal 6, which provides for "strong and effective institutions for ensuring a dynamic public sector with good governance principles and strong institutions delivering the support and services expected by all citizens of Vanuatu". This assessment was endorsed by the Office of the Public Service Commission (OPSC). The two figures below summarize the results, and the full report has been archived in the literature reviewed for this feasibility study as well as the funding proposal.





Annex E. Map: Vanuatu

This is a map of Vanuatu. Additional and more detailed maps indicating drought vulnerability for each main island can be seen here: https://mol.gov.vu/images/water/Maps/Drought-Severity-Index.pdf and locations where DWSSPS prior to December 2019 had been completed here: https://exchange.riscon.solutions/drinking-water-safety-and-security-plans-information-graphics/