CLIMATE CHANGE IMPACTS ON WATER SECURITY IN VANUATU

WATER

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This case study describes climate change impacts on water security in Vanuatu, using a step-by-step approach. Guidance around conducting this type of step-by-step assessment is provided in more detail on the Van-KIRAP web portal, along with other climate impact related case studies (also termed infobytes), factsheets, visualisation tools and technical resources. This case study can be used as an example for undertaking similar climate hazard-based impact assessments.

STEP 1 Understand the context and scope

Past droughts have caused significant impacts in Vanuatu affecting water security and agricultural production [1]. In the coming decades droughts are projected to become longer and more intense, with a higher proportion of events in the extreme drought category [2], thereby impacting water security. While there may be more extreme daily rainfall in future, little change in annual-average rainfall is projected [2]. At the same time, annual-average temperature is projected to increase, with more heatwaves. Increased climate variability, through more extreme El Niños and La Niñas in future [3, 4], may also increase water management challenges.

With access to clean drinking water being a fundamental human right [5], water security is identified in the Vanuatu National Sustainable Development Plan (NSDP) as an important issue [6], particularly in a changing climate. **Here we explore the impact of drought on water security under current and future climate conditions.** The scope is limited to an overview of drought impacts on water security. Such an assessment can then inform a more detailed risk assessment for the water sector in Vanuatu if required (see the Climate risk factsheet).

STEP 2 Engage and meet with stakeholders

The Vanuatu Meteorology and Geo-hazards Department (VMGD) provides a range of climate data and information services relevant to the water sector, including a monthly climate update, El Niño Southern Oscillation (ENSO) update, early action rainfall watch, ocean outlook, tourism climate outlook and fisheries climate outlook. To inform this assessment, staff from VMGD Climate Section and water sector experts in Vanuatu provided advice on water security issues including potential impacts of climate change. From these discussions, important issues relating to water security were identified, as well as gaining a better understanding of how water resource access is planned and managed in Vanuatu.

STEP 3 Explore background information and historic climate data

Normal seasonal rainfall variability can affect water access with, in most islands, the driest three months of the year (July–September) producing rainfall levels that are 60 %–75 % lower than that in the wettest three months (January–March) [7]. Annual rainfall variability varies with ENSO, particularly for the more southerly locations where there is a clearer relationship between wetter years and La Niña [2].

Station-based climate observation data accessed through the VMGD indicate there has been little change in annual average rainfall since around 1950 [8], though extreme rainfall has increased slightly [2]. Since 1950, Bauerfield and Efate show positive trends in drought, while Sola and Aneityum indicate negative trends, but these are not significant [9]. Longer dry spells were typically experienced during El Niño years compared to La Niña years [8]. While the frequency of tropical cyclones (TCs) affecting Vanuatu has declined [2, 10], the TC-induced mean seasonal maximum daily rainfall has increased since around 1970 [11].

While access to a proximate source of drinking water is high in Vanuatu (94 % access to an improved drinking water source and 86 % access on the premises), the safety and reliability of the water consumed by most people in Vanuatu is not known [6]. About 36 % of the population relies on small-scale rainwater harvesting systems such as domestic water tanks as a drinking water source [7]. Where there are no nearby rivers, piped water, bottled water, bores and wells can also support access to water [12].

A detailed study on the performance of 1,878 rainwater tanks across 19 islands in Vanuatu found around half of households have private rainwater tanks and half have communal rainwater tank access [7]. Of these, more than half of the tanks assessed failed to provide a sufficient supply of water across the year, with the communal tanks having less reliability of supply. Rainwater dependency and a lack of storage is undermining water security [7, 13-14].

Vanuatu Klaemet Infomesen blong Redy, Adapt mo Protekt · Van-KIRAP · LONG GOD YUMI STANAP · Vanuatu Meteorology and Geo-Hazards Department · CSIRO · SPREP Secretariat of the Pacific Regional Environment Programme · GREEN CLIMATE FUND

Figure 1 Water tanks in Tanna supplied by the Government of Vanuatu aimed at supporting resilience (top left), providing water for household uses (top right), for example, washing clothes (bottom).Photo credit: Leanne Webb and Gina Ishmael.

In Vanuatu, major droughts occurred in 1982–1983, 1997–1998 and 2015–2016 [1], with their frequency and intensity differing over space and time.

- From March 1982–May 1984 the drought started in Pekoa (Vanuatu North), then spread south to Port Vila (Vanuatu Central) and down to White Grass. Overall, the government had to respond to 27 months of drought conditions, with rainfall 40–50 % below average [1].
- The 1997–1998 drought started in the south and moved north to Pekoa where it became more severe, with rainfall about 50 % below normal. This drought was broken by rainfall associated with TCs Zuman and Yali [1].
- The 2015–2016 drought occurred in the aftermath of TC Pam which had already caused considerable damage to agricultural production [15]. Through the drought, most water tanks were empty or severely depleted. Villagers in 20 % of households walked more than 30 minutes, or some hired trucks, to collect water for cooking and washing [1].

These drought events were associated with the El Niño phase of ENSO, one of the main natural influences on drought in the Pacific [9, 16] (see Climate variability explainer). TCs and TC-induced rainfall, also influenced by ENSO, were associated with either delay in drought onset or breaking the droughts [1].

STEP 4 Collect information about future climate scenarios

In addition to the warming that has already occurred, the climate is projected to change further dependent on greenhouse gas (GHG) emissions and regional climate responses to these emissions. GHG emissions range from low (RCP2.6) to high (RCP8.5) based on global assumptions about socio-economic change, technological change, energy use and land use [17]. Incorporating this emissions range, model projections indicate annual average temperatures will increase in Vanuatu from 0.7 to 1.3 °C by 2050, relative to 1986–2005 (Table 1). This warming will be associated with more heatwaves. According to the models it is unclear whether rainfall will increase or decrease by 2050 [2, 18]. Projected changes in average rainfall by 2050 are small, especially if greenhouse gas emissions are not too great. However, the intensity of rainfall on the wettest days is projected to increase, and while TCs are projected to occur less often, they will be associated with more rainfall, and a greater proportion will be severe [2, 10, 19].

<table>
<tr><th></th><th>2030</th><th>2050</th></tr>
<tr><td rowspan="2">Temperature from 1986-2005 (°C)</td><td rowspan="2">0.6
(0.3 to 1.0)</td><td>0.7
(0.5 to 1.1)</td></tr>
<tr><td>1.3
(0.8 to 2.0)</td></tr>
<tr><td rowspan="2">Annual rainfall from 1986-2005 (%)</td><td rowspan="2">1
(-9 to 13)</td><td>1
(-6 to 9)</td></tr>
<tr><td>0
(-12 to 14)</td></tr>
</table>

Table 1 Projected changes in Vanuatu of average annual temperature and rainfall for 20-year periods centered on 2030 and 2050 relative to 1986–2005 [18]. Multi-model median changes are given, with the 10–90th percentile uncertainty range in brackets. Changes are shown for low emissions (RCP2.6: green) and high emissions (RCP8.5: red). In 2030, changes are similar for low and high emissions [18].

The characteristics of drought are represented here by three measures, following [20]:

- Drought duration: the average length (in months) of a drought event within a 20-year period.
- Drought frequency: the number of droughts within a 20-year period.
- Drought intensity per event: the average of cumulative SPI from all events within a 20-year period. The more negative the value, the more intense the event.

Drought projections, based on the Standardised Precipitation Index (SPI; see Drought explainer) [21], are similar across Vanuatu's sub-regions [2] (Figure 2 and Regional climate summaries). Drought duration is projected to change little by 2050, consistent with observations [9, 22]. However later in the century, under a high emissions scenario, large increases in extreme drought duration may occur [2]. Moderate and severe drought frequency is projected to have little change, also consistent with the observed drought trends [22]. Climate models indicate a tendency toward increasing frequency for extreme drought [2]. This is consistent with the projected increase in the frequency of extreme El Niño events [4]. There is little change projected in the intensity of moderate or severe droughts. Extreme droughts however, may tend to be more intense [2].

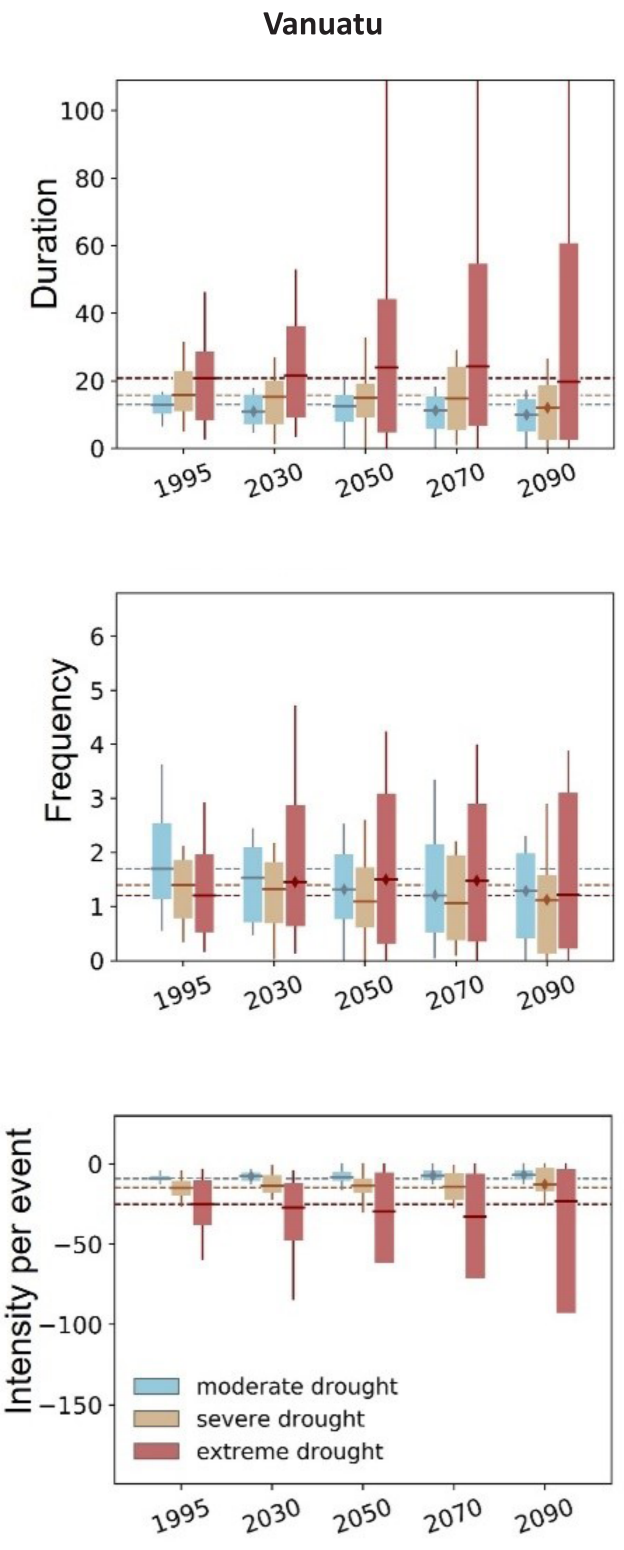


Figure 2 Vanuatu average of drought duration (top), frequency (middle) and intensity (bottom) in the reference period (20 years centred on 1995) and future periods (20 years centred on 2030, 2050, 2070, 2090) for the high (RCP8.5) emissions scenario for different drought categories (moderate, severe, and extreme). Drought duration is in months, frequency is in 'number of events per 20-year period', while intensity is unitless but otherwise visually proportional in terms of change over time whereby the more negative the value, the more intense the event. Results from 34 climate model simulations are shown for the median (50th percentile), 10th and 90th percentile (bars) and minimum and maximum values (whiskers). The dashed lines show the multi-model median for the baseline period for each category of drought [1, 20]. SPI is calculated monthly with the value for each month representing the rainfall anomaly over the past 12 months.

STEP 5 Analyse climate-related impacts

With extreme droughts becoming potentially longer and more intense under some emissions scenarios, the impacts on water security may worsen. Such impacts will likely include limitations in supply of domestic and industrial water, including urban, peri-urban and rural areas with deleterious consequences for public health, commerce and overall economic productivity. The agriculture sector impacts specifically will include reduced productivity, with loss or reduced output of crops and livestock, with deleterious consequences for food security for local communities and reduced exports affecting the economy more generally (see also Step 3).

A more detailed risk assessment is likely therefore needed, incorporating drought hazards and the physical exposure and socio-economic vulnerability of communities and assets, to better understand the implications for water and food security (e.g. [23]). The results of such an integrated risk assessment would better inform priorities for addressing future water security needs for Vanuatu including enhanced water storage, treatment and reticulation infrastructure and sustainable water resource management policy and practices.

STEP 6

Evaluate other climate and non-climate factors

This case study is limited to the impact of drought on water security in Vanuatu under current and future climate conditions, in particular as relates to projected changes in rainfall under different emissions scenarios. Other climate and non-climate factors causing potential impacts are listed below that may also influence water security. Further analysis around these may be prudent.

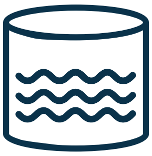
Climate factors affecting water security	
Temperature and evapotranspiration	Future impacts on water security will be compounded by projected increases in temperature and evapotranspiration, which compound drought related reductions to soil moisture, streamflow, and related water quality [2]. Projected increases in air temperature will also likely increase demand for drinking water and water sanitation in the future.
Tropical cyclones	While a drought is often broken by heavy rainfall from a TC, cyclones can also cause reduced access to water if transport and water storage, treatment and reticulation infrastructure are damaged (e.g. after TCs Judy and Kevin) [24].
Sea level rise	Reliance on wells (which can become increasingly brackish during droughts) for cooking and washing may be compromised by rising sea level causing salt-water intrusion if in close proximity to the coast [1]; such an impact is also exacerbated by TC-induced storm surges [25].
El Niño Southern Oscillation (ENSO)	ENSO is a large-scale driver of climate variability in the Pacific affecting rainfall, temperature [9] and cyclones, with the El Niño phase associated with droughts [9, 26]. This is because in El Niño years the South Pacific Convergence Zone (SPCZ) moves north-east, leading to drier conditions over Vanuatu. In La Niña years the SPCZ moves south-west, leading to wetter conditions over Vanuatu. Extreme La Niña and El Niño events are projected to increase in future [3, 4].
Non-climate factors affecting water security	
Socio-economic factors	Exposure and vulnerability influence water security risks in the Pacific. For example, in relation to drought, exposure is higher in communities with limited access to rivers and wells, and vulnerability is higher in communities with limited ability to alleviate water shortages and associated sanitation issues. Likewise, local communities are more exposed where agricultural crops and livestock are relied upon for domestic consumption through local markets and/or subsistence purposes (e.g. home gardens). However larger-scale commercial agriculture can also be impacted where producers have limited access to diversified cropping and grazing options (latter including access to supplementary fodder for stock). Impacts are magnified if followed/preceded by heavy rains, floods, or tropical cyclones directly and/or indirectly impacting communities and agricultural production [1].
	Water demand may increase due to population/tourism growth, including development of enhanced living standards creating greater access to and dependence on reticulated water, potentially exacerbating water stress under drought conditions as local communities move away from traditional practices.

STEP 7 Plan future adaptation

The Vanuatu National Sustainable Development Plan (NSDP) notes the importance of water security in a changing climate. Adaptation can be incremental or transformative, with enablers and barriers, synergies and trade-offs, pathways and limits, costs and benefits. The process usually starts with consideration of adaptation options. A list of activities and adaptation options that could be considered, tested, and verified in the community to improve resilience may include:

Climate change awareness-raising and training activities for water sector experts and associated development of decision-support tools [13].

Early warning systems to improve the capacity of communities to forecast, prepare for and respond to drought events.



Initiatives where houses with 50 m^2 roof catchments are supplied with rainwater tanks [2].

Mobile water desalination units to help provide fresh and clean drinking water for schools and islands affected by drought [14].

STEP 8 Communicate findings

Communicating the assessment findings to key sector stakeholders is the final step of the climate hazard-based impact assessment. Multiple communication formats, co-designed and co-produced with target users in mind are more likely to support action and decision-making. The contents of this infobyte, together with other related resources shown below, can be disseminated and shared with key stakeholders to help them plan for and adapt to the changing climate.

[Van-KIRAP Web Portal](#)

[Case Studies](#)

[Fact Sheets](#)

[Guidance Material](#)

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