International CLIMATE CHANGE ADAPTATION Initiative

Pacific Climate Change Science Program

Current and future climate of **Vanuatu**

> Vanuatu Meteorological Service
> Australian Bureau of Meteorology
> Commonwealth Scientific Industrial Research Organisation (CSIRO)

Australian Government

Vanuatu's **current climate**

Across Vanuatu the annual average temperatures are between 23.5–27.5°C. Changes in the temperature from season to season are strongly tied to changes in the surrounding ocean temperature. The country has two distinct seasons – a warm wet season from November to April and a cooler dry season from May to October (Figure 1). The difference between seasons is slightly more evident in Port Vila as Aneityum receives more rainfall from extra-tropical influences such as cold fronts during the dry season.

Rainfall in Vanuatu is affected by the South Pacific Convergence Zone. This band of heavy rainfall is caused by air rising over warm waters where winds converge, resulting in thunderstorm activity. It extends across the South Pacific Ocean from the Solomon Islands to east of the Cook Islands (Figure 2). During the wet season the South Pacific Convergence Zone intensifies and moves further south, bringing higher rainfall to Vanuatu.

Low pressure systems embedded in this band often become tropical cyclones during the cyclone season.

Mountains also play a role in the variations in rainfall across some islands. During the wet season, rainfall is particularly high on the windward (south-east) side of the mountain ranges of the bigger islands, and scarce during the dry season, especially on the leeward (north-west) sides.

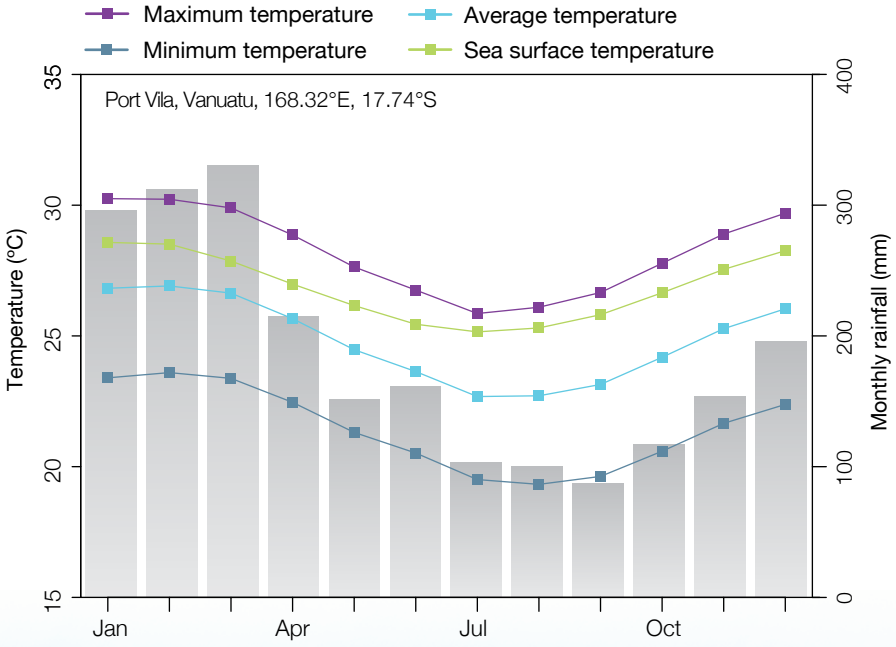

Figure 1: Seasonal rainfall and temperature at Port Vila

Vanuatu's climate varies considerably from year to year due to the El Niño-Southern Oscillation. This is a climate pattern that occurs across the tropical Pacific Ocean and affects weather around the world. There are two extreme phases of the El Niño-Southern Oscillation: El Niño and La Niña. There is also a neutral phase. In both Port Vila and Aneityum El Niño events tend to bring drier conditions as well as a late start to the wet season and cooler than normal dry season. The opposite occurs during La Niña events.

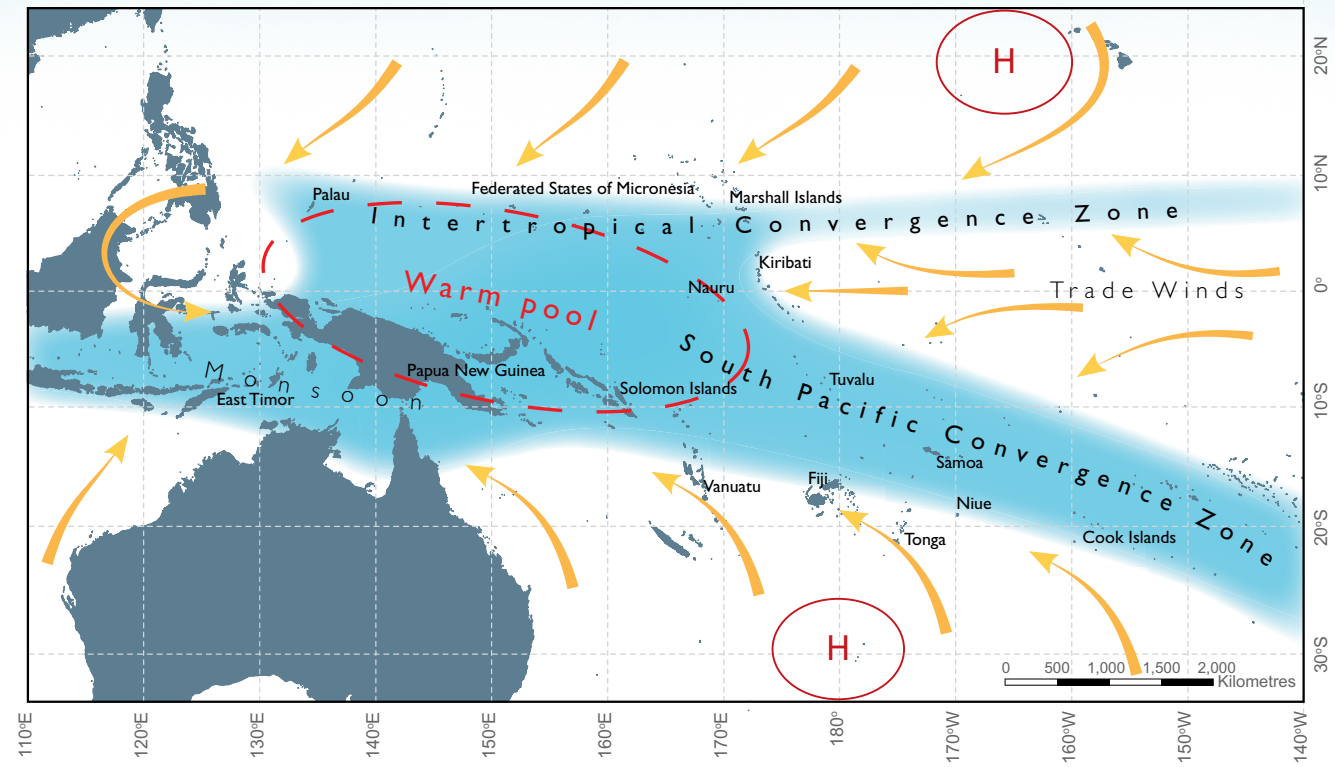

Figure 2: The average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

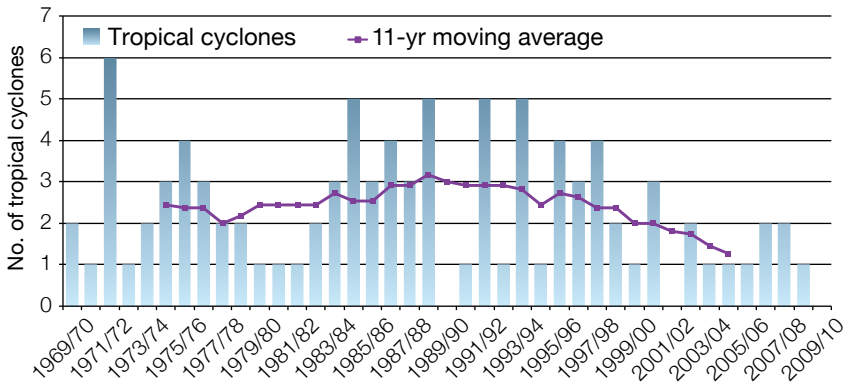

Figure 3: Tropical cyclones passing within 400km of Port Vila. Eleven-year moving average in purple.

Tropical cyclones

Tropical cyclones affect Vanuatu between November and April. In the 40-year period between 1969 and 2010, 94 tropical cyclones passed within 400 km of Port Vila, an average of two to three cyclones per season (Figure 3). The number of cyclones varies widely from year to year, with none in some seasons but up to six in others.

Vanuatu's **changing climate**

Temperature and rainfall

Annual maximum and minimum temperatures have increased in both Port Vila and Aneityum since 1950 (Figure 4). At Bauerfield Airport in Port Vila, maximum temperatures have increased at a rate of 0.17°C per decade and at Aneityum the rate of increase has been 0.18 °C per decade. These temperature increases are consistent with the global pattern of warming. Over the same period, there has been a decrease in average annual rainfall (Figure 5) but there is substantial variation between years.

Sea level

As ocean water warms it expands causing the sea level to rise. The melting of glaciers and ice sheets also contribute to sea-level rise.

Instruments mounted on satellites and tide gauges are used to measure sea level. Satellite data indicate the sea level has risen near Vanuatu by about 6 mm per year since 1993. This is larger than the global average of 2.8–3.6 mm per year. This higher rate of rise may be partly related to natural fluctuations that take place year to year or decade to decade caused by phenomena such as the El Niño-Southern Oscillation. This variation in sea level can be seen in Figure 7 which includes the tide gauge record and the satellite data since 1993.

Ocean acidification

About one quarter of the carbon dioxide emitted from human activities each year is absorbed by the oceans. As the extra carbon dioxide reacts with sea water it causes the ocean to become slightly more acidic. This impacts the growth of corals and organisms that construct their skeletons from carbonate minerals. These species are critical to the balance of tropical reef ecosystems. Data show that since the 18th century the level of ocean acidification has been slowly increasing in Vanuatu's waters.

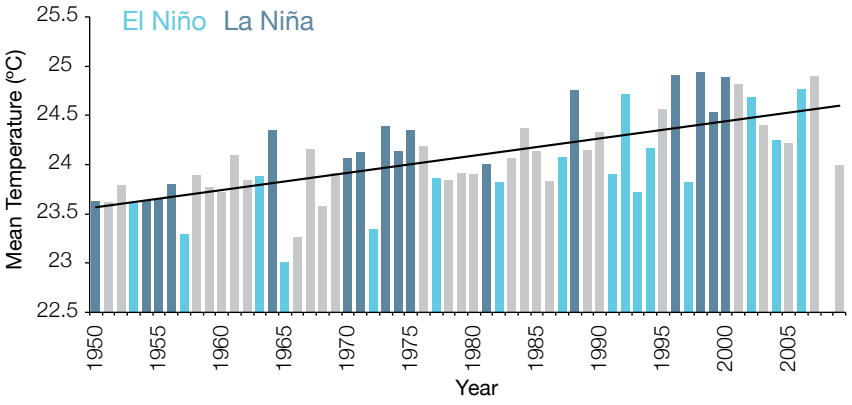

Figure 4: Annual average temperature for Bauerfield Airport, Port Vila. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

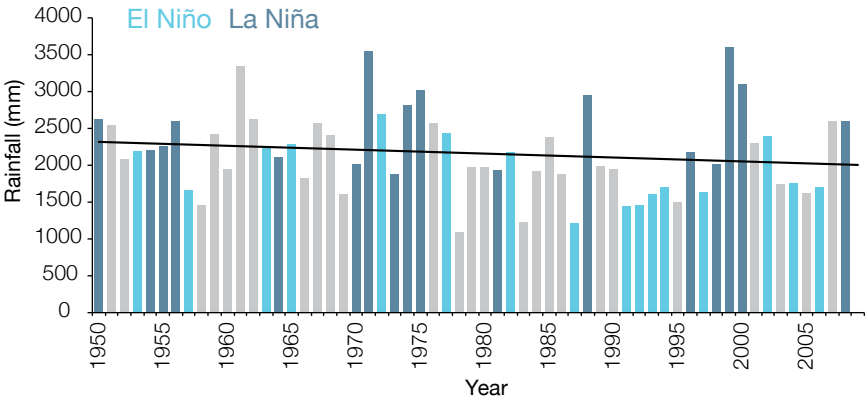

Figure 5: Annual rainfall for Port Vila. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

Vanuatu's **future climate**

Climate impacts almost all aspects of life in Vanuatu. Understanding the possible future climate of Vanuatu is important so people and the government can plan for changes.

Developing climate projections

Global climate models are the best tools for understanding future climate change. Climate models are mathematical representations of the climate system that require very powerful computers. They are based on the laws of physics and include information about the atmosphere, ocean, land and ice.

There are many different global climate models and they all represent the climate slightly differently. The 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report developed projections based on 24 global climate models. Scientists from the Pacific Climate Change Science Program (PCCSP) have evaluated these models and found that 18 of the 24 best represent the climate of the Pacific region. These 18 models have been used to develop climate projections for Vanuatu.

The future climate will be determined by a combination of natural and human factors. As we do not know what the future holds, we need to use a series of possible future conditions, or scenarios, in climate models. The IPCC developed a series of plausible scenarios based on a set of assumptions about future population changes, economic development and technological advances. For example, the A1B (or medium) emissions scenario envisages global population peaking in mid-century and declining thereafter, very rapid economic growth, and rapid introduction of new and more efficient technologies. Emissions scenarios are used in climate modelling to provide projections that represent a range of possible futures.

The climate projections for Vanuatu are based on three IPCC emissions scenarios (low (B1), medium (A1B) and high (A2)) for time periods around 2030, 2055 and 2090 (Figure 6). Since individual models give different results, the projections are presented as a range of values.

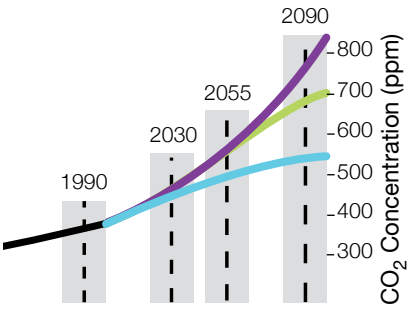

Figure 6: Carbon dioxide (CO_2) concentrations (parts per million, ppm) associated with three IPCC emission scenarios: low emissions (B1 – blue), medium emissions (A1B – green) and high emissions (A2 – purple). The PCCSP has analysed climate model results for periods centred on 1990, 2030, 2055 and 2090 (shaded)

Vanuatu's **future climate**

Temperature

Projections for all emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future in Vanuatu (Table 1). Such increases will also result in a rise in the number of hot days and warm nights and a decline in cooler weather. For instance, in the case of a low emissions scenario, by 2055 a very hot day that currently occurs once every 20 years will occur once every year. By 2090 under a high emissions scenario the frequency increases to once every two months.

Table 1: Annual average air temperature projections for Vanuatu for three emissions scenarios and three time periods. Values represent 95% of the range of models.

	2030 (°C)	2055 (°C)	2090 (°C)
Low emissions scenario	0.2–0.6	0.3–0.7	0.5–1.3
Medium emissions scenario	0.4–1.1	0.7–1.7	1.2–2.8
High emissions scenario	0.4–1.1	0.7–1.9	1.7–4.1

Rainfall

Average annual and wet season rainfall during the wet season is likely to increase over this century, due to the expected intensification of the South Pacific Convergence Zone. Projections for dry season rainfall suggest a general decrease, however the model results are not consistent.

Model projections show extreme rainfall days are likely to occur more often. Under a high emissions scenario by 2090 a rainfall event that currently occurs once every 20 years will occur once every five years.

Tropical cyclones

On a global scale, the projections indicate there is likely to be a decrease in the number of tropical cyclones by the end of the 21st century. But there is likely to be an increase in the average maximum wind speed of cyclones by between 2% and 11% and an increase in rainfall intensity of about 20% within 100 km of the cyclone centre.

In the Vanuatu region, projections also show a decrease in the frequency of tropical cyclones by the late 21st century and an increase in the proportion of the more intense storms.

Sea level

Sea level is expected to continue to rise in Vanuatu (Table 2 and Figure 7). The sea-level rise combined with natural year-to-year changes will accentuate the impact of storm surges and coastal flooding. As there is still much to learn about sea level, particularly how large ice sheets such as Antarctica and Greenland contribute to sea level rise, scientists warn larger rises than currently predicted could be possible.

Table 2: Sea level rise projections for Vanuatu for three emissions scenarios and three time periods. Values represent 90% of the range of the models.

	2030 (cm)	2055 (cm)	2090 (cm)
Low emissions scenario	5–16	10–27	17–47
Medium emissions scenario	5–16	8–31	20–59
High emissions scenario	3–17	7–31	21–63

Ocean acidification

Under all three emissions scenarios (low, medium and high) the acidity levels of waters in the Vanuatu region will continue to increase over the 21st century, with the greatest change under the high emissions scenario. The impact of increased acidification on the health of reef ecosystems is likely to be compounded by other stressors including coral bleaching, storm damage and fishing pressure.

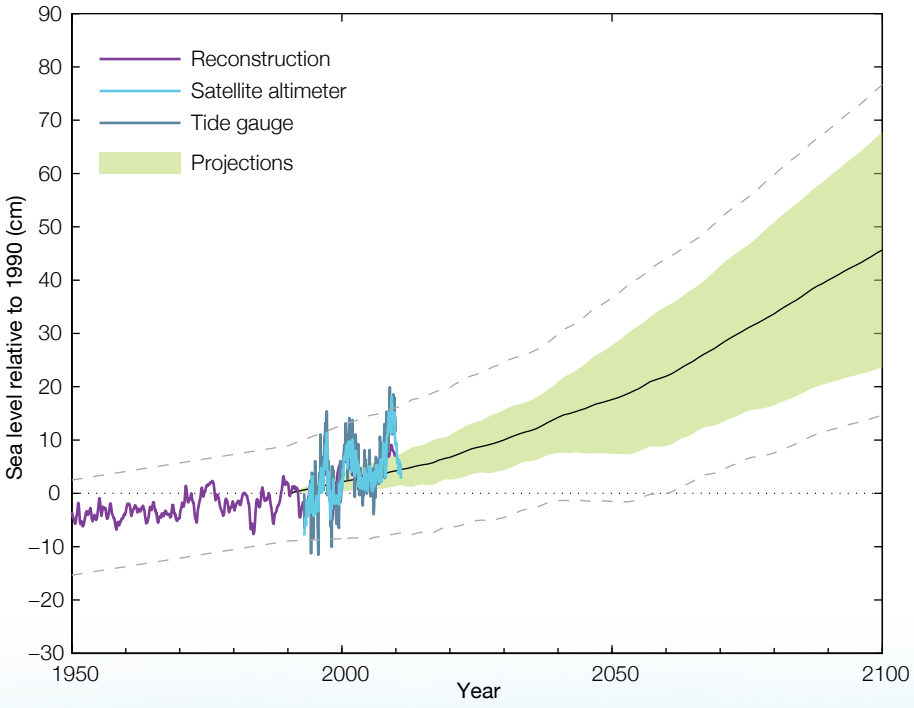

Figure 7: Observed and projected relative sea-level change near Vanuatu. The observed sea-level records are indicated in dark blue (relative tide-gauge observations) and light blue (the satellite record since 1993). Reconstructed estimates of sea level near Vanuatu since 1950, from Church and White 2011) are shown in purple. The projections for the A1B (medium) emissions scenario (representing 90% of the range of models) are shown by the shaded green region from 1990 to 2100. The dashed lines are an estimate of 90% of the range of natural year-to-year variability in sea level.

The content of this brochure is the result of a collaborative effort between the Vanuatu Meteorological Service and the Pacific Climate Change Science Program, a component of the Australian Government's International Climate Change Adaptation Initiative. This information and other research conducted by the Pacific Climate Change Science Program builds on the findings of the 2007 IPCC Fourth Assessment Report. For more detailed information and on the climate of Vanuatu and the Pacific see: Climate Change in the Pacific: Scientific Assessment and New Research. Volume 1: Regional Overview. Volume 2: Country Reports. Available from November 2011:

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