International CLIMATE CHANGE ADAPTATION Initiative

Pacific Climate Change Science Program

Current and future climate of **Papua New Guinea**

> Papua New Guinea National Weather Service
> Australian Bureau of Meteorology
> Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Australian Government

Papua New Guinea's **current climate**

The temperature of the ocean surrounding Papua New Guinea has a strong influence on average monthly air temperatures. Changes in the temperature from season to season are small but more marked around Port Moresby than further to the north.

Papua New Guinea has a wet season from November to April and a dry season from May to October (Figure 1), but these seasons are only noticeably different in Port Moresby, where about 78% of the yearly average rainfall comes in the wet season. Due to their location in the West Pacific Warm Pool, islands in the north of Papua New Guinea experience rain throughout the year. As a result, Kavieng's average annual rainfall (3150 mm) is much higher than Port Moresby's (1190 mm).

Most of the rainfall in Port Moresby comes from the West Pacific Monsoon. Large differences in temperature between the land and the ocean drive the monsoon, and its seasonal arrival usually brings a switch from very dry to very wet conditions. In the north of the country rainfall is more consistent year-round, although the peak in rainfall corresponds to the monsoon season.

Rainfall in the north of Papua New Guinea is also affected by the Intertropical Convergence Zone and, to a lesser extent, the South Pacific Convergence Zone. These bands of heavy rainfall are caused by air rising over warm water where winds converge, resulting in thunderstorm activity. The South Pacific Convergence Zone extends across the South Pacific Ocean from the Solomon Islands to east of the Cook Islands, whilst the Intertropical Convergence Zone lies across the Pacific just north of the equator (Figure 2).

Papua New Guinea's climate varies considerably from year to year due to the El Niño-Southern Oscillation. This is a natural 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. Generally in Papua New Guinea El Niño years are usually drier than normal while La Niña events are usually wetter. La Niña-associated prolonged rainfall has led to flooding and landslides, whilst El Niño-associated droughts have also taken their toll on Papua New Guinea. During El Niño events the monsoon season also starts later. The dry season at Port Moresby is cooler than normal in El Niño years and warmer than normal in La Niña years, while the wet season tends to be warmer and drier than normal during an El Niño event.

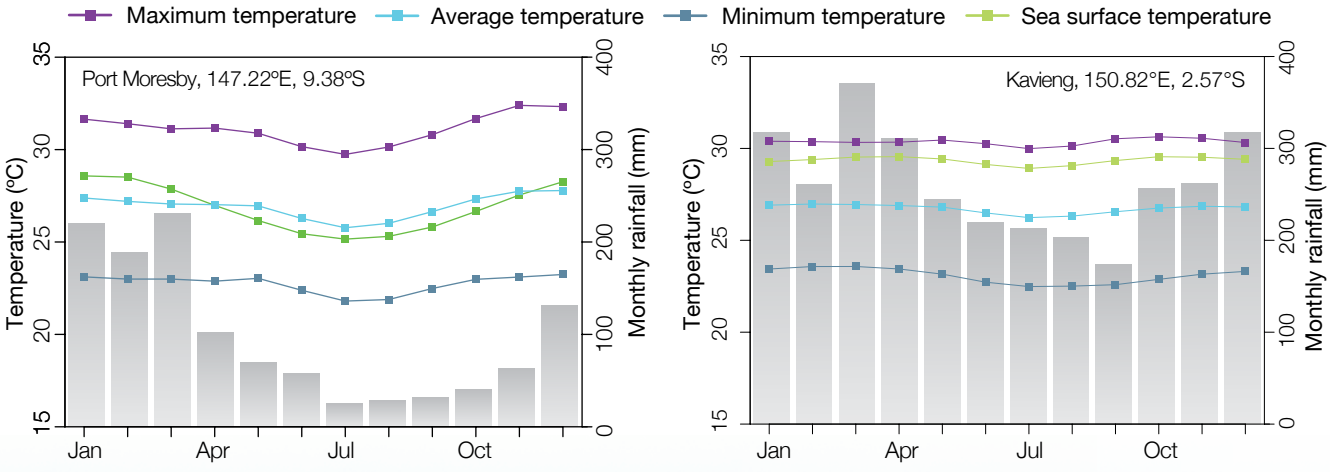

Figure 1: Seasonal rainfall and temperature at Port Moresby and Kavieng.

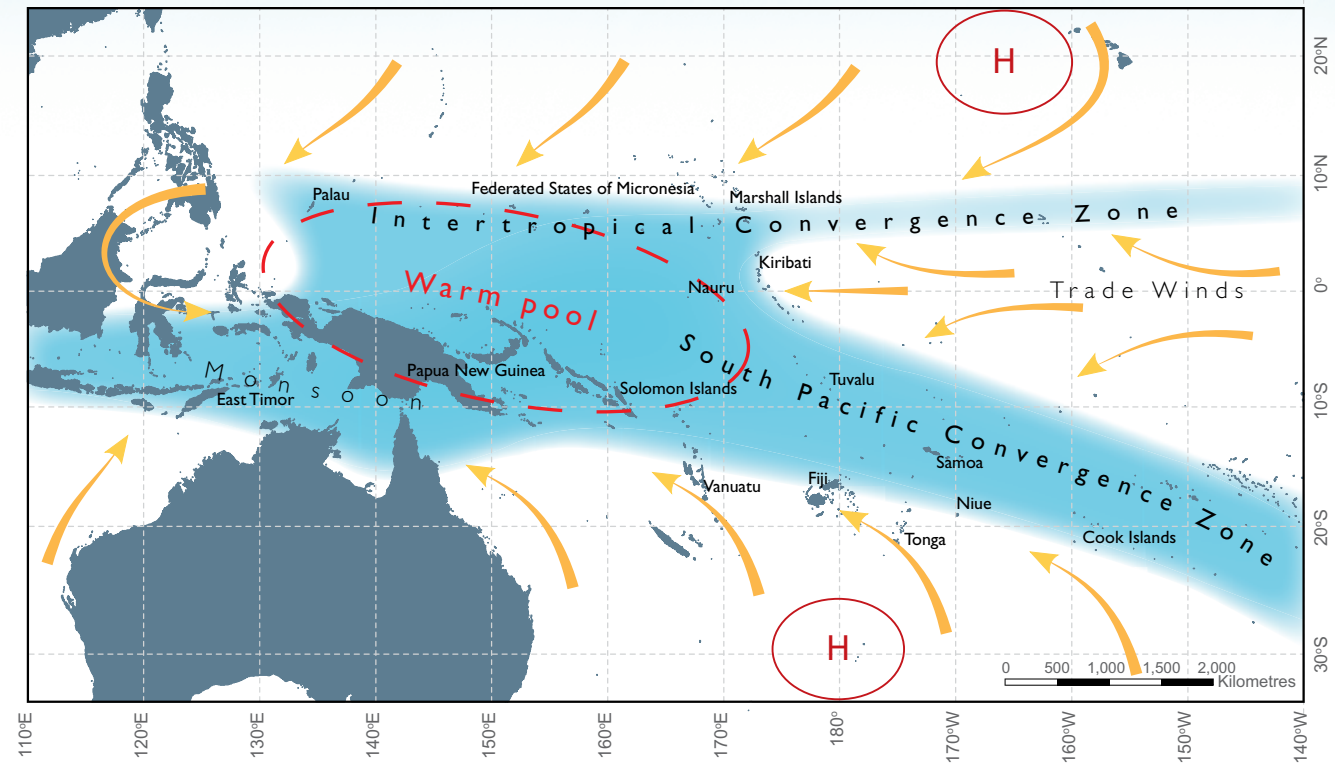

Figure 2: The average positions of the major climate features in November to April. The arrows show near surface winds, the blue shading represents the bands of rainfall convergence zones, the dashed oval shows the West Pacific Warm Pool and H represents typical positions of moving high pressure systems.

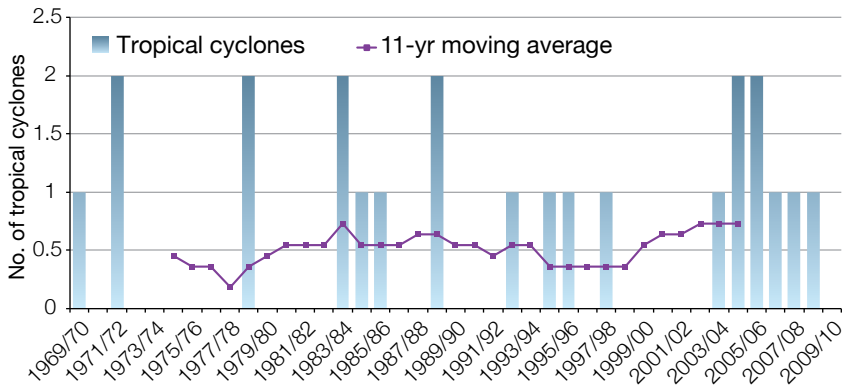

Figure 3: Number of tropical cyclones passing within 400 km of Port Moresby. Eleven-year moving average in purple.

Tropical cyclones

Tropical cyclones affect southern Papua New Guinea between November and April. In the 41-year period between 1969 and 2010, 23 tropical cyclones passed within 400 km of Port Moresby, an average of less than one cyclone per season (Figure 3). Over this 1969–2010 period, cyclones occurred more frequently in neutral phases of the El Niño-Southern Oscillation.

Papua New Guinea's **changing climate**

Temperatures have increased

Annual maximum and minimum temperatures have increased in Port Moresby since 1950 (Figure 4). Maximum temperatures have increased at a rate of 0.11°C per decade since 1950. These temperature increases are consistent with the global pattern of warming.

Port Moresby's rainfall unchanged

Data since 1950 show no clear trends in annual or seasonal rainfall at Port Moresby (Figure 5). However, at Kavieng there has been a decrease in wet season rainfall. Over this period, there has been substantial variation in rainfall from year to year at both sites.

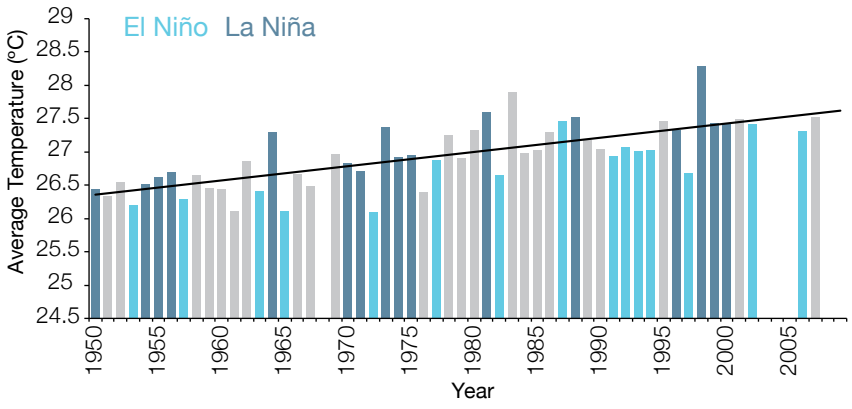

Figure 4: Annual average temperature for Port Moresby. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

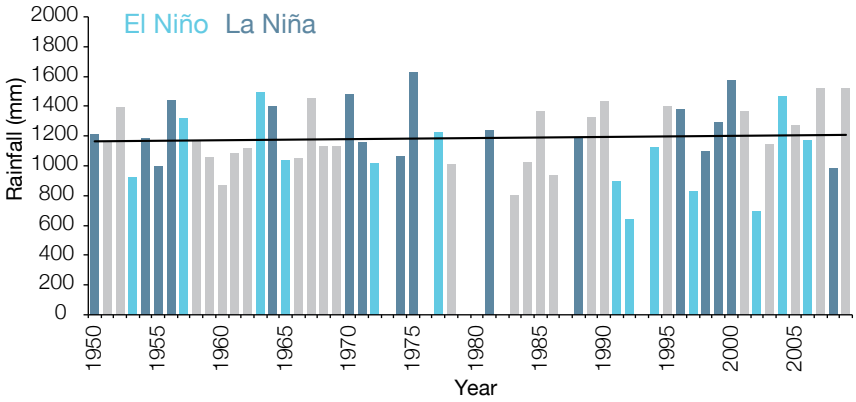

Figure 5: Annual rainfall for Port Moresby. Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years.

Sea level has risen

As ocean water warms it expands causing the sea level to rise. The melting of glaciers and ice sheets also contributes 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 Papua New Guinea by about 7 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 records since 1966 and the satellite data since 1993.

Ocean acidification has been increasing

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 Papua New Guinea's waters.

Papua New Guinea's **future climate**

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

How do scientists develop 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. Scientists from the Pacific Climate Change Science Program (PCCSP) have evaluated 24 models from around the world and found that 18 best represent the climate of the western tropical Pacific region. These 18 models have been used to develop climate projections for Papua New Guinea.

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 consider a range of possible future conditions, or scenarios, in climate models. The Intergovernmental Panel on Climate Change (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 mid-century and declining thereafter, very rapid economic growth, and rapid introduction of new and more efficient technologies. Greenhouse gas and aerosol emissions scenarios are used in climate modelling to provide projections that represent a range of possible futures.

The climate projections for Papua New Guinea 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.

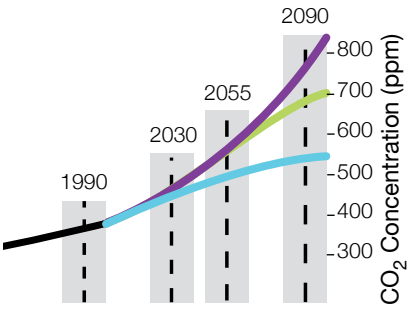

Figure 6: Carbon dioxide (CO_2) concentrations (parts per million, ppm) associated with three IPCC emissions scenarios: low emissions (B1 – blue), medium emissions (A1B – green) and high emissions (A2 – purple). The PCCSP has analysed climate model results for periods centred on 1990, 2030, 2055 and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

Papua New Guinea National Weather Service

Above: Taking weather observations, Papua New Guinea Weather Service.

Left: A coastal village near Port Moresby completely destroyed by Tropical Cyclone Justin in 1992.

Papua New Guinea's **future climate**

This is a summary of climate projections for Papua New Guinea. For further information refer to Volume 2 of *Climate Change in the Pacific: Scientific Assessment and New Research*, and the web-based climate projections tool – *Pacific Climate Futures* (available at www.pacificclimatefutures.net).

Temperatures will continue to increase

Projections for all emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future in Papua New Guinea (Table 1). By 2030, under a high emissions scenario, this increase in temperature is projected to be in the range of 0.4–1.0°C.

More very hot days

Increases in average temperature will also result in a rise in the number of hot days and warm nights and a decline in cooler weather.

Table 1: Annual average air temperature projections for Papua New Guinea for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (°C)	2055 (°C)	2090 (°C)
Low emissions scenario	0.3–1.1	0.6–1.6	1.0–2.2
Medium emissions scenario	0.4–1.2	1.0–2.0	1.6–3.2
High emissions scenario	0.4–1.0	1.1–1.9	2.2–3.4

Changing rainfall patterns

Average annual and seasonal rainfall is projected to increase over the course of the 21st century. Projected increases are consistent with the expected intensification of the West Pacific Monsoon and the Intertropical Convergence Zone. However, there is some uncertainty in the rainfall projections and not all models show consistent results. Drought projections are inconsistent for Papua New Guinea.

More extreme rainfall days

Model projections show extreme rainfall days are likely to occur more often.

Rouna Falls, Sogeri Road, Port Moresby.

Less frequent but more intense 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 also 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 Papua New Guinea region, projections tend to 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.

Weather balloon launch, Papua New Guinea National Weather Service.

Sea level will continue to rise

Sea level is expected to continue to rise in Papua New Guinea (Table 2 and Figure 7). By 2030, under a high emissions scenario, this rise in sea level is projected to be in the range of 4-15 cm. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding. As there is still much to learn, 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 Papua New Guinea for three emissions scenarios and three time periods. Values represent 90% of the range of the models and changes are relative to the average of the period 1980-1999.

	2030 (cm)	2055 (cm)	2090 (cm)
Low emissions scenario	4–14	10–26	17–46
Medium emissions scenario	5–14	9–30	20–58
High emissions scenario	4–15	10–29	22–60

Ocean acidification will continue

Under all three emissions scenarios (low, medium and high) the acidity level of sea waters in the Papua New Guinea 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.

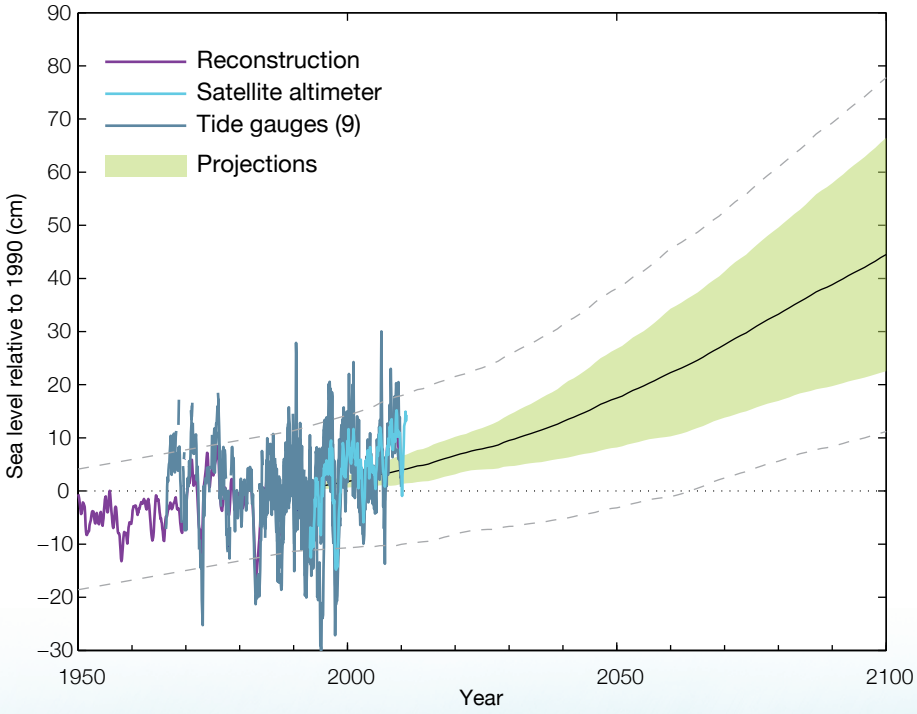

Figure 7: Observed and projected relative sea-level change near Papua New Guinea. The observed sea-level records are indicated in dark blue (relative tide-gauge observations) and light blue (the satellite record since 1993). Reconstructed estimates of sea level Papua New Guinea (since 1950) are shown 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.

Changes in
Papua New Guinea's climate

> Temperatures have warmed and will continue to warm with more very hot days in the future.

> Rainfall shows no clear trend since 1950 at Port Moresby but a decrease in wet season rainfall at Kavieng. Rainfall is generally projected to increase over this century with more extreme rainfall days expected.

> By the end of this century projections suggest decreasing numbers of tropical cyclones but a possible shift towards more intense categories.

> Sea level near Papua New Guinea has risen and will continue to rise throughout this century.

> Ocean acidification has been increasing in Papua New Guinea's waters. It will continue to increase and threaten coral reef ecosystems.

The content of this brochure is the result of a collaborative effort between the Papua New Guinea National Weather Service and the Pacific Climate Change Science Program – a component of the Australian Government's International Climate Change Adaptation Initiative. This information and research conducted by the Pacific Climate Change Science Program builds on the findings of the 2007 IPCC Fourth Assessment Report. For more detailed information on the climate of Papua New Guinea 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.

www.pacificclimatechangescience.org

Contact the Papua New Guinea National Weather Service:

phone: + 675 325 2557

Australian AID

Australian Government
Bureau of Meteorology

Australian Government
Department of Climate Change and Energy Efficiency

CSIRO