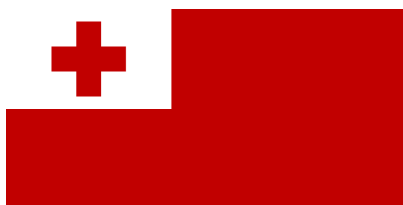


Summary: Climate Change in Tonga 2022

Historical and Recent Variability, Extremes and Change



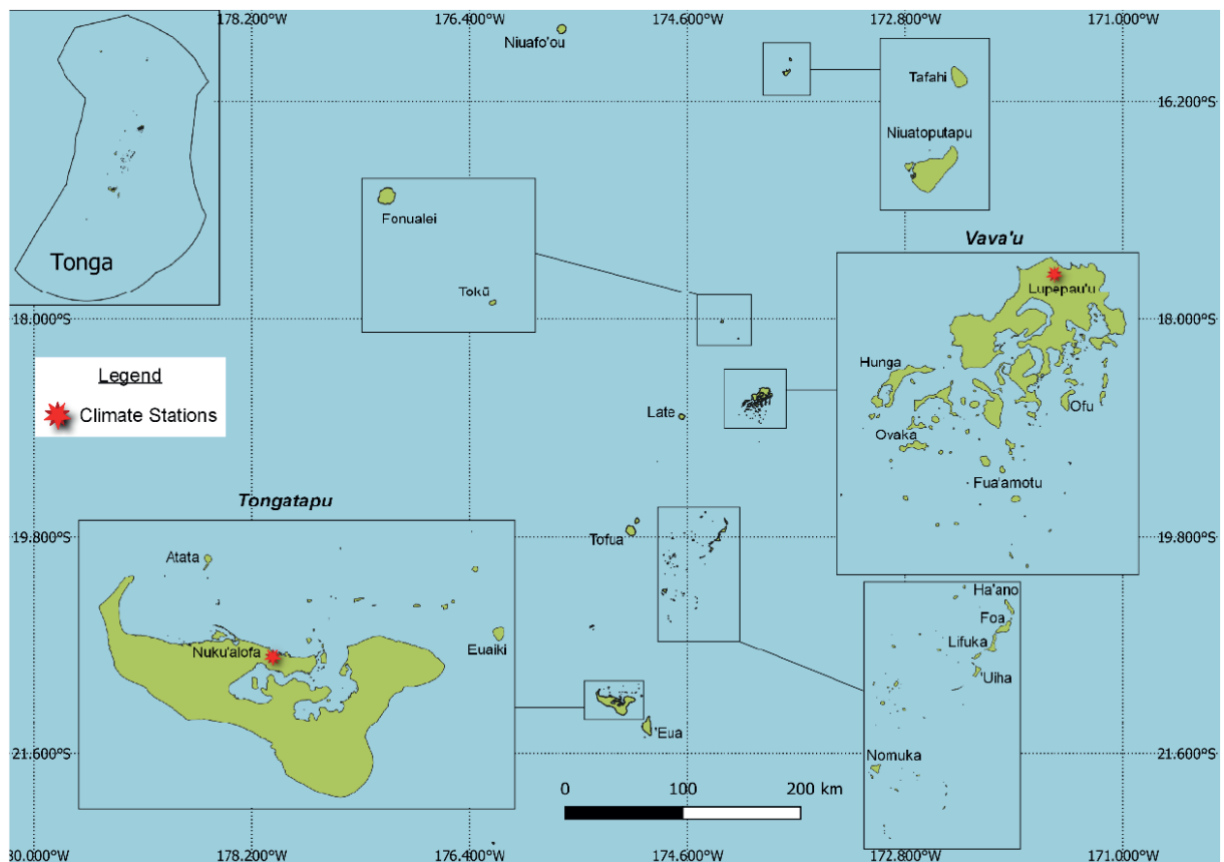
COSPPac
Climate and Oceans Support
Program in the Pacific

This brochure provides a snapshot of key long-term changes in climate and ocean variables in Tonga. Long-term changes were determined by analysing trends in historical climate and ocean data. Trends provide information about climate change in Tonga 'to date'.

Climate variability strongly influences extreme events in Tonga. The brochure also provides up-to-date scientific information on climate variability and its influence on extreme events.

Figure 1:

Tonga and the location of the climate stations used in Climate Change in the Pacific 2022 report.



Dry season rainfall has increased in central Tonga

Dry season (May–October) rainfall has increased since 1951 at Lupepau'u. There has been little change in wet season (November–April) rainfall and annual rainfall. The proportion of total annual rainfall received from very wet days at Lupepau'u increased by around 1.47 % per decade over the same period.

There has been little change in annual and seasonal rainfall at Nuku'alofa since 1951. There has also been little long-term change in maximum one-day rainfall (in a year) and meteorological drought in the wet and dry seasons since 1971.

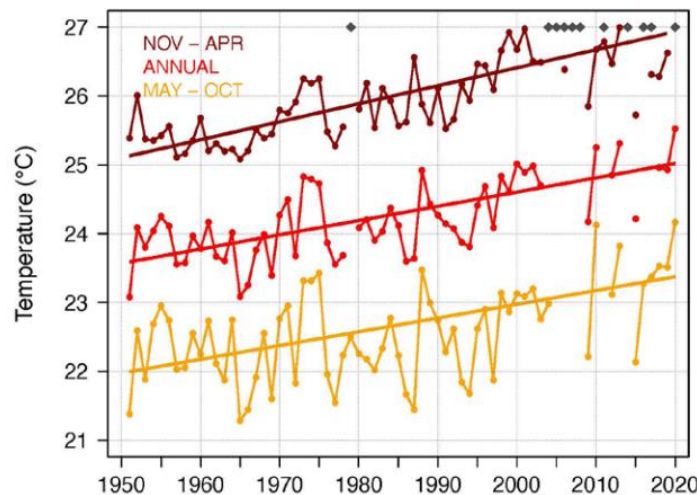
The El Niño–Southern Oscillation (ENSO) – a natural mode of climate variability – influences rainfall variability from year to year in Tonga. La Niña years typically receive more rainfall than El Niño years.

Air Temperature has increased

Average annual temperatures at Nuku'alofa have increased by 0.21 °C per decade since 1951. Both wet season (November to April) and dry season (May to October) temperatures have increased, as well as daytime maximum temperatures and nighttime minimum temperatures. Wet season temperatures have warmed faster than dry season temperatures (Figure 2) and minimum temperatures more than maximum temperatures.

Figure 2:

Average annual, November–April and May–October temperatures for Nuku'alofa. Straight lines indicate linear trends. Diamonds indicate years with insufficient data for one or more variables.



Long-term increases in both average temperature and temperature extremes in the Pacific are likely driven by human-associated climate change, due to the rate of the observed changes and consistency with global trends that have been attributed to climate change (PCCM, 2021).



Tropical cyclone severity has decreased

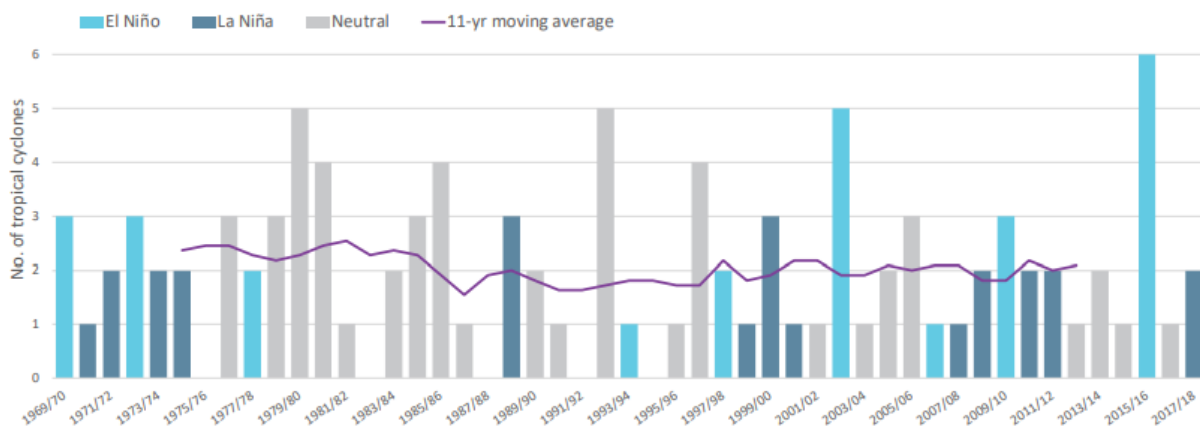
In the greater Southwest Pacific, the total number of **severe** tropical cyclones¹ has decreased over the last 40 seasons. There has been little change in the total number of tropical cyclones of any category in the southwest Pacific. The number of tropical cyclones that became severe events has marginally declined.

Tropical cyclones usually affect Tonga during the southern hemisphere tropical cyclone season, which is from November to April, but also occasionally occur outside the tropical cyclone season.

The number of tropical cyclones occurring in Tonga's Exclusive Economic Zone (EEZ) varies considerably from one year to the next (Figure 3). Tropical cyclones were most frequent in neutral years (23 cyclones per decade), followed by El Niño years (20 cyclones per decade) and least frequent in La Niña years (17 cyclones per decade).

Figure 3:

Number of tropical cyclones passing within the Tonga EEZ per season. Each season is defined by the ENSO status, with light blue being an El Niño year, dark blue a La Niña year and grey showing a neutral ENSO year. The 11-year moving average is presented as a purple line and considers all years.



Due to this high interannual variability and the relatively small number of tropical cyclones passing through any country's EEZ since reliable records began, individual country analysis of long-term trends in frequency and intensity is not possible.

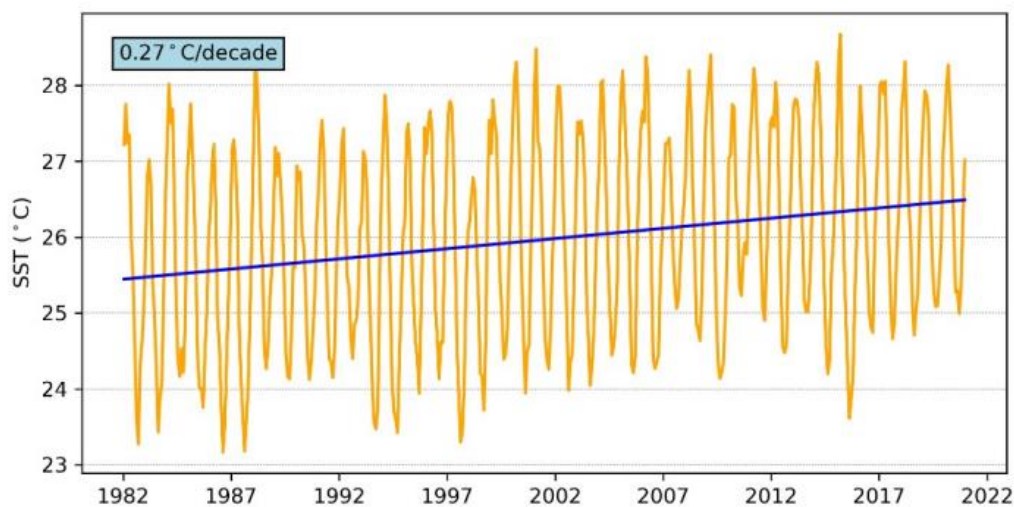
¹ A 'severe' tropical cyclone is defined as having a minimal central pressure of <970 hectopascals (hPa). Pressure is often used when comparing intensity of tropical cyclones.

Sea surface temperature has increased

Sea surface temperatures averaged across Tonga's EEZ increased by 0.27 °C per decade since 1982 (Figure 4).

Figure 4:

Sea surface temperature from satellite observations averaged across the Tonga EEZ, shown as the orange line. The blue line shows the linear regression trend.



Globally, sea surface temperature is one of the most widely used indicators used to monitor human-associated climate change. Modes of climate variability influence sea surface temperatures on an interannual and decadal/multi-decadal basis; however, climate change is a driver of the long-term positive trend (PCCM, 2021).

Sea surface temperatures at Nuku'alofa tend to be warmest in February/March, reaching, on average, a maximum of 27.5 °C, but individual days in January to March can get as high as almost 30 °C. Sea surface temperatures are usually coolest in August, reaching, on average, a minimum of 23 °C. Hourly temperatures can be up to 3 °C higher or lower than these monthly averages at Nuku'alofa and may differ at other locations in Tonga.

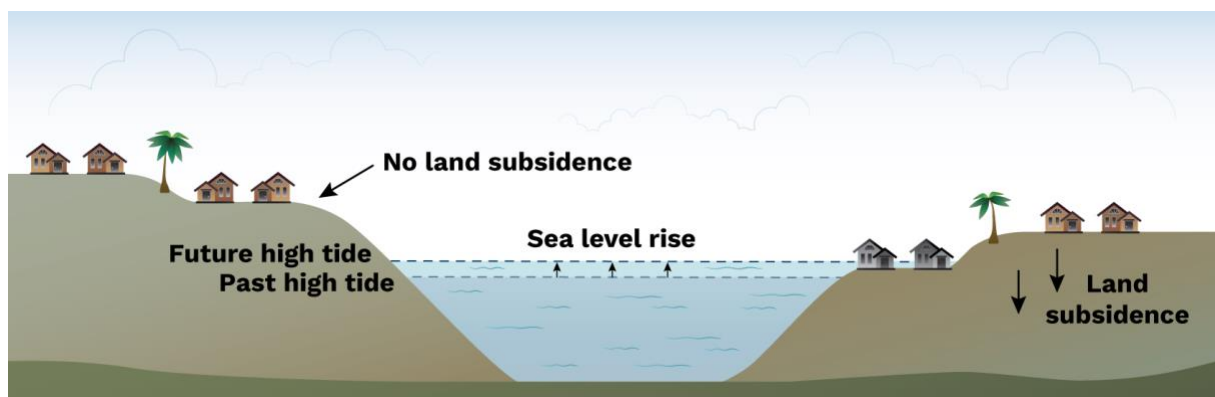


Sea level has increased

A combination of sea level rise and land subsidence has increased relative sea level at the Nuku'alofa tide gauge by 6.6 mm per year since 1993 (Figure 5). The number of hours per month that sea level has exceeded the 99th percentile of historical maximum sea level has increased since 2009. Peak sea levels typically occur between December and February.

Figure 5:

The effect of sea level rise and land subsidence on local sea level.



The long-term trend in sea level from satellite altimetry across Tonga's EEZ is 3.5–5 mm per year since 1993. This trend is higher than the global average trend.



The rise in Pacific mean sea level since 1993 is primarily attributable to global warming. Naturally-occurring modes of climate variability in the Pacific region - for example, the El Niño–Southern Oscillation (ENSO) on interannual time scales, and the IPO (Interdecadal Pacific Oscillation)/PDO (Pacific Decadal Oscillation) on decadal to multi-decadal time scales - influence sea level and can amplify or dampen the underlying trends arising from global warming (PCCM, 2021).

Tonga coastline



Waves

Waves at Nuku'alofa come from the northeast to the southeast. On average, Nuku'alofa experiences approximately four extreme wave events – defined as reaching or exceeding a wave height of 2.95 m per year.

There has been no long-term change in average annual wave height since 1979. Wave height, wave period (the time interval between two waves) and wave direction changes from month to month with the seasons and, to a lesser degree, year to year with climate variability modes. The highest waves usually occur between November and March and the longest wave periods also occur over these months.

Further reading

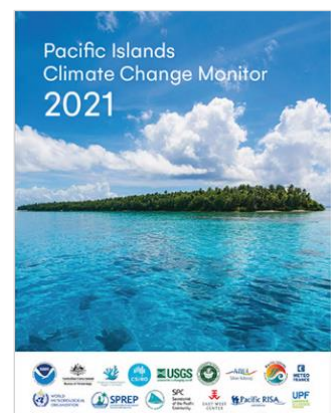
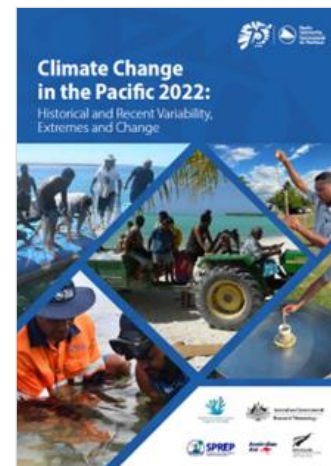
For more information, refer to Climate Change in the Pacific 2022: Historical and Recent Variability, Extremes and Change. Climate and Oceans Support Program in the Pacific. Fifteen country chapters are available at <https://purl.org/spc/digilib/doc/kskiv>

For more information on Pacific-wide observed and future trends in climate indicators, see the Pacific Islands Climate Change Monitor 2021, available at

https://www.pacificmet.net/sites/default/files/inline-files/documents/PICC%20Monitor_2021_FINALpp_0.pdf

Historical climate trends and basic climate information from observation sites across the Pacific Islands are available through the web-based Pacific Climate Change Data Portal at www.bom.gov.au/climate/pccsp

Information about future climate change can be found in the 'NextGen' Projections for the Western Tropical Pacific country reports <https://www.csiro.au/en/research/environmental-impacts/climate-change/pacific-climate-change-info>





Fafa Island

The content of this brochure is an outcome of the high degree of cooperation and collaboration that exists between the implementing partners of the Australian Aid funded Climate and Oceans Support Program in the Pacific (COSPPac), specifically the Bureau of Meteorology (the Bureau), the Pacific Community (SPC) and Pacific Regional Environmental Programme (SPREP), together with the valuable ongoing support from the national meteorological services in the 15 partner countries and territories. Publication support has been provided through New Zealand Aid Programme.



For more detailed information on the climate of Tonga and the Pacific, see: *McGree, S., G. Smith, E. Chandler, N. Herold, Z. Begg, Y. Kuleshov, P. Malsale and M. Ritman. 2022. Climate Change in the Pacific 2022: Historical and Recent Variability, Extremes and Change. Climate and Oceans Support Program in the Pacific. Pacific Community, Suva, Fiji.*



Contact the Tonga Meteorological Service:

web: <https://met.gov.to/>

phone: +676 740 0062