Pacific-Australia Climate Change Science and Adaptation Planning program

International CLIMATE CHANGE ADAPTATION Initiative

Vanuatu

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Observed climate variability and change and projected future climate of Vanuatu

Vanuatu is comprised of many, mainly volcanic, islands where the majority of the 234,023 Ni-Vanuatu live in the coastal areas. While the isolation of these islands has been a hindrance to economic development, the country's economy is driven by agriculture and tourism, which generally benefit from fertile volcanic soils and a favourable tropical climate. Tropical cyclones and extreme rainfall events at times impact the islands negatively. Understanding climate variability and change in Vanuatu is very important to economic development. The main climate drivers that influence the current weather of Vanuatu are the South Pacific Convergence Zone (SPCZ), the El Niño/Southern Oscillation (ENSO), the number of tropical cyclones, subtropical high pressure cells (Figure:1), and, to a lesser extent, the Madden-Julian Oscillation (MJO). These large-scale climate features have been, and will be, the main contributors to the current and future climate of this country.

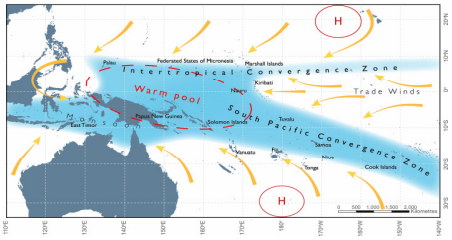

Figure:1.
Main climate drivers in the Pacific affecting Vanuatu

Seasonal Cycles

Vanuatu has 2 distinct seasons; the hot/wet period during November to April and cold/dry period from May to October. Rainfall varies greatly seasonally and from year-to-year due mainly to the influence of the ENSO (Figure:2b). The seasonal rainfall pattern is strongly influenced by the position and strength of the SPCZ. During summer/winter this climate driver intensifies and moves further south/north, bringing the higher/lower rainfall of the wet/dry season (Figure:5). The wettest years receive up to three times more than the driest years.

The movement of the climate drivers also have a great influence on the temperatures patterns. Being further south, mean monthly Aneityum temperatures are about 2ºC cooler than those in Port Vila as they are influenced by high pressure cells bringing cold winds from higher latitudes. During warmest months in Vanuatu (January-February), temperatures are about 4ºC higher than those in the coolest months (July-August). The warming trends are evident in both annual and seasonal mean air temperatures for Bauerfield Airport (Port Vila) for the period 1950–2009 (Figure:2a).

Low pressure systems embedded in SPCZ often become tropical cyclones. Port Vila experiences, on average, about 23 events per decade, with most occurring in January and February. The high interannual variability in tropical cyclone numbers makes it difficult to identify any long-term trends in frequency (Figure:6).

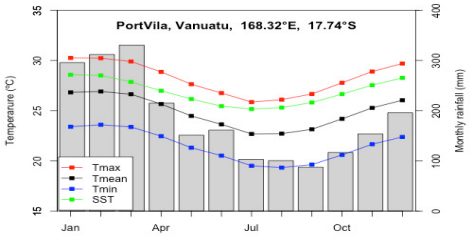

Figure:5
Mean annual cycle of rainfall (grey bars) and maximum (Tmax), minimum (Tmin), mean (Tmean) and sea surface (SST) temperatures at Port Vila (left).

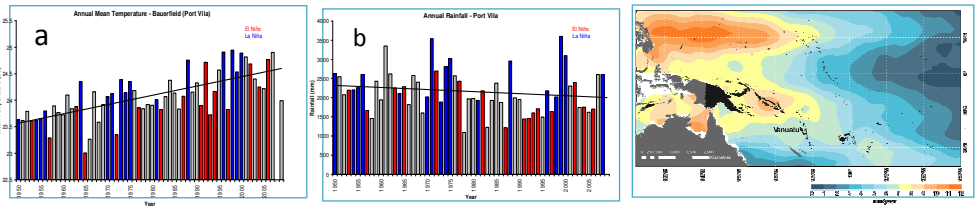

Figure:2.
Annual mean temperature at (a) Bauerfield Airport (Port Vila) and (b) annual rainfall at Port Vila. Red and blue bars denote El Niño and La Niña years respectively.

Figure:3
The regional distribution of the rate of sea-level rise measured by satellite altimeters from January 1993 to December 2010, with the location of Vanuatu indicated.

Climate Variability and Observed Trends

There are significant correlation between ENSO indices and both rainfall and air temperature in Vanuatu (Table:1). El Niño events tend to bring a late start to the wet season and lower rainfall in both the wet and dry seasons. Opposite impacts are usually observed during La Niña events.

Climate Feature/Index		Dry Season (May-October)			Wet Season (November-April)		
		Tmin	Tmax	Rain	Tmin	Tmax	Rain
ENSO	NINO3.4	-0.41	-0.41	-0.45			-0.49
	SOI	0.36	0.41	0.36			0.51
IPO				-0.28			
Southern Annular Mode							
ENSO Modoki Index		-0.40	-0.36	-0.26	-0.28		-0.45
No. of years		62	62	98	62	63	100

Table:1.
Correlation coefficients between indices of key climate drivers and temperatures and rainfall at Port Vila. Only correlation coefficients that are statistically significant at the 95% level are shown.

There are warming trends in air temperatures which is evident in Bauerfield station (Figure:2a). In addition to other extreme events, between 1969/70 and 2009/10 seasons, the centre of 94 tropical cyclones passed within 400km of Port Vila making this site the most impacted capital city of the countries involved in the Pacific Climate Change Science Program. Moreover, ENSO-related drought and flooding are prevalent and continue to impact the socio-economic livelihood of Ni-Vans while sea level rise observed near Vanuatu by satellite altimeters since 1993 has confirmed that it rises to about 6 mm per year (Figure:3).

Methods

Vanuatu's climate projections were derived using outputs from 18 global climate simulations from 24 original CMIP3 models. These models captures the broad-scale climate features and represent an average change over land and surrounding ocean over Vanuatu. These projections were based on three most widely used emissions scenarios; B1 (low), A1B (medium) and A2 (high) that captures possible climate futures. Since it is uncertain how Vanuatu's climate will evolve over the next century, the level of confidence associated with a given projection is determined by expert (PCCSP Scientist) judgment that depends on agreement between models. The confidences are higher for some variables (e.g. temperatures) and lower for others (e.g. precipitation)

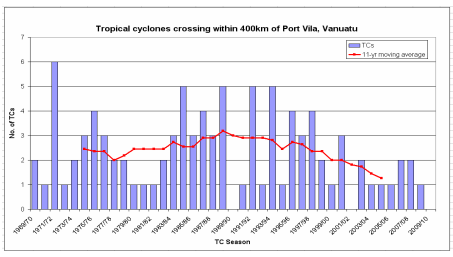

Figure:6
Tropical cyclones passing within 400 km of Port Vila. The 11-year moving average is in red.

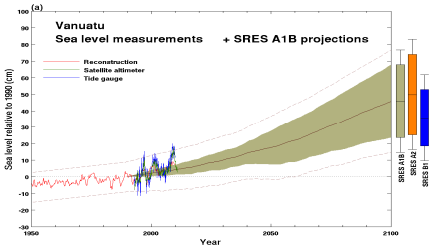

Figure:4.
Observed and projected relative sea-level change near Vanuatu.

Climate projections

The following projections are based on the Climate Change in the Pacific report:

- Tropical cyclone frequency to show no change or decrease in frequency and increase in severe events in the south-west Pacific basin (moderate confidence)
- Wet season rainfall to increase over the course of the 21st century (moderate confidence)
- Dry season rainfall to decrease (moderate confidence)
- Total annual rainfall to increase (low confidence)
- The intensity and frequency of days of extreme heat to increase (very high confidence)
- The intensity and frequency of days of extreme rainfall to increase (high confidence)
- Little change in the incident of drought (low confidence)
- The acidity of the ocean to continue to increase (high confidence)
- Mean sea level to continue to rise (high confidence) (Figure:4).
- Surface temperature and sea surface temperature to increase (high confidence) (Figure:7)

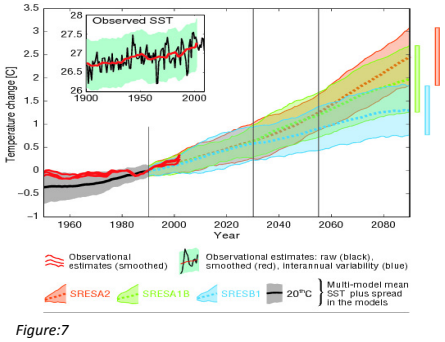

Figure:7
Historical climate (from 1950 onwards) and simulated historical and future climate for annual mean sea surface temperature in the region surrounding Vanuatu.

Materials in this presentation are obtained from BoM and CSIRO (2011) Climate Change in the Pacific: Scientific Assessment and New Research (Vol. 2: Country Reports) produced by the Pacific Climate Change Science Program (PCCSP).

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