Pacific-Australia Climate Change Science and Adaptation Planning program

International CLIMATE CHANGE ADAPTATION Initiative

Tuvalu

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Observed Climate Variability, Change and Future Projections in Tuvalu.

Tuvalu is the second smallest independent nation consisting of five atolls and four islands located between 176–180°E and 5–11°S in the western South Pacific Ocean (Fig. 1). Tuvalu has a total land area of 26 km square with a maximum height of between 3-4 metres above mean sea level. The Exclusive Economic Zone is 900 000 km square. The nation has a population of less than 12,000 inhabitants. Dominant contributors to the economy include the fisheries sector, seafarers and foreign aid.

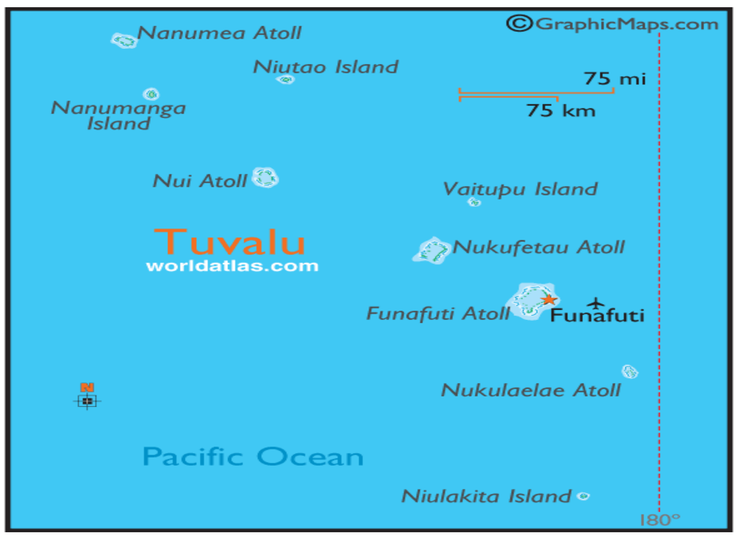

Figure 1: Location of Tuvalu

Observed climate and climate summary.

Tuvalu experiences two distinct seasons, the Wet Season from November to April and the Dry Season from May to October. The mean annual rainfall for Funafuti is around 3400 mm and for Nanumea is 2900 mm (Fig 2). The seasons are mainly influenced by the strength of the South Pacific Convergence Zone (SPCZ) with the SPCZ strongest in the wet season. Interannual variability is modulated by the El Niño Southern Oscillation, which tends to produce wetter conditions during El Niño events. Droughts occasionally occur during La Niña events.

The seasonal variation for temperature is very small with maxima averaging 30-31 °C and minima 25-26 °C.(Fig 2). Tropical cyclones are most common in El Niño years (12 cyclones per decade) and least frequent in La Niña years (4 cyclones per decade, Fig 3 above). Extreme sea level events tend to occur mainly during February and March (Fig 3 below).

Warming trends are marked in annual and seasonal mean air temperature (Fig 4 above) with the strongest trend in the dry season (+0.2°C/decade). (Fig 4 below). Observed rainfall changes are small.

Figure 2: Mean seasonal cycle of temperature and rainfall at Funafuti and Nanumea.

Coral bleaching linked to an increase in sea temperature.

Waves crash inland from the lagoon.

Coastal erosion.

Future Climate

Methods

At least 18 global climate models from the CMIP3 database were used for climate projections for Tuvalu. These models were selected based on their ability to reproduce the main features of the current climate of Tuvalu. The projections are across three different emissions scenarios (B1 (Low), A1B (medium) and A2 (high) and three 20 year periods (centered on 2030, 2055 and 2090, relative to 1990).

Climate Projections

There is a range of possible climate futures that have been given by a number of global climate models. The projections below (Fig 5) focus on the average change in mean sea surface temperature (SST) over the broad geographical region encompassing the islands of Tuvalu and the surrounding seas near Tuvalu (Fig 1). A clear increasing trend in SST for Tuvalu is projected over the course of the 21st century. This change (using CMIP3 models) includes a small increase (<1°C) in annual and seasonal mean temperature by 2030 ranging to a substantial increase (>2.5°C) by 2090 under A2 (high emissions) scenario. The projections are in general agreement with the modelled and observed temperature trends over the past 50 years in the vicinity of Tuvalu (Fig 5).

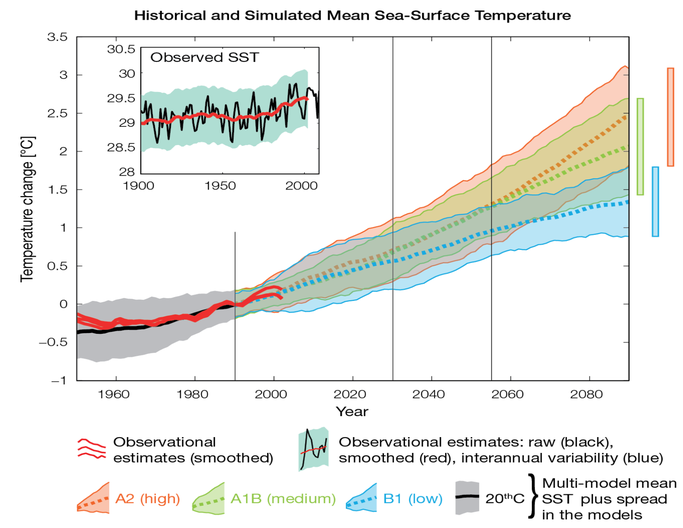

Figure 5: Historical climate (from 1950 onwards) and the simulated historical and future climate for annual MSS Temperature in the vicinity of Tuvalu.

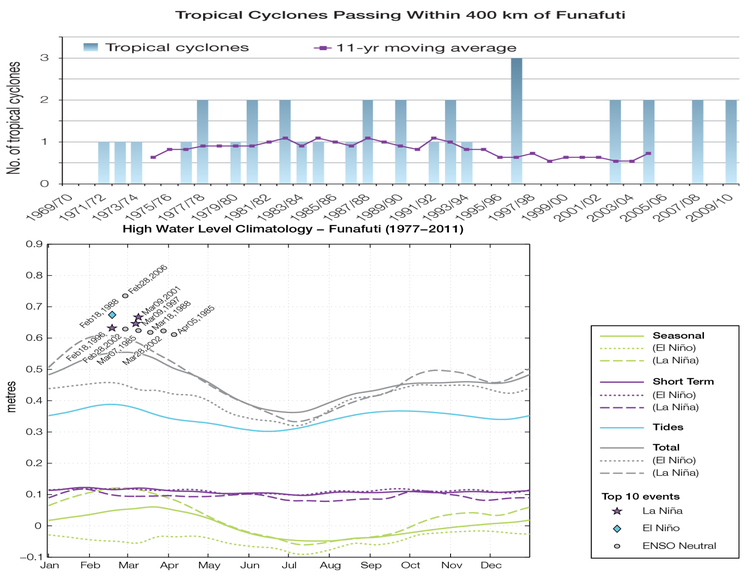

Figure 3: Tropical cyclone (above) and annual cycle of water [Tides] (below).

Summary of Projections

Tuvalu as an atoll and a small dot on a global map also has a small range of climatological conditions. These climatological conditions are subjected to change with time and due to a wide range of environmental factors such as global warming.

There is 'very high confidence' in an increase in surface air temperature, sea surface temperature, intensity and frequency of days of extreme heat, ocean acidification and mean sea level rise over the course of the 21st Century. There is 'high confidence' in an increase in annual rainfall and intensity of days of extreme rainfall. There is 'moderate confidence' in a decrease in the incidence of droughts and the frequency of tropical cyclones.

Variable	Season	2030	2055	2090	Confidence
Surface air temperature (°C)	Annual	+0.7 ± 0.4 +0.8 ± 0.4 +0.7 ± 0.3	+1.1 ± 0.4 +1.5 ± 0.5 +1.4 ± 0.4	+1.5 ± 0.6 +2.3 ± 0.8 +2.7 ± 0.6	High
Maximum temperature (°C)	1-in-20-year event	N/A	+1.0 ± 0.6 +1.5 ± 0.6 +1.5 ± 0.5	+1.4 ± 0.7 +2.1 ± 1.1 +2.7 ± 1.3	Low
Minimum temperature (°C)	1-in-20-year event	N/A	+1.2 ± 1.8 +1.5 ± 2.0 +1.5 ± 1.8	+1.6 ± 1.8 +2.2 ± 2.0 +2.4 ± 1.9	Low
Total rainfall (%)*	Annual	+3 ± 8 +3 ± 8 +4 ± 8	+7 ± 11 +7 ± 10 +7 ± 12	+7 ± 12 +12 ± 14 +11 ± 18	Moderate
Wet season rainfall (%)*	November-April	+3 ± 10 +3 ± 9 +4 ± 8	+7 ± 9 +6 ± 11 +6 ± 10	+7 ± 11 +11 ± 14 +11 ± 16	Moderate
Dry season rainfall (%)*	May-October	+3 ± 10 +4 ± 11 +5 ± 13	+7 ± 16 +7 ± 16 +8 ± 19	+8 ± 18 +12 ± 23 +12 ± 26	Moderate
Sea-surface temperature (°C)	Annual	+0.6 ± 0.4 +0.7 ± 0.3 +0.7 ± 0.4	+1.0 ± 0.3 +1.3 ± 0.4 +1.3 ± 0.5	+1.3 ± 0.5 +2.1 ± 0.6 +2.5 ± 0.6	High
Aragonite saturation state (Ωar)	Annual maximum	+3.6 ± 0.1 +3.5 ± 0.2 +3.5 ± 0.2	+3.3 ± 0.1 +3.2 ± 0.2 +3.2 ± 0.1	+3.2 ± 0.2 +2.8 ± 0.2 +2.6 ± 0.2	Moderate
Mean sea level (cm)	Annual	+9 (4–14) +9 (5–14) +9 (4–14)	+17 (9–25) +19 (10–29) +19 (9–28)	+31 (16–45) +37 (19–56) +39 (19–58)	Moderate

Figure 6: Projected change in annual and mean seasonal climate for Tuvalu. B1 (low, blue), A1B(medium, green) and A2 (high, purple). Values represent the multi-model mean change ± twice the inter-model standard deviation. Numbers for aragonite saturation represent actual rather than projected changes.

	Funafuti Tmax (°C per 10 yrs)	Funafuti Tmin (°C per 10 yrs)	Funafuti Tmean (°C per 10 yrs)	Funafuti Rain (mm per 10 yrs)	Nanumea Rain (mm per 10 yrs)
Annual	+0.21	+0.22	+0.21	-45	-2
Wet season	+0.18	+0.20	+0.19	-37	-4
Dry season	+0.24	+0.25	+0.24	-13	+1

Figure 4: Observed annual and seasonal average temperature and rainfall changes at Funafuti, Tuvalu.

Acknowledgement

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.

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