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Climate Projections and Impacts for Yap

Current Climate Changes

- Annual mean air temperatures show little change (+0.06°C) since the 1950s (unlike other parts of the FSM, e.g., Pohnpei which has increased ~1°C)
- Climate variability is influenced by the El Niño-Southern Oscillation (ENSO). Generally, El Niño years are drier than average and La Niña years are wetter.
- Average annual rainfall is ~120 in/yr
- Sea levels have risen globally by 4-8 inches over the last 100 years; Tide gauge data in Yap indicates a sea-level rise of ~4.7 inches since 1969, less than surrounding areas due to tectonic uplift (University of Hawaii Sea Level Center 2015). The FSM generally experiences higher sea-levels during La Niña.
- Tropical cyclones affect the FSM mainly between June and November. They are more likely to occur in El Niño years and less likely in La Niña years.

Yap, Federated States of Micronesia

Climate changes over the next few generations

Climate Feature	Climate Projections	Potential Impacts
Sea Level Rise	Sea level is projected to increase in Yap by: • ~5 inches over the next generation (by 2030) • ~10 inches by 2050 • ~16-35 inches or more by the end of the century (2100 or four generations)	Sea-level rise exacerbates flooding from high tides and storms. This can increase the potential for loss of lives, damage and loss of coastal homes, lands, and infrastructure, contaminated drinking water, and destruction of crops. Increased coastal erosion can result from higher sea levels especially when combined with large waves. Salinity intrusion can damage coastal aquifers and agricultural land.
Air Temperature	Annual temperatures will to continue to rise: • ~0.8°C over the next generation (2030) • ~1.4°C by 2050 • ~3°C by 2090	Impacts to human health and health systems related to heat stress if working outside or outdoor recreation. Increased need for cooling systems and energy required for cooling. Air temperature impacts sea surface temperature, storms, and precipitation, also impacting agriculture and water resources.
Storm Patterns	Globally, cyclones are projected to be fewer but the ones that occur will be of higher intensity. Models show inconsistent results for Yap; most suggest a decrease in formation (20-50%), but the confidence for these projections is low.	More severe cyclones when they do occur and combined with sea level rise will result in increased flooding and potentially coastal change resulting in damage and loss of lives, coastal homes, land, and infrastructure.

Climate change impacts and natural hazards in Yap

Typhoon damage in Yap; Source: Graham Gaines

Climate Feature	Climate Projections	Potential Impacts
Sea-Surface Temperature (SST)	Projected increases in SST: • ~0.8°C over the next generation (2030) • ~1-2°C by 2050 • ~2-4°C by 2090	Coral bleaching is expected to increase. When sea temperatures increase 1–2°C above the normal maximum for > 4-6 week, coral bleaching is likely. Coral diseases may also increase due to warming seas. Coral bleaching and disease can adversely affect reef-dependent species and reduce services reefs provide (tourism; coastal protection; food/livelihoods; habitat; medicine).
Rainfall Patterns	Average rainfall is projected to increase, over the Federated States of Micronesia. In Yap, rainfall is projected to increase: ~2% by 2030; ~5% by 2050; ~10% by 2090. More intense (heavy) rainfall events are also expected. Droughts are projected to decline in frequency. There will still be wet and dry years and decades due to ENSO-related variability, but most models show that the long-term average is expected to be wetter.	Increases in rainfall intensity will lead to increasing flooding, damage to crops, and increases in run-off/pollutants into coastal waters. A wetter climate may also lead to increases in vector-borne diseases (e.g., dengue). Impacts will be felt from periods of drought affecting human health, water supply and agriculture.
Ocean acidification	As atmospheric CO_2 concentrations continue to rise, oceans will warm and continue to acidify. Over the last two centuries in Yap, the aragonite saturation state (a proxy for coral reef growth rate) has declined from 4.5 to 3.9. Models suggest the aragonite saturation state will continue to decrease to 3.5 (marginal conditions to support coral reefs) by 2030 and decrease further to values where coral reefs have not historically been found (< 3.0).	Ocean acidification (OA) affects many marine organisms that rely on calcium carbonate to build their shells/skeleton (e.g., corals, clams, mussels). OA can result in decreased growth and reproduction and weaker and more brittle skeletons, prone to increased damage from storms. Corals are critical because they provide habitats for fish, support food/livelihoods, income from tourism, medicines, and coastal protection to islands.
El Niño/La Niña – ENSO	El Niño and La Niña events will continue to occur in the future, but there is little consensus on whether they will change in intensity or frequency.	Impacts vary depending on ENSO years but affect sea level, precipitation patterns, temperature (air and sea), and storm patterns resulting in intense flooding and drought. In Yap, drought may occur in the year after a moderate/strong El Niño. ENSO also can impact coral reefs (e.g., through bleaching).

Acknowledgements:
Climate projections derived using Global Climate Model data from the Coupled Model Intercomparison Project, Phase 5 (CMIP5). Projections are for greenhouse gas and aerosol concentration emission scenario RCP8.5 (Representative Concentration Pathway; very high emissions). Climate projection data are obtained from Australian Bureau of Meteorology and CSIRO (2014). Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports and The Pacific Islands Regional Climate Assessment (PIRCA): http://www.pacificrisa.org/projects/pirca/