PAST AND PROJECTED FUTURE CLIMATE IMPACTS TO CORAL REEFS IN GUAM

About

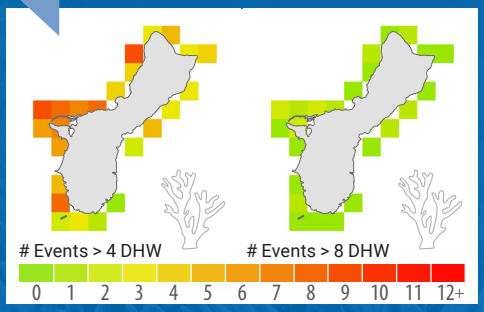
Island of Guam

Coral reefs in Guam are among the most biodiverse of the U.S. coral reef jurisdictions, including over 1000 species of reef fish, 400 coral, 650 algae, 1700 mollusc and over 800 crustacean species.

Reefs in Guam have been exposed to thermal stress severe enough to cause coral bleaching in the past (Pago Bay in 2016 on left), and are expected to in the future. Vulnerability to climate change is a function of both exposure of reef systems to climate pressures and the resilience of the system to those pressures. Past and projected future climate impacts are summarized here. We can support reef resilience and reduce climate vulnerability by reducing the stress on reefs caused by human activities, such as pollution, anchoring and overfishing.

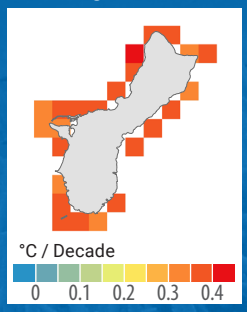
Past (1985-2012)

BLEACHING HISTORY



Frequency of exposure to thermal stress events that likely caused mild/moderate bleaching (4 DHW) and severe bleaching (8 DHW)

ANNUAL TREND



Rate of increase of sea surface temperatures.

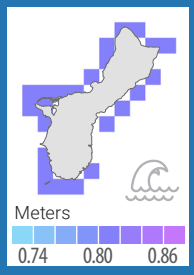
Reefs were exposed to thermal stress that likely caused mild/moderate bleaching (4 Degree Heating Weeks, DHW) 19 times in the 27 year period, and were exposed 8 times to thermal stress that may have caused severe bleaching (8 DHWs). Roughly half of the coral reefs in Guam were exposed to moderate thermal stress five times or more during the study period. <5% of reefs (n=1 4-km pixels total) were exposed to severe thermal stress in 1999, 2003, 2009 and 2012. Reefs in Guam have been exposed to moderate or severe thermal stress 9 of the most recent 10 years of the study period (2002-2012), a 3-fold increase from the first 10 years (1986-1996). This increase can be attributed to increases in sea temperature, which have averaged 0.35 °C/decade in Guam.

Projected Future (2017-2100)

Climate models[1] project that all coral reefs in Guam will be exposed to severe thermal stress (8DHWs) every year by 2045 under emissions scenario RCP8.5 (assumes climate policy will not be effective). Such frequent thermal stress may cause recurrent bleaching, suggesting cover of bleaching-sensitive corals will decline further in the decades ahead. RCP4.5 is a stabilization scenario that requires greater emissions reductions than pledged under current climate policy. There is 5 years difference on average between RCP4.5 and 8.5 in the onset of annual severe thermal stress. The projected change in aragonite saturation state (Ω_{arag}) between 2006 and 2050 is -0.6, which may cause a 9% decline in calcification (based on 15% declines for each unit decline of Ω_{arag}, Chan and Connolly 2006). Sea level rise is projected to increase 0.8 meters in Guam this century.

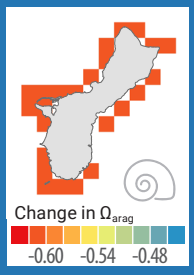
[1] Intergovernmental Panel on Climate Change (IPCC) fifth phase of the Coupled Model Interpolation Project (CMIP5) models (see van Hooidonk et al. 2015 for list of models for each scenario); projections shown are ensemble averages.

SEA LEVEL RISE



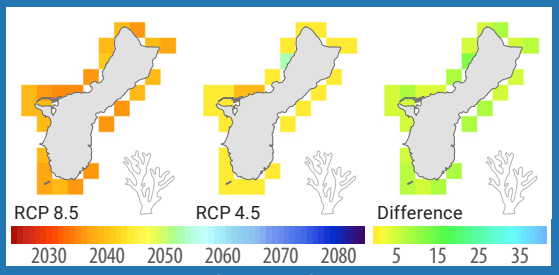
Sea level rise by 2100.

OCEAN ACIDIFICATION



Change in aragonite saturation state between 2006 and 2050.

ONSET OF ANNUAL SEVERE BLEACHING (YEAR)



Climate model projections of the onset of annual severe bleaching under RCP4.5 (stabilization scenario that requires greater emissions reductions than pledged under current climate policy), RCP8.5 (assumes climate policy is ineffective), and the difference in years between the scenarios.

These data and maps are adapted from these publications:

Heron, S. F., Maynard, J. A., et al. (2016). Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. *Scientific Reports*, 6.

van Hooidonk, R., Maynard, J., et al. (2016). Local-scale projections of coral reef futures and implications of the Paris Agreement. *Scientific Reports*, 6.

van Hooidonk, R., Maynard, et al. (2014). Opposite latitudinal gradients in projected ocean acidification and bleaching impacts on coral reefs. *Global Change Biology*, 20(1), 103-112.

References:

Chan NCS, Connolly SR (2013) Sensitivity of coral calcification to ocean acidification: a meta-analysis. *Global Change Biology*, 19, 282–290.

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