RSC 5020 Ocean Acidification Excerpt from *Climate Change and Maui: Indicators, Impacts, and Responses*

Ocean Acidification

Indicators

Half of the anthropogenic CO_2 produced after the Industrial Revolution has dissolved into the world's oceans, lowering its pH and making it more acidic (Kennedy, 2010). "Over the past 250 years, the mean pH of the surface global ocean has decreased from ~8.2 to 8.1, which is roughly equivalent to a 30% increase in $[H^+]$" (Dore et al., 2009, p. 12235). Depending upon the emission scenario, current models predict that surface ocean pH may decline by an additional 0.3–0.4 during the 21st century (IPCC, 2007).

Impacts

Higher sea surface temperatures and ocean acidification, as the result of absorbed anthropogenic increases of atmospheric CO_2, will negatively impact marine ecosystems. Due to the rise in ocean temperatures, coral reef bleaching, which can weaken or kill coral colonies, is expected to occur annually in Hawai‘i by 2040, and by the end of the century, ocean acidification levels will "severely compromise their [corals'] ability to grow" (USGCRP, 2018). Coral reefs provide shoreline protection against storm waves and erosion, create a unique habitat for a diversity of marine organisms, and support local fisheries and tourism industries.

Economic losses associated with coral reef degradation in Hawai‘i are substantial. Burke et al. (2011) estimated present-day annual tourism and fisheries losses in Hawai‘i of $430.2 million and $3.5 million, respectively (adjusted to 2018 dollars). By 2050, coral reef cover in Hawai‘i is expected to decline from 38% to 11% and to 1% by 2100, representing total economic losses (tourism, fisheries, and shoreline protection) of $1.3 billion annually in 2050 and $1.9 billion annually in 2090 (both in 2015 dollars) (USGCRP, 2018).

Coral Reef Recommendations

Recommendations to enhance the resiliency of the coral reef communities in Hawai‘i focus mainly on reducing stressors, (outside of climate change) so that corals may better adapt to increasing sea surface temperatures and ocean acidity. Overfishing, sedimentation, pollution, and habitat destruction are considered stressors that can be effectively managed (Coral Reef Alliance, 2018). More direct recommendations, such as the selective breeding of resilient coral species, establishing of permanent no-take Marine Protected Areas (MPAs) and Herbivore Fishery Management Areas (HFMAs) are among the top listed suggestions to decrease outside stressors (Rosinski et al., 2017).

References

Burke, L., Reytar, K., Spalding, M., & Perry, A. (2011). *Reefs at risk revisited*. World Resources Institute. Washington, DC.

Coral Reef Alliance (2018). *Adaptive reefscapes.* Retrieved from https://coral.org/adapt/

Dore, J., Lukas, R., Sadler, D., Church, M., & Karl, D. (2009). Physical and Biogeochemical Modulation of Ocean Acidification in the Central North Pacific. *Proceedings of the National Academy of Sciences*, 106, 12235-12240.

IPCC (2007). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf

Kennedy, C. (2010, Nov 3). Ocean acidification, today and in the future. *Climate Watch Magazine*. NOAA. Retrieved from https://www.climate.gov/news-features/featured-images/ocean-acidification-today-and-future

Rosinski, A.,Walsh, W., Oliver, T., Williams, I., Gove, J., … & Conklin, E. (2017). *Coral Bleaching Recovery Plan: Identifying Management Responses to Promote Coral Recovery in Hawai'i.* University of Hawai'i, Coral Bleaching Recovery Steering Committee, Honolulu, HI, 47 pp. Retrieved from https://dlnr.hawaii.gov/reefresponse/files/2016/09/CoralBleachingRecoveryPlan_final_newDARlogo.pdf

USGCRP (2018). *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II, Chapter 27: Hawai'i and U.S. Affiliated Pacific Islands*. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Retrieved from https://nca2018.globalchange.gov/chapter/27/