Coral bleaching is caused by more than just heat

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Coral responses to temperature depend on a range of local inputs. Credit: Wikimedia Commons

Analysis of reef damage in the Indo-Pacific during the 2016 El Nino reveals that several stressors influence bleaching.

Scientists in the Indian and Pacific Oceans used the El Nino of 2016—the warmest year on record—to evaluate the role of excess heat as the leading driver of coral bleaching and discovered the picture was more nuanced than existing models showed.

The findings were, in a word, complicated, according to marine researchers led by the US based Wildlife Conservation Society (WCS). The international cohort included scientists from Macquarie University in NSW, the University of Queensland, University of WA and two western Australian state government departments.

In a paper published in the journal *Nature Climate Change*, the researchers reveal a more complex view than that embodied in current models, which assume coral bleaching events are caused primarily by heat stress. Rather, the scientists found that bleaching is driven by a variety of stressors, and each region responds differently.

"In this work, we tried to understand how the impact of temperature characteristics result in different degrees of bleaching," explains Dr. Joseph Maina, senior lecturer in Spatial Information Science at Macquarie University.

"By studying the temperature patterns, we were better able to understand how organisms responded.

"Up until now, attempts to predict the timing and severity of coral bleaching events have relied on metrics that don't give good predictability. The approach we're using will allow us to make more accurate assumptions, which will help formulate ecosystem management decisions."

The authors—including another Macquarie researcher, Dr. Stéphanie D'agata—note that any good predictions of the future will need to

consider these complexities, specifically because they are important for effective policies, management, and conservation plans.

"Our results suggest that coral responses to global climate change may be changing as corals have different past experiences and tolerances to heat and stress," says Dr. Tim McClanahan, WCS Senior Conservation Zoologist and co-author of the study.

"The consequence is that management and policies need to be aligned with the locations and types of stresses if we are to identify potential refugia and other priority actions for coral reefs."

The widespread coral bleaching in the Indo-Pacific during the most recent El Niño event (2014-2017) was the latest in a series of thermal stresses to impact corals in the region, preceded by events in 1983, 1988, 1998, 2005, 2010, and 2013. The year 2016 brought about the most severe bleaching episodes, including extensive mortality in the Great Barrier Reef.

Coral communities are symbiotic relationships between animals (corals) and algae that give their hosts color and sustenance. According to previous studies and field observations, coral bleaching generally occurs when corals expel their algae while under stress from water temperatures significantly above normal. Reefs closer to the warmer equator have also bleached more in the past and expected to degrade further in 2016.

But assessments made from the field during the study—with data collected from 226 sites stretching from East Africa to Fiji—found that coral bleaching patterns did not neatly align with past predictors of excess temperature and distance from the equator. Instead, bleached corals were highly variable in terms of warm water temperatures and location, with some reefs suffering bleaching levels of up to 60 percent and others surviving with no impact.

To determine what other mechanisms are at work in coral bleaching events, the scientists evaluated 26 variables and more than 2000 models that were solved by a supercomputer to test the effects of factors such as thermal exposure, depth, habitat, coral community composition, and the types of management used in reef systems.

In terms of geography, the researchers found that bleaching depended greatly on where the corals lived along the longitudinal gradient from East Africa to Fiji, with the strongest bleaching observed in East Africa. Consequently, some regions, it seems, will be affected earliest and worse than other regions.

Examining seawater temperatures 90 days before the bleaching, the researchers found that the best predictors of coral bleaching were highest average temperatures, how long cool water endured prior to peak temperatures, and the existence of two peaks in temperature. However, this depended on where the reefs were located, and East African reefs were found to be more stressed than reefs in Indonesia and Fiji. Thus, it was general stress rather than just warm water that affected corals the most, and some coral locations responded to stress better than others did.

More information: Tim R. McClanahan et al. Temperature patterns and mechanisms influencing coral bleaching during the 2016 El Niño, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0576-8

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