Rapid-fire climate extremes leave the Great Barrier Reef a bleached 'checkerboard'

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Escape Reef bleached in 2020. Photo: Morgan Pratchett/ARC Centre of Excellence for Coral Reef Studies. Credit: James Cook University

A new study reveals the impacts of multiple climate extremes on coral reefs over the past three decades, with only 2% of the Great Barrier Reef escaping bleaching in that time.

Lead author Professor Terry Hughes from the ARC Centre of Excellence for Coral Reef Studies at James Cook University (Coral CoE at JCU) said the frequency, intensity and scale of climate extremes is changing rapidly due to global warming—and this includes the record-breaking marine heatwaves that cause corals to bleach and die.

"We no longer have the luxury of studying individual climate-related events that were once unprecedented or very rare," Prof Hughes said. "Instead, as the world gets hotter, we have to understand the effects of sequences of rapid-fire catastrophes, as well as their combined impacts."

The study shows only 2% of the Great Barrier Reef has escaped bleaching since the first event in 1998, then the world's hottest year on record. Bleaching is a stress response by overheated corals during heatwaves, where they lose their color and many struggle to survive. Eighty percent of reefs bleached severely in 2016, 2017 and 2020.

"Five bouts of mass bleaching since 1998 have turned the Great Barrier Reef into a checkerboard of reefs with very different recent histories, ranging from 2% of reefs that have escaped bleaching altogether, to 80% that have now bleached severely at least once since 2016," Prof Hughes said.

The Great Barrier Reef is comprised of more than 3,000 individual reefs stretching for 2,300km. The ecosystem supports 65,000 jobs in reef tourism. Globally, 100s of millions of people depend on the survival of coral reefs for their livelihoods and food security.

To better predict how coral reefs will fare under future climate change,

Prof Hughes calls for a better understanding of compounding impacts: multiple, climate-driven disturbances that interact with each other over time and space, generating combined effects that cannot be predicted from single events alone.

"For the first time, in 2020, we saw severe bleaching across the whole length of the Reef—in parts of the northern, central and especially the southern region," Prof Hughes said.

But, he added, each bleaching event has a different geographic footprint. The northern Reef escaped damage in 1998 and 2002 before being the worst-affected region in 2016. The south escaped in 2016 and 2017.

Drawing upon satellite data, the authors of the study also measured the duration and intensity of heat stress the Reef was exposed to each summer, to explain why different parts were affected in each event.

"Heat stress is a very precise predictor of the severity of bleaching every year," said coauthor Dr. Mark Eakin, formerly of the US National Oceanic and Atmospheric Administration (NOAA).

The scientists found the responses to extreme heat depended on the recent history of bleaching. In 2002 and 2017, it took more heat to reach similar levels of bleaching to those in 1998 and 2016.

"To our surprise, we found the threshold for bleaching was much higher on reefs that had experienced an earlier episode of heat stress," Dr. Eakin said.

"Consequently, the most vulnerable reefs each year were the naïve ones that had not bleached recently."

Co-author Professor Sean Connolly from the Smithsonian Tropical

Research Institute said when pairs of successive bleaching episodes were only one to three years apart, as they have been recently, the earlier event may have hardened affected areas to further impacts.

"But," he cautioned, "more frequent, severe bleaching events will only undermine the resilience of coral reef ecosystems. Corals still need time to recover before another round of heat stress so they can make babies that will disperse, settle and recover the depleted parts of the Reef."

"Action to curb climate change is crucial."

"Ironically, the publication of our study coincides with the COP26 meeting in Glasgow," Prof Hughes said.

"A drastic cut in greenhouse gas emissions by all countries is vital for the future of corals reefs, and for the 100s of millions of people who depend on them."

More information: Terry P. Hughes et al, Emergent properties in the responses of tropical corals to recurrent climate extremes, *Current Biology* (2021). DOI: 10.1016/j.cub.2021.10.046

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