Gulf of Mexico coral reefs to protect from storm surge in the future—But will they?

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LSU doctoral student in biology Joanna Griffiths and professor Kristine DeLong stand behind a coral reef fossil from the Gulf of Mexico during the last interglacial period about 120,000 years ago. Credit: Kristine DeLong

Coral reefs support 25 percent of all marine life around the globe. Those in the Gulf of Mexico, along the coasts of Louisiana, Florida, Texas and Mexico, might be less known and less popular among tourists than other reefs; nevertheless, they also serve as important barriers to storm surge, lessening the impact of dangerous hurricanes. In a new paper published in the journal *Frontiers in Marine Science*, LSU geography and anthropology professor Kristine DeLong and her team of researchers used coupled climate model simulations as well as studies of fossil corals to describe how climate change will impact reefs in the Gulf of Mexico in the not-so-distant future, including a realistic snapshot of years 2080-2100.

While researchers have done a lot of work on the Great Barrier Reef in Australia and in the Pacific and Caribbean reefs, DeLong and her team are among the first to produce climate projections specifically for the Gulf of Mexico.

In an effort to learn from history, DeLong studied fossil corals from the last interglacial period—between ice ages—when the Earth was 11 percent warmer in the northern hemisphere and there was a greater loss of Arctic sea ice, with sea levels up to six meters higher than they are today. About 120,000 years ago, DeLong and her co-authors found, coral reefs were able to adapt to a new and relatively extreme climate by, for example, moving geographically, i.e., toward the North and South Poles, as well as up or down in the water column to avoid warmer surface waters. The Florida Keys in the southeastern Gulf of Mexico actually had extensive coral reef coverage during the last interglacial

period. This could seem promising in a scenario where sea surface temperatures are expected to go up at least 2 degrees Celsius or as much as 3.4 degrees Celsius by 2100 (about 0.37 degrees Celsius per decade), according to the team's projections. But not so fast, they say. The rise in temperature is happening much more rapidly today than in the distant past, leaving coral reefs little time to adapt. Also, due to the acidification of the oceans, including at depth, coral reefs are increasingly trapped between warmer surface waters and more acidic environments deeper in the water column. Further, there is no evidence of acclimatization to acidification, and moving north is out of the question for Gulf of Mexico coral reefs, as they'd end up on land.

"We are all very concerned about our coral reefs," DeLong said about herself and her collaborators at the University of Texas at Austin and Rice University in Houston, Tx. "We wanted to get the perspective of what happened in the past, how reefs have responded to changes in climate that are either natural or anthropogenic, meaning caused by humans. There has been substantial natural climate variability that it's important to look at because it tells us something about what we might expect in the next 100 years. It can help us answer many important questions."

By dating corals, going back even further with uranium-thorium dating than with radiocarbon dating, DeLong and her co-authors can observe paleoenvironmental changes in ancient coral skeletons.

"You see chemical changes in coral skeletons as the composition changes in their environment," she explains. "Because corals are growing in water, they record that information every day as they're growing that skeleton. We have a very good idea of how old some fossils are and can get pretty precise records. I'm looking at the last 2 million years, and from a geologist's perspective, that's pretty recent."

In their paper, the researchers point out that there are no coral reefs left on the planet in pristine condition. The Gulf of Mexico reefs have experienced heat stress since the 1970s and are now considered to be in poor to fair condition. One of the reefs that is faring the best is the Flower Garden Banks, sitting on top of a salt dome in the northern Gulf of Mexico on the edge of the continental shelf. It's a five-hour boat ride to get out there, and there are oil platforms all around the coral reef because there's oil underneath the salt dome that the corals are growing on top of.

"In my opinion, that's the most beautiful reef in US waters," DeLong said. "Unfortunately, a lot of people don't see it because it's so remote."

Major threats to all reefs are changes in seawater pH and carbonate chemistry, which significantly reduce coral biomineralization, which turns an animal—the coral—into what's essentially rock, or calcium carbonate.

"You can think of coral as an individual building, while a reef is a whole city," DeLong explains. "There are sponges and algae, too, but coral is the foundation species that makes the reef work. Without coral, it would be like trying to build a city without concrete."

As this "concrete" weakens, it's likely to suffer worse damage by storms, which will increase in intensity and severity with rising temperatures.

"If you lose a coral reef, you lose everyone who lives there and everyone who depends on what lives there," DeLong continues. "Juvenile fish, such as the red snapper we all love to eat, and Caribbean spiny lobsters live on reefs in the Gulf of Mexico. Reefs are nurseries for a lot of the fisheries we depend on for food."

DeLong's team found that the only way to prevent severe damage to Gulf

of Mexico reefs would be to limit global warming to 1.5 degrees Celsius by 2100 and stabilize atmospheric carbon dioxide below 2005 levels by limiting our use of fossil fuels—something they call a "lofty target."

"If we limit greenhouse gas emissions, and don't go on with business as usual, we can stop the temperatures from going up, keep Greenland and Antarctica from melting more, and sea levels from rising," DeLong said. "As coral reefs build structure—rock—they help break up waves when big storms come through. Reefs break up wave energy and protect our coasts from storm surge, so we have many reasons to care about them."

"Although LSU's campus is about 30 feet above sea level, we're still in a low-lying coastline," she continued. "This past summer, for example, there was great worry about flooding from the Mississippi River with Hurricane Barry. Storm surge and river flooding do not mix, and we were very fortunate that Barry didn't drop a lot of rain on us. We got lucky; the levees worked, but every time there's a flood event or storm, we're more and more susceptible. National Oceanic and Atmospheric Administration predictions for Category 5 storms are now showing storm surge from the Gulf of Mexico going as far north as LSU's campus and we're three hours from the coast! Hopefully, that will never happen, but we all have to worry about this and be concerned."

More information: Sylvia G. Dee et al, The Future of Reef Ecosystems in the Gulf of Mexico: Insights From Coupled Climate Model Simulations and Ancient Hot-House Reefs, *Frontiers in Marine Science* (2019). DOI: 10.3389/fmars.2019.00691

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