New research reveals how hurricanes shape the coastal landscape in the Everglades

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LSU researchers performing field work in the Florida Everglades mangrove forests (Shark River Estuary, Florida). Right to left: Dr. Victor H. Rivera-Monroy; LSU graduate students Xiaochen Zhao, Ivan Vargas-Lopez, and Alejandro Castro-Aviles. Credit: Luca Marazzi, FIU Postdoctoral Associate

That hurricanes can create sudden and dramatic changes to the landscape is obvious to anyone who lives along the Gulf of Mexico's coast. They are powerful, high-energy destructive forces that can flood homes and fell trees, and can leave a lasting impression on all those affected by them; however, the mark hurricanes leave on unpopulated areas, such as Florida's Everglades National Park, have been less known until now. In a recent paper published in the *Proceedings of the National Academy of Sciences*, or *PNAS*, researchers from different universities, including LSU, examined how Hurricanes Wilma in 2015 and Irma in 2017 fertilized the Florida Coastal Everglades, paradoxically facilitating mangrove wetlands recovery.

Mangrove wetlands are a critical component of the coastal landscape because they are highly productive, absorbing damaging winds and floodwater from hurricanes, sequestering carbon that otherwise would be released into the atmosphere (and contribute to climate change), and providing habitat for many species of economic importance. As any plant, mangrove trees need nutrients, such as phosphorous, to grow along the coast; however, the Everglades have a limited amount of this key nutrient, unlike Louisiana soils, which are high in phosphorous due to nutrients traveling down the muddy Mississippi River.

"The Everglades has different geology and hydrology than other areas in the Gulf of Mexico, causing phosphorus limitation, and as a result, low plant and algae productivity. These conditions make the coastal ecosystem 'oligotrophic,' which means 'nutrient limited,'" said Victor Rivera-Monroy, co-author of the study and associate professor in LSU's Department of Oceanography & Coastal Sciences.

The researchers analyzed surface soil and plant nutrient concentrations from 2004-2018. Comparing storm deposits from Hurricane Irma and nutrient inputs across mangrove sites, they found that hurricane-induced mineral inputs increased the amount of phosphorous present in the soil

and absorbed by the mangroves within an area that stretched up to six miles (10 kilometers) inland from the coast. This fertilization was cumulative over several years as hurricanes impacted the area and extensively affected the mangroves.

Irma's and Wilma's storm surges, 12 years apart, mixed the waters and re-suspended nutrient-rich sediment from the ocean floor, much like when a gardener rakes topsoil. In addition to enriching the soil with phosphorous, this redistribution of sediment has the added benefit of increasing soil elevation, which can help to offset sea level rise in certain areas. The researchers estimated the amount of soil elevation the mangroves would normally experience in a year increased by approximately 14.4 times due to the hurricanes' storm surges.

The environmental impacts of hurricanes are a trade-off. While hurricanes defoliate and, in some cases, flatten trees, this input of phosphorus also gives the mangroves opportunities to regenerate; however, "it's not an even distribution. It's not going to save the coast, but it is a significant change that makes a difference in the long-term depending on the hurricane intensity and frequency," Rivera-Monroy said.

Rivera-Monroy emphasized that the best way to get the fullest picture of complicated natural processes that affect the coast is via long-term data, interdisciplinary studies like this one, which involved collaboration between 10 experts from five institutions in Louisiana, Florida, and Virginia.

"It would not have been possible to obtain this data had it not been for the collaboration of multiple researchers from different disciplines. Studying the problem from so many perspectives made this long-term project unique to the understanding of natural processes that occur over large spatial and temporal scales," Rivera-Monroy said.

Contributors with LSU ties include Edward Castañeda-Moya, lead author of the paper, a research assistant professor at Florida International University and LSU alumnus who along with Rivera-Monroy designed the research. In addition, Rivera-Monroy and his graduate assistant Xiaochen Zhao conducted the research and analyzed the data and LSU assistant professor in the Department of Oceanography & Coastal Sciences Matt Hiatt modeled the data.

More information: Edward Castañeda-Moya et al. Hurricanes fertilize mangrove forests in the Gulf of Mexico (Florida Everglades, USA), *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1908597117

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