Trees in areas prone to hurricanes have strong ability to survive even after severe damage

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Nearly 90 percent of the trees in nine designated plots in Dominica were damaged by Hurricane Maria. Only 10 percent died immediately. Credit: Benton Taylor

As their plane flew low on its approach to land at the airport on the island of Dominica, researchers from Clemson and Harvard universities looked out the window to see miles of forests with trees that looked like matchsticks.

It was nine months after the island in the West Indies had taken a direct hit from Category 5 Hurricane Maria.

But when the researchers actually got into the forests and examined the trees more closely, they discovered that while 89% of the trees sustained damage—76% of which had major damage —only 10% were immediately killed. Many of the trees had resprouted.

"These hurricane-prone forests are, in many regards, incredibly resistant to even extremely powerful hurricanes. I don't want to minimize the scale of damage that these forests received—it was immense—but the fact that 90% of the trees survived shows an impressive level of resistance," said Benton Taylor, a former graduate student in the Clemson Department of Biological Sciences who is now an assistant professor in the Harvard University Department of Organismic and Evolutionary Biology.

With climate change, hurricanes are increasing in frequency and severity. Many regions of the world experiencing frequent hurricane disturbance also play particularly important roles in carbon, water and nutrient cycling and are global "hotspots" of biodiversity.

Hurricane Maria hit Dominica on September 18, 2017, with winds topping 160 mph—the strongest hurricane on record to make landfall there. Days later, Maria devastated the U.S. territory of Puerto Rico.

With funding from the Clemson Caribbean Initiative, Department of Biological Sciences Chair Saara DeWalt, Taylor and Dominican

researcher Elvis Stedman remeasured and assessed damage of all the trees in nine forest stands across Dominica. The plots were established in 2006 by DeWalt and former Clemson researcher Kalan Ickes. They also measured wood density and carbon content for the 44 most common tree species to pair with the tree measurements to estimate biomass and determine how much carbon had been relocated from living to dead by the hurricane.

They found the most common damage types were stem snapping (40% of trees) and major branch damage (26% of trees), but the damage types with the highest rates of mortality were uprooting and being crushed by a neighboring tree. Thirty-three percent of uprooted trees and 47% of trees that were crushed died.

"Snapping wasn't as lethal as you might think," said DeWalt, a senior researcher on the study.

Clemson University researcher Saara DeWalt measures a tree in Dominica. Credit: Clemson University College of Science

Larger individual trees and species with lower wood density were more susceptible to snapping, uprooting and mortality. Trees on steeper slopes were more prone to being crushed by neighboring trees.

More frequent storms will shape the structure and composition of forests in hurricane-prone regions, DeWalt said. She expects that they'll shift toward smaller, high wood-density species.

"Forests are adapted to this kind of disturbance, but we may see a shift in the types of species that are most common in these forests with increasing frequency of strong hurricanes. You might get more of the 'live fast, die young' species because you're constantly resetting the forest," she said.

Fewer big, old trees could impact wildlife, Taylor said. Two parrots native to Dominica—the Sisserou and Jaco, both of which occur only on this small island nation—rely on cavities in large trees to nest.

"Larger trees tended to suffer more damage and mortality. These large trees store immense amounts of carbon, and in Dominica many of these large trees create unique habitats for animals, such as the parrots," he said. "The data we obtained on how different species and sizes of trees experience damage from hurricanes can help us predict the future of these forests and the many services they provide."

Understanding forest responses to hurricanes in general translates to the hurricane-prone southern United States, but Taylor urges caution.

"In a field where opportunities to study a phenomenon are rare—hurricanes themselves are rare events and it's even rarer that one hits a forest plot that was measured before the hurricane hit—any additional data are useful," he said. "That said, our study highlights that the effects of hurricanes can be very different based on the local topography and tree species that make up a forest. So comparing a small mountainous island populated by tropical rainforest trees to the forests of the coastal plains and piedmont regions of the southern United States should be approached with caution."

The findings appeared in the March 2023 issue of the journal *Forest Ecology and Management*. The paper is titled "Widespread stem snapping but limited mortality caused by a category 5 hurricane on the Caribbean Island of Dominica."

In addition to DeWalt, Taylor and Stedman, the authors of the study were Professor Skip Van Bloem of the Clemson Department of Forestry and Environment Conservation and Assistant Professor Stefanie Whitmire of the Clemson Department of Agricultural Sciences.

More information: Benton N. Taylor et al, Widespread stem snapping but limited mortality caused by a category 5 hurricane on the Caribbean Island of Dominica, *Forest Ecology and Management* (2023). DOI: 10.1016/j.foreco.2023.120833

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