Hurricane Maria study warns: Future climate-driven storms may raze many tropical forests

March 25 2019

Defoliated and uprooted trees in Puerto Rico's Toro Negro state forest following October 2017's Hurricane Maria. A new study shows that damage from the storm was not only worse than, but different from any previously documented event. Credit: Kevin Krajick/Earth Institute, Columbia University

A new study shows that damage inflicted on trees in Puerto Rico by Hurricane Maria was unprecedented in modern times, and suggests that more frequent big storms whipped up by a warming climate could permanently alter forests not only here, but across much of the Atlantic tropics. Biodiversity could suffer as result, and more carbon could be added to the atmosphere, say the authors. The study appears this week in the journal *Nature Communications*.

Hurricane Maria not only destroyed far more trees than any previously studied storm; big, old trees thought to be especially resistant to storms suffered the worst. Lead author Maria Uriarte, a faculty member of Columbia University's Earth Institute, said that because hurricanes are projected to intensify with warming climate, the damage probably presages more such events. "These hurricanes are going to kill more trees. They're going to break more trees. The factors that protected many trees in the past will no longer apply," she said. "Forests will become shorter and smaller, because they won't have time to regrow, and they will be less diverse."

When Maria hit Puerto Rico in October 2017, it came in as a Category 4, with winds up to 155 miles per hour and up to three feet of rain in places. Many trees were denuded of foliage, snapped in half or blown clear out of the ground. The strongest storm to hit the island since 1928, Maria killed or severely damaged an estimated 20 million to 40 million trees.

Uriarte, who has been monitoring tree growth and mortality across Puerto Rico for the past 15 years, returned soon after the hurricane and began documenting its effects. For the new study, she and two colleagues homed in on a 40-acre section of the El Yunque National Forest, near the capital of San Juan, that has been intensively monitored by multiple teams since 1990. This long-term monitoring allowed Uriarte and her colleagues to compare damage from Maria with that of past hurricanes,

including 1989's Hurricane Hugo and 1998's Hurricane Georges—Category 3 storms, but the only things even close to Maria in recent times.

Forest ecologist Maria Uriarte (foreground) and students take in a once-lush plot where almost every tree was splintered or simply blown away. Credit: Kevin Krajick/Earth Institute, Columbia University

They found that Maria killed twice as many trees outright as previous storms, and broke more than three times as many trunks. Some species suffered much worse, with breakage rates up to 12 times those of previous storms. Alarmingly, these tended to be the slowest-growing, most valuable hardwoods that in the past were the most resilient to big

storms: towering mahogany-like tabonucos with great crowns, prized for furniture and boat-building, and thick ausubos, whose wood is so dense it does not float in water. These and other big trees provide habitat for many birds and other creatures that smaller trees do not. About half of the trees with broken trunks will die within two to three years, said Uriarte.

However, a few species did well in all the storms, and one stood out: the common sierra palm, whose slender, flexible trunk bends with wind and quickly resprouts, grass-like, from its top if it loses foliage. Uriarte believes that the palms and a few pioneer species that can take root quickly and grow following storms may be the future of forests across the Atlantic tropics and subtropics. "This will yield lower statured and less diverse forests dominated by a few resistant species," she said.

Tropical cyclones derive their energy from ocean heat. Atlantic temperatures are already ascending, and models predict that by 2100, maximum sustained hurricane winds could increase by as much as 15 percent. Warmer air also carries more moisture, so rainfall could increase by up to 20 percent near storm centers. Both factors destroy trees; extreme winds do it directly, while rain saturates and destabilizes soil, encouraging uprooting. "The expected changes in hurricane winds and rainfall may have profound consequences for the long-term resilience of tropical forests in the North Atlantic basin," says the study.

New seedlings are taking over a previously shaded forest floor, now opened to the sky by Hurricane Maria. Fast-growing pioneers and wind-resistant species could quickly replace more diverse assemblage of trees. Credit: Kevin Krajick/Earth Institute, Columbia University

The potential loss of many tree species could have cascading effects on forest wildlife and plants, say the researchers. This also would probably alter forests' growth dynamics, such that instead of soaking in more atmospheric carbon than they give off—which they currently do—the equation would reverse, and forests would become net emitters. This would be because the decay of felled trees would outweigh carbon taken in by any replacements. Along with palms, one species that probably would take over would be the fast-growing yagrumo, which shoots up quickly in sunny clearings created by big storms. But the yagrumo also is

often the first to fall in storms, and so would just add to the problem. Thus, forests would help feed the very warming that is destroying them. Separate estimates suggest that trees killed or damaged by Hurricane Maria alone will release about 5.75 million tons of carbon to the atmosphere, or about 2.5 percent of the carbon taken up annually by all forests in the United States.

Edmund Tanner, a senior lecturer emeritus at the University of Cambridge who studies tropical trees but was not involved in the new research, said the study is important, because "it reports different, rather than just intensified, effects of strong versus weaker hurricanes." Tanner said the effects are "probably representative of huge areas of tropical lowland forest near sea coasts, some of which are likely to experience similar or worse damage in a warming world." Maria "was a Category 4 hurricane," noted Tanner. "There is a Category 5."

More information: "Hurricane Maria Tripled Stem Breaks and Doubled Tree Mortality Relative to Other Major Storms," *Nature Communications* (2019). DOI: 10.1038/s41467-019-09319-2

Provided by Columbia University