How does the Amazon rain forest cope with drought?

6 February 2019, by Jessica Hanna

Uncontacted indigenous tribe in the brazilian state of Acre. Credit: Gleilson Miranda / Governo do Acre / Wikipedia

The Amazon rain forest isn't necessarily a place that many would associate with a drought, yet prolonged dry spells are projected to become more prevalent and severe because of climate change. The question at hand is how these droughts are going to affect the rain forest, as it has a large influence on global climate and future warming.

A study led by Marielle Smith, a research associate in Michigan State University's forestry department, and Scott Stark, assistant professor of forestry, examines the Amazon's response to droughts in order to better predict how forest growth and physiology will affect tree diversity and, ultimately, the planet's climate.

Due to its combination of wet forest structure and a strong dry season, the Tapajós National Forest in Brazil may be a good indicator for climate change responses, which is what led researchers to the location.

To gather information and monitor the rainforest, researchers took a detailed view of its structure by walking the ground with a lidar instrument, a tool also used in autonomous vehicles to map terrain. The lidar produced information in two-dimensional slices that describe how leaf area is structured across heights and micro-environments varying in light, temperature and humidity.

"This is useful because the activity of a forest as a whole—its growth and exchanges of gas and energy with the atmosphere—is largely determined by how leaves are distributed in the mosaic of environments that the forest itself creates," Smith said.

A total of 41 monthly surveys were conducted over the course of four years, between 2010 and 2017, and included three non-drought years and one El Niño drought year.

"Through the lidar lens, we surveyed the structure of an eastern Amazon forest over several years to see how it changed in response to seasonal water stress and a strong El Niño drought," Smith said.

The research yielded surprising results.

Researchers found that the rainforest increased the amount of leaves in the highest canopy during dry seasons and drought, despite reports from previous studies that found big trees to be more vulnerable to drought.

Previous satellite lidar observations have shown that when leaf amounts in the upper canopy go up, the amounts in the lower canopy go down, and vice versa, over the seasonal cycle of the Amazon forest. This could be due to seasonal variation in the amount of shading inflicted on the lower canopy by the upper.

"Our higher-resolution data allowed us to divide the forest by both height and light environments, and

revealed something more complex," Smith said.

The expectation was that when the amount of leaves in tall trees increases during the dry season it gets shadier underneath, and smaller trees lose some of their leaves as a result. However, the data showed that's not what happened. Instead, it was the small trees that were in open areas where shading was low and sunlight high—forest "gaps—that lost leaves. Trees that were shaded, surprisingly, added leaf area at the same time as the tall trees. The trends were the same in response to drought.

"It is key to understand that dry periods are typically sunnier periods," Smith said. "Tall trees that also have deeper roots, giving more access to water, may take advantage of the increased light and expand their crowns. Small trees with shallow roots may be hurt more by hot, sunny conditions and contract their crowns or die. Small trees in the shade, however, may take advantage of increased light in the cooler, more humid understory."

These results show that a tree's response to dry periods is dependent on environmental conditions imposed by the structure of the rainforest itself, the researchers said. The findings agree closely with emerging studies showing that short statured vegetation, particularly in hot, high light environments, is most impacted by water shortages.

At the same time, the research is helping build a picture of how canopy micro-environments, tree heights, seasonality and drought come together to determine which trees will win and lose under drier climates. This is crucial to understanding the future resilience of the Amazon to climate change, the researchers said.

The research is published in the *New Phytologist*.

More information: Marielle N. Smith et al. Seasonal and drought related changes in leaf area profiles depend on height and light environment in an Amazon forest, *New Phytologist* (2019). DOI: 10.1111/nph.15726

Provided by Michigan State University