Destruction of an Atlantic rain forest fragment raises the local temperature

4 March 2020, by Elton Alisson

Brazilian researchers show that if 25% of a one-hectare forest remnant is cut down, the impact on the local climate will be a temperature increase of 1 °C. The study is published in *PLOS ONE* . Credit: Carlos Joly/BIOTA-FAPESP

A study conducted in Brazil by researchers at the University of São Paulo (USP) and the University of Campinas (UNICAMP) shows that if 25% of an Atlantic rainforest fragment that is approximately 1 hectare is deforested, then the local temperature will increase by 1 °C. Clear-cutting the entire fragment would increase the local temperature by as much as 4 °C. The findings are published in the journal *PLOS ONE*.

"We were able to detect the warming effects of the climate due to the deforestation of Atlantic rainforest fragments, of which there are many in Southeast Brazil," Humberto Ribeiro da Rocha, principal investigator of the study, told. Rocha is a professor at the University of São Paulo Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG-USP).

The investigation was conducted under the aegis of two projects supported by São Paulo Research Foundation - FAPESP, one associated with its Research Program on Global Climate Change (RPGCC) and the other with its Research Program on Biodiversity Characterization, Conservation, Restoration and Sustainable Use (BIOTA-FAPESP).

According to Rocha, scientific evidence is already available that shows that the destruction of tropical forests leads to warmer air at a local scale, but this evidence is based on measurements taken in large areas, mainly by research conducted in the Amazon.

"No one had ever produced detailed information on the deforestation of small fragments or studies that take into account different levels of anthropization [transformation of the environment by human activity]," said Rocha, who is a member of the RPGCC's steering committee.

To fill this research gap, researchers analyzed the relationship between the degree of deforestation and local temperature increases in Atlantic rainforest remnants located in Serra do Mar, a mountain range that stretches along the northern coast of São Paulo state.

Land surface temperature (LST) was estimated using heat flux data continuously recorded around the globe by infrared optical sensors such as those on board NASA's Landsat Earth observation satellites.

Based on these data, the researchers calculated an annual average LST for tens of thousands of Atlantic rainforest samples, each with an area of approximately 1 hectare. The forest cover in these areas ranged from the entirety of the area being covered to no area having forest cover (deforested). These areas also displayed different degrees of anthropization, with a 1% variation gradient.

The calculations were performed during the Ph.D. research of Raianny Leite do Nascimento Wanderley, under Rocha's supervision. They showed higher temperatures in less forested areas. Each 25% increase in the destruction of native vegetation resulted in an LST increase of 1 °C; thus, total deforestation was correlated with a warming of 4 °C.

"This detected pattern is interpreted as characterizing the impact of forest cover loss on the microclimate," Rocha said.

Impact on the forest

According to the researchers, the Atlantic rainforest fragments they studied were located at relatively higher altitudes and had proportionately more carbon stored in the ground than those in the Amazon rainforest areas. Deforestation of Atlantic rainforest areas can therefore jeopardize the biome's carbon balance.

"The Atlantic rainforest is currently in equilibrium and may even be marginally absorbing carbon from the atmosphere but could become a source of carbon emissions," said Carlos Joly (bv.fapesp.br/en/pesquisador/28 … carlos-alfredo-joly/), a professor at UNICAMP and one of the authors of the study. Joly is a member of BIOTA-FAPESP's steering committee.

Rising temperatures in these forest fragments affect plant respiration more than photosynthesis. This also contributes to the release of larger amounts of carbon from the forest into the atmosphere, Joly explained.

"The two processes combined create a hazardous synergy that leads to a rise in carbon emissions from the forest to the atmosphere," he said.

The effects of deforestation-driven warming in Atlantic rainforest fragments may vary from one tree species to another, he added. Pioneer species, which survive under adverse conditions owing to their high reproductive capacity, usually display greater resilience to temperature changes.

"We don't have enough data yet to predict how long it will take, but in the long run, rising temperatures in Atlantic rainforest fragments due to deforestation could certainly influence the survival of tree species in the forest, albeit some species more than others," he said.

"The proportion of typical mature forest species may diminish, while that of pioneer or initial secondary species, which are more plastic, could increase."

Functions impaired

Considered one of the world's richest and most endangered forests, the Atlantic rainforest occupies 15% of Brazil's land mass in an area that is home to 72% of the population. The biome decreased by 113 square kilometers between 2017 and 2018, according to recent data from the Atlas da Mata Atlântica based on continuous monitoring by NGO Fundação SOS Mata Atlântica in partnership with the National Space Research Institute (INPE).

In addition to the impact on biodiversity, the researchers stressed that even small-scale deforestation impairs important ecosystem services provided by the Atlantic rainforest, such as heat regulation.

"The forest is extremely important to maintaining milder temperatures on the local and regional scale. Changes in its functioning could disrupt this type of ecosystem service," Joly said.

Water supply may also be affected. The Atlantic rainforest is home to seven of Brazil's nine largest drainage basins, where rivers originate that flow into reservoirs that are responsible for almost 60% of the nation's hydroelectric power and supply water to 130 million people.

"The Atlantic rainforest doesn't produce water but protects the springs and permits the storage of water in reservoirs for consumption, power generation, agricultural irrigation and fishing, among other activities," Joly said.

Located in extremely rugged terrain, the Atlantic rainforest helps prevent landslides at times of heavy rain. "Destruction of these forest fragments

or changes in their functioning could greatly diminish this protection," Joly said.

Deforestation of the biome, now reduced to 12.4% of its original size, is more severe in São Paulo state than in other areas owing to the construction of roads, gas pipelines and other kinds of infrastructure, he added. This area has also suffered from urban expansion, including the construction of both shantytowns and high-income gated communities.

As one of the most endangered biomes in South America, the Atlantic rainforest has been a focus for numerous studies regarding restoration in recent years. Most of the studies have been conducted by researchers affiliated with BIOTA-FAPESP, according to Joly.

The largest initiative to restore the biome is governed by the Atlantic Rainforest Restoration Pact, launched in 2009 as a multi-stakeholder movement to restore 15 million hectares by 2050.

"A great deal of knowledge has been acquired regarding restoration of the Atlantic rainforest. Evidently, we won't be able to replace everything that has been lost, but at least some of the biome's functions can be restored," Joly said.

More information: Raianny L. N. Wanderley et al, Relationship between land surface temperature and fraction of anthropized area in the Atlantic forest region, Brazil, *PLOS ONE* (2019). DOI: 10.1371/journal.pone.0225443

Provided by FAPESP