Tree lifespan decline in forests could neutralize part of rise in net carbon uptake

December 3 2020, by Luciana Constantino

Study by Brazilian researchers reported in *Nature Communications* shows that trees are growing faster in forests worldwide, including the Amazon, but their lives are getting shorter. Credit: A dead tree trunk in the Peruvian Amazon / Roel Brienen, University of Leeds

Accelerating tree growth in recent years has been accompanied by a reduction in tree lifespan, which could eventually neutralize part of the increase in net uptake of carbon dioxide (CO_2). This trade-off between tree growth and life expectancy applies to forests worldwide, including in the Amazon and other tropical regions, as well as temperate regions

and the Arctic.

Models and projections of future forest carbon uptake based on the existing system may therefore overestimate the capacity of forests to absorb greenhouse gases over time. In other words, while tree planting is important to help reduce levels of these gases in the atmosphere, it is not sufficient. Efforts to reduce carbon emissions remain essential.

These are the key points discussed in an article published in *Nature Communications*. It reports the findings of a study conducted by a cross-border group of researchers, including Gregório Ceccantini and Giuliano Locosselli, researchers at the University of Paulo's Institute of Biosciences (IB-USP) in Brazil. Both are supported by FAPESP (São Paulo Research Foundation).

"There's an inverse relationship between tree growth and longevity," Locosselli told Agência FAPESP. "We consistently show that this relationship exists regardless of species and location. If trees are growing faster, they're also assimilating carbon faster. The problem is that they'll live shorter lives and the carbon will be stored for less time."

Trees need large amounts of CO_2 to grow and develop, so this growth acceleration has led to substantial carbon uptake. Recent studies show that about a third of the greenhouse gas emissions resulting from human activities in the past 50 years has been absorbed by terrestrial ecosystems thanks to a combination of new trees and expanding secondary forest growth.

The paper published in *Nature Communications* questions how far forests will continue to absorb excess atmospheric carbon in the future, arguing that this "depends not only on the growth response of trees to a changing climate and atmospheric composition but also on changes in mortality rates that ultimately release carbon back to the atmosphere. [...] This

negative feedback on carbon storage via increased mortality will offset—at least to some extent—the beneficial effects of increased growth on total carbon storage of forests. Our current, incomplete knowledge of the universality and causes of the feedback hinders its representation in Earth System Models and thus is an important uncertainty in predictions of future forest carbon uptake in response to global change".

According to Locosselli, most climate change projections and models of forest biomass dynamics take into consideration tree growth but not the negative relationship with longevity. The drivers of faster growth are not entirely clear, but they may include temperature and atmospheric CO_2, as well as the production and use of fertilizer and fossil fuels, which have significantly altered the amount of nitrogen in the environment.

Climate change

A report issued in 2019 by the United Nations Environment Program (UNEP) warned that global greenhouse gas emissions must fall by at least 7.6% each year over the next decade to limit the average temperature rise to 1.5°C, as promised by the Paris Agreement.

If the average temperature rise exceeds this limit, the impacts across the planet will include more intense heat waves and more frequent storms, according to the Intergovernmental Panel on Climate Change (IPCC).Greenhouse gas emissions have risen 1.5% per year in the last decade, largely owing to fossil fuels and land-use change such as deforestation.

The G20 countries account for about 75% of total greenhouse gas emissions, led by China and the United States. Brazil ranks 14th in the world, according to the Global Carbon Atlas. Deforestation and forest fires alone account for a significant proportion of Brazil's emissions. In

its Paris Agreement climate commitments, Brazil undertook to achieve a 37% reduction in emissions from the 2005 level by 2025 and a 43% reduction by 2030.

The latest study by the World Meteorological Organization (WMO) shows global CO_2 fossil fuel emissions reaching a record 36.7 gigatons in 2019, for an increase of 62% compared with 1990 when climate negotiations began. Because the pandemic has forced countries to restrict mobility for several months, CO_2 emissions are set to fall 4%-7% in 2020 compared with last year, according to the WMO. Although in April daily emissions reached the lowest level seen between January and August, they were the same as in 2006, when they were rising sharply.

The means to mitigate this rise in carbon emissions include more public policies to increase the use of renewable energy sources and low-carbon transportation and to eliminate coal, as well as reducing deforestation and forest fires throughout the world.

Last year a group of 66 countries, plus 10 regions, 102 cities, 93 businesses, and 12 investors, committed to achieving net-zero CO_2 emissions by 2050. Carbon pricing mechanisms under discussion entail taxing emissions and incrementing the carbon credit market so that the polluter pays if mitigation is not performed domestically. The ultimate goal is to make low-carbon production steadily more advantageous.

Methodology

To return to the relationship between tree lifespan and net carbon uptake, Locosselli explained that the study was based on an analysis of annual growth rings. The researchers compiled and analyzed tree-ring datasets for more than 210,000 trees belonging to 110 species.

When a tree grows faster, it lays down more tissue in the year, resulting

in a wider growth ring, and vice-versa. The age of a tree can be calculated by counting its annual rings.

"This is how we were able to measure the dynamics of trees that are 500 or 600 years old. We extrapolated time beyond what other studies did with permanent plots," said Locosselli, who is supported by FAPESP with a Young Investigator grant for the project "Functional forests: biodiversity to benefit cities".

Forest burning also accelerates tree mortality, but this factor was not included in the study, he said. Other research has shown that when the Amazon or any other tropical forest burns, it retains 25% less carbon even after three decades of regrowth.

More information: DOI: 10.6084/m9.figshare.12620414 R. J. W. Brienen et al. Forest carbon sink neutralized by pervasive growth-lifespan trade-offs, *Nature Communications* (2020). DOI: 10.1038/s41467-020-17966-z

Provided by FAPESP