Soil carbon changes in transition areas suggest conservation for Amazon, scientists say

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Conservation efforts on the edges of the Amazon forest, especially in light of recent deforestation by human disturbance, could help the region weather the storm of climate change, researchers say.

That assessment comes from an analysis of vegetation changes and carbon isotope signatures in the soil at 83 sites. The project, led by University of Oregon doctoral student Jamie Wright, established a record of soil changes associated with both climate and human activity over the last 1,600 years based on radiocarbon dating.

The study was published online Oct. 30 ahead of print in *Global Change Biology*.

Woody vegetation expansion into savannas, the research team found, had continued amid increasing moisture levels regardless of human impacts until only recently, mostly from rapid deforestation in the last decade. Climate modeling previously has suggested that local water and carbon cycles, as well as global climate patterns, are at risk.

"The past, like most things, leaves a trace behind and with it a rich history left to be told," said Wright, a member of the UO's Soil Plant Atmosphere Lab headed by co-author Lucas Silva, a professor in the Environmental Studies Program.

The forest-savanna borderlands, known as the Amazon-Cerrado transition, experience broad climatic and ecological influences. The study helped address uncertainties of those influences in the tropical ecosystem.

"Through the use of soil science, specifically with carbon isotopes, we unearthed a history of forest expansion over several millennia. This region is at the epicenter of deforestation and socio-ecological transformations that cause and drive climate change," Wright said.

Previous studies had suggested that forest expansion was primarily driven by increased precipitation, but that work, Silva noted, did not fully consider the impacts of local influences, such as fire frequency and intensity or whether it was occurring because of climate dynamics in the region. Focusing on soil changes, he said, allowed for these factors to be examined.

"Carbon storage in woody savannas and forests plants at this large of scale can be a significant carbon sink," Wright said. "Increasing tree cover also can ameliorate adverse climatic change impacts, such as droughts, by influencing the hydrological cycle and generating rain clouds."

In total, 742 soil samples were taken from forests, savannas and transition zones across a large swath of north-central Brazil, between latitudes 4 to 16 degrees south and longitudes 46 to 56 degrees west—an area where precipitation and distribution vary significantly.

The research team also measured the leaf index of the ecosystem's cover, mostly the forest canopy, to understand changes in carbon isotope signatures in the soil. Such changes reflect land usage. To determine changes over time, radiocarbon activity and isotopic ratios were profiled in 43 selected depths that represented the different sites.

While the research affirmed that forest expansion has occurred in most of the past 1,600 years, the researchers found a trend of decreasing woody vegetation in the study area's easternmost sites. The decline, they said, may reflect the prevalence of dry deciduous or semi-deciduous tree species in those areas.

The observed incremental expansion into savannas, they wrote, could have significant impacts on carbon-water relations, potentially affecting the balance between precipitation and evapotranspiration as seen in previous research. However, they noted, they did not see a clear effect of changes in vegetation on soil carbon stocks.

Future studies, they said, are needed to focus on the mechanisms that drive the permanence of carbon derived from woody vegetation expansion, especially because of recent documentation of hotter and longer dry seasons, as well as rising mortality rates of wet climate species.

The next phase of understanding, they said, will come from integrating plant, soil and atmospheric data to understand the influence of human activity on ecosystem-climate feedbacks as a path towards improving carbon sequestration and water conservation.

"Our data indicate a regional increase in tree cover prior to modern deforestation, which could help inform conservation and management for climate change mitigation," said Silva, who also is a professor of geography and member of the Institute of Ecology and Evolution. "We hope that our research will lead to a greater appreciation of ecological processes in the region and their importance for global climatic stability."

In addition to Silva and Wright, the study's co-authors are Barbara Bomfim, a former postdoctoral researcher in Silva's lab who is now at the Lawrence Berkeley National Laboratory, Corrine Wong of Boston College, and Ben Hur Marimon-Junior and Beatriz Marimon, both of the State University of Mato Grosso in Nova Xavantina, Brazil.

The research team is continuing to work closely with collaborators in the Amazon region in an effort to secure funding to launch a reforestation project, Silva said.

More information: Jamie L. Wright et al, Sixteen hundred years of increasing tree cover prior to modern deforestation in Southern Amazon and Central Brazilian savannas, *Global Change Biology* (2020). DOI: 10.1111/gcb.15382

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