

Climate change, dams, deforestation a vicious cycle for Amazon rivers, lakes

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Once surrounded by forests, this riparian stream in the Amazon Basin is now imperiled by agricultural fields and heavily impounded by small dams built to provide water for cattle. Credit: Paulo Brando

Dams, mining, land-cover changes, and climate change are degrading the streams, rivers, lakes, and forests of the world's largest river basin at unprecedented rates, according to scientists.

Most studies to date have focused on threats in streams and rivers, such

as dams, or on land directly adjacent to them, such as deforestation. A new study by Virginia Tech and Woods Hole Research Center scientists evaluates the combined impacts of all these threats, including climate change, across the entire Amazon River basin.

In addition to the warming influence of global [climate change](#), Amazonian rivers, watersheds, and rain forests are suffering from changes to their own regional climate. In recent decades, deforestation has contributed to a warmer, drier, less predictable climate in the region.

"Changes in climate inevitably cause changes in rivers and lakes as well as all life and ecological processes associated with them—including people's livelihoods," said Leandro Castello, assistant professor of fisheries in Virginia Tech's College of Natural Resources and Environment. "If these trends continue, they will mark the next phase in Amazonian development."

Castello and Marcia Macedo, assistant scientist at the Woods Hole Research Center, synthesized nearly 200 studies in an article published Dec. 23 in *Global Change Biology*.

"Managing the waters and land that make up a single watershed and management of a single tributary [river basin](#) will not suffice to preserve these rivers," Castello said. "These tributary basin areas are hydrologically linked, making it necessary to manage the whole water cycle, including its atmospheric phase, to account for what happens in adjacent catchments areas."

"Climate change and deforestation are a double whammy for [freshwater ecosystems](#)," Macedo said. "Climate change-induced droughts can kill trees and trigger wildfires, which reduces the amount of water recycled to the atmosphere by trees. Regional deforestation worsens drought. These processes ultimately warm the land surface, reduce rainfall, and

degrade freshwater ecosystems."

Already, deforestation is delaying the onset of the rainy season in a region of the Amazon at a rate of six days per decade, according to the report. "As a result of these changes, many headwater streams rich in biodiversity may become intermittent," Castello said. "With the Amazon being home to thousands of aquatic species, including fish, insects, turtles, caimans, and many others, these changes represent a threat to global biodiversity."

Changed water flows also affect many terrestrial animals, such as jaguars and birds, reducing access to water and food and altering migratory routes.

If all of the dams that are planned are built, there will be only three free-flowing tributaries in the Amazon Basin. Agriculture and ranching have already affected half of the riverside forest. In addition to such impacts as biodiversity loss, warmer streams, and more frequent flood-plain fires, there will be reductions in water quality, fish yields, and water for navigation, power generation, and human use, the researchers report. "All these impacts will negatively affect local populations who depend on rivers and lakes for food, water, and income," Castello said.

The review concludes that existing policies are "wholly insufficient to address the growing array of impacts."

A network of nature reserves, indigenous lands, and sustainable use areas covers 54 percent of the Brazilian Amazon, but, "This protected area network is largely based on the geographical distribution of terrestrial plants and animals, leaving many headwater streams, rivers, and wetlands unprotected," Castello said.

A promising step forward is the use of satellites to monitor the health of

Amazonian freshwater ecosystems. "Although satellite records cannot directly measure water quality or aquatic animal communities, they can provide indicators of ecosystem health when combined with other data sources," the researchers write. "The history of Amazonian conservation suggests that collecting and disseminating sound environmental monitoring data is a crucial first step towards management." These methods could also be applied to other large, tropical river basins such as the Congo and Mekong, which are facing similar threats.

Some Amazonian countries are implementing water resource management laws to protect the availability and quality of water for people, but the focus on human needs over preservation is short sighted. "A lack of international collaboration undermines the potential effectiveness of these laws. Amazonian countries need to start talking to each other about these issues if they are to be solved," Castello noted.

There is reason for optimism, however. "Many of the existing policies, if revised to address deficiencies, could form the basis for a unified framework for conserving the freshwater ecosystems," Castello and Macedo concluded. "Existing management efforts focused on collaborative partnerships and stakeholder involvement are promising first steps."

They suggest a unified framework built on the principles of the European Union Water Framework Directive, beginning with tributary basins within countries and scaled up to the whole Amazon Basin.

"Fortunately, public awareness about the impacts of hydrological alterations, such as dams and deforestation, has been increasing," Macedo said. "This review provides a framework for understanding the linkages among Amazon freshwater ecosystems and the land, water, and climate systems that sustain them. Understanding the threats to those connections represents a critical step towards developing sound

management policies."

The College of Natural Resources and Environment at Virginia Tech, which is ranked the top program of its kind in the nation, advances the science of sustainability. Programs prepare the future generation of leaders to address the complex natural resources issues facing the planet. World-class faculty lead transformational research that complements the student learning experience and impacts citizens and communities across the globe on sustainability issues, especially as they pertain to water, climate, fisheries, wildlife, forestry, sustainable biomaterials, ecosystems, and geography. Virginia Tech, the most comprehensive university in Virginia, is dedicated to quality, innovation, and results to the commonwealth, the nation, and the world.

More information: Leandro Castello et al. Large-scale degradation of Amazonian freshwater ecosystems, *Global Change Biology* (2016). [DOI: 10.1111/gcb.13173](https://doi.org/10.1111/gcb.13173)

Provided by Virginia Tech

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