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For nature-based climate solutions to work, they must be restructured

Humans have engineered climate change by manipulating the environment. There's a hope that we may also be able to mitigate this, predominantly through reducing emissions, but in some cases by leveraging some of these same natural processes, a plan called Nature-based Climate Solutions (NbCS).

A majority of the climate-altering carbon dioxide humans release into the atmosphere by burning fossil fuels gets drawn into Earth's oceans and landscapes through natural processes such as photosynthesis, where plants turn atmospheric carbon dioxide into biomass.

Efforts to slow the climate crisis have long sought to harness nature, often through carbon "offsets," aimed at bolstering forests, wetlands and agriculture, but have generally had only marginal success so far.

New research out of the University of Utah, UC Santa Barbara and eight other institutions analyzes various strategies for improving such nature-based climate solutions, specifically exploring the role of the world's forests in pulling carbon out of the atmosphere and storing it in long-lived trees and even in the ground. The results, published in the journal Nature, were funded by the National Science Foundation.

"Forests have potential as nature-based climate solutions, aligned with broader sustainability benefits," said co-author Anna Trugman, an associate professor in

UCSB’s Department of Geography. “Unfortunately, a broad body of literature has revealed widespread problems in forest NbCS projects and protocols that undermine the climate mitigation of forest carbon credits and hamper efforts to reach global net zero.” She and her co-authors agree that improving NbCS will require better science and policy going forward.

Nature-based climate solutions are currently falling short

“Nature-based climate solutions are human actions that leverage natural processes to either take carbon out of the atmosphere or stop the emissions of carbon to the atmosphere,” said lead author William Anderegg, a professor of biology at the University of Utah. “Those are the two main broad categories. There's the avoided emissions, and that's activities like stopping deforestation. Then there's the greenhouse gas-removal pathways. That's things like reforestation where you plant trees, and as those trees grow, they suck up CO2 out of the atmosphere.”

The UU-led study identifies four components where nature-based climate actions have not lived up to their billing and proposes reforms to improve their performance and scalability.

Forests are the focus because of trees’ ability to store vast amounts of carbon that would otherwise be in the atmosphere exacerbating the climate crisis. Conversely, deforestation, especially in the Amazon rainforest, is releasing carbon at an alarming rate.

About half the emissions associated with human activity are absorbed into plants through photosynthesis, and oceans, with the rest building up in the atmosphere where these gases trap heat. Terrestrial ecosystems pull 31% of human-caused emissions out of the atmosphere, according to the study. While forests are seen as Earth’s most vital carbon sponge, current rates of deforestation release 1.9 gigatons of carbon a year, on par with Russia’s annual emissions. Thus, “actions to halt and reverse deforestation are a critical part of climate stabilization pathways,” the authors write.

Various programs are in place for companies to mitigate their emissions through purchasing carbon offsets, which fund projects aimed at preserving or restoring forests. But as currently configured, these programs are not delivering much in the way of climate benefits, according to co-author Libby Blanchard, a postdoctoral researcher in Anderegg's lab.

"There are widespread problems with accounting for their climate impact," said Blanchard, who has extensively studied the impacts of offset programs. One stems from the land's albedo — its capacity to reflect the sun's energy back into space. "For example, despite the potential for albedo to reduce or even negate the climate mitigation benefits of some forest carbon projects, calculating for the effect of albedo is not considered in any carbon-crediting protocols to date."

According to the authors, a successful nature-based climate solution should: lead to net global cooling; result in additional climate benefits; avoid carbon "leakage"; and store carbon long enough to make a difference.

Creating more effective nature-based solutions

The study proposes structural reforms aimed at encouraging corporations to financially contribute to climate mitigation, as opposed to claiming credit for something that may ultimately provide little benefit. A contribution approach would be more scientifically accurate and legally defensible than the current system, potentially resulting in higher quality projects, the authors argue.

The first piece of the roadmap is accounting for various feedback cycles to ensure that the NbCS results in an actual cooling effect on the climate. Planting trees can change a landscape's albedo. "If you go in an ecosystem that is mostly snow covered and you plant really dark conifer trees, that can actually outweigh the carbon storage benefit and heat up the planet," Anderegg said. "Right now, none of these programs really consider albedo and some of these other feedbacks."

Next, the project must result in additional actions that would not have otherwise occurred. "You have to change behavior or change some sort of outcome," Anderegg said. "You can't just take credit for what was going to happen anyway. One great example here is if you pay money to keep a forest from deforestation, but

it was never going to be cut down to begin with, then you haven't done anything for the climate.”

The third problem, “leakage,” occurs when a climate action simply pushes a land-disturbing activity from one place to another while the fourth component addresses a climate action’s durability, or how long it will keep carbon out of the atmosphere. This is particularly important given the longevity of carbon dioxide molecules. When fossil fuels are burned, carbon that was permanently locked in geological formations is released into the biosphere where it will cycle in and out of living things and landscapes for thousands of years.

A climate solution should always aim to keep carbon locked up for as long as possible, preferably at least a century, according to the researchers. But drought, storms, insects, wildfire and other climate-related hazards can quickly negate any gains by killing trees.

“You have to know how big the risks are, and you have to account for those risks in the policies and programs,” Anderegg said. “Otherwise, you're going to lose a lot of that carbon storage as climate change accelerates the risks.”

The methods now in place to account for these risks, known as “buffer pools,” are not robust or rigorous enough, the authors claim. Anderegg expects to release a study soon that will highlight potential fixes.

Certain carbon market protocols are currently open for public comment by different carbon market registries and United Nations Framework Convention on Climate Change. Trugman, Anderegg and their colleagues are focused on communicating the group’s findings to inform these protocols and their roles in net-zero carbon emissions efforts.

Brian Maffly at the University of Utah contributed to this story.

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