Hotter tropics may worsen climate change, reforestation could lessen it: Studies

by Taran Volckhausen on 2 October 2020

- *Researchers know tropical forests play an important part in regulating the global climate, but there is great uncertainty still as to how various forest mechanisms will work as the world warms in the years ahead.*
- *Two new studies shed light on the problem: one finds that a hotter global climate could release far more carbon from tropical soils than currently believed. The research conducted in Panama found that soil carbon emissions increased by 55% over two years when those soils were heated by four degrees Celsius.*
- *However, more research is needed to see if such large losses would be maintained over time, as well as what future results might be in other tropical forests and soils around the world.*
- *In another study conducted in Malaysia, scientists determined that active restoration of degraded tropical forests could be a key tool for lowering atmospheric CO2 concentrations, potentially curbing climate change and helping moderate global temperatures.*

Researcher Ben Turner works in a soil pit to research soil carbon releases on Barro Colorado Island, Panama. Image by Sean Mattson.

Tropical rainforests may not be known for their cool climates, but they are known for keeping the climate cool. Storing an estimated 25% of the world's carbon, tropical forests play a leading role in soaking up human-caused greenhouse gas emissions. The Amazon forest alone sequesters an estimated 90 to 140 billion tons of carbon, the equivalent of 9 to 14 decades of human CO_2 emissions.

While scientists know tropical rainforests play a pivotal role in regulating the world's climate, they still have a lot to learn about what global warming means for the future of those forests. But two recent studies have provided surprising revelations that could clarify our views on the interaction between climate change and tropical forests going forward.

The first study published in *Nature* suggests bad news: that a hotter climate could release a great deal more carbon from tropical soils than previously assumed. This means, alongside human fossil fuel emissions, tropical forests could become another potent contributor to global warming once the climate heats up past a certain threshold.

Another recent study published in *Science* offers some good news: finding that the tropics could in future serve as a powerful carbon sink, if degraded forests are actively restored. Active tropical forest restoration could be a key tool for lowering atmospheric CO_2 concentrations, reversing the greenhouse effect to some degree, and helping moderate global temperatures.

Researchers set up equipment in Panama to measure the release of soil carbon. Soils were artificially heated to imitate future global warming in the tropics. Image by Geetha Iyer.

Heating up the tropics may lead to more emissions

For the past 15 years, climate scientists have worried that a warmer climate threatens to release carbon frozen into soils at higher latitudes, such as the Arctic tundra. Meanwhile, little attention had been given to the tropics.

The recent *Nature* study's lead author, Andrew Nottingham, an ecologist at Edinburgh University, told Mongabay via email that the lack of warming experiments performed in the tropics has created a massive gap in understanding how climate change could interact with one of the key climate-regulating biomes on Earth.

As a postdoctoral project, Nottingham wanted to directly measure the effects of warming on carbon emissions from tropical forest soils. His University of Edinburgh research team built heating devices to artificially raise soil temperatures in a lowland tropical forest in Panama. The researchers predicted only modest carbon loss from tropical soils, but were surprised to find carbon emission increases of 55% over two years when those soils were heated by four degrees Celsius.

"Tropical soil carbon appears to be much more susceptible to short-term warming than has been previously recognized," Nottingham said. "These results demonstrate that soil carbon in tropical forests is highly sensitive to warming, creating a potentially substantial positive feedback to climate change."

A researcher installs a heating device for soil carbon experiments in Panama. Image by Geetha Iyer.

The authors note that the study only measured results for two years, and there are reasons to believe the carbon release would not continue indefinitely at the same high rate. One of those reasons is that there is a limited amount of carbon in the soil, and if it kept losing carbon at the same rate, it would be completely depleted in 20 years — which Nottingham said would be a "truly catastrophic outcome."

Benjamin Gaubert, a scientist with the National Center for Atmospheric Research (NCAR) who was not involved in the current study, said the findings "reveal a potentially large positive climate feedback." At the same time, Gaubert cautioned that it remains to be seen if all of the tropics will behave in the same way the research suggests. "This study opens new research questions on the mechanism[s] underlying this increase in tropical soil carbon loss. Understanding those mechanisms will be key for the development of the next generation of numerical models," he said.

Nottingham believes the study helps flesh out a larger picture emerging across various biomes, including the Arctic tundra and its permafrost, demonstrating that a warming world may likely trigger increased carbon emissions from all kinds of soils.

"This has important implications for future climate [change], given how much carbon is stored in tropical forests worldwide," Nottingham said. "Together, these results must provoke more urgency towards strengthening current efforts to slow up the rate of change of Earth's climate, and towards reducing negative human impacts upon it."

Rainforest canopy in Sabah, Malaysia. Image by Christopher Philipson.

Active tropical forest recovery ups carbon uptake

Over half of tropical forests around the world have been degraded by humanity in a multitude of ways, which means reduced carbon storage and biodiversity. In the scientific community, there is a debate over whether naturally or actively restored tropical forests regenerate faster. A study recently published in *Science* offers evidence that actively restored forests recover faster than areas left to regenerate naturally after being logged.

The study took place in Sabah, Malaysia, in a tropical forest which had been heavily logged in the 1980s. Subsequently, the area was protected from timber harvesting as well as conversion to plantation agriculture. Researchers took measurements from 257 forest plots, comparing biomass recovery in actively restored and naturally regenerating forests.

The results: over time the natural forest recovered carbon stocks that had been depleted due to the logging, but the actively recovered forest significantly faster. The researchers wrote: “restoration enhanced decadal [aboveground carbon density] recovery by more than 50%, from 2.9 to 4.4 megagrams per hectare per year.”

Study lead author Christopher Phillipson, who is senior scientist at ETH Zurich's Chair of Ecosystem Management, told Mongabay via email that his team's research indicates that carbon stocks could be recovered decades faster with active restoration as compared to passive restoration practices. "A single logging event would be fully recovered after 40 years with active restoration, as opposed to around 60 years if left to regenerate naturally," he said.

Field team takes forest recovery measurements in Sabah, Malaysia. Image by Sonny Royal.

According to Phillipson, the active restoration work involved cutting away climbing plants that compete with young trees for access to light and nutrients, as well as the selection of seedlings of important timber species, which were given preferential treatment by cutting back competing growth for several years after planting. These steps gave the tree seedlings a head start in the race to form a new forest canopy.

Despite the high rate of recovery of actively recovered forests, the study found that current carbon prices set at between $2 and $10 would likely be insufficient to create an economically viable model for incentivizing reforestation.

Michelle Kalamandeen, a post-doctoral researcher at the University of Cambridge Department of Plant Sciences, UK, who was not involved in the research but reviewed it for Mongabay, said the study offered important findings "on how active restoration, which may be required for some sites, can

assist in sequestering carbon within a shorter period of time, using relatively 'low-tech' restoration techniques."

But Kalamandeen cautioned that reforestation efforts will only solve one small part of a larger climate problem that includes a global dependency on fossil fuels, lack of protection for intact forests, and weak enforcement of existing policies that require restoration of degraded areas caused by extractive industries.

Further, Kalamandeen said that a $40 to $80 cost per ton of carbon would be difficult to achieve. "At the moment, getting anyone to pay $5 is difficult, much less a 700% increase in cost," Kalamandeen said. "Such pricing may be more feasible over the long term."

A new related study recently published in *Nature* suggests that the United Nations Intergovernmental Panel on Climate Change (IPCC) has underestimated the rate of carbon sequestration by global forest restoration by 32%. The authors proposed that a large-scale planetary reforestation effort to combat climate change would require a dietary shift away from meat consumption to allow pasture and grain croplands to revert to forestlands.

Citations:

Andrew T. Nottingham, Patrick Meir, Esther Velasquez, Benjamin L. Turner. *Soil carbon loss by experimental warming in a tropical forest*. Nature, 2020.

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Banner Image: Rainforest canopy in Sabah, Malaysia. Image by Chien Lee.

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