The Carbon Brief

Blog

Ask the scientists: Are rainforests resilient to climate change?

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Is climate change bad for rainforests or not? Two scientific papers have suggested these important carbon sinks may be less vulnerable to rising temperatures than previously thought. With some parts of the media suggesting this means rainforests will survive global warming after all, we asked some experts for their views.

In the past, scientific models have predicted vast swathes of rainforest would degrade rapidly because of changes to temperature and rainfall patterns - a process known as rainforest dieback.

Greater resilience

Tropical rainforests store a lot of carbon as living biomass. So any changes in the size of the

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global rainforest can have a big impact on the amount of carbon dioxide in the atmosphere.

Two new studies - published in the journals Nature and Nature Geosciences - suggest die-back is likely to be far less severe than scientists previously thought. In fact, all but one climate model used in the most recent study predict rainforest growth in Africa, Asia and the Americas over the coming century.

Summarising the new research, Dr Chris Huntingford from the UK Centre for Ecology and Hydrology, a lead author on the Nature Geosciences paper, tells us:

> "[L]ooking across different climate models, there is evidence that tropical rainforests may be more resilient to carbon dioxide-induced climate change than previously believed."

So why are the scientists' new predictions more positive than previous ones?

Refining models

Predictions have changed as climate models have got better at representing some of the ways carbon cycles between plants and the atmosphere, and how temperature and rainfall patterns are likely to evolve in different regions.

As Huntingford says, one difference between the new estimates and previous ones is the old models predict "an especially large estimate of future warming and drying across Brazil". This is lower in the newer models, reflecting more refined projections.

Without the same scale of drought, trees do better. Professor Philip Fearnside from the National Institute for Research in Amazonia (INPA) Brazil explains a bit more:

> "[I]n the previous version of the model the trees essentially died of thirst, succumbing to the combination of lack of water and the increased need for water that higher temperatures imply for maintaining basic metabolism."

Carbon dioxide fertilisation

The new models also account for the fact that tree growth is likely to be enhanced by higher

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carbon dioxide levels - a process known as carbon dioxide fertilisation. As Fearnside explains:

> "[C]arbon dioxide enrichment increases forest resistance both by increasing tree growth and by causing tree leaves to close their stomata, thereby reducing their loss of water."

Dr Ben Booth, senior climate scientist at the Met Office and co-author on both papers, explained in the new models, losses in rainforests' ability to store carbon are largely balanced out by the positive effects of carbon dioxide fertilisation. He says:

> "[The] forests become more efficient at assimilating carbon from the atmosphere with more carbon dioxide, and this is sufficient to offset moderate levels of climate driven loss."

Remaining questions

This might seem like good news for rainforests as the climate warms. But it would be premature to conclude that tropical rainforests are safe from warming-induced die-off, scientists tell us. There are still important questions about how rainforests will respond that the new research can't answer.

As Dr Rosie Fisher from the National Centre for Atmospheric Research (NCAR) in the US - and co-author on the Nature Geosciences paper - tells us:

> "[Our research] reports a 'simulated' resilience of the forest to climate change. Simulated' is a critical word [and] the details of the models that we use here are very relevant."

Both pieces of research are subject to three big uncertainties; how carbon-dioxide emissions will evolve, how plants and soil will respond to changes in temperature and rainfall, and how much the forest will benefit from increasing carbon dioxide. And Dr Fisher explains that ironing out these uncertainties is not straightforward:

> "Testing how forests respond to increasing carbon dioxide and temperature really needs large and difficult manipulation experiments that ecologists have only just learned how to do, and are just now beginning to plan in the tropics."

While climate models do the best job they can of representing the carbon cycle, a small number of experiments in the field suggest things may be more complicated in the real world. Dr Simon Lewis from the university of Leeds explains such experiments - at least for the moment - seem to tell a different story to the climate models. He says:

> "There have been two opposing trends in rainforest research over recent years … evidence from monitoring tropical forests has accumulated that suggests rainforest may be less resilient to climate change than previously thought."

For example, there is some evidence carbon dioxide fertilisation could be limited by the availability of nutrients - significantly increasing their vulnerability to climate change. Until scientists can match models up to what we're seeing now, it's hard to know for sure how accurate their predictions of future changes are.

Missing factors

As well as being mindful of the uncertainties that remain, Lewis tells us we should "cautiously interpret the new model findings" because "resilience to climate change alone is not the same thing as resilience to climate change plus the other direct human impacts together."

Some important factors affecting rainforest survival are not included in the newer climate models - such as logging, deforestation and forest fires. Professor Oliver Phillips from the University of Leeds, another co-author, tells us:

> "Almost all scientists would agree that the largest threats to the biological integrity of tropical forests remain deforestation, fire, and over-exploitation of remaining forests. climate change is likely to interact with those land-use threats, worsening them."

It's worth remembering too that the new research only looks at carbon-dioxide induced warming. Temperature rise caused by other greenhouse gases in the atmosphere, such as methane, won't have the same positive effect on plant growth.

Since factors not included in the new models could be at least as important as the ones included, lead author Chris Huntingford told us he hopes the new research isn't interpreted

as a reason to not worry any more about the potential for climate change damage to tropical ecosystems. It does, however, provide a counter to some of the more extreme estimates of die-back to come out of previous modelling studies.

Cox et al., (2013) Sensitivity of tropical carbon to climate change constrained by carbon dioxide variability. Nature doi:10.1038/nature11882

Huntingford et al. (2013) Simulated resilience of tropical rainforests to CO2-induced climate change. Nature Geosciences doi:10.1038/ngeo1741

Tags | Climate science, New research

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Rudy Haugeneder

One of the good things about current planet Mars exploration is that the results slowly show Mars was once much like earth and then was destroyed: intelligent life, perhaps our distant, distant ancestors who were not hairy primates, were too scientifically human for their own good -- and ours.

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