

Mass tree deaths prompt fears of Amazon 'climate tipping point'

Scientists fear billions of tree deaths caused by 2010 drought could see vast forest turn from carbon sink to carbon source

- [Damian Carrington](#)
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Aerial view of a drought-affected area within the Amazon basin in Manaus, Brazil.

Photograph: Rodrigo Baleia/LatinContent/Getty Images

Billions of trees died in the [record drought that struck the Amazon in 2010](#), raising fears that the vast forest is on the verge of a tipping point, where it will stop absorbing greenhouse gas emissions and instead increase them.

The dense [forests](#) of the Amazon soak up more than one-quarter of the world's atmospheric carbon, making it a critically important buffer against global warming. But if the Amazon switches from a carbon sink to a carbon source that prompts further droughts and mass tree deaths, such a feedback loop could cause runaway [climate change](#), with disastrous consequences.

"Put starkly, current emissions pathways risk playing Russian roulette with the world's largest forest," said tropical forest expert [Simon Lewis](#), at the University of Leeds, and who led the research published today in the journal [Science](#). Lewis was careful to note that significant scientific uncertainties remain and that the 2010 and [2005 drought – thought then to be of once-a-century severity](#) – might yet be explained by natural climate variation.

"We can't just wait and see because there is no going back," he said. "We won't know we have passed the point where the Amazon turns from a sink to a source until afterwards, when it will

be too late."

Alex Bowen, from the London School of Economics and Political Science's Grantham research institute on climate change, said huge emissions of carbon from the Amazon would make it even harder to keep global greenhouse gases at a low enough level to avoid dangerous climate change. "It therefore makes it even more important for there to be strong and urgent reductions in man-made emissions."

The revelation of mass tree deaths in the Amazon is a major blow to efforts to reduce the destruction of the world's forests by loggers, one of the biggest sources of global [carbon emissions](#). The use of satellite imagery by [Brazilian law enforcement teams has drastically cut deforestation rates](#) and [replanting in Asia](#) had slowed the net loss. [Financial deals to protect forests](#) were one of the few areas on which some progress was made at the 2010 [UN climate talks in Cancún](#).

The 2010 Amazonian [drought](#) led to the declaration of states-of-emergencies and the [lowest ever level of the major tributary, the Rio Negro](#). Lewis, with colleagues in [Brazil](#), examined satellite-derived rainfall measurements and found that the 2010 drought was even worse than the very severe 2005 drought, affecting a 60% wider area and with an even harsher dry season.

On the ground, the researchers have 126 one-hectare plots spread across the Amazon, in which every single tree is tagged and monitored. After 2005, they counted how many trees had died and worked out how much carbon would be pumped into the atmosphere as the wood rotted. In addition, the reduced growth of the water-stressed trees means the forest failed to absorb the 1.5bn tonnes of carbon that it would in a normal year.

Applying the same principles to the 2010 drought, they estimated that 8.5 billion tonnes of CO₂ will be released - more than the [entire 7.7bn tonnes emitted in 2009 by China](#), the biggest polluting nation in the world. This estimate does not include forest fires, which release carbon and increase in dry years.

"The Amazon is such a big area that even a small shift [in conditions] there can have a global impact," said Lewis.

Lewis said that two such severe droughts in the Amazon within five years was highly unusual, but that a natural variation in climate over decade-long periods cannot yet be ruled out. The driving factor of the annual weather patterns is the warmth of the sea in the Atlantic. He said increasing droughts in the Amazon are found in some climate models, including the sophisticated model used by the Hadley centre. This means the 2005 and 2010 droughts are consistent with the idea that global warming will cause more droughts in future, emit more carbon, and potentially lead to runaway climate change. "The greenhouse gases we have already emitted may mean there are several more droughts in the pipeline," he said.

Lewis said that the 2010 drought killed "in the low billions of trees", in addition to the roughly 4 billion trees that die on average in a normal year across the Amazon. The researchers are now trying to raise £500,000 in emergency funding to revisit the plots in the Amazon and gather further data.

Brazilian scientist Paulo Brando, from the [Instituto de Pesquisa Ambiental da Amazônia](#) (Amazon Environmental Research Institute), and co-leader of the research said: "We will not know exactly how many trees were killed until we can complete forest measurements on the

ground. It could be that many of the drought-susceptible trees were killed off in 2005. Or the first drought may have weakened a large number of trees so increasing the number dying in 2010."

Brando added: "Our results should be seen as an initial estimate. The emissions estimates do not include those from forest fires, which spread over extensive areas of the Amazon during hot and dry years and release large amounts of carbon."

Climate tipping points

Scientists know from the geological record that the Earth's climate can change rapidly. They have identified a number of potential tipping points where relatively small amounts of global warming caused by human activities could cause large changes in climate. Some tipping points, like the losses to the Amazon forests, involve positive feedback loops and could lead to runaway climate change.

Arctic ice cap: The white ice cap is good at reflecting the Sun's warming light back into space. But [when it melts](#), the dark ocean uncovered absorbs this heat. This leads to more melting, and so on.

Tundra: The high north is warming particularly fast, [melting the permafrost](#) that has locked up vast amounts of carbon in soils for thousands of years. Bacteria digesting the unfrozen soils generate methane, a potent greenhouse gas, leading to more warming.

Gas hydrates: Also involving methane, this tipping point involves [huge reservoirs of methane](#) frozen on or just below the ocean floor. The methane-water crystals are close to their melting point and highly unstable. A huge release could be triggered by a little warming.

West Antarctic ice sheet: Some scientists think this [enormous ice sheet](#), much of which is below sea level, is vulnerable to small amounts of warming. If it all eventually melted, sea level would rise by six metres.

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Amazon drought 'severe' in 2010, raising warming fears



By Richard Black Environment correspondent, BBC News



Both droughts had a major impact on people living in the Amazon basin, as well as the forest [Continue reading the main story](#)

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Last year's drought in the Amazon raises concerns about the region's capacity to continue absorbing carbon dioxide, scientists say.

Researchers report in the journal *Science* that the 2010 drought was more widespread than in 2005 - the last big one - with more trees probably lost.

The 2005 drought had been termed a "one in a century" event.

In drought years, the Amazon region changes from being a net absorber of carbon dioxide into a net emitter.

The scientists, from the UK and Brazil, suggest this is further evidence of the Amazon's vulnerability to rising global temperatures.

They also suggest the days of the Amazon forest curbing the impact of rising greenhouse gas emissions may be coming to an end.

The 2010 drought saw the Amazon River at its lowest levels for half a century, with several tributaries completely dry and more than 20 municipalities declaring a state of emergency.

Research leader Simon Lewis, from the University of Leeds, is the scientist who gained an

apology from the Sunday Times newspaper last year over the so-called "AmazonGate" affair.

"It's difficult to detect patterns from just two observed droughts, but to have them close together is concerning," he told BBC News.

Both droughts were associated with unusually warm seas in the Atlantic Ocean off the Brazilian coast.

"If that turns out to be driven by escalating greenhouse gas concentrations in the atmosphere, it could imply that we'll see more drought years in the near future," said Dr Lewis.

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“Start Quote

Current emissions pathways risk playing Russian roulette with the world's largest rainforest”

End Quote Dr Simon Lewis Leeds University

"If events like this do happen more often, the Amazon rainforest would reach a point where it shifts from being a valuable carbon sink slowing climate change to a major source of greenhouse gases."

Some computer models of climate change - in particular, the one developed at the UK's Hadley Centre - project more droughts across the region as the planet warms, and a diminishing capacity to absorb CO₂.

There are several ways in which warming can turn greenhouse gas-absorbing forests into emitters.

In the Amazon, the principal mechanism is simply that trees die and then rot; in addition, those trees are then not available to absorb CO₂ from the air.

Eye in the sky

For this research, scientists used data from the Tropical Rainfall Measuring Mission (TRMM), a US/Japanese satellite that monitors rainfall in a belt extending either side of the Equator.

Its observation showed that whereas the 2005 drought covered an area of nearly two million sq km, in 2010 it stretched for three million sq km.



Data came from the US/Japanese TRMM

satellite, a window on tropical rainfall

Following the 2005 drought, scientists were able to study the impact on trees and work out the relationship between the rainfall loss and the release of carbon.

In an average year, the basin absorbs about 1.5 billion tonnes of CO₂ from the atmosphere.

By contrast, the impact of the 2005 drought, spread over a number of years, was calculated as a release of five billion tonnes.

The new paper calculates the figure for 2010 as about eight billion tonnes, as much as the annual emissions of China and Russia combined; but this, the researchers acknowledge, is a first estimate.

"It could be that many of the susceptible trees were killed off in 2005, which would reduce the number killed last year," said Paulo Brando from the Amazon Institute of Environmental Research (IPAM) in Belem, Brazil.

"On the other hand, the first drought may have weakened a large number of trees, so increasing the number dying in the 2010 dry season."

Leeds University is part of a research group that maintains about 130 land stations across the Amazon region.

If funds are forthcoming, the team will visit them all in the coming months to gather first-hand data on tree deaths.

This should provide for a more accurate estimate of the 2010 drought's contribution to global emissions.

Closing the gate

The likely fate of the Amazon under climate change came under focus early last year when, as one of a series of attacks on the Intergovernmental Panel on Climate Change (IPCC), the Sunday Times newspaper accused the panel of having included an unsubstantiated claim that up to 40% of the forest could be affected by climate change in future.



Some Amazon rivers saw their lowest level for decades in 2010

It used quotes from Dr Lewis in support of its claim.

In fact, Dr Lewis was concerned about the region's vulnerability and had sent the newspaper a sheaf of scientific papers to back the case.

He told the newspaper that the IPCC had sourced its statement to a report from environmental group WWF, when it should have referenced the scientific papers WWF had used in its report.

"In fact, the IPCC's Amazon statement is supported by peer-reviewed scientific evidence," the Sunday Times acknowledged in its apology.

Commenting on that so-called "AmazonGate" episode from the perspective of the new research, Dr Lewis noted:

"The notion that the Amazon is potentially very vulnerable to droughts linked to climate change was reasonable and defensible at the time, and is consistent with the new findings.

"If greenhouse gas emissions contribute to Amazon droughts that in turn cause forests to release carbon, this feedback loop would be extremely concerning.

"Put more starkly, current emissions pathways risk playing Russian roulette with the world's largest rainforest."