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The vicious cycle of climate change, deforestation, and fire in the Amazon

As long as deforestation continues in the Amazon, so will fire. And climate change is making it worse.

Sarah Ruiz Science Writer

Manoela Machado Postdoctoral Researcher

The Amazon rainforest is one of the planet's best natural climate solutions. Roughly 123 billion tons of carbon are estimated to be stored in the trees and soils of the Amazon and, if protected, it has the power to continue sequestering billions of tons of carbon each year.

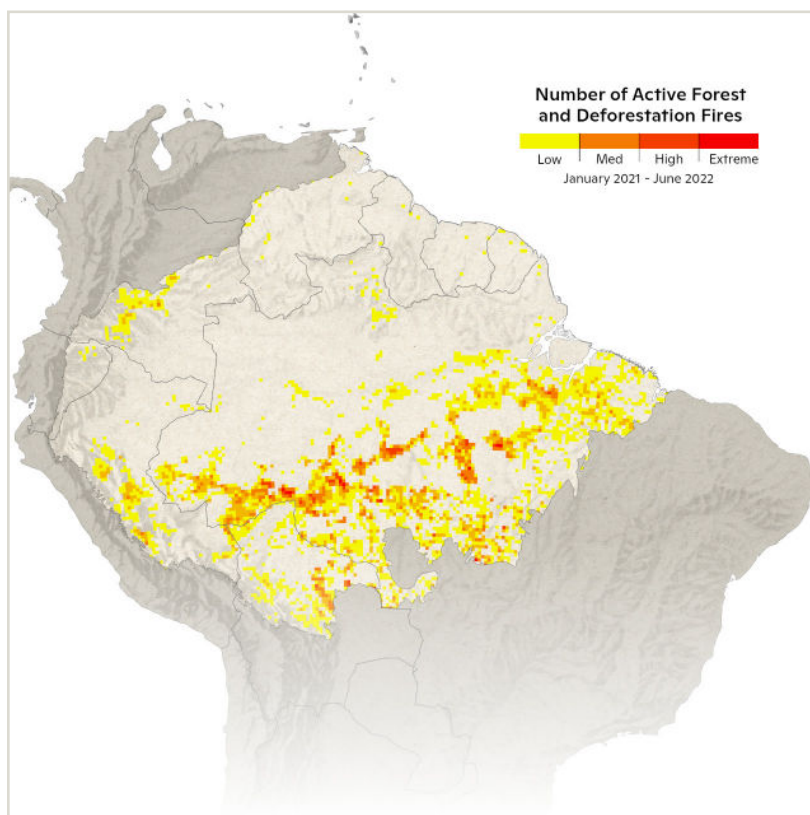
But that irreplaceable carbon sink is under steady threat from a cycle of deforestation, fire, and drought that is both exacerbated by and contributing to climate change. Preliminary analysis from Woodwell of last year's data has outlined that the most vulnerable regions of the Amazon are where drought and deforestation overlap.

2021 data shows deforestation drives fire in the Amazon

Opted not to put a swag notice since there's one going out tomorrow. Also wasn't sure how much of Jen's media attention to put in the In the news section. Unlike temperate or boreal

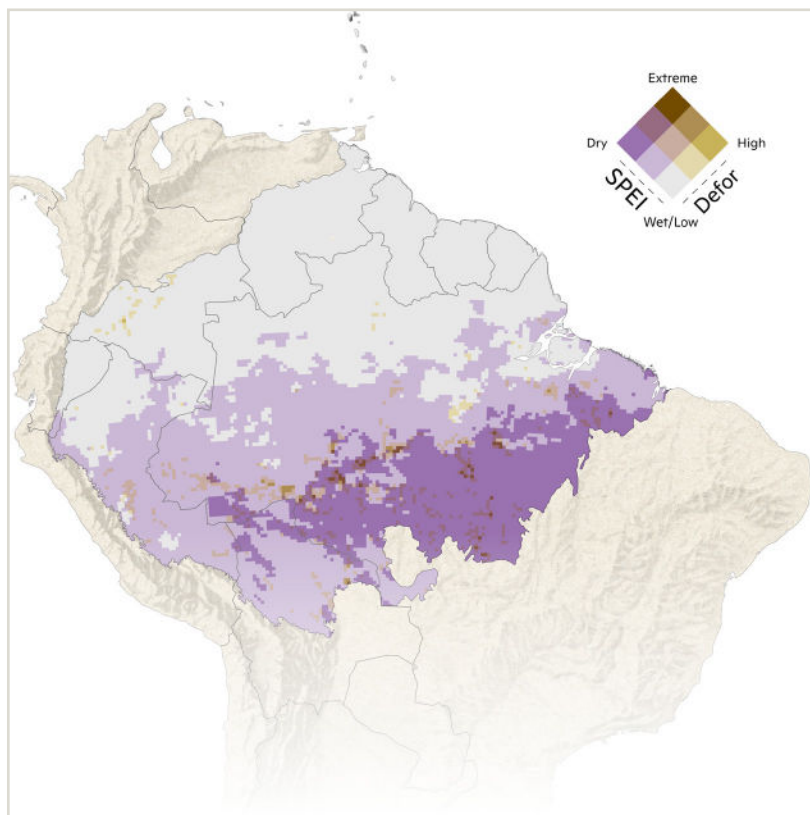
forest ecosystems—or even neighboring biomes in Brazil—fires in the Amazon are almost entirely human caused. Fire is an intrinsic part of the deforestation process, usually set to clear the forest for use as pasture or cropland. Because of this, data on deforestation can provide a good indicator of where ignitions are likely to happen. Drought fans those flames, producing the right conditions for more intense fires that last longer and spread farther. Examining the intersection between drought and deforestation in 2021, Woodwell identified areas of the Amazon most vulnerable to burning.

Areas of deforestation combined with exceptionally dry weather to create high fire risk in northwestern Mato Grosso, eastern Acre, and Rondonia. Although drought conditions shifted across the region throughout the course of the year, deforestation caused fuel to accumulate along the boundaries of protected and agricultural land.



above: Cumulative deforestation and forest fires from January 2021 to June 2022 (fire count of active fires). / map by Greg Fiske

below: Accumulated deforestation from January 2021 until June 2022 in yellow and areas of drought (light purple) and extreme drought (dark purple) according to the Standardized Precipitation-Evapotranspiration Index (SPEI). / map by Greg Fiske



left: Close up of a burning tree in an Amazon fire. / photo by Illuminati Films

These areas of concentrated fuel showed the most overlap with fires in 2021, indicating that without the ignition source that deforestation provides, fires would be unable to occur, even during times of drought.

In June of 2021, we identified a dangerous and flammable combination of cut, unburned wood and high drought in the municipality of Lábrea, that put it at extreme risk of burning. Data at the end of December of 2021 confirmed this prediction. The observed fire count numbers from NASA show, Lábrea led all other municipalities in fires last year.

Fires and climate change form a dangerous feedback loop

As a result of deforestation in 2021, at least 75 million tons of carbon were committed to being released from the Amazon. When that cut forest is also burned, most of the carbon enters the atmosphere in a matter of days or weeks, rather than the longer release that comes from decay.

This fuels warming, which feeds back into the cycle of fire by creating hotter, drier, conditions in a forest accustomed to moisture. Drought conditions weaken unburned forests, especially around the edges of deforestation, which makes them more susceptible to burning and releasing even more carbon to the atmosphere to further fuel warming.

Fire prevention strategies enacted by the current administration over the past three years have been insufficient to curb burning in the Amazon, because the underlying cause of deforestation remains unaddressed. Firefighting crews are not sufficiently supported to continue their work in regions like Lábrea that are actively hostile to combating deforestation and fire. If deforestation has occurred, fire will follow. To ensure the safety of both the people and the forests in these high-risk municipalities, the root causes of deforestation must be addressed with stronger and more strategic policies and enforcement.

LEARN MORE

The Amazon deforestation and fire outlook includes a closer look at 2022 to date: woodwellclimate.org/project/amazon-fire-outlook

Digging into rangeland soil carbon storage with Woodwell's scientists

A research trip to southwest Colorado collected data that will help rangeland managers track carbon captured in their soils

Sarah Ruiz Science Writer

It's a windy morning in May and the Valdez ranch in Delta County, Colorado is alive with the sounds of lowing cattle, chattering sparrows, and the whirrs and clanks of scientific equipment. This particular field is not being grazed at the moment, so Woodwell's soil carbon team has free rein over the rows of alfalfa and sweetgrass.

In collaboration with Dr. Megan Machmuller at Colorado State University,

assistant scientist Dr. Jennifer Watts and senior scientist Dr. Jon Sanderman have brought their teams here to collect field observations that will help inform a comprehensive model of carbon storage on rangelands across the United States. Grazing lands have the potential to be a valuable carbon sink, provided the livestock on them are being sustainably managed, but the true magnitude of that value is not yet well understood.

Developing a regional model of the way carbon moves through rangelands will deepen our understanding of the role they play as a natural climate solution.

Ensuring the model's accuracy requires the team to collect an array of field data from different ranch types—from irrigated and planted pasture, to the natural vegetation of high mountain and desert grazing lands. Here's how climate scientists study carbon in the field:



above: Dr. Yushu Xia and Haydée Hernández-Yáñez sampling vegetation while a carbon flux chamber operates in the foreground. / photo by Sarah Ruiz



Carbon flux: What's moving in and out of the atmosphere?

Soil carbon storage begins where plants interact with the air. As they grow, plants draw carbon out of the atmosphere through photosynthesis. When they decay, microbes in the soil digest plant matter and breathe carbon dioxide and methane back out. Measuring the difference between these two processes gives us “net ecosystem flux”—a measure of whether a patch of land is sequestering or emitting carbon overall.

Measuring carbon flux requires a specially made chamber. Dr. Watts and Seasonal Field Technician Jonas Noomah employed a plexiglass contraption that Noomah constructed himself. The chamber is placed over a patch of ground, connected by clear tubes to a machine that can analyze the volume of CO₂ within the cube. A handheld fan dangles inside the box to keep the air circulating. The transparent plexiglass allows photosynthesis to continue unhindered. After a few minutes, the box is covered to block out the light and the analysis is run again to capture emissions without the photosynthesis component. The numbers can be compared to assess the rate and overall carbon sink or source status of flux within the ecosystem.



Plant productivity: What's growing under-hoof?

While plants are growing, they lock away carbon as part of their leaves, stems, and roots, so another important metric in the carbon model is plant productivity—more productive plants with established root systems are more likely to store more carbon belowground.

Productivity can be estimated with satellite imagery, but needs to be validated with on-the-ground measurements. Postdoctoral researcher Dr. Yushu Xia and research assistant Haydée Hernández-Yañez walked transects of pasture to collect data on a variety of indicators that could influence aboveground (and belowground) biomass, including height of vegetation, soil moisture, and temperature. Then the scissors come out and all the plants in a plot are cut and put into a labeled paper bag to be weighed and analyzed later in a lab to determine the total mass of plant matter.

Rangelands managed for better carbon storage also come with a host of co-benefits, including higher levels of plant diversity. Different plants cycle carbon and other nutrients at different rates, so Hernández-Yañez sifts through the vegetation before it's snipped, identifying and recording the species to provide more detail in productivity estimates.



Soil carbon: What's locked deep in the ground?

Over time, carbon passes out of the cycle of growth and decay, becoming locked underground as soil organic carbon. Accessing and analyzing soil organic carbon requires coring deep into the earth and pulling out a stratified cylinder of dirt. Dr. Machmuller led the team's soil coring effort along with Dr. Sanderman and research assistant Colleen Smith.

With a hydraulic soil coring machine attached to the back of a pickup truck, the team rambled through muddy pasture and over sharp bushes to collect 50 centimeter cores. When the terrain was too steep, they pulled out a handheld corer that had to be driven into the soil with a sledgehammer.

The soil cores are separated into three sections and crumbled up. Smith then uses a handheld scanner that employs the same technology used by astronomers to determine the chemical makeup of distant star systems to read the carbon content of each section. The scanner bounces light off the soil particles and the pattern of reflection gives clues to what molecules are present at different depths. Abundance of carbon is sometimes obvious to the naked eye in the cores, showing up as darker, wet sticky soil.



Putting data in the hands of land managers

Drs. Watts and Sanderman and their team are in the process of creating a rangeland carbon management tool that will make the soil carbon data model accessible directly to ranch managers. The website, developed by Dr. Xia, will generate data on carbon and plant productivity, for any geographic area down to the size of a single pasture. The hope is that the tool could be integrated into land managers long-term decision making, and show the results of adapting to more holistic, sustainable management practices over time.

“In the western U.S. on our rangelands, just like in our croplands, we can change how we manage in a way that potentially could become a natural climate solution,” says Dr. Watts. “One where we’re bringing in more carbon than we’re emitting and we’re creating ecosystems that not only are beneficial for carbon sequestration, but also have more biodiversity, offer more habitat for wildlife, and more water conservation.”

Demonstrating the co-benefits of managing rangelands for carbon will also help expand conversations about whether ranching can be done sustainably, from the ground up.

“It allows for transfer of climate solutions into the hands of practitioners who may not otherwise think about climate change. It opens the conversation,” says Dr. Watts.

Ultimately, having that data could be useful for rangeland managers taking part in carbon credit markets, which could help them get paid for sustainable management

“Rangelands haven’t been included in voluntary carbon credit markets like cropping systems have,” says Dr. Sanderman. “Their monitoring is a big problem because there’s so much land. How do you keep track of all that? That’s what our tool will be able to offer.

above left: Roots can extend deep into the soil as shown in this core section from 50cm belowground.
above right: View of the mountains from Harts Basin / photos by Sarah Ruiz



Earth Emergency screening on Nantucket and Martha's Vineyard

Join Woodwell Climate on Nantucket on August 10 and Martha's Vineyard on August 11, for *Earth Emergency* screenings followed by panel discussions with Woodwell scientists.

Learn more at: woodwellclimate.org/earth-emergency-film

In the news: highlights

Dr. Jen Francis has been in demand to provide analysis and comments on the heat waves affecting:

ABC News on the connection between climate change and heat waves on the record-breaking heat in Europe and the U.S.

Reuters explainer piece on what's behind the heat waves affecting the United States, which was picked up by *U.S. News & World Report* and *Al Jazeera*, among others.

Financial Times article discussing the influence of Arctic warming on the jet stream, and *BusinessFast* (UK) on how the jet stream is connected to simultaneous heatwaves across the globe.

CBS News interview on the Northeast's oppressive heat.

Dr. Jonathan Sanderman is quoted in an in-depth piece on grasslands preservation in *The Atlantic*.

Amazonia.org interviewed Dr. Ludmila Rattis about the fires bringing the Pantanal and Xingu regions of Brazil closer to a "point of no return." (Portuguese)

An article from *South China Morning Post* cited a Woodwell report discussing the impacts of climate change on India-China relations.

The Falmouth Enterprise ran two stories mentioning Woodwell this week; one about Falmouth Water Stewards' sampling of ponds and streams, and another about the Permafrost Pathways project.

Dr. Manoela Machado was quoted in a widely-syndicated *Reuters* article covering record deforestation in the Brazilian Amazon. The article was published in over 270 different outlets from around the world, in languages including Spanish, German, Czech, Mandarin, and Greek.

The Carbon Copy podcast welcomed Dr. Sue Natali to talk about Permafrost Pathways and filling the gaps in our knowledge of the climate impact of permafrost.

An article profiling Dr. George Woodwell in *BlueDot Living Martha's Vineyard* shares some history of the Center and quotes numerous Woodwell staff, including Dr. Skee Houghton, Dr. Sue Natali, and Dr. Heather Goldstone.

An article from *Colgate University News* quoted Dr. Sue Natali on a recent study which she co-authored, finding that permafrost is deteriorating faster than expected.

A Woodwell map of average 2021 wind speed across the US was featured on *Visual Capitalist*.

Snopes quoted Dr. Heather Goldstone to help clarify a meme claiming to "debunk" sea level rise and climate change.

Dr. Brendan Rogers was quoted in a news article from *Nature* about the impact of Russia's war in Ukraine on Arctic research and carbon and methane monitoring.

Brooke Woods was a guest on *Talk of Alaska*, discussing how community, tribal, and state advocates are trying to fill food security gaps caused by rising prices and fewer fish.

ClimalInfo shared a presentation by Dr. Ludmila Rattis on the impacts of climate change—and the resulting water crisis—on Matopiba, a Brazilian agricultural frontier responsible for 10% of the country's grain and fiber production (Portuguese).

Dr. Anna Liljedahl was quoted in an article from the *Durango Telegraph* on the relationship between receding glaciers and landslides.

Dr. Spencer Glendon was a guest on Chris Colbert's *Insert: Human* podcast, discussing Probable Futures and sharing how Dr. George Woodwell inspired him to learn more about climate science.

Martha's Vineyard Times mentioned Woodwell as a collaborating organization in planting 1,000 rare New England blazing star plants at Katama's Bamford Preserve.

GreenBiz quoted Wellington's Wendy Cromwell on the beginnings of their partnership with Woodwell, and why understanding climate risks matters. Wellington was recently awarded the ESG Innovation of the Year Award for their data-driven tools to assess material financial risks of climate change.

Donations play an important role in securing the future of Woodwell Climate Research Center's work—and help safeguard the health of our planet for generations to come.

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