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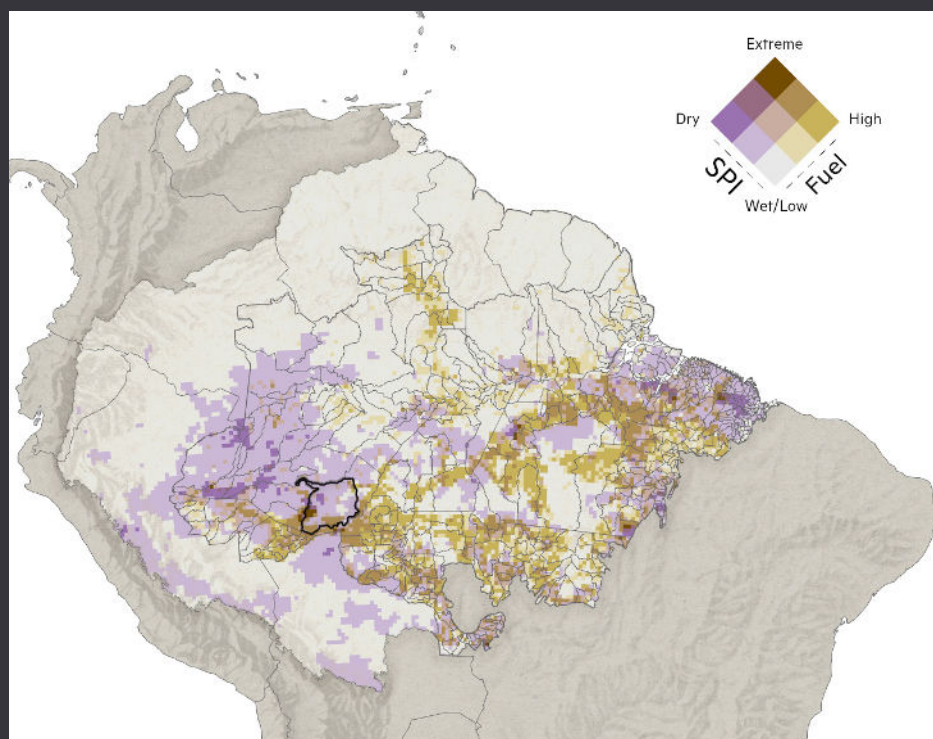
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Newsletter • July 2021
woodwellclimate.org

Amazon deforestation and fire outlook

by Dr. Heather Goldstone
Chief Communications Officer



In 2019 and 2020, fires raged through the Amazon. Unusual in years without extreme drought conditions, the cause lies in a new upward trend in deforestation, which has reached levels not seen in over a decade. This spring, deforestation levels jumped even higher than the previous two years. This, combined with widespread drought conditions, has raised concerns about fires during this burning season, which typically begins in July and lasts up to four months.

Long-burning and intense fires are not a natural feature of the Amazon, but the normally humid conditions of the rainforest are being rapidly altered by human activity. When forests are cleared, the dead trees and brush are piled up to dry out, creating fuel that is burned to complete the cycle of deforestation. These intense fires can leak into forests and, if combined with drought conditions, can cause widespread damage. Such drought conditions are becoming more common as a result of both local deforestation and global climate change. In addition, these fires release carbon dioxide equivalent to tens of millions of cars, creating a vicious cycle that warms the planet and creates conditions for ever more intense fires.

The Brazilian federal government has authorized the use of military forces to combat deforestation over the next two months. They have also declared a nation-wide fire ban. However, fires continued to escalate under a similar ban last year, highlighting the need for more effective strategies.

Fire-fighting in the Amazon is limited by a lack of both funding and accurate information on where the risk of fire is highest. Combining available satellite data on past deforestation and fires

with climatic analysis, we assess areas at highest risk of burning (dark “extreme” on map above) during Brazil’s 2021 fire season.

High fuel loads

Official deforestation data shows more than 10,000 square kilometers of rainforest were deforested in 2019—the highest numbers in more than a decade—and nearly the same occurred again in 2020. Preliminary numbers from 2021 show the rate of deforestation increasing.

An overlay of deforestation alerts from DETER-INPE, an official Brazilian monitoring system, with active fire data from NASA shows that almost 5,000 square kilometers of area deforested since 2019 has not yet burned (gold)—meaning those areas are tinderboxes of fuel waiting for a spark. Many of these fuel-heavy areas are adjacent to standing forests, making them prime locations for fires to jump from cleared land to remaining forest.

Drought conditions

To make matters worse, the southern Amazon this year has been experiencing drought conditions (purple) carried over from 2020, likely related to ongoing La Niña in the Pacific ocean and continued warm sea surface temperatures in the tropical north Atlantic. The drought has also been exacerbated by increasing average temperatures due to climate change. Warmer temperatures increase evaporation and reduce soil moisture, which increases flammability. Droughts like this will place increasing pressure on remaining forests, particularly in the southern Amazon.

Forest fire risk

Comparing areas of high fuel load with a drought index identifies areas at the highest risk of escaped forest fires this year. Municipalities in the southern and central Amazon are extremely high risk, particularly northwestern portions of Mato Grosso, much of Rondonia, eastern Acre, and a long stretch of the trans-Amazon highway, which cuts through Para and other southern Amazon states. **Lábrea**, a municipality in the state of Amazonas (outlined in bold on the map), is both high in fuel and experiencing extreme drought, a high-risk combination that could worsen as the burning season progresses.

The top 10 municipalities experiencing drought or extreme drought conditions currently hold 283 square kilometers of unburned, deforested area (i.e. fuel). These municipalities also hold large swaths of remaining forest that could be destroyed if fires burn uncontrolled, and should be prioritized for fire prevention efforts.

Overall, more than one third (35.5%) of available fuel is concentrated in just 10 municipalities. Though not all of these municipalities are experiencing drought, areas with high fuel loads should be watched closely, regardless. Any fires set to burn downed trees pose a threat to neighboring forests, even in non-drought conditions.

IN THE NEWS

This outlook, released by Woodwell and IPAM, was covered by major Brazilian outlets, including Globo.com and CNN Brazil. The analysis highlighted municipalities where accumulated fuel and drought conditions combine to produce high fire risk.

Woodwell partners with EDF to assess and improve soil carbon markets

Review of credit protocols finds inconsistencies with measurement, reporting, and verification of net climate impact



Soils store at least three times as much carbon as all trees on Earth, but thousands of years of agriculture have degraded soils and released immense quantities of carbon. Restoring carbon in soils presents a major opportunity for mitigating climate change, and the growing realization of this fact has led to an explosion of interest in soil carbon markets that would pay farmers and landowners for carbon capture and storage. Due to the difficulty of measuring soil carbon, credits for soil carbon sequestration currently lack comparability and consistency, which creates uncertainty in soil carbon markets. Efforts are underway, however, to improve the quality of credits and help realize the full greenhouse gas mitigation potential of agricultural soils.

In a new report—*Agricultural Soil Carbon Credits: Making sense of protocols for carbon sequestration and net greenhouse gas removals*—Environmental Defense Fund and Woodwell Climate Research Center reviewed the 12 published protocols used to generate soil carbon credits through carbon sequestration in croplands. The protocols take different approaches to measuring, reporting and verifying net climate impacts, and to managing the vital issues of additionality, reversal and permanence. The result is a confusing credit marketplace where it is difficult to compare credits or guarantee climate benefits have been achieved.

“As addressing climate change becomes ever more urgent, we’re seeing a gold rush of investment in soil carbon credits. The stakes for the climate and farmers are extraordinarily high,” said Dr. Emily Oldfield, lead report author and agricultural soil carbon scientist at EDF. “Agricultural soils could remove 4-6% of annual U.S. emissions. We need credible, consistent and cost-effective measurement and verification to know with confidence that soil carbon credits are moving us toward that target.”

Soil carbon remains difficult to monitor for a variety of reasons. Scientists don’t yet have a clear understanding about how on-farm conservation practices like planting cover crops and reducing tillage influence both the amount and longevity of new carbon sequestration. Detecting soil carbon changes over time requires a

high number of samples, which are costly to collect and analyze, and may need to be collected from different soil depths depending on soil type and conservation practices used.

“There are exciting new research efforts and technological developments underway that will greatly reduce the cost of verifying soil carbon credits,” said Dr. Jonathan Sanderman, contributing report author and associate scientist at Woodwell Climate Research Center. “Increasing accuracy at scale, while still being able to pass on most of the value of a carbon credit to the farmer is critical to ensuring functioning carbon markets.”

Public and private sector efforts are underway to improve measurement technologies and methods and to set unified standards for high-quality agricultural carbon credits.

This report underscores the need for guidelines for high-quality soil carbon credits that accurately represent carbon sequestration and net greenhouse gas removals.

“Guidelines for soil carbon credits will be crucial for ensuring business investments generate real and durable climate benefits,” said Katie Anderson, senior manager for EDF+Business. “In the interim, businesses need to reduce emissions at the pace and scale that the science demands.”

Agricultural soils can contribute meaningfully to climate mitigation and resilience efforts. Once guidelines and standardization between protocols are in place, the enthusiasm for soil carbon credits can be channeled productively toward slowing the rate of climate change and adapting to impacts that are already here.

IN THE NEWS

EDF & Woodwell’s soil carbon markets assessment was reported on in *Politico*.

Read the EDF-Woodwell report at: <https://bit.ly/soil-carbon-credits>



US communities ‘LEARN’ the carbon value of their trees

A new data analysis tool helps cities and counties realize the potential of a powerful natural climate solution

by Sarah Ruiz
Science Writer

Every living tree—whether it’s part of a forest, lining a golf course or subdivision, or growing in a tree-well on a city sidewalk—removes carbon from the atmosphere. But, in counties and cities across the United States, the amount and value of these carbon removals are rarely accounted for in greenhouse gas inventories. A partnership between Woodwell Climate Research Center, Local Governments for Sustainability (ICLEI), and the World Resources Institute (WRI), is working to change that.

Forests and trees in the U.S. offset 13 percent of emissions from other sectors annually. Changes to land management practices could bring that number up to 21 percent—a big step towards reaching both local and national emissions reduction goals. But capitalizing on the full potential of trees for climate mitigation requires a thorough knowledge of how much carbon trees are sequestering now, as well as their

potential for future sequestration, in any given location.

That’s the expertise that Woodwell Senior Scientist, Dr. Richard Birdsey, brought to the table. Dr. Birdsey, alongside a team of researchers at WRI, developed a method for calculating carbon emissions on a local scale by combining emission and removal factors—estimates of carbon associated with activities like harvesting or regrowth—for different regions across the U.S., with remote sensing data on tree cover, land use change, and disturbances such as wildfire. Where the data showed undisturbed or re-growing forests and trees, the calculations recorded carbon uptake; where the data showed clearing for development, farmland, or harvest, they recorded emissions.

Automating the analysis

In 2019, the methodology was piloted in three U.S. communities representing a breadth of landscapes—from rural,

forested Whatcom county in Washington state, to suburban Montgomery County, Maryland, to the urban center of Los Angeles, California. That first year, Dr. Birdsey and the team did most of the calculations using spreadsheets, refining the process. But in order to make the data impactful and widely available, the approach would have to be scaled up to hundreds of cities and counties across the country. And for that, communities would need to be self-sufficient in tallying emissions.

That's where the Land Emissions and Removals Navigator (LEARN) tool came in. Developed for the project, the LEARN tool compiled the methods, maps, and the underlying land use data onto an interactive map. To calculate emissions and removals from trees, a user only has to select an area, a time frame between 2001 and 2016, and a nearby urban area with comparable emissions factors, and the tool will spit out the inventory data. They can then download a detailed report that further breaks down the data for use in local climate mitigation strategies.

The development of the LEARN tool significantly sped up the process of analysis. In 2020, with the help of ICLEI, the project was expanded to include more than 20 communities across the U.S. Yael Kisel, Analytics Lead for Climate Smart San José in California, says that without LEARN, she probably wouldn't have had the capacity to include trees in the city's 2019 inventory at all.

"I'm the main person doing all the data work for Climate Smart San José. So getting a tool that cuts down the amount of time that it takes to get a good estimate of what we have is extremely valuable," Kisel says.

Woodwell, WRI, and ICLEI hosted a series of trainings that walked communities through each step of the inventory process—from how to define forests, to how to access data and use the tool, to what to do with the report once they have it. Participants immersed themselves in the data and came away with, not

only baseline numbers, but a deepened understanding of how trees were playing a role in their communities. For Kisel, one of the main surprises was that removals from trees and forests were both larger and smaller than expected.

"The number itself is sizable, but also very small compared to our total emissions," Kisel says. "For cities like San José, we are never going to be able to plant enough trees to balance out those emissions. But if we get closer to zero, then they can take us that last little bit of the way."

For some, like Douglas Weisburger, a Senior Planning Specialist with Montgomery County's Department of Environmental Protection, simply having numbers to show at the end of the process was eye-opening.

"Having just that baseline data, it created this heightened awareness of the potential for natural solutions," Weisburger said. In Montgomery County, forests and trees offset 6 percent of emissions from other sectors. Weisburger said his team is now considering future possibilities to get that number up even further—from regenerative agriculture strategies, to easements to preserve forests on private land. "It's blowing up our world in a very positive way, to be thinking about exciting new opportunities."

Community action adds up

Beyond introducing communities to the LEARN tool, the trainings also introduced communities to each other as additional resources. Cindy Jayne, Chair of the Climate Action Committee for Jefferson County, Washington, found a good point of comparison in neighboring Whatcom county, which had similar forest cover. Rebecca Longvall, Conservation Agent for the town of Bolton, Massachusetts, was already working in collaboration with two neighboring municipalities, but said the wider cross-pollination of ideas helped to broaden her perspective.

"Overall it definitely helped us go across borders, for not only our three towns, but

also talking to and hearing from other communities that also used this tool," Longvall says. "It helps us understand how it all ties together at the landscape scale and then how carbon sequestration overall is impacted."

That collaborative community approach, Dr. Birdsey says, is what the LEARN project was hoping to accomplish. Although climate change is a global issue, Birdsey says starting to tackle it on the local level is an effective way to jumpstart action.

Having just that baseline data... It's blowing up our world in a very positive way, to be thinking about exciting new opportunities.

Douglas Weisburger
Senior Planning Specialist,
Montgomery County Department of
Environmental Protection

"Communities are where the action takes place with respect to land management," Dr. Birdsey says. "So if the action is being done there, talking and working with people at that level is a fruitful way to go."

Dr. Birdsey also says now is a great time for this work to accelerate. With a new federal administration more focused on climate and sustainability, more funding streams will be open to cities and counties with ambitious plans backed by data.

"A tool like this can support a community either for identifying what they could do, what the benefits might be, or they could use it to apply for funding. [This] gives them ammunition to argue for what they want."

Funding for this project was provided by the Climate and Land Use Alliance and Doris Duke Charitable Foundation.

High-resolution maps reveal the tenuous state of the Arctic carbon sink

Boreal remains a powerful biome for carbon sequestration

by Sarah Ruiz
Science Writer

When Dr. Anna Virkkala looked at the literature on carbon fluxes in the Arctic-Boreal zone, she noticed something was missing: maps. Namely, high resolution maps that could detail where and how much carbon dioxide (CO₂) is flowing in and out of these vital high-latitude ecosystems.

To fill this gap, Dr. Virkkala and colleagues from Woodwell joined forces with researchers from 42 other institutions in a massive community effort to pool data and analyze the patterns. The resulting paper, recently published in *Global Change Biology*, synthesizes the latest available terrestrial CO₂ flux data—combining field measurements from nearly 150 sites with five statistical and machine learning techniques to map the balance of CO₂ release and uptake for the entire region.

Mapping CO₂ flux in high resolution

In ecosystems, flux measurements involve two component processes—gross primary productivity (i.e., photosynthesis) which draws carbon out of the atmosphere, and ecosystem respiration, which releases it back. The balance between them is the net ecosystem exchange.

In the field, researchers measure exchange using either towers or chambers placed over vegetation and fitted with carbon dioxide sensors. Tower sensors detect the concentration of CO₂ in the air, and combine that with vertical air movements to estimate the overall flux. Chamber sensors estimate flux by recording the change in CO₂

concentrations while the chamber is closed.

These measurements formed the base of the new synthesis. Each data point acted as a touchstone to train the models Dr. Virkkala and her colleagues were using in a process called upscaling. Combining field data with high-resolution, satellite-derived data on environmental conditions, like topography and land cover, the models were able to extrapolate CO₂ flux for a large area without obscuring variation across the landscape.

“[Upscaling] is incredibly important,” Dr. Virkkala says. “Previous studies have synthesized fluxes and calculated budgets by averaging across sites. While those compilations provide valuable insights, they do not account for how representative the data are, or how expansive certain environmental conditions are across the high latitudes.”

The more field sites included in the upscaling, the better the model will typically be at accurately estimating flux. The new synthesis is uniquely detailed, built upon field observations from 148 sites across the Arctic-Boreal region, including some in the more remote reaches of Northern Canada. It also averages the outputs across five separate statistical models, reducing uncertainties surrounding the estimates.

“There are different kinds of uncertainties associated with different models. By taking an average across several models, one can decrease the uncertainty associated with individual models alone,” Dr. Virkkala says.

Employing these methods, Dr. Virkkala and her colleagues were able to predict Arctic and boreal CO₂ fluxes for every year between 1990 and 2015 at 1 km spatial resolution.

Ancient carbon is potentially being released as the region thaws

The results show that, on average, the Arctic and boreal biomes have functioned as terrestrial CO₂ sinks over this time period, and that sink is stronger in the southern latitudes—an expected outcome given the large swaths of boreal forest. According to Dr. Brendan Rogers, Associate Scientist at Woodwell and co-author on the paper, boreal forests form about one third of all forests, but they harbor nearly two thirds of global forest carbon, most of it locked in soil and permafrost.

“The reason boreal forests and Arctic tundra contain so much carbon in the soil and the permafrost is because the region has been so cold for thousands and thousands of years. Decomposition is slow. On average these systems have been photosynthesizing more than they’ve been respiring,” Dr. Rogers says.

The more surprising finding was the fact that some large areas, particularly in Northern Alaska and Canada, were becoming sources of emissions. According to Dr. Rogers, these regions hold carbon that hasn’t re-entered the atmosphere in centuries or even millennia, so the fact some of them are sources should raise concern.

“You can look at the soil profile and see ‘this carbon was sequestered 100

years ago, 200 years ago, etc.'. So the fact that our modeling has some of the regions being a source is somewhat disconcerting," Dr. Rogers says.

The future of the Arctic-boreal carbon sink

According to Dr. Rogers, rising temperatures will increase the rates of both primary productivity and respiration, but not evenly. While productivity will likely plateau due to environmental limitations, respiration doesn't have a strong upper limit, and may continue to increase exponentially so long as there is still carbon left to release. Predicting what the future of Arctic and boreal carbon will look like is highly uncertain, but Woodwell's researchers and their collaborators are building upon this synthesis to try to bridge this gap.

There are some elements to the synthesis that Drs. Virkkala, Rogers and their collaborators hope to improve on in future iterations. These calculations, for example, don't factor in disturbances like fire or harvest which could affect the balance in boreal forests. Improving the geographic spread of field measurements, too, could help deepen our understanding of regional dynamics.

"There are not that many sites from Canada or Russia. There are big regions where we have a poor understanding of carbon fluxes. We can only extrapolate from the data we have," Dr. Virkkala says.

Drs. Rogers, Virkkala, and others from Woodwell are currently fundraising to build more CO₂ towers in these underrepresented regions. Woodwell

scientists are also working towards a better network for methane fluxes, given its potency as a greenhouse gas, as well as leveraging different types of carbon models to reduce uncertainties. For Dr. Rogers, it's important we study the way things are changing now, because the nascent results picked out by this study might suggest more changes to come.

"Sometime in the future—could be years, decades, or centuries—the emissions from decomposing soil and permafrost thaw will start to overwhelm the sink," Dr. Rogers says. "Just because the region is a sink now, doesn't mean it's going to be a sink forever. And society will be much better off if we can predict and monitor these changes rather than realizing them after the fact – when it's too late to change course."

In the news: highlights

Top publications have called on Woodwell's climate change expertise to explain the extreme weather events of the past month—from the flooding in Europe, to the fires in western North America. Some highlights include:

Dr. Jen Francis has been quoted in two widely syndicated *AP* explainers:

"Numbers explain how and why West bakes, burns and dries out"

"Summer swelter trend: West gets hotter days, East hot nights"

Two stories in the *The New York Times*:

"Flooding Recedes in Europe, but Death Toll Rises and Questions Mount"

"'It Is All Connected': Extreme Weather in the Age of Climate Change"

A front page *Boston Globe* story:

"Welcome to the Climate Apocalypse. (It will get worse.)"

She's also quoted in *Miami Herald*, *Bloomberg*, and *PBS News Hour*, and wrote an invited op-ed for *The Hill*.

Dr. Phil Duffy was quoted in *The Daily Beast* (picked up by MSN and multiple *Yahoo! News* channels) and *Axios'* daily *Generate* newsletter, and was a guest on *Cheddar News*.

Other media coverage

Dr. Sue Natali explained some basic permafrost science for an *Inverse* story about a new Amazon action film, *The Tomorrow War*.

Senior Arctic Policy Fellow Rafe Pomerance was quoted in *Yahoo! News'* analysis of Chancellor Angela Merkel's climate policy.

SUMMER EVENT SERIES (IN PERSON)

Creating a climate for change through art & science

Explore the synergies between art and science for breaking through barriers, inspiring change, and stimulating action. On August 25, Woodwell Climate's lead cartographer **Greg Fiske** will discuss how maps tell stories and shape our worldview. And the series wraps up on September 8 with a conversation between Woodwell Artist in Residence **Justin Brice** and oceanographer Dr. Konrad Huguen, moderated by Woodwell's **Dr. Heather Goldstone**.

This in-person event series is presented by Highfield Hall & Gardens in collaboration with the Marine Biological Laboratory, Woods Hole Oceanographic Institution, and Woodwell Climate Research Center, and sponsored by the Woods Hole Foundation and the Brabson Library and Educational Foundation.

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cover: View of forests in Jefferson County, Washington from Colonel Bob Peak. / photo by Cindy Jayne

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