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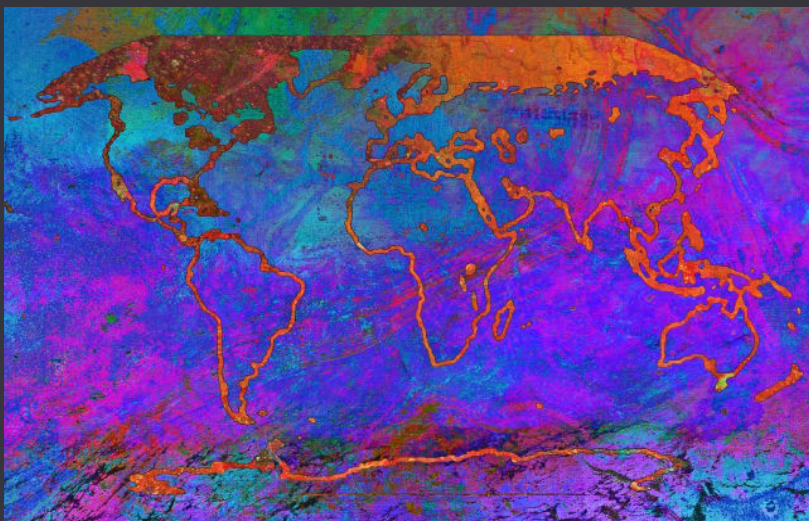
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Takeaways from the latest IPCC report

AR6 is a resounding affirmation of what has become increasingly clear not only with each new study but through everyday experience.

by Dr. Philip Duffy

President and Executive Director



On August 9, the IPCC released the first volume of its latest climate science assessment report (AR6). It is a resounding affirmation of what has become increasingly clear not only with each new study but through everyday experience: our efforts to date have not been nearly enough to alter the disastrous trajectory that rising greenhouse gas emissions have put us on—one of rapid warming, worsening ecological disruption, and increasingly frequent and severe extreme weather events that threaten the health, safety, and well-being of people around the globe.

These reports present no new research. Rather, they are massive syntheses of the ever-growing body of climate science. And, thus, their findings should come as no surprise. Even so, they are important indicators of where we are in understanding and addressing the climate crisis, and there are four aspects of this report that are particularly salient to our work at Woodwell Climate Research Center:

- In a departure from previous IPCC reports, this one notes the importance of considering the full range of climate risks, “including low-likelihood, high impact outcomes,” in decision-making. This, of course, is fully in line with the work of Woodwell’s Risk Program, whether assessing risks to the global economy or helping under-resourced communities plan for greater resiliency.
- Greenhouse gas emissions from permafrost thaw, are not fully taken into account in this report, but at least the issue is explicitly acknowledged. This also represents an improvement over previous IPCC reports, which were based upon models which omitted entirely this potentially important source of emissions. Understanding these emissions and including them in models, carbon budgets, and climate policy discussions generally is an important focus of Woodwell’s Arctic Program.
- All of the scenarios considered in this report show global warming exceeding 1.5°C by roughly 2030 and highlight

the importance of large-scale removal of CO₂ from the atmosphere for keeping that exceedance minimal and temporary. Woodwell’s work on natural climate solutions focuses on the best means we have at present for achieving the needed level of CO₂ removal.

- However, the report notes with high confidence that land and ocean ecosystems’ are expected to become less effective at absorbing emissions at higher levels of CO₂. Our own work has pointed in this sobering direction, which makes it even more important to prioritize forest protection now over reforestation at some future date.

The good news is that as science illuminates the problem, it also points to solutions. And today, as we also observe the UN’s International Day of the World’s Indigenous Peoples, it is appropriate that we recognize the important role that Indigenous communities around the globe play in protecting the forests that protect our climate. Two new analyses involving Woodwell Climate scientists show that Indigenous territories in Brazil experience far less carbon loss from deforestation and forest degradation than other lands, adding to the evidence that strengthening Indigenous land rights is both a just social policy and an effective climate policy.

Of course, this is just one piece of the puzzle. Decision-makers at all levels and across all sectors must take bold action to advance rapid decarbonization, preserve essential ecosystems, and foster resilience in the face of inevitable impacts. At Woodwell Climate Research Center, we’re working with Indigenous leaders and business leaders, local officials and national policymakers, to generate scientific insights that drive the changes our situation demands.

Thank you, as always, for your support and interest in this important work.

READ

The Sixth Assessment Report can be found at:
ipcc.ch/report/sixth-assessment-report-working-group-i

Carbon dioxide loss outpaces uptake in many regions of Alaska and Northwest Canada

by Sarah Ruiz
Science Writer

A new paper from Woodwell scientists and 24 collaborating organizations confirms that soil respiration is overpowering carbon uptake in many permafrost landscapes, especially in tundra and recently burned forests. The study, recently published in *Environmental Research Letters*, adds new year-round data on carbon dioxide (CO₂) fluxes from soil respiration in Alaska and Northwest Canada to a growing body of work suggesting that the Arctic-boreal zone may be reaching a critical tipping point.

For this study, researchers deployed 10 new soil respiration stations, specially designed for Woodwell in partnership with Dr. Dave Risk at Flux Lab Canada. The stations use small chambers

Carbon is released from soils as organic matter gets broken down by microscopic organisms. In permafrost environments, this process of respiration is restricted in the winter when soils freeze. However, the data collected by Dr. Watts, along with Woodwell Arctic Program Director, Dr. Sue Natali, and their team showed respiration continued through the winter at a rate that could substantially impact the net carbon balance of the Arctic-boreal region.

“We’re losing a lot of CO₂ in winter because soils aren’t staying frozen as long,” Dr. Watts says. “Where there’s unfrozen water in the soil, microbes are hard at work. They produce CO₂ when they consume stored soil carbon, and that CO₂ is released into the atmosphere. This is something that we really need to keep an eye on because it could escalate climate warming.”

Dr. Watts and her team were able to calculate a carbon budget for the region based on their data and the best available datasets on carbon uptake. In some areas of the landscape, soil respiration was releasing more carbon than growing vegetation could absorb in a year. Meaning that some areas of permafrost—having stored carbon for a very long time—are now becoming overall sources of emissions.

“We found that in many tundra regions, and in boreal landscapes recently impacted by fire, ecosystem carbon loss—combined soil and aboveground respiration—is offsetting most or all of annual vegetation carbon uptake,” Watts said.

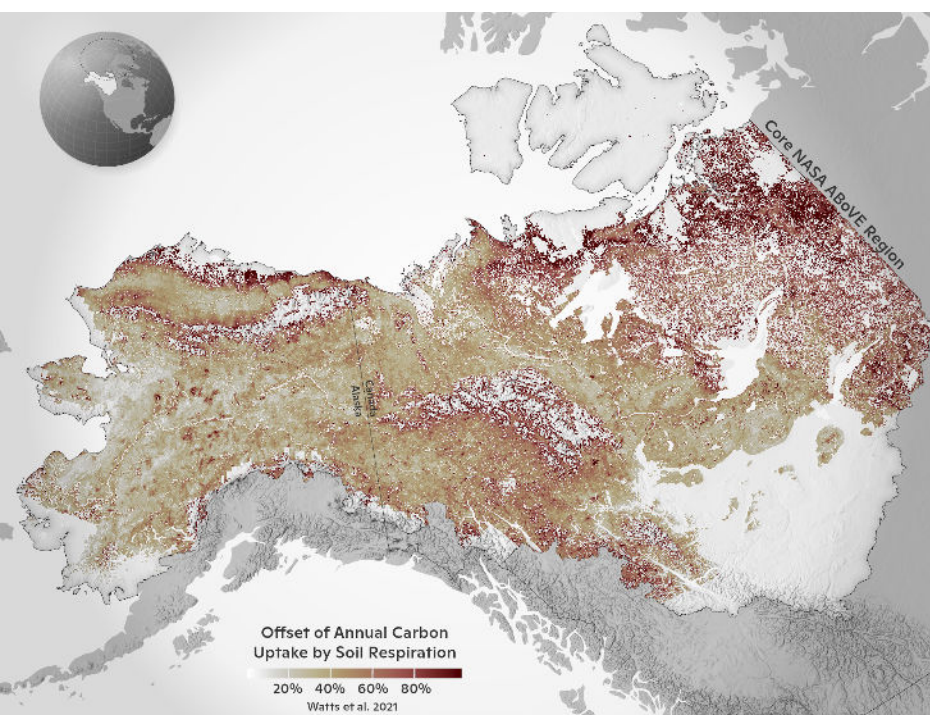
Faster warming in the winter in particular, threatens the carbon balance in the region.

According to Dr. Natali, “Arctic winters are warming faster than the summer season. This is a period when plant uptake of carbon has ceased,

yet release of carbon by microbes continues. These emissions will likely increase as the winters continue to warm.”

For Dr. Watts, these findings underscore the need for continued carbon monitoring in the Arctic-boreal zone.

“We urgently need more investment in monitoring stations across Arctic and boreal regions to better understand what’s happening now,” Watts says. “If we don’t know what’s happening today, it’s really difficult for us to predict the future.”



placed on the soil surface to measure the transfer of CO₂ emitted from the soil. According to Dr. Jennifer Watts, Assistant Scientist at Woodwell Climate Research Center and lead author on the paper, these soil respiration stations represent a crucial technological advancement for carbon monitoring because of their relatively low cost and low energy requirements.

“The soil respiration stations are crucial to helping us better understand CO₂ loss from soils under warming climate conditions, because they are operating year-round in remote environments, providing us with data that we really didn’t have before,” Dr. Watts said.



Riparian forests stand guard over Amazonian streams

by Sarah Ruiz
Science Writer

In the remote headwaters of the Amazon, a small strip of forest—just 30 meters wide on either side of a stream—slices through a vast agricultural field. Although tiny, this forest stands as an important guardian of the health and biodiversity of the Amazon Rainforest.

In many places, riparian forests along the edges of streams and rivers are the last remaining forests on a landscape largely converted to agriculture. Brazil's forest code requires a permanent protection area be left on the banks of waterways to buffer the effects of land use change on downstream ecosystems. But how effective are such small slivers of forest in the face of widespread landscape change? A trio of papers from Woodwell's Tanguro Ranch research station in Mato Grosso, Brazil shows that even small forests can

have big impacts on biodiversity and nutrient transfer.

Maintaining the ecosystem highway

Rivers act as highways through the forest, carrying species, nutrients and organic matter across the landscape. Trees play an important role in regulating those roadways, both drawing up water and nutrients and depositing organic matter in the form of leaves, seeds, and fruit. Clear the forest, and the traffic patterns for those nutrients will change.

Dr. KathiJo Jankowski, a research ecologist at the United States Geological Service, conducted research with Woodwell on the question of whether maintaining riparian buffers successfully mitigated that change.

“Are streams now processing terrestrial materials differently? Are they processing carbon differently? And are they processing nutrients differently?” Dr. Jankowski asks. “We are interested in these questions, both in terms of how they affect stream food webs, and how they affect downstream ecosystems.”

She waded through the streams at Tanguro Ranch, collecting data—dissolved oxygen levels, leaf litter, temperature measurements—to answer these questions. When she compared data from agricultural streams with riparian buffers to intact forests, she found only subtle shifts in basic ecosystem functions. As long as those buffer forests remained, the streams mostly continued to flow as they always had.

“It provides good evidence that they are doing their job,” Dr. Jankowski said. “It highlights the importance of protecting those buffers because they are constantly under threat from people wanting to develop the land or simply not wanting to restore buffers that have been illegally removed.”

Preserving aquatic and terrestrial diversity

One difference Dr. Jankowski did observe, however, was in the amount of leaf litter present in the streams. Less overall vegetation on the landscape led to less organic matter in agricultural streams, a small change that can impact the wider food web.

Ecologist and researcher from the University of Brasília, Dr. Nubia Marques was conducting complementary research around the same time as Dr. Jankowski, but her research focused on the animals that rely upon the ecosystem functions Dr. Jankowski was studying. Tiny macroinvertebrates—crustaceans or insects that feed on stream organic matter—are found in most aquatic ecosystems, and their presence can indicate the overall health of a system.

According to Dr. Marques, degradation of riparian forests tends to simplify macroinvertebrate communities. Changes

to available food resources impact species that rely on specific food more strongly than generalist species. Three taxonomic orders, Ephemeroptera, Plecoptera and Trichoptera (EPT) which include species like mayflies, stoneflies, and caddisflies, are particularly sensitive to disturbances.

“Many macroinvertebrates in the EPT orders cannot survive in sites of intense disturbance, so their absence may indicate that the health of the stream is not doing well when compared to similar streams that have not been disturbed at all,” Dr. Marques says.

Dr. Marques examined overall species composition, as well as functional composition (the presence of different feeding groups) across forested and agricultural streams. Streams with buffers tended to have greater overall diversity and slightly higher abundance of EPT species than those without, though watershed-level clearing did cause drops in EPT species with or without buffers.



Because macroinvertebrates form the base of the food web, changes in their abundance have the potential to ripple upwards to the species communities that feed on them.

Beyond preserving biodiversity inside the streams, riparian forests are also

important habitat for terrestrial rainforest species. Biologist at the State University of Mato Grosso and researcher at the Amazon Environmental Research Institute, Dr. Leonardo Maracahipes-Santos conducted detailed inventories of the size and species of trees, shrubs and vines in each of the transects to understand how the riparian forests themselves differed between intact and agricultural watersheds.

“There are some visible differences, that if you know the species you can see right away,” Dr. Maracahipes-Santos says. “One difference I noted was that in the agricultural riparian forest you tend to see more gaps. Also there are some species along the edges that are known to be pioneer species, they signal some level of degradation or turnover.”

His analysis confirmed his observations. Riparian forests tended to differ most from the composition of intact forests at the edges, where niches had been

opened for species that normally don’t occur in dense forest. Also, as seen with the critters in Marques’s study, some plant species were just not as resilient to disturbance and disappeared completely from agricultural landscapes.

Dr. Maracahipes-Santos’ work shows that, for all these little forests do, they themselves are vulnerable to the effects

of fragmentation. Though the law establishes a minimum width for riparian forests, the amount of forest considered functionally intact may be much smaller, highlighting the need for wider buffers with softer edges leading into agricultural fields.

Protecting the headwaters protects the landscape

The three studies together also revealed landscape-scale changes took place in streams despite the presence of buffers. Dr. Jankowski found agricultural streams tended to be warmer on average and

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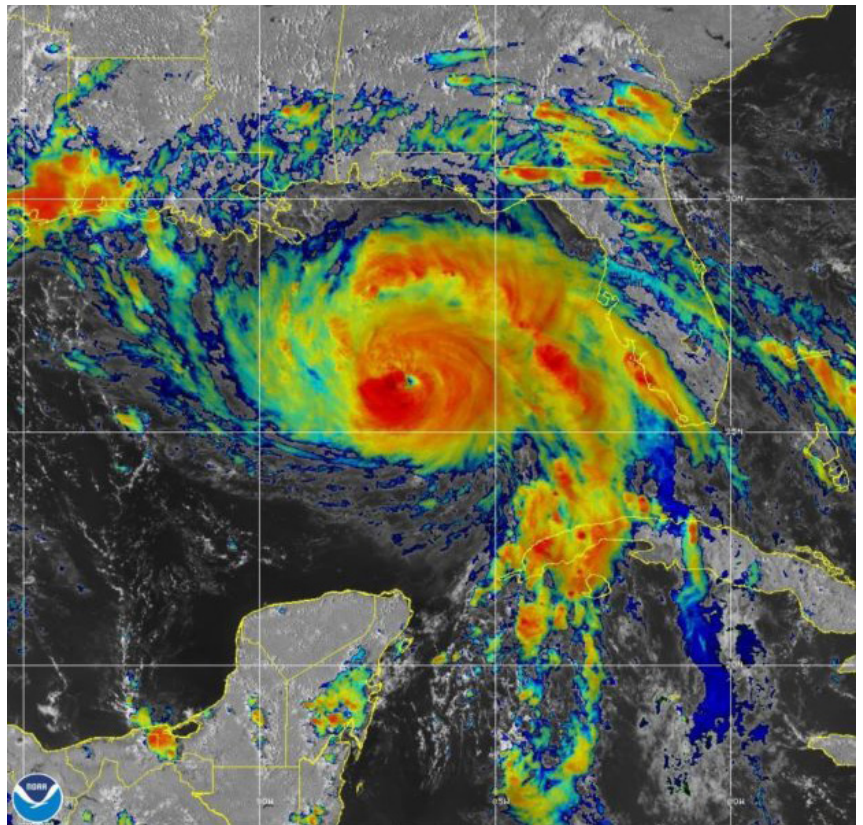
received more sunlight due to increased gaps in the canopy. With fewer trees to draw up water, stream levels were higher in agricultural landscapes as well. This tracks with Dr. Maracahipes-Santos’ findings—species sensitive to soggy soil were harder to find in the riparian buffers on agricultural land.

Dr. Jankowski’s experiment also introduced nitrogen and phosphorus into the stream systems, mimicking a fertilizer runoff event, to track how far the nutrients would flow. Tanguro is situated at the headwaters of the Xingu River, a major tributary of the Amazon, which means that anything added to the watershed here has the potential to affect the larger system downstream. Dr. Jankowski found that nitrogen traveled far downstream regardless of buffers. Multiply the effects of one nitrogen plume across the thousands of headwater streams in the Amazon watershed, and the impacts could potentially extend all the way to the Atlantic.

Despite this, riparian forests remain an important line of defense against pollutants and biodiversity loss. They will play a growing role in linking and protecting the Amazonian watershed as agricultural clearing continues. To play this part successfully, they will need support and protection of their own.

'Summer of extremes' briefing helps meteorologists connect extreme weather events to climate change

by Sarah Ruiz
Science Writer



The summer of 2021 has been a summer of extremes. Catastrophic wildfires, drought, flooding and deadly heat waves are all signals of a warming climate, but the nature of that connection is often not well understood by the public. To help deepen understanding of the links between extreme weather and climate change, Woodwell hosted a briefing last week for a group that is always thinking about the weather: meteorologists.

The briefing was led by meteorologist Chris Gloninger of KCCI 8 Des Moines, who moderated a Q and A with Woodwell senior scientist Dr. Jennifer Francis and Assistant Scientist Dr. Zach Zobel. Dr. Francis and Dr. Zobel provided attendees with insight into how weather events, like the recent hurricanes Henri and Ida or flash flooding in Tennessee for example, are exacerbated by climate change.

Meteorologists, tasked with preparing local communities for changes in the weather, are uniquely positioned to communicate the role of climate change in weather patterns to a broad public

audience. According to Dr. Francis, meteorologists are “often the only scientists that people come into contact with.” Which means they have a valuable opportunity to shape people’s perception of weather events as a consequence of climate change.

For Dr. Zobel, a meteorologist by training himself, one of the best ways to make those connections is by highlighting the specific elements of extreme events that the science shows are clearly linked to warming.

“Rather than focus on the storm itself, focusing on the features within the storm that climate models and observations show are clearly going to increase,” Dr. Zobel said. He cited the all time record for the amount of rainfall in one hour in New York that was broken during Henri. Heavy bursts of precipitation are likely to become more common with climate change, as a warmer atmosphere can hold more water vapor.

Meteorologists joined the briefing from across the United States, and

were interested in the best ways to communicate climate science across diverse audiences, some of which might not be familiar with or accepting of climate science. Dr. Francis used the example of farmers in the Midwest who have reported more persistent weather conditions—longer droughts or storms—affecting their crops.

“If we can take that and link it back to how we think climate change is starting to cause more persistent weather patterns, that is something we can talk to them about that is really affecting how they do their business, how they live their lives, and is certainly something they are seeing every day,” Dr. Francis said.

Dr. Zobel also emphasized the need to communicate climate change in terms of personalized, individual impacts.

“Until we are able to do that, climate change may seem like a distant, far away problem,” Dr. Zobel said. “Once people see it’s affecting them locally they tend to re-evaluate.”

In the news: highlights

Dr. Phil Duffy is co-author on an update to the 2019 climate emergency declaration paper which was covered extensively. Phil was quoted in more than 300 news reports, including by *Der Spiegel*, *Deutsche Welle*, *Sapo*, *Common Dreams*, and *SciTechDaily*.

A joint IPAM-Woodwell expedition with a provincial fire-fighting team has prompted high-profile coverage involving Dr. Ané Alencar, Dr. Ludmila Rattis, and Dr. Manoela Machado:

"Expedição por Mato Grosso quer encontrar soluções para o controle mais eficiente de incêndios e queimadas"

"Brazil Amazon deforestation reaches 10,000 sq km"

"Droughts, fires show LatAm climate change impact"

"Queimada no Pantanal destrói quase mil hectares em dois dias, diz instituto"

Dr. Foster Brown's air quality monitoring network has featured in coverage of the intersecting impacts of wildfire smoke and COVID-19 in Acre province:

"Fumaça das queimadas agrava Covid-19 na Amazônia"

"In Brazil's Acre, smoke from fires threatens health, could worsen COVID-19"

"A bad fire year predicted in Brazil's Acre state. What's to be done?"

Dr. Jen Francis was quoted in a front-page *Boston Globe* article and a widely syndicated Phys.org piece on recent

climate extremes, a *National Geographic* article about possible climate change connections to hurricane Henri, a *Guardian* piece on the need for immediate action to reduce GHG emissions, and was a guest on NPR's *All Things Considered*.

Dr. Max Holmes was quoted by the *Washington Post*, commenting on the potential risk of newly discovered methane emissions from thawing Arctic limestone deposits. The story was picked up by *Clean Technica* and *Smithsonian*.

Also in the *Washington Post*, Dr. Jen Francis pushed back on the idea that new modeling debunks her work linking Arctic amplification and extreme weather.

Dr. Jennifer Watts was quoted in a *Scientific American* piece examining the question: "How Much Worse Will Thawing Arctic Permafrost Make Climate Change?"

Dr. Jon Sanderma features prominently in a *Quanta Magazine* deep dive into paradigm shifts, debates, and open questions in soil carbon science, and that story was picked up by *The Atlantic*.

Politico ran an exclusive on a new analysis of soil carbon credit protocols released this month in collaboration with EDF.

Dr. Heather Goldstone participated in an environmental news roundtable on WGBH's *Under the Radar with Callie Crossley*.



KANEB VIRTUAL SPEAKER SERIES

Beyond 1.5

As the latest IPCC report made abundantly clear, human activities to date have kicked off unprecedented global warming and committed us to hitting or passing the 1.5° mark early next decade. We must now courageously confront what lies **Beyond 1.5°C**—the risks and choices that we face as we shape our climate future. Our fall event series invites you to do just that, guided by experts and thought leaders from across Woodwell's global network. Registration coming soon.

LEARN MORE AT:
WOODWELLCLIMATE.ORG/BEYOND1.5

SEPTEMBER 22

Internalizing risk: What 1.5°C (and beyond) looks like

OCTOBER 6

Tipping points: Is there a point of no return?

OCTOBER 20

Going negative: How much carbon can we capture?

NOVEMBER 3

Just in case: What do we need to know about geoengineering?

NOVEMBER 17

Seeing the future: What do success and failure look like?

cover: A strip of riparian forest runs through an agricultural field in Brazil. / photo by Christopher Neill

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