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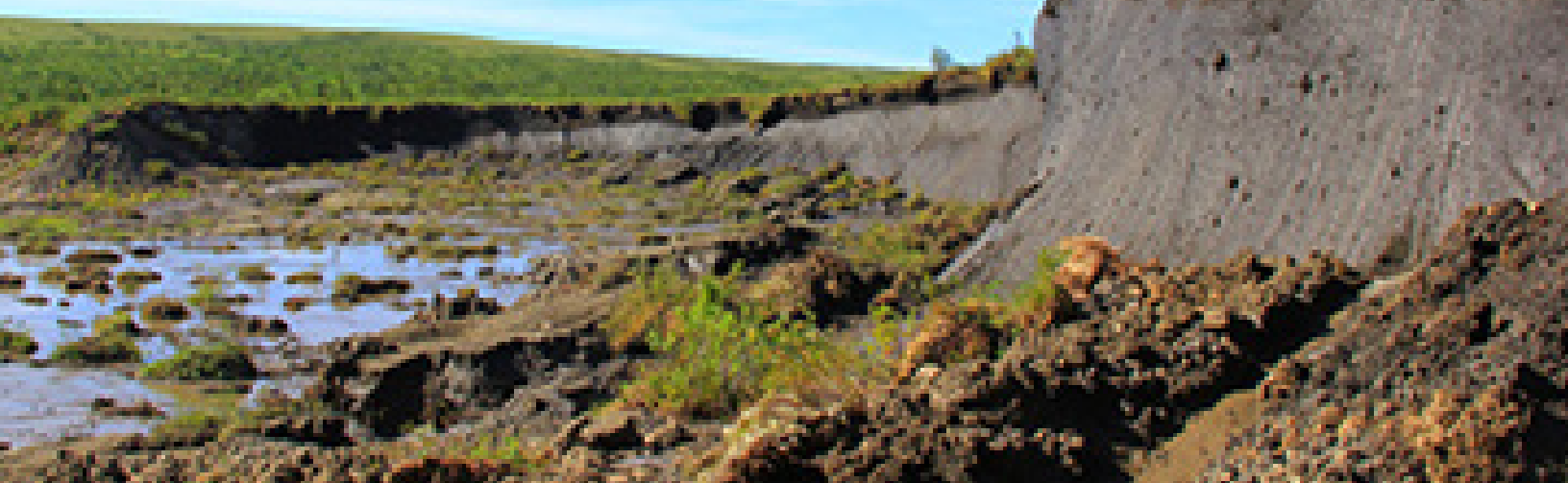
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Notes from the Field

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Permafrost carbon threatens global climate goals

Arctic feedback loops aren't being adequately considered in emissions targets



Since it was first signed more than five years ago, the Paris Agreement has set the bar for the global effort to reduce greenhouse gas emissions, with more than 70 countries taking on ambitious Nationally Determined Contributions that exceed initial commitments laid out in the Agreement. Now, however, a new commentary co-authored by several Woodwell Climate experts and published in *Proceedings of the National Academy of Sciences (PNAS)*, urges global leaders to rethink emissions goals in light of the latest science on Arctic climate feedback loops which have not been included in climate models and could undermine efforts to limit warming.

“Arctic warming poses one of the greatest risks to our climate, yet it has not been adequately incorporated into existing climate projections and policies,” said Dr. Sue Natali, lead author and Director of Woodwell Climate’s Arctic Program. “To build effective policy to address the climate crisis, it is essential that we recognize the full scope of the problem.”

Over the past decade, rapid Arctic warming has resulted in record-breaking Siberian heatwaves, extreme northern wildfires—which release massive amounts of carbon into the atmosphere—the loss of Arctic sea ice, and an acceleration of permafrost thaw. Arctic permafrost, which has been accumulating and storing carbon for thousands of years, contains approximately twice the amount of carbon that is currently in the Earth’s atmosphere, and is releasing that carbon into the atmosphere as it thaws. Those emissions exacerbate warming, which triggers more thaw, potentially leading to an

exponential increase in emissions and warming in the coming years. This new paper shows current carbon budgets fail to account for these carbon emissions from permafrost, and the dangerous climate feedback loops they will set off.

“Based on what we already know about abrupt thaw and wildfire, these feedback loops are likely to substantially exacerbate the permafrost thaw feedback and resulting carbon emissions,” said Woodwell researcher and paper co-author Dr. Rachael Treharne. “Unless our models account for these anticipated effects, we’ll be missing a major piece of the carbon puzzle.”

In order to keep the earth’s temperature below 1.5° or 2°C, the paper recommends decision-makers incorporate the latest science on Arctic carbon emissions into climate models and carbon budgets used to inform policy, and update our risk assessments to determine how quickly we need to reduce emissions to meet our climate goals.

“The science alone is not enough,” said Dr. Philip Duffy, President and Executive director of the Woodwell Climate Research Center and commentary co-author. “We urgently need communication between scientific and policy communities to make sure our climate policies are effective in addressing the scale and scope of the climate crisis.”

The paper was co-authored by Woodwell Climate scientists Dr. Sue Natali, Dr. John Holdren, Dr. Brendan Rogers, Dr. Rachael Treharne, Dr. Philip Duffy, Rafe Pomerance, and Erin MacDonald.

New model predicts overwintering fires in Alaska and northwestern Canada

by Anabelle Johnston
Communications Intern

Extensive overwintering fires burning throughout the Arctic in summer 2020 garnered a great deal of media attention because of how they started—or more accurately, how they never died. Unlike the majority of boreal fires, these overwintering fires, sometimes referred to as ‘zombie’ fires, are never fully extinguished, and instead slowly smolder organic soils throughout the cold season before picking back up as temperatures rise in early spring.

While overwintering fires only recently made their way into the public eye, anecdotes about them have been cycling through the fire management community for years. Across the Arctic-boreal zone of Alaska, Northwestern Canada, and Siberia, fire managers have found smoldering blazes early in the spring season—indicating that the blazes continued to burn through the winter. However, lack of concrete data made this phenomenon difficult to understand, monitor, or predict.

A recent study published in *Nature*, co-authored by Woodwell Climate’s Dr. Brendan Rogers, investigated what drives these overwintering fires and used this information to develop an algorithm to map their occurrence in Northwest Canada and Alaska. The model, which focused on the perimeter of previous fires to mark areas most susceptible to sustained burn, was successful in confirming overwintering fires that had been flagged by fire managers, as well as identifying ones that smoldered hitherto unnoticed.

“These fires have been on our radar for a long time, but we didn’t have the data to understand them or estimate how prevalent they are,” explains Rogers. “Through our contacts in the fire management community, and particularly collaborators at the Alaska Fire Science Consortium, we were able to access reports of these overwintering fires and learn about what was happening on the ground. This line of communication became

key to understanding where these fires are occurring.”

In April 2021, the team will present their work to a group of fire managers in interior Alaska. Rogers is hopeful their analysis can be used operationally by fire managers in the region to better anticipate and extinguish early season overwintering fires in the coming years.

This is particularly pertinent given where overwintering fires occur. Although overwintering fires account for only a small fraction of overall burned area in boreal forests, they typically occur in regions with lots of carbon-rich soil litter and organic matter. As global temperatures rise and climate change intensifies, the frequency of overwintering fires is anticipated to increase, furthering carbon feedback loops, a vicious cycle of emissions and warming. Predicting and preparing for these ‘zombie’ fires will become an important tool in climate change mitigation, and the new model may be the first step in making this possible.



Above left: Permafrost slump in Alaska. / photo by Scott Zolkos

Above: Burned forest and burned black spruce. / photos by Rachael Treharne

Guiding principles for just, effective natural climate solutions

On the heels of the Biden Administration's Leaders Summit on Climate, Woodwell Climate Research Center has released a set of five science-based principles to guide the use of natural climate solutions to meet emissions targets associated with the Paris Climate Agreement and limit global warming to less than 2°C. The principles address how both public and private-sector decision-makers at the national and sub-national level can incorporate natural carbon capture and storage into climate plans while protecting the wellbeing of local communities and the many services derived from the land and waters of the U.S., especially biodiversity and food production.

Currently, land, inland waters, and coastal ecosystems remove about 30% of global carbon dioxide emissions each year, and have the potential to do even more. However, maximizing these ecosystems' capacity to mitigate climate change will require careful analysis of options for deployment over the next few decades, and monitoring of results that may be impacted by climate change.

"Natural climate solutions are an essential component of reaching net-zero greenhouse gas emissions," said Richard Birdsey, Woodwell Climate

Senior Scientist and paper co-author. "Realizing their full potential requires taking into account the many co-benefits of ecosystems as well as the possible unintended effects of these solutions."

The framework underlying these principles includes considerations of time, space, and community. The time dimension recognizes that natural climate solutions involve changes in ecosystems and ecosystem management that have impacts that span decades and centuries. The effectiveness of a particular climate solution will vary over these timeframes—some will be effective in the short term, and some in the long term as climate changes and other factors evolve. Likewise, some will be ineffective at times and so the expected benefits as well as co-benefits need to be evaluated now and for the future.

The spatial dimension reflects that ecosystems are highly variable geographically, as are the various factors that influence ecosystems. For example, natural disturbances such as wildfire are much more common and severe in areas where drought and high temperatures are prevalent. Existing management practices are also highly variable, with some regions dominated by agriculture, some by forest management,

and some by protection from human-caused disturbances. Potential solutions will be different for these categories, as will the effectiveness of each for reducing greenhouse gas emissions to the atmosphere.

The community, or human, dimension is critical because natural climate solutions are implemented by people within specific social and economic contexts. All solutions have consequences that go beyond the goal of reducing greenhouse gases, and people will be affected in different ways. Impacts may be positive, such as providing jobs or cooling communities by planting trees near buildings, or negative by increasing the costs of goods and services or impacting specific economic sectors, such as agriculture and the forest products industry.

Therefore, it is essential to evaluate how deployment strategies will affect different communities, over different time frames, and in different regions. The core principles laid out in the paper were created with input from experts in developing and implementing climate mitigation strategies involving ecosystems and management, and include the following:

1 Natural climate solutions are identified and designed with full consideration of risks from climate extremes, natural disturbances, and socioeconomic events.

Many natural climate solutions will take time to reduce net greenhouse gas emissions, exceptions being reducing deforestation and forest degradation, delaying harvest, and reducing emissions from agricultural soils. If benefits are expected to accrue decades into the future, the solutions must consider that climate and other factors will likely be very different and so the expected benefits may not be as great as predicted by current conditions.

2 Avoid degrading ecosystems that have high carbon stocks or biodiversity value, and restore those that have already been degraded.

The carbon stored in high-carbon ecosystems may take decades to centuries to replace if the stocks are lost. Avoiding the fragmentation or degradation of these ecosystems can result in an immediate reduction in emissions and can help protect biodiversity. When possible, restore degraded land to native vegetation which can improve biodiversity while increasing carbon stocks to levels consistent with the potential of the site.

3 Natural climate solutions are implemented with full engagement of Indigenous Peoples and local communities and work to mitigate inequalities and injustices.

Natural climate solutions should be implemented with full engagement of Indigenous Peoples and local communities in a way that ensures respect for their land, culture, and human rights. The historical legacies and ongoing effects of institutional racism will require particular care to include the knowledge and interests of these communities. When implementing natural climate solutions consultation, participatory engagement, negotiations, and consent should be received.

4 Enhance human welfare and “do no harm.”

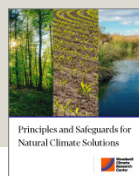
Natural climate solutions should aim to generate a net enhancement to human welfare, while doing no harm to impacted stakeholders. If the tradeoffs between the private and public benefits from policy choices are clearly defined and quantified, negative outcomes can be identified and mitigated to the greatest extent possible. Unless natural climate solutions can be demonstrated to have clear overall benefits to society and impacted stakeholders, and private costs mitigated, they are unlikely to be adopted.

5 Practice full system accounting so that all effects on the carbon cycle are assessed, and the contributions of a given natural climate solution can be evaluated.

Assessing the climate impacts of natural climate solutions requires a systems approach because of the connections between agriculture, forests, land use, food and fiber production, and energy production. It is therefore essential to practice full system carbon accounting including the effects of activities on ecosystems and their ability to maintain or increase carbon stocks, as well as impacts on fossil fuel emissions from related economic sectors. Full system accounting should be linked with effective monitoring and reporting.

Woodwell Climate scientists and team members Dr. Richard Birdsey, Natalie Baillageron, Dr. Glenn Bush, Dr. Richard (Skee) Houghton, Dave McGlinchey, Dr. Sue Natali, and Dr. Wayne Walker, plus five external reviewers participated in the development of this paper.

LEARN MORE



Read the full *Principles and Safeguards for Natural Climate Solutions* at

woodwellclimate.org/ncs-principles.

In the news: highlights

Dr. Rachael Treharne is quoted in *Reuters* coverage on a just-released *PNAS* paper, by an all-Woodwell list of authors, on the impact of permafrost thaw on climate change: “Arctic fires, thawing permafrost pose growing threat to climate - study,” May 17. The story quickly gained traction in other publications, including *U.S. News & World Report*, *India Today*, and *Daily Mail* (UK).

Dr. Phil Duffy is quoted and Dr. Jennifer Francis is interviewed, in an *ABC News* story on the effects of climate change: “Climate change may be causing an early start to fire season in the West, experts say,” May 17

Dr. Jennifer Francis is quoted in this *CBS Morning News* story about uneven warming, particularly how rapid Arctic warming is linked to cooling of ocean waters near Greenland: “When temperatures do odd things...: How this map reveals a warning for the climate,” May 13

Dr. Linda Deegan is quoted in *Falmouth Enterprise* coverage of Coonamessett River restoration work: “The Coonamessett River Trust Is Clearing The Way For Herring To Run,” May 11

Dr. Brendan Rogers’ experience in Alaska was mentioned in an in-depth *Grist* article: “Points of No Return,” Apr 27

Dr. Phil Duffy got the final word in an *NBC News* story about corporate climate action and net zero pledges: “Companies are aiming for ‘zero emissions’ — but few are clear on what that means,” Apr 26

Dave McGlinchey was quoted by *Mongabay* on the significance of the Biden administration’s new climate commitments: “Leaders make bold climate pledges, but is it ‘all just smoke and mirrors?’: Critics,” Apr 23; picked up by publications around the world, including *Eurasia Review*, Apr 25, *Eco-Business*, Apr 26, and *South Africa Today*, Apr 28

In the introduction of a recent episode of *Living on Earth*, host and board member Steve Curwood highlighted Dr. George Woodwell’s role in the show’s founding: “Greening the Economy,” Apr 23

Dr. Spencer Glendon was quoted by the *Houston Chronicle* in coverage of architecture giant Gensler’s climate goals: “Business Gensler unveils ambitious climate goals for its buildings By R.A. Schuetz,” Apr 21

Dr. Heather Goldstone is interviewed by PBS SoCal: “How to Talk to Kids About Climate Change,” Apr 19

cover: photo by Rachel Treharne

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