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Notes from the Field

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Agriculture and food security threatened by warmer, dryer world

Models predict increasing crop failures in major breadbaskets over the next three decades

Sarah Ruiz, Science Writer

Though droughts and bad harvest years are occasional risks for farmers, modern agriculture is built on the assumption of a predictable and stable climate. Rising temperatures are breaking down that assumption, leaving the future of food uncertain. Two new studies put the increasing risks in sharp relief.

Seventy-two percent of today's staple crops—maize, wheat, soybeans and rice—are grown in just 5 countries, in regions of the world known as breadbaskets. From the plains of North America to the river valleys of India and China, these regions earned their distinction for supporting hundreds of years of agricultural production with their climatic suitability.

“These regions have developed this way for centuries in the same way that human settlements have developed around water, because that's where the resource was,” says Woodwell Research Assistant, Monica Caparas.

Caparas works on agricultural risk models. Last year, she led an analysis of crop failures in global breadbaskets, projecting the likelihood of declining yields in the upcoming decades. Her results conjured a world where these centuries-old food producing regions may no longer be so reliable. By 2030, crop yield failures will be 4.5 times higher.

By 2050, the likelihood shoots up to 25 times current rates. By mid-century, the world could be facing a rice or wheat failure every other year, with the probability of soybean and maize failures even higher. A synchronized failure across all four crops becomes a possibility every 11 years.

If that sounds like rapid, drastic change, that's because it is. The immediacy of increasing failures surprised even Caparas.

“The fact that by 2050—which we are almost halfway to already—there could be a wheat failure every year. It's startling.”

One major component of crop failure predictions is water scarcity. In a warmer world, water is a critical resource. Climate change will shift precipitation patterns, drying out some regions and inundating others. Most of the world's breadbaskets are headed in the drier direction.

Caparas factored water availability into her analysis, finding the likelihood of crop failure much higher in water scarce sections of breadbaskets. Wheat is especially water dependent, particularly in India where 97% of wheat crops are growing in areas already experiencing water stress. Irrigation could make up for some lack of rain, but groundwater stores are already overdrawn in many places.

Farms beginning to feel the impacts of climate change in Brazil

In Brazil, agriculture is already showing signs of declining productivity from changing precipitation. Woodwell Assistant Scientist Dr. Ludmila Rattis works in Mato Grosso, where she researches the impacts of agriculture and deforestation on the regional climate. Central Brazil is a major breadbasket for soybeans and maize—as well as cattle—and as crop demand increases, farms and ranches have advanced into the Amazon rainforest and the Cerrado, the Brazilian Savanna.



Clearing and burning forests not only releases carbon that contributes to rising global temperatures, it can also have drying effects on the local watershed. In recent years, farmers in Mato Grosso and the Cerrado have reported issues with dry spells, though they would not attribute it to climate change. Dr. Rattis wanted to quantify these anecdotes to show that they were connected.

“I was trying to see why they were denying the climate changing at the same time they were feeling the climate changing. Were they feeling that in their pockets? Was it affecting the finance of their business?”

Dr. Rattis modeled temperature and precipitation changes along Brazil’s Amazon-Cerrado frontier. Her results not only predicted that by 2060, 74% of the region’s agricultural land would fall outside of the ideal range of suitability for rainfed agriculture, they showed that nearly a third of farms already did.

The changes are affecting crop productivity. When the temperature gets warmer, plants grow faster, releasing more water vapor into the air from their leaves as a byproduct of photosynthesis. If there isn’t a steady supply of soil moisture available to replace the lost water, plant growth is stunted. Rainy seasons are also starting later, limiting the possibility for planting two rounds of crops in a single season, which cuts into farmer’s profits and encourages further expansion via land clearing.

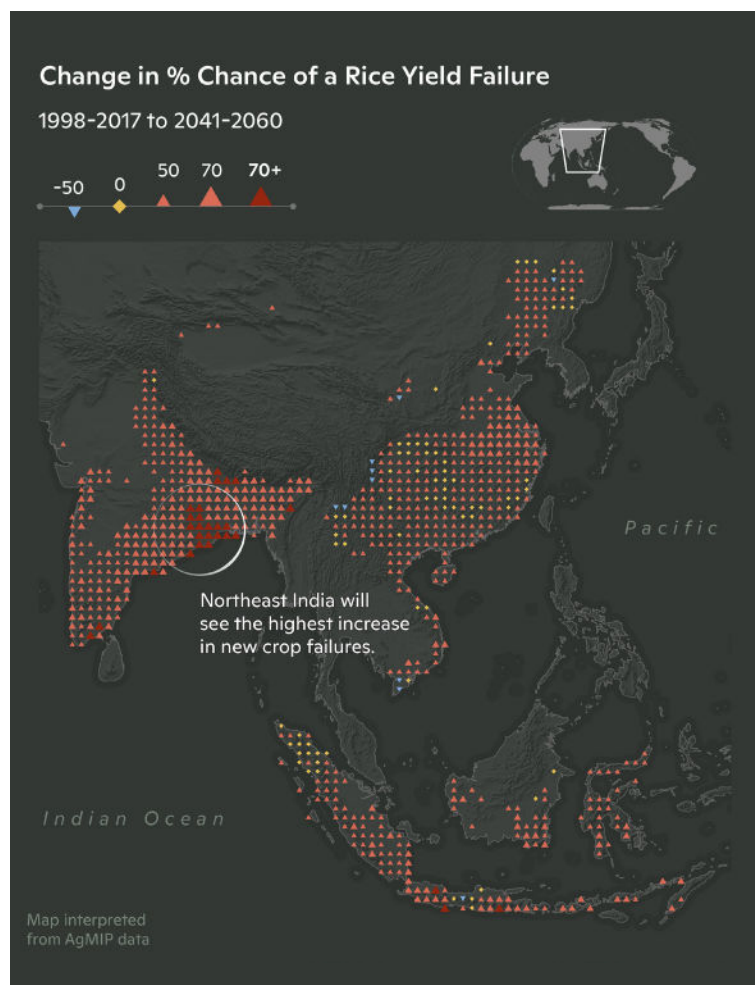
Ideal climate for agriculture migrating north

Caparas notes that increasing crop failure doesn’t necessarily mean we are headed for a world without maize or soybean. But it does mean a drastically different agricultural system—one where hard decisions have to be made about land use.

“Increasing crop failures doesn’t mean that these crops won’t ever be able to grow in these areas again, or that they should be abandoned, just that it’s going to be much harder for them to be as productive,” Caparas says. “There might be a certain threshold of losses that would lead people to leave these croplands.”

There is some potential for migration of the most productive lands as northern latitudes begin to warm. Caparas’s projections showed the greatest likelihood of breadbasket migration from the United States into Canada.

However, just because the climate suitability is migrating, doesn’t mean agricultural production will shift along with it. Other factors including soil fertility or existing land uses could limit the practicality of moving to new regions, especially if it jeopardizes existing climate solutions as the case in Brazil has shown. Clearing forests is only accelerating warming, drought and declining productivity.



Future of food depends on drought resilience

Shoring up food security in a changing climate will require system-wide changes to our current agricultural system. Part of that starts with adjusting farming strategies to mitigate the effects of the warming that's already unavoidable. Dr. Rattis has begun outreach to the farmers whose land she collected data on, giving them a picture of what their farms will look like if nothing changes.

"We need to make them feel that they're part of the research, because they are. If we do, once we get the results, the probability of them using those results to adapt the way that they produce food will increase," Dr. Rattis says. "They can see themselves in the historic part of the graphic and then I show them where, climatically speaking, their farm is going."

She's hoping these conversations will open Brazil's farmers up to practices that leave more native vegetation on the landscape, which would help stabilize the local climate and keep the natural watershed intact.

Caparas draws hope from the fact that the outcomes of her models are not set in stone. In the planet-wide experiment of climate change, we can affect the results.

"These projections are due to changes in climate. They don't account for adaptation strategies. The agricultural technology industry is fast-growing and so I think that there is hope, as long as adaptation techniques are implemented equitably," Caparas says.

Much of the innovation, Caparas says, will have to involve developing drought resistant crop varieties and less water intensive agricultural processes. In the long term however, securing a productive agricultural future for the Earth's nearly 10 billion people by 2050 will depend on securing a stable climate.

"First and foremost it always has to be getting climate change in check," says Caparas.

IMPACT ALERT

Woodwell weighs in with public comment on flood insurance

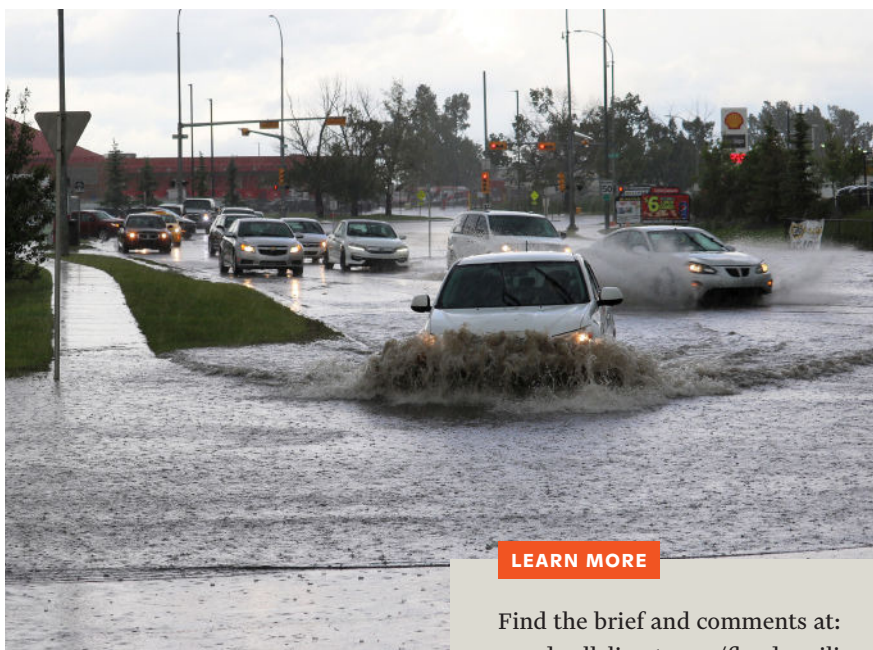
by Natalie Baillargeon
External Affairs Coordinator

In 1968, Congress established the National Flood Insurance Program to cover a critical gap in most standard homeowner insurance. NFIP requires households with federally backed mortgages to purchase flood insurance and enables property owners to obtain premiums at affordable rates. Today, more than 5.5 million homes in the United States are insured by NFIP. Woodwell Climate recently submitted a public comment to the Federal Emergency Management Agency (FEMA) calling for NFIP to address a critical gap in its own coverage—climate change.

While NFIP provides essential protection for high flood-prone areas, it does not adequately account for the fact that climate change is exacerbating flood risk in many regions of the United States. For example, in Decorah, IA, what is currently a 100-year rainfall event is on track to become a 1-in-28 year event by 2050.

The NFIP must meet the rising flood risk facing our country, but the underlying FEMA data that informs the program does not sufficiently account for climate change. While FEMA is pushing forward some improvements, such as Risk Rating 2.0, their Flood Insurance Rate Maps are outdated, do not consider climate change, and have not fully mapped the United States. The maps are used to determine who must purchase flood insurance, resulting in a considerable portion of flooding occurring outside of covered areas.

We greatly appreciated the opportunity to share Woodwell's science as part of this process. A brief we wrote on the issue and our full public comment is found on our website. Woodwell Climate Research Center is working to ensure that these policies incorporate the latest and best climate science.



[LEARN MORE](#)

Find the brief and comments at:
woodwellclimate.org/flood-resiliency



Woodwell convenes three panels to share perspectives on climate risk

by Sarah Ruiz
Science Writer

with Maddie Rocklin & Natalie Boyle
Contributors, 90 West

On February 15, Woodwell hosted the second of three virtual events in conjunction with the Massachusetts Office of the Attorney General and NYU State Energy and Environment Impact Center. The Seeing the Dangers Ahead series convenes climate, finance, and policy experts for discussions about how regulators and advocates can better understand the physical risks of climate change, and use that knowledge to propel decision-making.

The first event “Beyond the IPCC: Understanding and Harnessing the Latest Climate Physical Risk Data and Tools” delved into the practicalities of climate risk assessments—who is generating them, how we generate them, and what cutting-edge tools can help refine our calculations.

“We’re seeing the impacts of the climate emergency every day in our communities with high tides swamping our waterfront, extreme storms damaging our infrastructure, and heat waves killing our residents—especially people of color and those in low-income communities,” said Massachusetts Attorney General Maura Healy, who provided a keynote address to kick off the first event of the series earlier this month. “We must act now, and need the best science and analysis

to do so, which is why my office is proud to partner with NYU Law School’s State Energy and Environmental Impact Center and Woodwell Climate Research Center on this important series. Together, we are committed to putting what we learn into action, to help us protect people, our communities, and our future.”

Tuesday’s event, “Risky Business: How Regulators and Advocates Can Harness Physical and Financial Risk Data to Tackle the Climate Emergency,” focused on providing advocates and regulators with an understanding of the tools and data needed to assess climate risk and integrate it into decision making as the impacts of climate change hit communities across the nation and the world. Panelists discussed questions around the United States Securities and Exchanges Commission’s proposed ruling on corporate disclosure of climate risk.

“Because the United States is still catching up to the world and the market on this subject, getting this right is crucial,” said Robert Jackson, Professor of Law at New York University. “The nature of the American government is that you might not get more than one try at this, so I am certainly hopeful that the proposal the SEC comes out with

will stimulate a robust discussion among panels like this one.”

The final upcoming event in the series, “Toward Equity and Resilience: Harnessing Climate Risk Information for Better Decisionmaking,” will be held March 1 at 1pm ET, and the conversation will focus on how climate risk information can enable vulnerable communities in developing greater preparedness and resilience. Factoring climate risk data into infrastructure and planning decisions can help ensure communities are able to adapt to a warmer world.

Speakers at that final event will include former congressman Joe Kennedy III, Heather McTeer Toney, VP of community engagement at the Environmental Defense Fund, Robin Bronen, executive director of the Alaska Institute for Justice, Joyce Coffee, founder and president of Climate Resilience Consulting, Jennifer Jurado, chief resilience officer for Broward County Florida and Effie Turnbull-Sanders, environmental justice commissioner for California Coastal Commission. The discussions will be moderated by Woodwell’s chief communications officer, Dr. Heather Goldstone.

Fund for Climate Solutions awards four new grants

New awards leverage unique data and advance carbon markets

The Fund for Climate Solutions is a competitive, internal granting mechanism that supports early-stage and high-risk, high-reward research with breakthrough potential. The latest round of awards leverages Woodwell Climate's long-standing work in tropical forests and river systems around the globe, and advances efforts to develop effective, equitable financial mechanisms to incentivize forest conservation.

Promoting primary forest conservation as a key NCS strategy in the tropics; helping states enter the global carbon market

PROJECT LEAD: MICHAEL COE

COLLABORATORS: GLENN BUSH, WAYNE WALKER, AND JOSEPH ZAMBO

Standing forests, particularly tropical forests, are capable of providing almost a quarter of the cost-effective climate mitigation needed by 2030, yet they receive less than 3% of available finance. A truly functioning carbon market that could correct this imbalance has yet to develop, and a key reason is the lack of a uniform, global rating standard to guide suppliers, reassure investors, and generally ensure carbon credits are what they claim to be. Other FCS-funded work is underway to develop a Forest Carbon Rating Standard (FCRS). This project will build on that, developing model cases of adoption of the standard by state-level jurisdictions in Mato Grosso, Brazil and Equateur and Tshopo provinces in the Democratic Republic of Congo (DRC). This work has the potential to accelerate capital flows into programs that can keep primary tropical forests standing.

Making NCS work: Improving adoption of climate smart technologies in the DRC by including subsistence farmers technology preferences in the policy design process

PROJECT LEAD: GLENN BUSH

COLLABORATORS: KATHLEEN SAVAGE, JOSEPH ZAMBO, SAMANTHA BONELLI (WOODWELL-TUFTS STUDENT), AND FITALEW TAYE (GRIFFITHS UNIVERSITY)

Climate smart agricultural techniques have an important role to play in avoiding or reducing greenhouse gas emissions while maintaining or enhancing food production and economic development. Previous FCS-funded research showed that

System of Rice Intensification (SRI) is a viable climate smart technology for communities in the Democratic Republic of Congo (DRC), with the potential to increase yields by up to 30%. However, to design effective policy to incentivize adoption, we must understand the social and economic trade-offs between business as usual and the novel technology. This project aims to develop a social, cultural, and economic assessment method to understand SRI's potential for adoption by subsistence farmers in the DRC. While the method will be developed and tested in DRC, it will be broadly applicable, with the potential to inform the design of policies to promote natural climate solutions.

Intensification in the world's largest agricultural frontier: The impacts of land use transition on local climate and crop yields

PROJECT LEAD: LUDMILA RATTIS

The Brazilian Cerrado, the world's most biodiverse savanna, is key to regulating water availability and atmospheric moisture over South America. It is also where Brazilian agriculture is expanding the most. As a result, more than half the region has been deforested and deforestation continues at a rapid pace, with potential impacts on local temperatures and water availability. The relationship between deforestation and local climate has been well-studied in the Amazon region, but not in the Cerrado. The goal of this project is to model land use transition impacts on local climate and consequently, on crop yields in the Cerrado agricultural frontier. The results will provide new scientific insights into prospects for future food production in the Cerrado and have the potential to greatly strengthen our policy approaches to ending deforestation.

Integrating long-term global rivers data to enhance understanding, identify new research directions, and improve watershed management in a changing climate

PROJECT LEAD: MARCIA MACEDO

COLLABORATORS: MICHAEL COE, LINDA DEEGAN, ANNA LILJEDAHN, CHRISTOPHER NEILL, AND JONATHAN SANDERMAN

Climate change is altering river flows, temperatures, and chemistry globally, with impacts on ecosystems and human communities. But the changes vary widely, and there are few comprehensive, global datasets from which to extract a broader perspective. Woodwell's Water Program is uniquely positioned to address this challenge. Decades of work by Woodwell researchers and their partners at hundreds of sites around the world has resulted in an incredible array of data—global yet detailed, diverse yet comparable. By funding the first Woodwell Climate Postdoctoral Fellowship to analyze this data in an integrated framework, this project aims to expand the diversity of perspectives on Woodwell's science staff, consolidate our understanding of the threats facing global rivers, and identify cross-cutting research priorities moving forward.

In the news: highlights

Dr. Jen Francis participated in a *Texas Tribune* symposium marking one year since Texas' Feb. 2021 winter storm. A recording of the event is available.

The full episode of the PBS NOVA film *Arctic Sinkholes*, featuring Dr. Sue Natali, is available to watch online through PBS.

Dr. Sue Natali was featured in a UN News story about why you should be thinking about the climate impacts of thawing permafrost. The story also included a map by cartographer Carl Churchill.

An article on Dr. Anna Liljedahl's collaborative work on permafrost data is picked up by several news outlets.

The recently published paper on the CONSERV project, co-authored by Dr. Glenn Bush, was highlighted on IPAM Amazonia's website and featured on *eCycle*, *oEco* and *Acre 24 Horas*.

Dr. Foster Brown explains how weather stations in Brazil picked up atmospheric pressure waves from the Tonga volcanic eruption in an article for the Federal University of Acre, which was then picked up by *Acre 24 Horas* and *Globo*.

Dr. Ludmila Rattis was quoted on the impacts of deforestation in the Amazon and her research motivations in an IPAM News feature highlighting women scientists.

Dr. Heather Goldstone was quoted on the effects of climate change on Massachusetts daily life in an article published in *The Independent* and picked up by MSN and *Yahoo News*.

Chris Linder and his photography of the Polaris Project's work on Arctic permafrost were featured in an article in *Outdoor Photographer*.

Dr. William Moomaw co-authored an opinion article in *CommonWealth Magazine* urging support of two bills now before the Massachusetts legislature that would protect forested land.

Dr. Jen Francis and Heather Goldstone participated in an hour-long show on GBH's *Forum Network* last Friday, discussing Arctic warming and extreme weather.

Dr. Jen Francis was quoted about the impacts of changes in the jet stream on extreme weather in a *Yahoo News* article about 'super-extreme' weather events.

Seeing the dangers ahead

How regulators and advocates can harness physical and financial risk data to tackle the climate emergency



Join the State Energy & Environmental Impact Center, Woodwell Climate Research Center, and the Massachusetts Office of the Attorney General for the third and final event in this series that

provides essential information and tools to help regulators and advocates understand the latest available public and private data about physical, financial, and transition climate risks, how regulators might address key data gaps, and how to harness climate risk data for government decision-making.

Part III — Toward Equity and Resilience Harnessing Climate Risk Information for Better Decisionmaking

MARCH 1, 2022 • 1-2:30 PM ET

With intensifying climate harms, billions of dollars of new federal funding on the way for climate adaptation, and an array of new state and federal policies seeking corporate disclosure of climate

risk information, it has never been more critical for regulators, communities, and advocates to understand risk data and how to incorporate that knowledge into effective policy and advocacy.

Assessing risk and vulnerability is an important step in the climate adaptation planning process for state and local governments.

Experts in this panel will explore topics critical to helping policymakers harness climate physical and financial risk information for better decision-making.

REGISTER

Learn more and register at:
woodwellclimate.org/seeing-dangers

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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