# Beyond higher temperatures: Preparing for national security risks posed by climate change

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When talk turns to climate change, certain images pop to mind—maybe

polar bears on ever-shrinking ice floes, coral reefs drained of color, or more powerful hurricanes hitting the coast.

But also at stake is the security of the United States and other nations. What if people become desperate for food? What if long-dormant microbes come to life due to thawing permafrost? What if water and electricity become scarce?

These are the sorts of questions that researchers at the Department of Energy's Pacific Northwest National Laboratory (PNNL) are asking as they take part in a series of national forums. Scientists have raised these questions and more at recent gatherings of the American Geophysical Union (AGU), the American Meteorological Society, and the U.S. military.

This week, as the world celebrates Earth Day, more than a dozen PNNL scientists and others are gathering at Battelle's Conference of Innovations in Climate Resilience (ICR 2024) in Washington, D.C., to discuss climate change and its impact. Decarbonization, energy storage, clean fuels, and national security implications are among the topics discussed by PNNL researchers.

"National security has many facets affected directly by climate," said Jill Brandenberger, an oceanographer who is on the ICR organizing committee and who leads the Laboratory's climate security research. "It involves energy and water, which may be more obvious, but also food security, infrastructure, and health. These are all critical to national security and overall human security."

Understanding the changes starts with fundamental insights about the climate. PNNL is home to Ruby Leung, chief scientist of the Department of Energy's Energy Exascale Earth System Model (E3SM), a sophisticated undertaking to model climate and human interactions. The

model, breathtaking in the scope of data it encompasses, is the starting point for many scientific studies exploring Earth's future.

At the same time, PNNL is one of the nation's leading resources on national security issues, addressing an array of traditional threats (such as weapons of mass destruction) and emerging threats to protect its citizens.

At AGU last December, Brandenberger and colleague Brian O'Neill brought these two threads together and organized a special session on climate and national security. O'Neill, an Earth scientist at the Joint Global Change Research Institute (JGCRI), suggested that social and economic conditions, not just climate hazards, are important to understand the security risks from climate change.

"Oftentimes, the first tendency is to do climate modeling, project out extreme events, and then note society's vulnerability to climate's effects on food, water, and other issues," said O'Neill, a member of the National Academies' Climate Security Roundtable. "But typically, those issues are shaped much more by other underlying conditions, such as social and economic factors—they can be exacerbated by climate, but the baseline vulnerability apart from climate is crucial to take into account."

When broader factors beyond climate are considered, O'Neill said it's not at all clear that the future will be worse than the present, even with a warming climate.

In a comment in *Nature Climate Change*, he noted that factors such as poverty levels, income, and education have been improving in many parts of the world and are expected to continue to do so. While there will certainly be harmful effects of climate change that cannot be avoided, improving social conditions will likely outweigh warming climate conditions in some parts of the world.

"Climate has a direct influence on complex social dynamics and the geopolitical situation worldwide," added Todd Hay, who manages a five-year project funded by the Department of Defense to study climate threats. "Can we fuse the results of climate models with human domain systems in ways that planners can use to make decisions that will have broad consequences 10 or 20 years from now?"

## Food security in the future

Stephanie Waldhoff of JGCRI is looking at food security—an issue that goes far beyond concerns about which foods can be grown in warmer environments or in areas that will see more drought or heavier rain.

Waldhoff looked at factors that could contribute to a nation's food security—for instance, drought, income, global alliances, and dependence on other nations for food supplies. In particular, she studied the levels of income that will be needed for people to meet their dietary needs.

Her models show that more food likely will be available to people in Africa in the coming decades, thanks largely to increasing incomes and improved agricultural yields. But other parts of the world, such as areas of India, where incomes are expected to grow more slowly, are more likely to experience food shortages.

"You have to eat, but as prices rise, people will spend more on food, eat less, and change what they eat, shifting toward cheaper, but less nutritious foods, and increasing the amount they spend on food. This will translate into food insecurity," said Waldhoff.

"Low-income groups will need to make trade-offs to get food, and that can exacerbate negative outcomes on other aspects of well-being, like energy security or housing. An increase in food prices affects people

much differently if they make $10,000 a year compared to $100,000 a year."

## Dimming the sun

Ben Kravitz of Indiana University is exploring a way to reduce global warming by reducing the amount of sunlight hitting Earth. One approach to this solar geoengineering would be to use aircraft to deposit tiny particles known as aerosols high in the atmosphere, reflecting some sunlight away from Earth.

Kravitz discussed potential global concerns and how governments might work together to navigate the issues. For instance, who would make decisions about an effort that would affect the entire planet? And what if there are disagreements—for example, some locations where a bit more warming might actually help the local economy vs. large swaths of the planet that would be hurt?

"Geoengineering is a volatile topic," said Kravitz. "There would be winners and losers. Some people find the concept scary—but so is climate change. People are starting to recognize that there's a trade-off. It's magical thinking to think we're going to stay below an increase of 1.5° without taking strong action."

## Pathogens in the permafrost

The temperature increase is already real in the Arctic, where permafrost is thawing rapidly. Last year, Brandenberger helped organize a Pathogens and Permafrost Workshop where experts discussed the potential risks of the phenomenon. At the top of the list are potential pathogens that could be released as temperatures warm.

"We have not seen some of these pathogens for hundreds or even thousands of years. We're not sure what we're dealing with. We need to chart the pathways pathogens could follow to infect plants or animals," said Brandenberger. "We absolutely need to understand this problem better. We can't put this on the shelf and say we don't need to think about it."

An additional concern is water quality as long-frozen ice and snow turn to water. Being able to identify microbes that have perhaps never been seen will be critical to keeping the water supply safe for troops, scientists, and others. Detecting and identifying unknown pathogens, and determining whether they are friend or foe, is a longtime strength at PNNL.

Brandenberger's colleague Becky Hess is studying the microbes that might be found in thawed permafrost. Other teams have found snippets of genes from multiple bacteria in thawed permafrost. Hess is studying permafrost from 150 feet below the surface to see if long-dormant bacteria could still be alive once the permafrost thaws.

"Climate change is presenting new challenges on many fronts—there is no place on Earth that isn't affected, including the soil beneath our feet," said Brandenberger. "Earth Day offers an opportunity to consider how to prepare for our changing climate, including the challenges posed to national security. The models we're building are designed to anticipate changes and the impacts they may have on the environment and society, which in turn have an impact on national security."

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