MONTHLY NEWSLETTER
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Woods Hole Research Center

Cody O'Loughlin

The coming redistribution of the human population

Dr. Philip Duffy
WHRC President and Executive Director

The concept that each species has a "climate niche"—most simply characterized by a temperature range which the species "likes"—is commonly used and useful. As the planet warms these niches move geographically across the landscape, and in general species move with them. (Species also respond in other ways.) That's why, for example, lobsters have become more common in the Gulf of Maine and less common near Cape Cod. In 2009, I co-authored a widely-cited paper, *The Velocity of Climate Change*, which quantifies how fast species niches move, and among other things compares that to how fast the species themselves are able to move. Birds for example have no difficulty keeping pace with warming; it's tougher for plant species.

To my great chagrin, my co-authors and I failed to consider that humans are no different: we have a temperature range which we "like", and that niche is moving geographically as the planet warms. A paper published in May, *The Future of the Human Climate Niche*, points out that humans have largely lived within a range of mean annual temperatures between 11 and 15 C (52-59 F) for thousands of years, and that most agriculture and livestock grazing occur there as well. As Spencer Glendon and others have pointed out, populations which live outside of this niche tend to be less prosperous than others. The idea that preindustrial humans would have a preferred temperature range is perhaps unsurprising, but the persistence

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Alaska tsunami warning prompts state, federal response

State and federal officials are launching new efforts to monitor an unstable slope in Alaska's Barry Arm after a letter from a coalition of scientists, including WHRC's Dr. Anna Liljedahl, warned that its collapse could trigger a tsunami hundreds of feet high. WHRC is now part of a multi-agency effort to better understand what could trigger a landslide, to model what the impacts of a failure might be, and to detect changes in the slope that might forewarn of collapse.

"As global warming continues to thaw glaciers and permafrost, landslide-created tsunamis are emerging as a greater threat—not just in Alaska, but in places like British Columbia and Norway. In the short term, we need more scientific study of threats like the one we've identified in Barry Arm to provide earlier, more accurate warnings. And in the long term, we need governments to act on climate," said Dr. Liljedahl.

Barry Arm, a fjord off Prince William Sound, is frequently visited by as many as 500 people at a time, including tourists, fishing crews, and hunters. The scientists say that collapse of 650 million cubic yards of the slope, potentially triggered by an earthquake, extreme rain, or heat

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WHRC is an independent research organization where scientists study climate change and how to solve it, from the Amazon to the Arctic. Learn more at www.whrc.org.

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of the human temperature niche today indicates that we tend to overestimate the extent to which technological progress insulates us from basic physical realities.

During the next 50 years, absent migration, billions of humans will find themselves living outside of this preferred temperature range. Something like a third of the human population (3.5 billion people) will be exposed to a mean annual temperature exceeding 29 C (84 F), something now experienced by less than 1% of people (most of whom live in the Sahara). This means that billions of people will have to either migrate or adapt to very different living conditions. Either way, that's not going to be easy. This assumes relatively unrestrained future emissions of greenhouse gases. But even presuming very strong climate policies, the numbers remain daunting: about 1.5 billion people would need to move in order to keep the human population exposed to the same temperatures we are today.

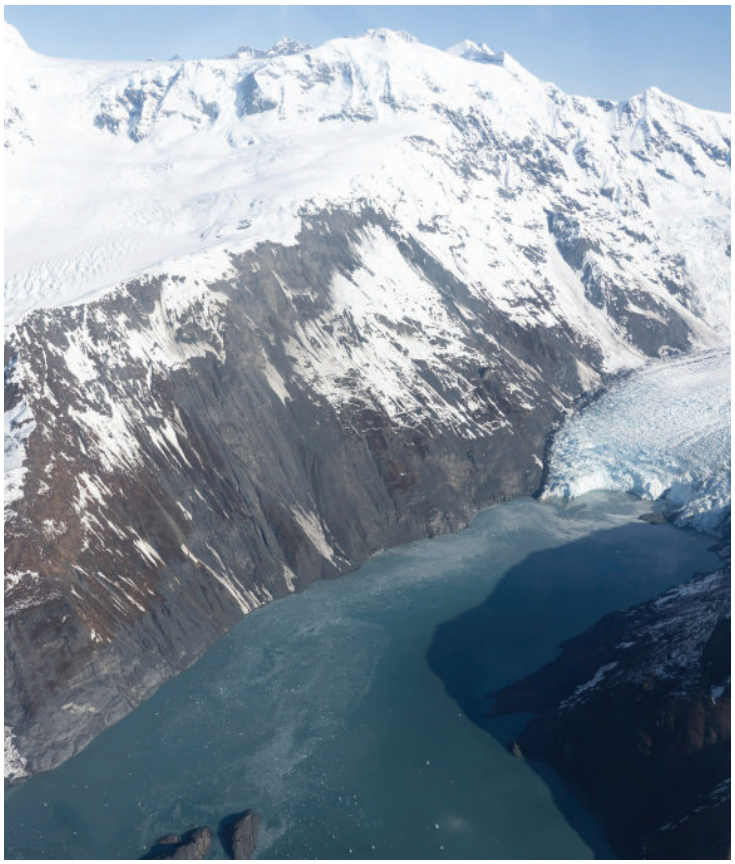
It's clear from this analysis and others that there will be enormous and widespread pressure on human populations to move to more habitable climates. How we actually respond to that pressure is, of course, more speculative. There is ample evidence from history that climate disruptions can trigger social unrest and migration. Examples exist in the ancient world and in modern times, including the "dust bowl" in the US, and the recent Syrian conflict and exodus.

One thing that's clear is that, like other aspects of climate change (and, it seems, everything else), this coming migration pressure will disproportionately affect the poor and people of color, and will tend to increase economic inequality. This follows because the areas most profoundly affected will be those which are already hot—the tropics. Recent work done at WHRC and published earlier this year by the McKinsey Global Institute (MGI), the research arm of McKinsey and Company, in fact shows that, for the first time in human history, parts of the tropics will at times soon be simply too hot to support human life. This work shows that there is now a very small but finite possibility of lethal heat waves in South Asia, and that this risk is projected to grow very substantially in the next several decades. Here are a few sentences from the MGI report:

By 2050, under an RCP 8.5 scenario [i.e. assuming relatively unrestrained emissions of greenhouse gases], the number of people living in areas with a nonzero chance of lethal heat waves would rise from zero today to between 700 million and 1.2 billion (not factoring in air conditioner penetration). Urban areas in India and Pakistan may be the first places in the world to experience such lethal heatwaves. For the people living in these regions, the average annual likelihood of experiencing such a heat wave is projected to rise to 14 percent by 2050.

The coming prevalence of extreme heat and drought are going to alter the human experience profoundly, and I don't see any easy way to accommodate what's coming. Our colleagues at Probable Futures (Spencer Glendon and Alison Smart) plan to explore the ramifications of coming increases in extreme heat and other changes in climate on their web-based platform, slated for launch in September. The coming changes are going to challenge us profoundly, and I am proud that WHRC, through our partners, is reaching wide audiences with this critical message.

Thanks, as always, for your interest and support.



Barry Arm, Alaska (Christian Zimmerman/USGS)

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wave, is plausible within the next year and likely within the next 20 years.

In addition to the massive tsunami wave in the immediate vicinity of Barry Arm, the team's analysis shows that about 20 minutes later the nearby community of Whittier would be in the danger zone for a possible surge of over 30 feet. A similarly-sized earthquake-generated tsunami in 1964 killed 13 people in Whittier. Ripple effects could cause damage across the Sound.

Alaska has a history of massive landslide-generated tsunamis, including the 1958 Lituya Bay, 1967 Grewingk and 2015 Taan events. In Greenland, a 2017 landslide-caused tsunami killed four people. However, the Barry Arm slump is both significantly larger and higher in elevation, leading the team to conclude its potential energy is significantly larger than any of those recent incidents.

"We've been in the business of studying landslide-generated tsunamis after they happen, but at Barry Arm I hope we can get ahead of the game and give people some warning. I worry that these large landslides into fjords and lakes near retreating glaciers might be getting a lot more likely with climate change. In the past they've been rare events, but I'm not sure about the future," said Dr. Bretwood Higman, a letter co-signer and executive director of Ground Truth Alaska.

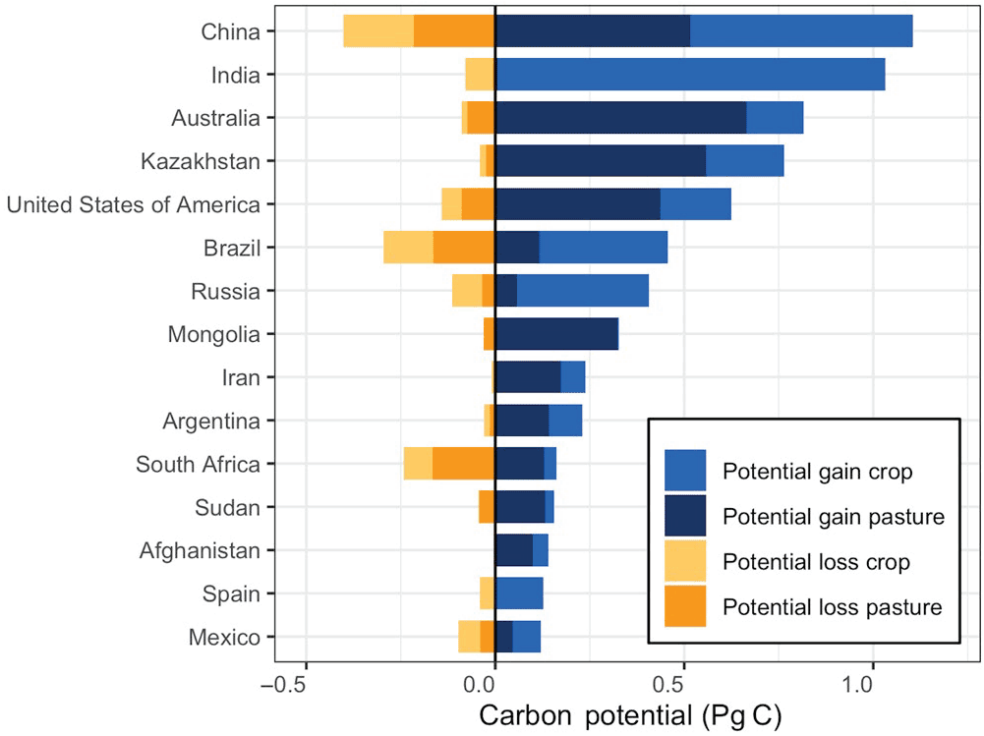
Scientists are making fly-overs at Barry Arm to make precision measurements of the unstable slope with LiDAR, a laser-based system used to make incredibly accurate three-dimensional digital representations. The Alaska Department of Natural Resources is also preparing to place solar-powered GPS monitors on the slope to provide real-time data on rates of movement that frequently precede catastrophic landslide failures.

Study finds big climate mitigation potential from adding trees to agricultural lands

Trees growing in agriculture landscapes hold more than three billion metric tons of carbon worldwide and expansion could move the needle on the global carbon budget, according to a new study published in Global Change Biology. The authors suggest that incorporating trees on agricultural land has the potential to both improve production and provide a natural climate solution through increased carbon storage. A scenario of just 10% adoption of trees integrated on agricultural land could realize as much as 7.6% of the total climate change mitigation needed by 2030 to keep global warming below 2°C.

Crop and pasture lands currently account for over one-third of global land cover, more than any other land use category. Emissions from agricultural production currently contribute 6 billion metric tons of greenhouse gases to the atmosphere per year, about 10 percent of the world's annual total, but researchers found that agricultural lands could store billions more tons of carbon in trees.

"More research is needed to understand how best to realize the carbon potential of increased integration of trees in agricultural landscapes at the regional and national scales. If we know what's driving higher adoption in certain regions—whether it's policy levers or economic incentives—we can look to apply those successes more broadly," said Melissa Chapman, Ph.D. Candidate at the University of California, Berkeley, former WHRC Research Assistant, and lead author of the study.



Chapman M., W.S. Walker, S.C. Cook-Patton, P.W. Ellis, M. Farina, B.W. Griscom, A. Baccini. 2020. Large climate mitigation potential from adding trees to agricultural lands. *Global Change Biology*. doi:10.1111/gcb.15121

The majority of carbon storage potential the study identified is in countries that don't currently classify adding trees to agricultural land as a climate mitigation technique. That could present an obstacle to adoption.

While some may see only the cost of adding trees to agricultural land, the practice also can deliver returns. For example, fruit and nut trees provide economic benefits, either as a cash crop or as a food source for livestock.

"Additions of trees to agricultural land is a win-win. By reducing soil loss and increasing shade, agroforestry practices have the potential to benefit farmers and their communities by increasing yields, protecting health, and improving biodiversity," said WHRC scientist Dr. Wayne Walker, a co-author of the study.

This study was made possible through support from the Doris Duke Charitable Foundation, as well as from the Government of Norway.

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WHRC staff spotlight: Dr. Scott Zolkos

Dr. Zolkos is a WHRC postdoctoral researcher who works on the effects of climate change on Arctic ecosystems, particularly from the lens of carbon and contaminant cycling. He is supported by a prestigious NSF Earth Sciences Postdoctoral Fellowship, and he was recently selected for the American Geophysical Union's Early Career Spotlight.

What questions does your research aim to answer?

What are the implications of northern high latitude environmental change for global biogeochemical cycles? I'm particularly interested in carbon and mercury cycling. I'll soon start a two-year NSF Earth Sciences Postdoctoral Fellowship, working with Dr. Sue Natali and Dr. Brendan Rogers at WHRC, and Dr. Elsie Sunderland at Harvard University. I'll be studying the effects of wildfire and permafrost thaw on mercury cycling and bioavailability in the Yukon-Kuskokwim (YK) Delta, in association with the NSF-supported Polaris Project and in affiliation with the NASA Arctic Boreal Vulnerability Experiment.

What's your biggest challenge or obstacle?

Due to the COVID-19 pandemic, collecting new water and permafrost samples in the YK Delta is the biggest challenge. Very understandably, there are indefinite travel restrictions to many northern communities. In the meantime, I aim to leverage samples archived at WHRC and existing data, and to make headway on the remote sensing component of the project.

What brought you to WHRC?

Before starting my Postdoctoral Researcher position in 2019, I was a Research Assistant (2011–2014). I applied for the RA position because I attended a talk by WHRC founder Dr. George Woodwell. Many readers will appreciate that, as an undergraduate studying environmental science, hearing George talk was a quasi-spiritual experience. I had never heard of WHRC and I didn't think such an organization existed, one with a mission that resonates so strongly with my core beliefs and interests. The exposure to research and incredible mentors that I had as an RA inspired me to apply for graduate school to study Arctic biogeochemistry.

What's it like to work with your spouse, Anya Suslova, who's also a scientist?

It's always a joy to work with people who are smarter and more creative, especially when they are your spouse. Anya makes me a better scientist and person. We had fun co-authoring a recently-published paper on mercury fluxes in the Arctic's largest rivers, as part of the Arctic Great Rivers Observatory (Arctic-GRO) project. Her father collects samples for Arctic-GRO in their hometown of Zhigansk, an Arctic village located on the Lena River. So, it's a family business.

In the news : highlights

Amazon Rainforest Fire Season Starts With Outlook for Record Burn. *Bloomberg* covers IPAM Amazônia report and mentions WHRC. June 8

Something like a pandemic. In *National Catholic Reporter*, Michael Sean Winters discusses his experience on WHRC's webinar. June 5

Youth Climate Action Hero. *Sandwich Enterprise* profile of Nico Gentile includes his WHRC internship. May 29

Heather Goldstone On Juggling Hurricane Season With COVID-19. WGBH's Boston Public Radio. May 28

NOAA Predicts 'Busy' Atlantic Hurricane Season for Fifth Year in a Row. *Smithsonian* quotes Jennifer Francis. May 26

Experts Discuss Strategies for Accessing Large-Scale Funding for Forest Conservation, Restoration and Afforestation. *Armenian Weekly* features Glenn Bush. May 26

Ahead of NOAA's hurricane season forecast, Jennifer Francis spoke to media on climate fingerprints (i.e. warming ocean temps):

Scientists Predict 'Busy' Atlantic Hurricane Season Amid Virus Crisis. *New York Times*. May 22

'Wake-up call.' Early storms redefine hurricane season. *E&E News*. May 22

Cape Officials Prepare For 'Worst' As Forecasts Warn of Busy Hurricane Season. WCAI. May 22

Another sobering hurricane forecast: NOAA sees busy season. *Palm Beach Post*. May 22

Coverage of the Alaska tsunami warning quoting Anna Liljedahl:

Prince William Sound at risk of 'devastating' tsunami. *The Cordova Times*. May 25

Potential Landslide Could Trigger Destructive Tsunami in Alaska, Scientists Warn. *Smithsonian*. May 20

Tsunami May Occur If Alaskan Slope Collapses, Experts Warn. *International Business Times*. May 19

COVID19 response. CNN's *Erin Burnett OutFront* featured an interview with John Holdren. May 22

Indigenous wisdom can heal the planet. *The Hill* op-ed cites WHRC's 2016 study on indigenous lands having lower deforestation rates. May 14

It's About To Be Dumb Cold From the Rockies to the East Coast. *Earther* quotes Jennifer Francis. May 7

Taking careful steps toward partial reopening

Nearly three months after WHRC's Falmouth campus shut down due to the COVID-19 pandemic, the Center is taking the first small, cautious steps toward reopening. WHRC leadership has established a meticulous process to ensure staff that need to return to campus for research or other duties can do so while prioritizing safety.

Since early March, few WHRC staff have set foot on campus. Director of Facilities Fred Palmer, Facilities Assistant Annalisa Eisen, and Director of Information Technology Hilary Davis were the exceptions, as they handle essential operations. In May, the three took part in Falmouth's Front Steps Project, an effort spearheaded by local photographer Lee Geishecker to build community by sharing photographs of people on their front steps during this period of social isolation. Other staff members shared webcam photos showing what work-from-home has looked like.

In recent weeks, as Massachusetts has begun phased relaxation of COVID-19 restrictions, WHRC has responded with efforts to safely resume some lab, field, and office activities. Lab Manager Lindsay Scott has been designated COVID-19 Safety Director, creating a control plan and leading trainings for staff returning to campus. Employees must register visits, wear masks, limit movement within the building, and disinfect constantly. Lindsay is also working with WHRC scientists who have field research to make sure their projects restart safely.

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WHRC scientist Chris Neill caught this moose on a trail cam on his property in Wendell, MA. After being driven out of MA by hunting and land clearing by about 1700, moose recently rebounded and started entering MA from neighboring states in the 1980s. An animal of cold regions, they're now being hurt by our warming climate.

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