the weekly anthropocene

dispatches from the wild, weird world of humanity and its biosphere

By Sam Matey

Scientist Spotlight: An Exclusive Interview with Dr. Katharine Mach

Dr. Katharine Mach (pictured) is Associate Professor at the University of Miami Rosenstiel School of Marine and Atmospheric Science. Her work focuses on the risks posed by climate change from sea level rise to wildfires to conflicts, and how we can adapt to them. She is a lead researcher at the UN Intergovernmental Panel on Climate Change, the world's leading climate science body.

A lightly edited transcript of this exclusive interview follows. This writer's questions and remarks are in **bold**, Dr. Pimm's responses are in regular type. ***Bold italics*** are clarifications and extra information added after the interview.

For more on Dr. Katharine Mach, see people.miami.edu/profile/kmach@rsmas.miami.edu.

Hello, Dr. Mach! It is an honor to be interviewing you today. Before I get into specific questions, could you give me the background story on how you became an environmental scientist, and a research leader focused on climate change risk specifically? Growing up, the outdoors were a big part of what was important in our family. Hanging out in the forest, going for hikes, spending time on the beach, it was an important part of our family. My grandmother was one of the first women in the Navy, my father grew up on a farm in rural Czechoslovakia, the outdoor world was just really important to me. I went to college, I was interested in biology, chemistry, ecology, and I really decided to focus on how the coastal environment shaped nearshore coastal systems, both in my undergraduate work and what I did as a graduate student. At some point I realized I was focusing very, very narrowly on how a crashing wave affects kelp in nearshore ecosystems, or how fluctuating temperatures affect snails, but zooming out, I wasn't looking at the dominant

organism in that ecosystem, people. And how acidification, plastics, climate change, overfishing were all part of this actual environment. I went from studying the changing environment of nearshore ecosystems to taking a wider view on climate change adaptation and the interactions between science and society as I went to my Ph.D. Then to working for the Intergovernmental Panel on Climate Change, and I've taken that kind of redrafted research forward with me to the current day with a lot of different topics in the space of the risks of changing climate and how people are managing those risks.

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Can you tell me about your experience as a lead author on both the IPCC Sixth Assessment Report and the US Fourth National Climate Assessment? These are huge, epoch-making reports, and you were a lead author. That is amazing-what was it like? In 2010, I was just finishing my Ph.D, and at that point in time I started as a postdoctoral scientist with the Intergovernmental Panel on Climate Change. And so that was the first time I'm thinking about the entirety of the climate issue, so not just my little snails and seaweed but all of the impacts on the ocean, and not just the ocean alone but rural areas and urban areas and every continent of the globe. In that staff science role, which became a codirector of science role for the IPCC fifth assessment report cycle, I really got this amazing opportunity to work with scientists from around the world, across all of the science. I think there, the excitement was really just recognizing that every discipline is relevant, on the science side. And on the responses side, how it's relevant in every country, to national and local governments, community groups, and the private sector. The wildest part of it was being part of the process that provided scientific support to the negotiations of the Paris Agreement. Also, being part of the government approvals of our summary for policymakers, you stay up all night in these big auditoriums with people thinking about every sentence in those reports collectively. It's just a profoundly diverse endeavor. Every country in the world in terms of the thinking behind the Paris Agreement, and to me that was just really inspiring and hopeful to see.

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Can you discuss your recent papers on strategic and managed retreat from flood-prone areas, and when and where you feel that should be applied? This is a very active area of ongoing work. The world is changing. The future will be different from the past. When we think about the role of climate change, it's not so much climate in isolation, but the way in which climate changes the range of possible futures, and requires some thought in terms of what's important to maintain as we head into the future. When we think about how you can manage climate risk, there's a range of options usually put forward. There are millions of specific things you can do, but kind of broad categories of response: resisting, first of all. Keeping water out, putting up seawalls and floodgates. Keeping water out is often very effective, technologically viable, but very, very, expensive. Finance is often a big limit. And there also can be real tradeoffs, with resisting in one location driving the water elsewhere. The same can be said for fire in a different context. Also the tradeoffs between nature and gray infrastructure. Another big category is accommodation: elevating infrastructure so water can flow under, hardening your home so it's more resistant to wildfires. A third category, controversial, would be saying maybe we should avoid development in hazardous locations in the first place. We're not very good at that one. We've developed faster in floodplains and fire-hazard areas than elsewhere. After the fact, that can be a question of, should we pull assets out of hazardous places? That's often thought about in the aftermath of disasters. In the future, under high magnitude climate change, will we make way for water in cities? To what degree does that require moving infrastructure, at least in a selective way if not writ large. All of those things make it important to think about. When we have all the tools on the table, including managed retreat, we may be able to better achieve priorities like safety, economic well-being, maintenance of cultures, if we're strategic. And so that question of where people want to go with the strategy, what are the visions of the future people are pursuing, and the management is more what tools are being used to get there.

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Can you tell me more about seminal paper on climate change as a risk factor for armed conflict? I saw you've published some more on this in recent months as well. I've done a number of projects focused on the very complex relationship between climate and violence. This is an area of research where there's been a lot more work over the last decade, linking to much longer standing studies on environmental security, the dependence of people on their environment and what happens when that environment is undergoing change. When we started our project, much of

the science out there had demonstrated that there was kind of a black box link between climate and conflict. We know if it's a hot year, dry decade, you're more likely to get conflict, from civil war to individual-level violence. Given that relationship, it's a bit counterintuitive in a way, as conflict is largely seen as a product of the stability of government, conflicts among groups, histories of conflicts through time. So what we did in the project was unfold that complexity. What we found is that across all of the experts who were part of this project, there was clear agreement that climate has been relevant, but the other factors are much more important. Climate matters, but the state of your government matters way more. The level of inequality among groups matters way more, the history of violence matters way more. The degree to which climate does modulate the risk of conflict is really the degree to which climate operates through these other things in society that lead to violence, especially in fragile states. Moving forward, the uncertainties absolutely grow as we head into a world with more climate change. Climate change puts a lot of pressure on many of our social and economic systems, whether it's how we grow food, how we get water, the nature of market interactions across countries. Those complex interactions involve a lot of risks that are very serious, even when they are far short of violence and conflict.

You've published several papers on the potential and limits of BECCS, bioenergy with carbon capture and storage. Can you discuss that with our readers? As we think about how we respond to the changing climate, there are a few different categories. The classic is saying we can reduce our emissions, we can adapt or prepare for impacts in the pipeline, or we can suffer. How we reduce our emissions, there has been increasing attention to not just reducing them, but actively removing carbon from the atmosphere. This may sound crazy, but that's what trees do, there's a clear basis, photosynthesis has been happening on planet Earth for a very long time now. So there are approaches that are totally biological, reforestation, improved forest management, using the terrestrial biosphere as a managed sink for pulling CO2 out of the atmosphere. An important note there is that as the climate continues to change and there's increased risk of wildfire, that is a sink that becomes susceptible to disturbance or release into the atmosphere. At the other end of the spectrum are the fully engineered approaches. Direct air capture, where it's relying on chemistry to pull that CO2 out of the atmosphere. In between those two, there ones where photosynthesis, plant matter, the stuff of life, gets carbon out of the atmosphere, but then through energy conversion processes, you're making energy or fuel. Bioenergy with carbon capture and storage is in

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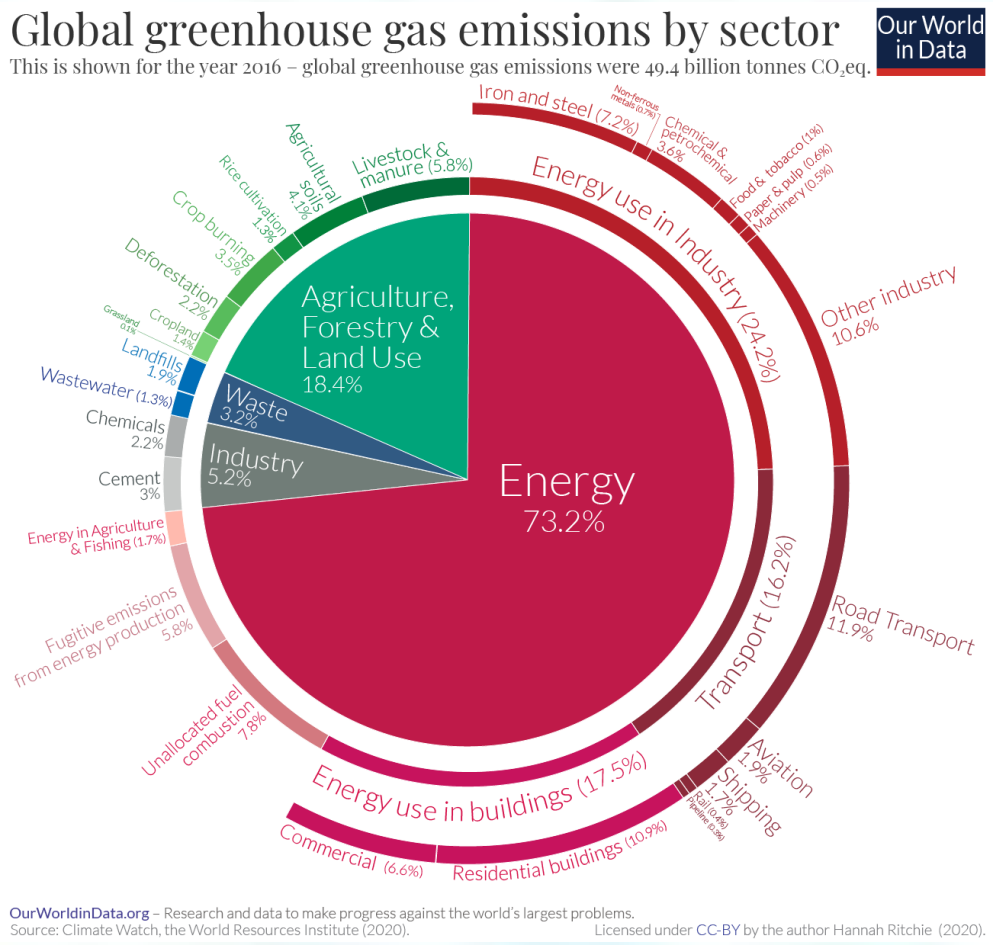
that category. There's been a tendency for it to feel like the numbers could be huge in terms of how much CO2 could come out of the atmosphere. But in reality it's important to recognize that carbon removal plays a crucial role but it's not an easy out in terms of the skills and the time that it will take to deploy them. The real question is, how can we do the tried and true, cost effective methods of renewables, reduced deforestation, moving our transport fleets away from carbon emitting forms, at the same time as we pull CO2 out of the atmosphere? With all of these categories of response, it's really crucial to recognize that we need an all of the above response, not one or the other.



Based on your expert opinion, do you feel any of these technologies are under-hyped, over-hyped, under-invested in, over invested in? There's a lot of controversy around direct air capture, for example. What should we be doing more or less of? My expertise is more on the adaptation side, but I would say from my work from the IPCC, I think if there's anything crucial to recognize it's that if you take tools out of the kit, it becomes a lot harder to solve the problem. There's a tendency to say no nuclear, no hydro, no BECCS, no direct air capture, and then it's kind of a question mark of how you're actually going to solve this. In a way, I tend to think about some of the responses into ones where we already have solutions that are cost effective and it's really just a question of scaling and fast, where on the basis of the proven technology we could get to 80% decarbonization if we just got going and it's really a question of making it happen much more ambitiously. But we know how to do it. And then the things left over are, how are we going to deal with cement and steel manufacturing, how are we going to ensure totally reliable electricity, how are we going to do carbon removal through direct air capture? Those remaining categories

become really important for getting to full decarbonization. In my mind, the crucial distinction is that based on technologies that exist now, much of the energy system modeling suggests that we could easily get to 80% emissions reduction, we just need to do it.

In the halls of power in the US recently, there's been a sort of toxic, hyper-macho, anti-intellectualism, obviously best exemplified by the recent ex-president. In that environment, what's it like being a scientist, and leading woman scientist, which is probably threatening to a lot of very unethical people in power. Gender has been relevant in my experiences in science. When I've been in rooms of scholars where there's more emphasis on the social science and understanding interactions among people, there's often more awareness of power, inequity, and the degree to which those play out in science itself. For me, it has been interesting that the dynamic in any given context can depend on what the norm is professionally of the people you're interacting with. As I went from being a student, to increasingly a role where I'm playing more of a mentorship role, for me that's kind of amazing, not just for students that are female, but students from backgrounds that are underrepresented in different ways, that creating an inclusive environment where we're all working together and everyone's thriving is incredibly important, and feels like a really big part of what I do.

If you could distill one message you wish more everyday citizens knew, what would it be? The key takeaway. I always think about the fact that climate responses are a way to build a better world. We tend to think about them as being all about tradeoffs, but actually because energy is intertwined with human well-being, the climate is intertwined with human well-being, often it's a really powerful entry point for addressing things that people want to work on anyway. Their visions, and aspirations.

"Climate responses are a way to build a better world."

Is there anything else you would like to share? It's been so interesting to see the level of engagement there has been on the climate issue. Watching the next generation step forward on the climate issue is really inspiring for all of us, they represent the future. I also think for people who have professional capabilities, in business, law, or science, there's so many entry points to taking action on the climate issue. Communicating that it's important to you. People achieve great things when they put their mind to it. An attitude of empowerment in climate solutions is crucial moving forward. **Thank you so much for joining this interview. It's been a pleasure talking with you.**