United States House of Representatives
Select Committee on the Climate Crisis

Hearing on April 15, 2021
"Making the Case for Climate Action: The Growing Risks and Costs of Inaction"

Questions for the Record

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The Honorable Kathy Castor

1. **In your testimony, you discussed some of the ways that the Earth's ice cover, a critical element to being able to forecast sea level rise and other changes to our ocean, can surprise us with changes that warrant changes in our estimates. What has been the trend over recent years between forecasts and observations? What are the implications if we do not adjust trajectory to reflect potentially accelerating changes?**

The trend has been that forecasts tend to underestimate ice changes. That is, observed changes are often more significant than we've expected.

With regard to sea-level rise, I noted that there are "wildcards" in the system. One of these wildcards is related to rapid break-up of floating ice at the ends of the outlet glaciers and ice streams that drain the ice sheet. These areas of floating ice (called ice shelves or ice tongues) provide a resistive force to the glaciers and ice streams that flow into them, and when they melt (as they are currently), that resistive or "buttressing" force is removed and the glacier flow accelerates. Then, the ice is discharged more rapidly into the seas, causing accelerated sea-level rise. The basic concept of how this process works is pretty well-understood and we have observed the effect in nature. However, the details of the physics are very complicated and are not yet fully captured in ice-sheet models, making it very difficult to predict their behavior.

Without the robust physics to describe these processes, the scientific community cannot say with confidence how likely such rapid loss will be and how much ice loss is likely to result. Therefore, the best we can do is capture the processes we can model well, and make clear that this wildcard exists, which could cause far greater sea-level rise than we can confidently predict today. It is notable that there are no known "wildcards" that will suddenly *slow* or *reduce* sea-level rise, so the uncertainty in prediction associated with large effects exists only in one direction—higher sea-level rise than we can confidently predict. In fact, history has shown that when the Earth's temperatures were this warm in the past (125,000 years ago), oceans were 5-10 meters (16-33 ft) higher, and the rates of rise were nearly 10 times greater than what we are seeing today (Rohling et al., 2019).

In the case of sea ice, the ice can melt from warm air above, from warm sea water below, and by being transported from colder areas at high latitudes to warmer areas at lower latitudes. While there are not the same kinds of "wildcards" as found on land ice, the models have historically been conservative and careful not to over-ascribe ice loss mechanisms. As a result, models do not yet fully capture the amount of sea-ice loss that is occurring in the Arctic as climate warms (SIMIP Community, 2020). On a positive note, however, when nature surprises us with excessive rates of loss, we have an opportunity to understand why there are discrepancies between models and reality, and we are able to improve our models. So progress is being made. But as with ice sheets, we need to recognize that while models provide our best estimates of future states, they may not fully capture all of the processes at work, and we need to allow for the possibility that the situation could be more adverse than predicted or projected.

If we do not take into account potentially accelerating changes in ice on both the land and sea and adjust our trajectory accordingly to avoid those larger changes, we can expect impacts that are significantly greater than predicted. In the case of sea-level rise, the difference between a 2-foot or 5-foot rise by 2100 equates to billions and possibly trillions of dollars of expense globally, associated with damage to buildings and infrastructure and displacement of individuals. Being able to understand what lies ahead is critical to motivating action to avoid the worst of the change, and to meeting the challenges associated with the change that does occur.

2. **You testified that science has not played its appropriate role in decision-making as it relates to sound policies to manage the risks and threats of climate change. As Congress develops infrastructure legislation, how important is it that we update standards and requirements to ensure that those projects will be resilient to current and future sea level rise and extreme weather? Are projections of these impacts sufficiently well-developed and available to include in federal infrastructure policy such as eligibility requirements for federal funding so that projects are built to better withstand those impacts?**

As Congress develops infrastructure legislation, it is extremely important that standards and requirements are updated to account for our best understanding of their likely vulnerability to rising seas and extreme events. While my expertise is in the science rather than policy or economics, it is easy to recognize that absent such standards and requirements, an enormous risk would be taken that could very easily result in tremendous costs in terms of dollars, health, lives, and livelihoods. The risk posture we, as a nation, choose to take is something for policy-makers to debate and decide, but determining the implications and likelihood of such risk postures requires an understanding of the types, magnitudes, and rates of change, and their associated implications. As a result, the best available scientific information should be incorporated into all decision-making and planning, so that informed actions can be taken and appropriate preparations for managing the risks and consequences can be made. Being wrong can cost us dearly, and appropriately incorporating science into our decision-making and planning best positions us to minimize unforeseen consequences.

3. **What resources are available to measure and manage climate risks at localized scales to support decisions about the siting and design of critical infrastructure, housing, and important public assets like schools and hospitals?**

The resources are available and exist within our global, national, and regional *scientific* infrastructure. This scientific infrastructure includes climate and weather models, developed at national labs and facilities, in partnership with universities. It also involves observational networks, made possible by international, national, state, and local investments, as well as satellites to observe processes at scales from global to local. Finally, it involves the scientists, engineers, and others who develop, maintain, and operate these observing capabilities and models, work to understand the processes that govern climate and weather, and seek to understand the implications of change. The United States has a strong scientific workforce to carry out these activities, but observational and modeling capabilities are resource-limited.

An additional consideration that needs to be brought to bear, as was raised in the hearing, is the fact that the adverse effects of climate change on infrastructure disproportionately affect minority and underrepresented communities. As climate risk is incorporated into infrastructure decisions, it is important that these social dimensions of climate change are also considered in the planning, design, and maintenance of buildings, roads, bridges, and other infrastructure elements.

4. **How can the federal government help decision-makers at all levels of government and in the private sector interpret the uncertainties in the models to make better decisions?**

The federal government can help decision-makers interpret uncertainty to make more fully-informed decisions first by ensuring decision-makers are aware that the ranges of predictions provided by the scientific community are themselves just estimates and not hard boundaries/limits on which to base decisions. Decision-makers, faced with real-world challenges and costs associated with decisions, want "a number" to work with. Whether it's how much sea level will rise by a certain date, how many category 5 hurricanes they can expect in a year, or some other manifestation of climate change, and the best that can be provided is a range of predictions with estimates of likelihood. It needs to be understood that even when we say we predict something with 90% confidence, there is still a 10 percent likelihood that what we are predicting will not be the case. That can easily be overlooked.

It would be valuable for government decision-makers to ensure that they or someone on their staff have a clear understanding (through training or experience) of what uncertainty really is, how it is calculated, what it means for planning, and the difference between mathematical uncertainty (the statistical output of a range of scenarios and outcomes) and physical uncertainty (the degree to which we do and do not understand physical processes). Uncertainty will always be a fundamental part of decision-making, but an understanding of uncertainty and its nuances by those who have to make decisions will ensure that decisions will be made with a full awareness of the risks associated with them. Such risk is inherent in any action or planning, and ensuring the most sound use of resources in the face of uncertainty requires an accurate understanding of the bases for that uncertainty and the implications of that uncertainty.

The Honorable Garret Graves

1. **In your exchange with Representative Bonamici, you both indicated that climate change impacts different regions and communities differently (this was also noted by Dr. Greenstone's data). Do you think this conclusion highlights the importance of a collaborative approach between the federal government and states and local communities, rather than a top-down, centralized approach that doesn't take into account the regional differences that exist in the United States?**

This is more of a policy question, but I will do my best to answer from the perspective of a climate scientist. Consider the need for some local/regional entities to determine the heights of sea walls needed to manage sea-level rise. Or they might be setting building codes to manage storm surges and extreme weather, water practices to manage severe droughts, etc. Those are local/regional issues. However, responses to those issues, in my mind, should be informed by research and investments in broader scale practices at the national level. While I would expect a coastal manager to understand that a certain sea-level rise will impact their region in a particular way, I would not expect such a coastal manager to know what the likely sea-level rise would be nor the character of future weather conditions that will impact storm surge. Likewise, I would not expect state and local governments to be in a position to fund studies and test management measures under a variety of conditions. I view these larger-scale activities more as a federal responsibility that can benefit all locales without requiring all local and state governments to make investments in such studies. As a result, in my view, the best approach is a shared approach in which the federal government conducts studies related to predictions, adaptation measures, and their effectiveness, and other aspects of climate change that will affect large areas; and the state and local governments determine which of the adaptation/mitigation measures are best suited to their particular circumstances. The former will involve larger investments, while the latter will permit tailored management approaches.

References Page

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