How to predict the unpredictable in a changing climate

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A glacier supports the large landmass of the Barry Arm fjord. Credit: Frank Kovalchek/Creative Commons

The retreat of an Alaskan glacier in the Barry Arm fjord, caused by rising temperatures, has left a steep and hefty land mass without

structural support. If the hillside collapses in a landslide, millions of tons of rock and soil will plummet into the waters below, generating a wave of water hundreds of feet tall, endangering nearby coastal towns. Perhaps even more troubling, scientists cannot predict the timing of the collapse and resulting tsunami with certainty, making preparation difficult.

Centering its focus on this example, a recent study discusses how studying past trends and using simulations can help to manage the unfamiliar and unpredictable impacts of climate change. Authored by Miriam Matejova and Chad M. Briggs, the paper was published in *Global Environmental Politics*.

One of the key tools that the authors discuss is scenario analysis, which involves studying past trends in order to extrapolate possible futures. For example, scenario analysis can be used to predict population growth, increases in temperature, or future levels of CO_2 emissions. However, studying past trends can only help so much as climate change will bring new risks. In order for scenario analysis to be effective in predicting environmental risks before they become hazards, they must incorporate a higher level of complexity. In many instances, simple models that rely on only one or two variables will not provide accurate predictions of how complicated social and environmental systems will react to change. As an example of how adding complexity helps, the authors highlight an enhanced scenario analysis conducted in Hawaii to look for systemic vulnerabilities to tropical storms or tsunamis on the island of Oahu. New risks related to food and energy infrastructure were identified for which the island in question would be otherwise unprepared.

In addition to scenario analysis, the authors suggest simulations as another way to prepare for impending risks. Simulations are defined as realistic situations which allow participants to train and practice responding to certain circumstances. With their origins in military

settings, simulations, also known as wargaming, have been used to design environments that test, measure and improve behavior and decision-making in complex and uncertain situations. For example, military officers often participate in simulations, learning how to implement certain strategies and tactics while under pressure. For natural disasters, simulations might involve political actors learning how to mobilize large groups of people, institutions learning how to provide proper aid and relief, or communities learning how to make decisions while managing risk.

Whittier, Alaska. A city well within range of the potential Barry Arm tsunami. Credit: Valerian Guillot/Creative Commons

Humans have, to an extent, learned to adapt their behavior based on past experiences and to make plans for disasters based on typical trends. But the Barry Arm tsunami risk highlights a crucial implication of climate change. As the environments and ecosystems surrounding human communities shift, being prepared becomes far more difficult. Beyond just fjords and glaciers, other ecosystems may also develop new, perhaps unnoticeable risks as a result of climate change. How effective will current measures for preparation and response be in the face of unfamiliar and unexpected risks?

In an interview with GlacierHub, Sue Perry, a former disaster scientist for the United States Geological Survey, spoke of her experience with a risk familiar to many today: "In my universe, everyone who ever went near an ocean would know that tsunamis are rare but can happen at any time, and that—depending on how far away the tsunami starts—they could have hours or a scant few minutes to take action. They'd know the warning signs that a tsunami is imminent, how to get to safety, that a tsunami can move a mile or more up rivers, and that tsunamis can send more than one damaging wave ashore." But as circumstances change, communities that were once unaffected will need to learn to manage new disaster threats. Even communities that have had experience with natural disasters may need to adjust as well.

The authors suggest that scenario analysis and simulations should play a key role in identifying weak signals, such as the change in the Barry Arm Fjord, that have been overlooked. They define weak signals as "pieces of information that may seem random but reveal important patterns if interpreted in a new context." Such signals are often ignored, whether it's due to misinterpretations or the psychological avoidance of unfavorable outcomes.

Perry remarked, "We'd make a lot more progress if we (first-world) humans stopped seeing ourselves as the managers and rulers of this

planet. And of course the U.S. might educate its youngsters so that upcoming generations could leave today's ignorance behind." While there are systems in place that help people prepare for natural disasters, many of them may soon be obsolete as natural disasters change in quantity, ferocity and location because of climate change. Through scenario analysis, key weak points can be identified, and through simulations, the necessary political actors, institutions and stakeholders can learn just how to respond to future risks.

Scenario analysis and simulations will always face some limitations. As the authors note, 2020 demonstrated repeatedly that we cannot always predict what's to come. There exists, however, a growing opportunity to attempt to understand emerging risks and to bring together diverse actors and stakeholders in order to manage such risks. Whether it's pursuing research that once seemed unnecessary or connecting communities that were previously unlinked, there are plenty of discoveries to be made. As we barrel into unprecedented times, we cannot rely solely on the precedents of past experience.

More information: Miriam Matejova et al. Embracing the Darkness: Methods for Tackling Uncertainty and Complexity in Environmental Disaster Risks, *Global Environmental Politics* (2020). DOI: 10.1162/glep_a_00591