Hurricane Fiona's legacy: How studying storm impacts can help us better prepare for future events

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Hurricane Lee is currently growing in the Atlantic Ocean and on course for potential landfall in Canada. Can we learn from our past experiences with hurricanes to develop better responses? Credit: NOAA

Hurricane Lee became the busy 2023 hurricane season's first Category 5 storm and one of the most intense hurricanes on record in the Atlantic Ocean. As hurricane Lee's uncertain storm track could potentially take it towards the Canadian Maritimes, it provides a timely opportunity to

reflect on hurricane Fiona, one year after.

The aftermath of hurricane Fiona in Atlantic Canada not only points to the importance of studying how storms affect our communities and their patterns, but also underscores Canada's need to better prepare. It also raises an interesting question: can hurricane Fiona give us a hint about what future climate change might bring to Eastern Canada?

Unraveling this question could lie in understanding ancient storm records.

An unprecedented hurricane

Usually, hurricanes that reach Eastern Canada's shores weaken into post-tropical cyclones as they enter Canada's colder waters. Nevertheless, Fiona reached Nova Scotia with winds as strong as a Category 2 hurricane, thanks to an extraordinary low atmospheric pressure of 931.2 mb. This led to widespread destruction and made Fiona the most expensive extreme weather event in Atlantic Canada's history.

Eastern Canada's coastline is no stranger to destructive hurricane force winds. Situated at the northern edge of the Atlantic hurricane track, the Maritimes region has faced several tropical storms and hurricanes like hurricane Juan in 2003, hurricane Igor in 2010 and hurricane Dorian in 2019.

Between 1900 and 2019, the Canadian Disaster Database recorded 35 similar events that have totaled damages exceeding $300 million. Adding Fiona, with its $800 million in insured damages, will almost quadruple that number.

By most aspects, hurricane Fiona proved to be a record-breaking event in Canada's history, showing us how important it is for communities to

think about long-term resilience. The issue is that we do not have a very good idea of how much hurricanes might affect us in the future, making it harder for communities to prepare for such events.

Challenges in predicting hurricane risks

Estimating whether a hurricane will hit a specific location remains complex. Forecasts are mostly limited to short-term outlooks. For instance, Environment and Climate Change Canada predicted a near-normal hurricane season for 2023, but they cannot offer forecasts for the next decade.

While we may not predict exact hits, it's possible to estimate the chances of a hurricane affecting a certain coastal area each year. A crucial part of this involves calculating return periods for severe storms—how often a hurricane of a certain strength is expected to happen. For example, if a major hurricane has a return of 50 years, we might expect about two of these storms in the next 100 years.

This method, however, assumes that storm frequency remains consistent over time, which isn't always the case and will become increasingly untrue as global warming continues unabated. The climate isn't stationary, meaning what's extreme today might be normal tomorrow, and vice versa.

A hurricane with a 50-year return period today could have that period reduced in the future—perhaps to 20 years. This poses a challenge for communities. Structures and policies to protect communities from harmful storms are based on historical (the last 150 years) extremes, which may not align with future realities.

Reconstructing storm history for resilience

To understand future storms better, we can turn to paleo-tempestology, which examines past storms using natural archives like sediment cores. Storm surges, for instance, can overcome sandy barriers and leave sediment layers in areas normally secluded from storm impacts, like a wetland or a coastal lake. By identifying and dating these layers, we can estimate the frequency of past storms.

With this technique, researchers have uncovered traces of pre-historic storms in various places, including in peat bogs, mineral deposits, blue holes, and even in tree rings. And these investigations often lead to the discovery of extremely powerful hurricanes.

For instance, the flooding magnitude of hurricane Sandy, which hit New York City in 2012, was previously thought to occur once in a thousand years. However, analysis from a Staten Island sediment core revealed an even more intense hurricane related surge dating back to 1821, significantly changing the perception of hurricane risk in that region. This hurricane is known only through historical accounts and had gone under the radar of research since it occurred before regularized data on tide levels became the norm.

More recent research has likewise yielded similar results in a study comparing the return period of a hurricane capable of generating a surge exceeding five meters in Appalachian Bay, Florida, using historical and paleo-storm records. The return period, initially estimated at 400 years based on historical data, was reduced by a factor of 10 to a 40-year return period when incorporating the longer paleo-storm record.

In Eastern Canada, a paleo-storm reconstruction from Nova Scotia showed that the region experienced at least four hurricanes comparable to or more powerful than hurricane Juan between the 15th and 17th centuries.

These studies tell us that relying solely on historical data for protecting our coastal communities can lead to a significant underestimation of hurricane risks. This approach might not provide sufficient long-term protection in an era of climate change.

Canada's window of opportunity

Hurricane Fiona struck Canada during the federal government's effort to establish a comprehensive emergency management model, an effort prompted by a rising frequency of disasters in the last 10 years. Although the resulting National Risk Profile doesn't yet include hurricanes, it plans to in its next public release.

The National Risk Profile is a promising initial step towards building resilience in the face of extreme events. To truly achieve this goal, developing accurate risk assessment tailored to our coastal communities is imperative.

To do so, Canada's government has a responsibility to leverage research into long-term hurricane risks as part of its initial national-level risk assessment. Promoting paleo-storm research in Eastern Canada and integrating it into the National Risk Profile is one way to better protect and enhance the resilience of our coastal communities.

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