New model finds climate change could expose North America, East Asia and the Caribbean to costly hurricane damage

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Image: NASA

If you're planning to build that dream beach house along the East Coast of the United States, or would like to relocate to the Caribbean, a new study by economists and climate scientists suggests you may want to reconsider.

Researchers from MIT and Yale University have found that coastal regions of North America and the Caribbean, as well as East Asia, are most at risk for hurricane damage — a finding that may not surprise residents of such hurricane-prone communities. However, the researchers say by the year 2100, two factors could more than quadruple the economic damages caused by tropical storms in such regions and

around the world: growing income and global warming.

In a paper published this week in *Nature* Climate Change, researchers developed a model to predict hurricanes around the world, looking at how hurricane activity might change in the next 100 years both with and without climate change.

Even in a world without climate change, where rates of greenhouse gas emissions remain stable, the researchers found that annual economic damages from hurricanes could double in the next century: Global population is expected to reach 9 billion by 2100, likely leading to more development along hurricane-prone coastlines. Given such growth, the researchers projected that worldwide annual damage from hurricanes — currently $26 billion — could increase to $56 billion in the next century.

Under a similar economic scenario, but with the added factor of climate change, the team found that annual hurricane damage could quadruple to $109 billion by 2100. According to the researchers' model, proliferating greenhouse gases would likely increase the incidence of severe tropical cyclones and hurricanes, which would increase storm-related damage.

Furthermore, the researchers found that the distribution of damage is not even across the world. Their model indicates that climate change would cause the most hurricane-related damage in North America, followed by East Asia, Central America and the Caribbean. The rest of the world — particularly the Middle East, Europe and South America — would remain relatively unscathed, experiencing little to no hurricane activity.

Treading new territory

Kerry Emanuel, the Cecil and Ida Green Professor of Atmospheric Science at MIT, says results from the model developed by the team may have wide-ranging implications for regional planning and emergency

preparedness.

“It could be used by lots of different people … to understand what resources to put into certain countries to mitigate or adapt to tropical cyclone changes resulting from climate change,” says Emanuel, a co-author of the paper. “For example, urban planners in cities might want to know how high to make the flood barriers if sea levels go up.”

Emanuel worked with researchers at Yale to develop the hurricane prediction model, an effort that combined two disparate disciplines: atmospheric modeling and economics. Emanuel describes the work as “treading new territory,” and the researchers had to “do a lot of back and forth to understand each other’s terminology.”

After sorting out semantics, the group set out to predict tropical cyclone and hurricane activity around the world. The researchers relied on four existing climate models commonly used by the Intergovernmental Panel on Climate Change to assess climate risks. Each of the models track and forecast certain climate variables such as wind, temperature, large-scale ocean currents and ocean temperatures. However, the models only track these variables at a relatively coarse resolution of 100 to 200 kilometers. Since a tropical cyclone that may whip into a massive hurricane under certain weather conditions requires resolutions of a few kilometers, using climate models to simulate storms is highly problematic.

Seeds of a cyclone

Instead, Emanuel and his colleagues embedded a tropical-cyclone model within each climate model. The combination allowed the team to see where storms may develop around the world, based on regional weather systems. The researchers randomly scattered hundreds of thousands of “seeds,” or potential tropical cyclones, throughout each of the four models, then ran the models to see where the seeds developed into

significant storms. There was some variation between models, but in general, they revealed that 95 percent of storms simply dissipate, leaving 5 percent that were likely to turn into hurricanes under favorable conditions such as warm ocean water and high winds. They used enough seeds to generate 17,000 surviving storms in each simulation.

The team also looked at each country's hurricane-related damage after adjusting for its gross domestic product (GDP). The researchers found that wealthier nations like the United States are able to absorb economic losses from a hurricane better than many others, such as island nations in the Caribbean.

"These are all small islands, and most of their GDPs are exposed," Emanuel says. "In the United States , you take all this damage and divide it by the GDP of the whole country, and you get a smaller relative impact."

Dan Osgood, a lead scientist in the financial instruments sector team for the Earth Institute at Columbia University, sees the new model as a useful tool, particularly for the insurance industry.

"Insurance companies [are] hungry for climate research such as this," says Osgood, who was not involved in the research. "Having solid science, they can often offer more reasonable and more accurate prices, providing better deals to consumers, as well as accurate price incentives to help people [avoid] taking unreasonable building risks."

The researchers stress that there was a fair amount of uncertainty in predictions made among the four climate models. For example, in estimating the effect of climate change on tropical-cyclone damage, the models' predictions ranged from $14 billion to $80 billion a year.

Emanuel also points out that "looking at natural disasters strictly through

an economic lens doesn't tell you the whole story." For example, despite a growing economy and population, if severe tropical cyclones become more frequent, people may choose to build elsewhere — a phenomenon Emanuel says an improved model will have to take into account.

Other authors on the paper are Robert Mendelsohn, Shun Chonabayashi and Laura Bakkensen from the Yale School of Forestry and Environmental Studies.

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