One is bad enough, but climate change raises the threat of back-to-back hurricanes

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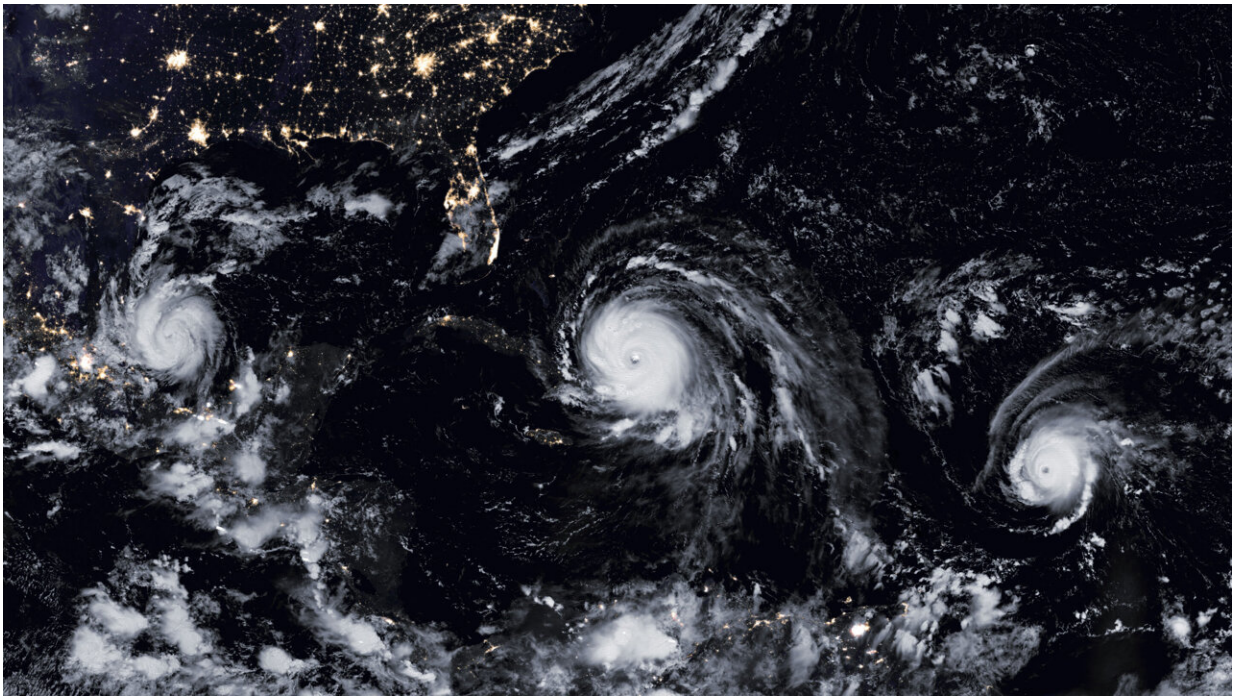

Princeton researchers explored the increasing risk of multiple destructive storms hitting locations on the Atlantic and Gulf coasts. In this image, three storms formed in the Atlantic basin in 2017. Credit: NASA

Getting hit with one hurricane is bad enough, but new research from Princeton University's engineering school shows that back-to-back versions may become common for many areas in coming decades.

Driven by a combination of rising sea levels and climate change, destructive hurricanes and tropical storms could become far more likely to hit coastal areas in quick succession, researchers found. In an article published Feb. 27 in the journal *Nature Climate Change*, the researchers said that in some areas, like the Gulf Coast, such double hits could occur as frequently as once every 3 years.

"Rising sea levels and climate change make sequential damaging hurricanes more likely as the century progresses," said Dazhi Xi, a postdoctoral researcher and a former graduate student in civil and environmental engineering and the paper's lead author. "Today's extremely rare events will become far more frequent."

Researchers led by Ning Lin, an associate professor civil and environmental engineering at Princeton University, first raised questions about increasing frequency of sequential hurricanes after a particularly destructive hurricane season in 2017. That summer, Hurricane Harvey struck Houston followed by Irma in South Florida and Maria in Puerto Rico. The emergency planning challenges raised by 3 major hurricanes led researchers to question whether multiple destructive storms could occur more readily due to climate change, and what steps could be taken to prepare for this. In the late summer of 2021, Hurricane Ida struck Louisiana, followed shortly by Tropical Storm Nicholas, which had made landfall as a hurricane in Texas.

The researchers said their study showed that sequential storms have become more common on the East Coast and the Gulf Coast, although they remain relatively rare.

"Sequential hurricane hazards are happening already, so we felt they should be studied," Lin said. "There has been an increasing trend in recent decades."

The researchers ran computer simulations to determine the change in likelihood of multiple destructive storms hitting the same area within a short period of time such as 15 days over this century. They looked at two scenarios: a future with moderate carbon emissions and one with higher emissions. In both cases, the chance of sequential, damaging storms increased dramatically.

There is a general scientific consensus that climate change will increase the intensity of Atlantic hurricanes in the coming century. But there is some uncertainty in whether the number of storms will increase, decrease, or stay the same over the period, the researchers noted. The model used by Lin's team showed an increasing number of storms, but other models have shown no increase. However, Lin's team found that even without an increase in the overall frequency of storms, the increase in intensity will make it much more likely that areas along with East Coast and Gulf Coast will experience sequential storms.

"The proportion of storms that can have an impact on communities is increasing," Lin said. "The frequency of storms is not as important as the increasing number of storms that can become hazardous."

The increasing hazard is mainly driven by two developments: rising sea levels and increasing precipitation driven by climate change. Sea level rise is occurring worldwide with the changing climate, and it is compounded on the Atlantic coast by geography. As sea levels rise, storm surge becomes more of a threat to coastal communities because the baseline water level is higher. A 3-meter storm surge on top of a historically normal water level is less damaging to roads than the same surge on top of a water level that is elevated by .5 meters. At the same time, storms are intensifying and higher average air temperatures mean that storms carry more water. This means rainfall and flooding from storms are likely to increase.

The combination of both factors means that storms that might have passed with little notice in the past will become threats, particularly when they hit one after another. In 2021, for example, Tropical Storm Nicholas was relatively weak when it hit Louisiana, but the storm caused more problems than expected because the state was still recovering from the destruction related to Hurricane Ida.

"Nicholas was quite a weak storm and one reason it produced a significant hazard was that the soil was already saturated," Lin said. "So there was a lot of flooding."

The researchers said it is important for community planners and regional emergency officials to recognize this emerging threat. Improvements in both resilience and response are required to meet the increasing hazard. For resilience, communities will need to deal with increased flooding threats and harden systems that remove floodwater and protect critical infrastructure such as transportation, water systems and power grids. Emergency response teams will have to be prepared to handle multiple storms in relatively quick succession. On the state and federal level, this could mean being ready to dispatch resources to many stricken communities at the same time.

"If a power system requires 15 days to recover from a major hurricane, we cannot wait that long in the future because the next storm can hit before you can restore power, as in the case of Nicholas following Ida" Lin said. "We need to think about plans, rescue workers, resources. How will we plan for this?"

More information: Dazhi Xi et al, Increasing sequential tropical cyclone hazards along the US East and Gulf coasts, *Nature Climate Change* (2023). DOI: 10.1038/s41558-023-01595-7

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