Unpicking North Atlantic Hurricane Risk:

Exposure changes compound the impact of climate change on hurricane losses by more than twice over

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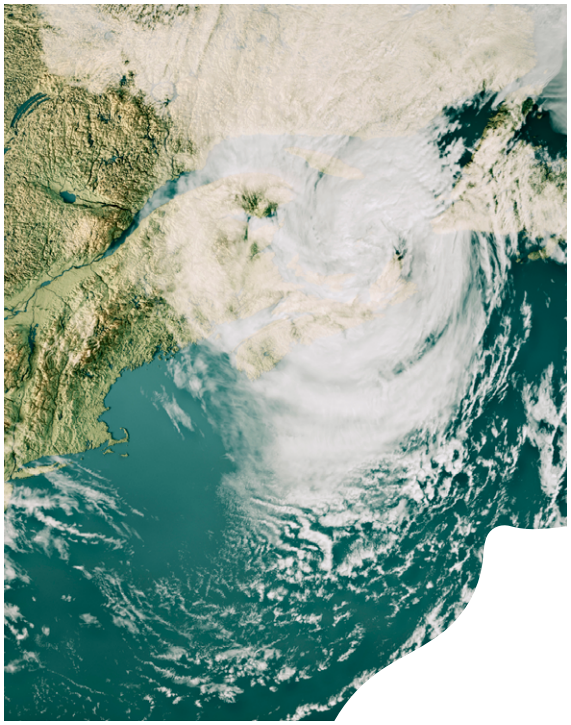


There has been much discussion in the market about the effect of climate change on hurricane risk.

Whilst there remains some uncertainty around changes in tropical cyclone frequency, there is little debate that anthropogenic global warming has increased the severity of North Atlantic hurricanes. A lot of analysis has been directed towards modelling the impact of the change in hurricane severity. But, in our view, an ongoing re-balancing of the discussion between hazard and exposure is needed within a reinsurance context.

Changes in hazard due to climate change is only one part of the picture. Changes in exposure mean more people living in coastal communities in the US than ever before, and inflation driving replacement costs to record levels.

With Hurricane Ian overtaking Maria as the third costliest hurricane to hit the US in terms of economic losses adjusted for CPI[1] and costing re/insurers upwards of $50-65bn alone[2], we've asked ourselves: what is the relative effect of each of these forces?

Inver Re analysis at the end of the 2022 hurricane season estimated exposure effects could have twice the impact of hazard effects due to climate change on hurricane losses between now and 2030. That is assuming a worst-case scenario of two degrees of global warming by 2055 (RCP8.5), under an intermediate scenario (RCP4.5) exposure effects could have four times the impact. This is not to suggest that it is not critically important to mitigate potentially catastrophic effects of climate change within a broader context. But specifically within the context of North Atlantic hurricane risk, changes in exposure are a more significant driver of the increasing cost of these events.

Discussion

Hurricane risk can be broken down into three components: vulnerability, hazard, and exposure.

Vulnerability

The vulnerability of a built environment is complex. Properties in the US are being constructed under improved building codes, ensuring built environments are more robust to repeated hazards. As demonstrated last season in Punta Gorda, first struck by Hurricane Charley in 2004 and again by Hurricane Ian in 2022.

In time, improvements to the built environment should negate the effect of historical building regulations. Such regulations for example allowed contractors in Houston to build over swampland with concrete, potentially exacerbating flooding from Hurricane Harvey by not allowing rainfall water to effectively run off.

Changes in the building code and other mitigation and climate adaptation measures will hopefully help to mitigate the effects of hurricane risk in the future. But at present, changes in hazard and exposure will likely have a more material impact on hurricane risk.

Hazard

The primary components of hurricane hazard are: windspeed, precipitation and storm surge.

Studies have shown that windspeed has increased because of the impact of climate change on oceanic factors such as sea surface temperatures (SSTs). As the earth continues to warm, SSTs and consequently windspeed will continue to increase. Windspeeds are currently estimated to increase by around 3% under 2 degrees of global warming[3].

It is less clear whether relative precipitation has increased to date. Although changes in hurricane translation speed could have contributed to hurricanes dropping more water it is not clear what, if anything, has caused this. Rainfall rates are currently estimated to increase by around 16% under 2 degrees of global warming, but with a greater degree of uncertainty around this than with windspeed[3].

Storm surge has been exacerbated by an increase in sea levels, although it is difficult to quantify the exact impact. Sea levels in the US have increased by approximately 20cm in the past 100 years and a study found that in the case of Hurricane Sandy, roughly half of that sea level rise was attributed to anthropogenic global warming, adding an additional $8bn in economic losses to Hurricane Sandy[4].

The Intergovernmental Panel on Climate Change (IPCC) reports that uncertainty in sea-level rises to 2050 is relatively small and expects increases in gross mean sea-level of between 0.24m and 0.32m on average[5]. Sea levels are expected to rise slightly more on the gulf coast than the east coast of the US but in both cases will likely exacerbate the impact of storm surge.

In summary, under 2 degrees of global warming, hurricanes are expected to become more intense, with higher rainfall rates and storm surges reaching further inland.

Exposure (Inflation & Demographics)

Exposure describes the number of buildings and value of the buildings that are exposed to hurricane hazard.

There has been significant population growth in the eastern coastal states of the US, particularly Florida, which has seen a 60% population increase since Hurricane Andrew in 1992, roughly double the US national rate[6]. Growth has been enabled and encouraged by political factors including the National Flood Insurance Program (NFIP), low taxes and good job opportunities.

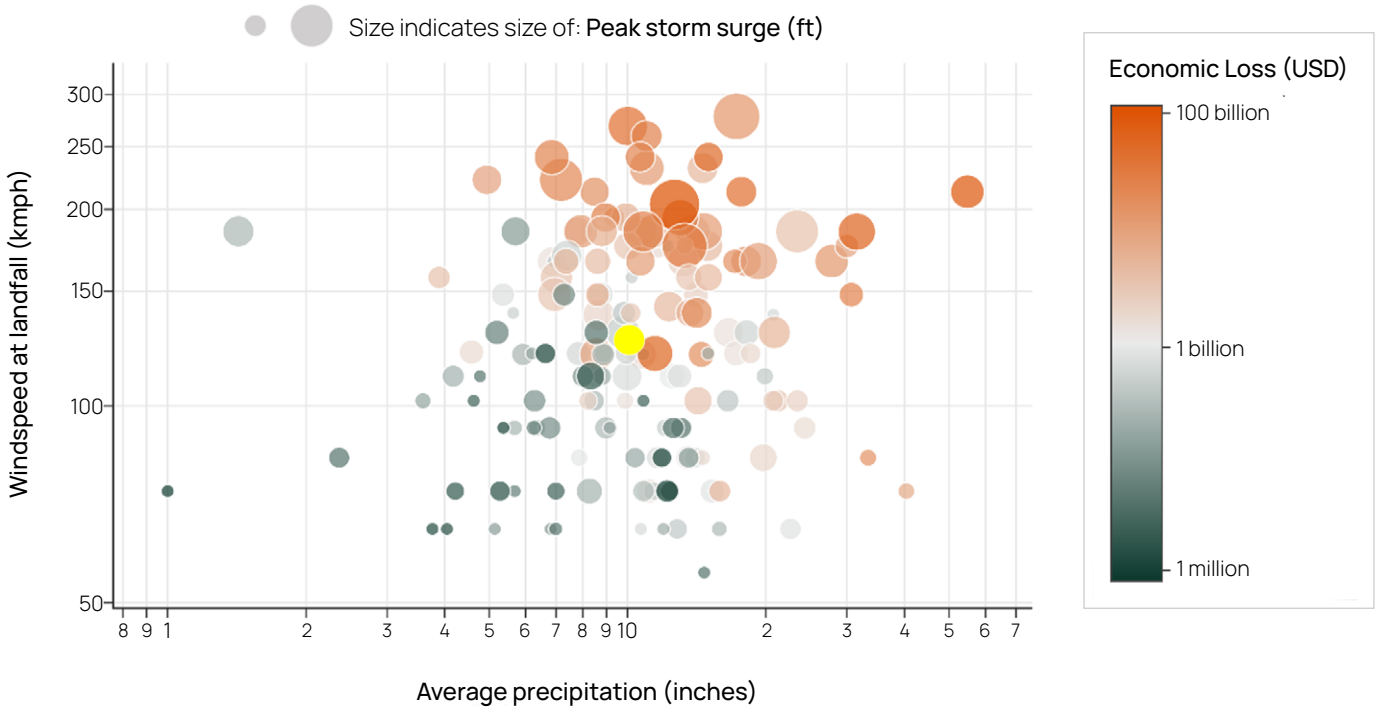
Consequently, there is significantly more property in the way of landfalling hurricanes in the US. Population growth in Florida is expected to continue at least over the next 5 years, at a compound annual rate of up to 2% in areas including key coastal cities like Houston and Jacksonville[7].

Annual US replacement cost inflation averaged 10.8% in the two years up to the start of the 2022 hurricane season[8] and outpaced CPI at a compound annual rate of 2.1% since 2012[9]. COVID-19 had a significant impact on this, but replacement cost inflation outpaces CPI even after normalizing for these effects. The bottom line is that the value of the buildings exposed to hurricane hazard has increased significantly, not only in absolute terms but in real terms too.

Changes in hazard and exposure interact to have a multiplicative effect on economic losses. As the reinsurance industry has experienced, the product of severe hurricane events, replacement cost inflation and demographic trends have made it extremely difficult to accurately predict and price hurricane risk.

Analysis

At Inver Re, we have utilized the latest data science technologies to extract, structure, and validate hazard and exposure data from numerous open sources, primarily the National Oceanic and Atmospheric Administration (NOAA). A set of 164 tropical cyclone events making landfall in the US since 1960 and which it was possible to source data for, are presented in the chart below.



Note: the yellow point represents a Category 1 hurricane event with "average" characteristics

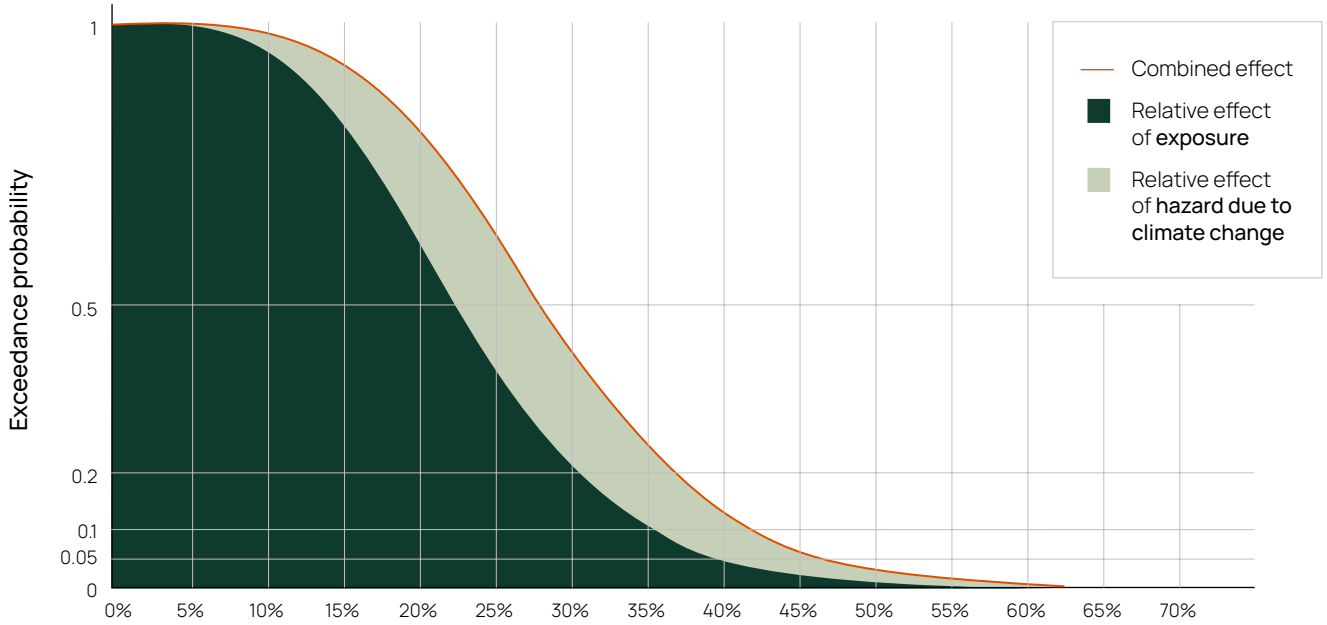
The data demonstrates a clear relationship between windspeed, precipitation, storm surge and economic loss, from which we have developed a top-down model that is able to capture a significant amount of the variance within this set of 164 historic events.

Assuming 2 degrees of global warming by 2100, we have broadly applied the results by Knutson et al. 2020, approximate changes in storm surge based on projected sea-level rises and projected inflationary and demographic trends to estimate the relative effect of hazard and exposure on economic losses out to 2030.

Taking an average Category 1 hurricane event as indicated by the yellow point in the chart above, our estimate of the relative effects of hazard and exposure on a projected change in economic losses over a 7-year period to 2030 is presented in the chart on the next page.

North Atlantic Hurricane: Modelled relative effect of exposure and a change in hazard due to climate change on economic losses

For a Cat-1 hurricane of "average" characteristics making landfall in Florida, assuming 2 degree global warming by 2100 (RCP4.5) and continuation of inflationary and demographic trends since 2002.



Change in CPI-adjusted economic loss by 2030

Our analysis suggests there is a 0.5 probability that economic losses from an average Category 1 hurricane making landfall in Florida increase by more than 28% by 2030, assuming a pathway of 2-degrees of global warming by 2100 and continuation in the inflationary and demographic trends observed over the past two decades. For an increase of 28% or more, the impact of climate change on hurricane hazard is estimated to account for roughly a fifth of the increase, with inflationary and demographic effects accounting for the remaining 80%.

Assuming a worst-case scenario of 2 degrees global warming by 2055 (RCP8.5) there is a 0.5 probability of losses increasing by more than 36%, with the impact of climate change on hurricane hazard estimated to account for just over a third of the increase in this case.

Solution

In our view, this demonstrates the need for the ongoing re-balancing of the discussion between hazard and exposure within the context of North Atlantic hurricane risk.

Fundamentally, it is essential that as a starting point underlying exposures are accurate and up to date, and rate changes reflect underlying inflationary dynamics. Assuming these criteria are met, reinsurers will be much better equipped to navigate a changing North Atlantic hurricane risk.

At Inver Re, we have an insights focused analytics team supporting world class parametric, facultative and treaty capabilities. Together, we are devoted to developing bespoke risk transfer strategies that can help our clients successfully navigate all aspects of this complex and evolving risk landscape.

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