FOCUS/ RISK MODELLING

The most damaging hurricanes are not becoming more frequent

Recent hurricane activity has to be put into its proper perspective before climate change can be attributed as a cause

Miami beach after the hurricane of 1926, still the most damaging storm in US history, based on estimated insured losses and current exposures

Peter Sousounis
AIR Worldwide

Given the many intense hurricanes that have developed in the Atlantic basin in just this century, the most recent of which are Harvey and Irma, it is natural to ask whether climate change is having an effect on the frequency and intensity of hurricanes in the Atlantic. Irma set the record for sustaining 185 mph winds, at 37 consecutive hours. It almost set the record for accumulated cyclone energy (ACE), but landed in second place behind 2004's Hurricane Ivan.

$128bn
Likely insured losses were the Miami hurricane of 1926 to happen today

Harvey was no slouch either, making landfall as a Category 4 hurricane and generating all-time precipitation records in the US. In the recent past, 2012's Hurricane Sandy walloped the New York City area with unprecedented storm surge, and in 2005, Hurricane Wilma set the record for lowest sea-level pressure in the Atlantic. Earlier that same year, Hurricane Katrina caused catastrophic damage to property as well as causing thousands of casualties. There are other recent examples, so it is not surprising that public perception is that intense storms are becoming more frequent.

However, recent hurricane activity has to be put into proper perspective before such perceptions can be ascertained as fact and climate change can be attributed as a cause. It is important to remember that reconaissance flights have occurred regularly for all Atlantic storms identified by satellite since the late 1960s, whereas storms such as the Galveston Hurricane in 1900 and the Great Miami Hurricane in 1926 (see chart), never had the benefit of being measured several times a day to compute their maximum sustained wind speeds over the open ocean or their ACE. Before the late 1960s, hurricane assessments could really only be made on board ships at sea or at landfall. While there are earlier records of hurricanes at sea, it is likely the numbers, and possibly the intensities and lifetimes, of these storms are underrepresented.

Basin activity and landfall activity

The potential impact of climate change on basin activity has implications when it comes to insured losses. However, it is important to distinguish between basin activity and landfall activity. Not all hurricanes that form in the basin make landfall, so many of them do not cause damage or more specifically, insured losses. Two other important aspects to consider when comparing insured losses caused by hurricanes now against those in the past are inflation and growth in the number of coastal properties at risk over the years. The last consideration is an especially important one, as now there are simply more buildings and contents that can be damaged. To level the playing field and get a truer perspective of the influence of climate change on insured US hurricane damage, it is important to take that growth into account. Accounting only for inflation is insufficient.

This article lists the top 10 historical US hurricanes since 1900 based on insured losses. These rankings were calculated using the 2017 AIR US Hurricane Model, which includes the AIR industry exposure database (IED) and reflects the counts of all insurable properties and their respective replacement values at end of 2016 conditions. Inflation is also accounted for by virtue of IED replacement values in 2016 dollars. The loss numbers in the chart represent what these events would cost the insurance industry today, based on AIR's detailed IED and peril-specific take-up rates (insurance penetration).

Before examining any historical trends in the events, it is interesting to note some of the storms that do not make the top 10 list. Many of the storms mentioned earlier are not on the list. In fact, the only storm this century to make the list is Hurricane Katrina. Hurricane Sandy, which caused $19.1bn in insured losses, is not on the list. Many of the storms on the list affected Florida and the Gulf Coast – including Texas. In fact, the costliest on the list is one unknown to many: the 1926 Great Miami Hurricane. This Category 4 storm made a direct hit on Miami but, at the time, Dade and Broward counties only had a combined population of roughly 135,000. With a combined population of more than 4.5 million today, that storm would likely result in insured losses of $128bn. Storms make the list not only because of their Saffir-Simpson category at landfall, but also because the areas they impacted have experienced tremendous growth in the number of properties since. The recent rapid growth of Houston is another unfortunate prime example. Harvey is not on the top 10 list because it was not a major wind and surge event, the sub-peril losses upon which these rankings are based. And while the insured losses for wind and surge have yet to be tallied for Irma, this storm will not likely crack the top 10.

Most damaging storms

A quick tally of when the most damaging storms occurred shows six of the top 10 events occurred before 1950; four of those before the Great Depression. While these facts may suggest there is no increasing trend in Atlantic hurricane activity, it is important to realise several limitations of applying these results to draw such a conclusion.

First, this list of storms only captures the landfalling and loss-causing activity. Basin activity could tell a different story. We simply don't know that story, as the data is insufficient.

Second, the list only focuses on the top 10 loss-causing events. Again, the story could be different if we were to compute the average annual loss (AAL), for example. This would require running the complete historical record through the US Hurricane Model, accounting for uncertainties in features such as the radius of maximum winds and gradient wind reduction factors for all events.

Third, all storms regardless of when they occurred, use the latest sea levels. A well-known argument for climate change is rising sea levels; roughly 20 cm since 1900 but varying regionally. It would be a more complete comparison to use the 1900 sea level for the 1900 Galveston storm, etc. But even if that information were available, because of the way storm surge losses are factored into the insured loss estimate (10% of surge losses are added to wind losses) of the model, it would not likely change the results. Insurable or economic losses could again yield a different story.

The results in the chart should be taken at face value until additional data are available. Importantly, they do answer the headline question "Are the most damaging hurricanes to the US becoming more frequent? To, this we can confidently answer, "No."■

Dr Peter Sousounis is director of meteorology at catastrophe modelling firm AIR Worldwide

Table: Estimated insured losses for the top 10 historical hurricanes based on current exposures

Date	Event name	Category	2017 insured loss*
Sept 18, 1926	Great Miami Hurricane	4	$128bn
Sept 17, 1928	Great Okeechobee Hurricane	4	$78bn
Aug 29, 2005	Hurricane Katrina	3**	$64bn
Sept 17, 1947	1947 Fort Lauderdale Hurricane	4	$62bn
Sept 9, 1965	Hurricane Betsy	4***	$57bn
Aug 24, 1992	Hurricane Andrew	5	$56bn
Sept 10, 1960	Hurricane Donna	4	$50bn
Sept21, 1938	The Great New England Hurricane	3	$50bn
Sept 9, 1900	Galveston Hurricane of 1900	4	$49bn
Aug 17, 1915	Galveston Hurricane of 1915	3	$25bn

*Modelled loss to property, contents, and business interruption and additional living expenses for residential, mobile home, commercial, and auto exposures as of December 31, 2016 Losses include demand surge and account for storm surge.

**This refers to Katrina's second landfall in Louisiana.

***This refers to Betsy's second landfall in Louisiana.

Harvey and Irma affirm value of new cat models

The traditional catastrophe model output does not provide the timely and granular data senior executives want when storms like Irma and Harvey are unfolding

Karen Clark
Karen Clark & Company

A borderline category four/ five hurricane with 155 mph wind speeds is headed for downtown Miami with a track that threatens the most densely populated areas of Florida. The projected track then shifts toward the west coast of Florida and the most vulnerable areas in the US with respect to storm surge flooding.

Re/insurer chief executives and boards want credible estimates of what their wind and flood losses are going to be with each change in track and intensity. As the in-house catastrophe modelling expert, what information are you going to provide to senior management in real time?

The traditional cat models do not give much guidance or information on real hurricanes as they are unfolding. The newer RiskInsight open loss modelling platform is the only cat model that gives insurers estimated claims and losses by line of business and geography for actual events in real time.

Real-time loss estimates are important for claims-planning purposes and to verify the accuracy of the model. If a model can accurately reproduce losses for actual events, re/insurers can have more confidence in the loss estimates for the hypothetical events underlying the exceedance probability (EP) curves.

Cat modelling experts using RiskInsight were able to generate high-resolution wind and flood intensity footprints every few hours starting days before Hurricanes Harvey and Irma made landfall. RiskInsight produces the footprints using storm track information provided by the National Hurricane Center (NHC) and other meteorological organisations and powerful algorithms based on the most up-to-date scientific research and formulas.

Once accurate intensity footprints are created, they are used to estimate industry-wide and company-specific losses, including the numbers of claims and average claim severity by intensity band (wind speed and water height). The NHC projected track for Hurricane Harvey was consistent and relatively accurate days before landfall, so insurers could plan their claims-adjusting activities well in advance, particularly for the severe wind and storm surge damage along the coast.

Less predictable

Hurricane Irma was a less predictable storm that seemed to conduct a complete survey of the Florida coastline before deciding on the landfall points of Cudjoe Key followed by Marco Island. But when this hurricane was threatening to make landfall near Miami as a strong category four hurricane, it appeared Irma would be the "Big One" with an insured loss of significantly more than $150bn.

We got lucky with Irma. Had this storm taken a different track, insured losses could well have exceeded the probable maximum losses (PMLs) and reinsurance programmes of many Florida insurers. The current frailty of the Florida market – driven in large part by the over-reliance on PMLs – would have been painfully exposed with likely unwelcome and unanticipated consequences to the private market.

Karen Clark & Company (KCC) has been warning for some time that PMLs are not sufficient risk management metrics, and they can mask exposure concentrations and give a false sense of security. The PMLs are generated using a sample of randomly generated hypothetical events. A particular random sample may not include a direct hit on Miami by a category five hurricane. Using randomly generated events, some sections of coastline may be under-sampled and others over-sampled with respect to major hurricanes.

Another issue with the current usage of PMLs is that they vary widely depending on which model (or model version) is used and which levers are turned on and off. For the same insurer and set of exposures, the PML can differ by a factor of two or three.

Characteristic events

The characteristic events (CEs) are better risk metrics for monitoring and managing exposure concentrations that can result in solvency-impairing losses. Using the CE methodology, the 100-year hurricane is defined for each coastal region and that event is simulated at evenly spaced gates along the coast. The result is a complete and insightful view of expected losses from the 100-year hurricane and where, geographically, losses are likely to go over the PML.

For example, the 100-year CE for south Florida is a category five hurricane with peak winds similar to Hurricane Andrew in 1992. Andrew made landfall near Homestead, well south of Miami, and all the models agree that if Andrew occurred today, the insured losses would be $50bn for the exact same storm. KCC estimates that if Andrew had shifted 20 miles north it would cause more than $200bn in insured losses today.

While the probability is low for any specific landfall location, it's equally likely a major hurricane will make landfall in Miami rather than Homestead.

Chief executives do want reliable estimates of losses as live events are unfolding – what they do not want are surprises. CEs eliminate unpleasant surprises by illustrating, in advance, where companies can have large losses and outsized losses relative to peers. Senior management should be fully informed on what their losses and share of industry losses would be from equally probable events at all landfall points so they can take appropriate action to reduce any unwanted exposure concentrations before the events occur.

The traditional catastrophe model output does not prepare insurers for the losses they could experience or provide the timely and granular data senior executives want when storms like Irma and Harvey are unfolding. Neither do the Lloyd's realistic disaster scenario events provide enough guidance on large loss potential.

Harvey and Irma clearly demonstrated the power and affirmed the value of newer cat models that can track hurricanes in real time, produce accurate loss estimates, and provide more insightful and operational information on large losses before the events occur.■

Karen Clark is chief executive of Karen Clark & Company

Maps: Hurricane Irma's actual and alternative tracks. and resulting estimated losses