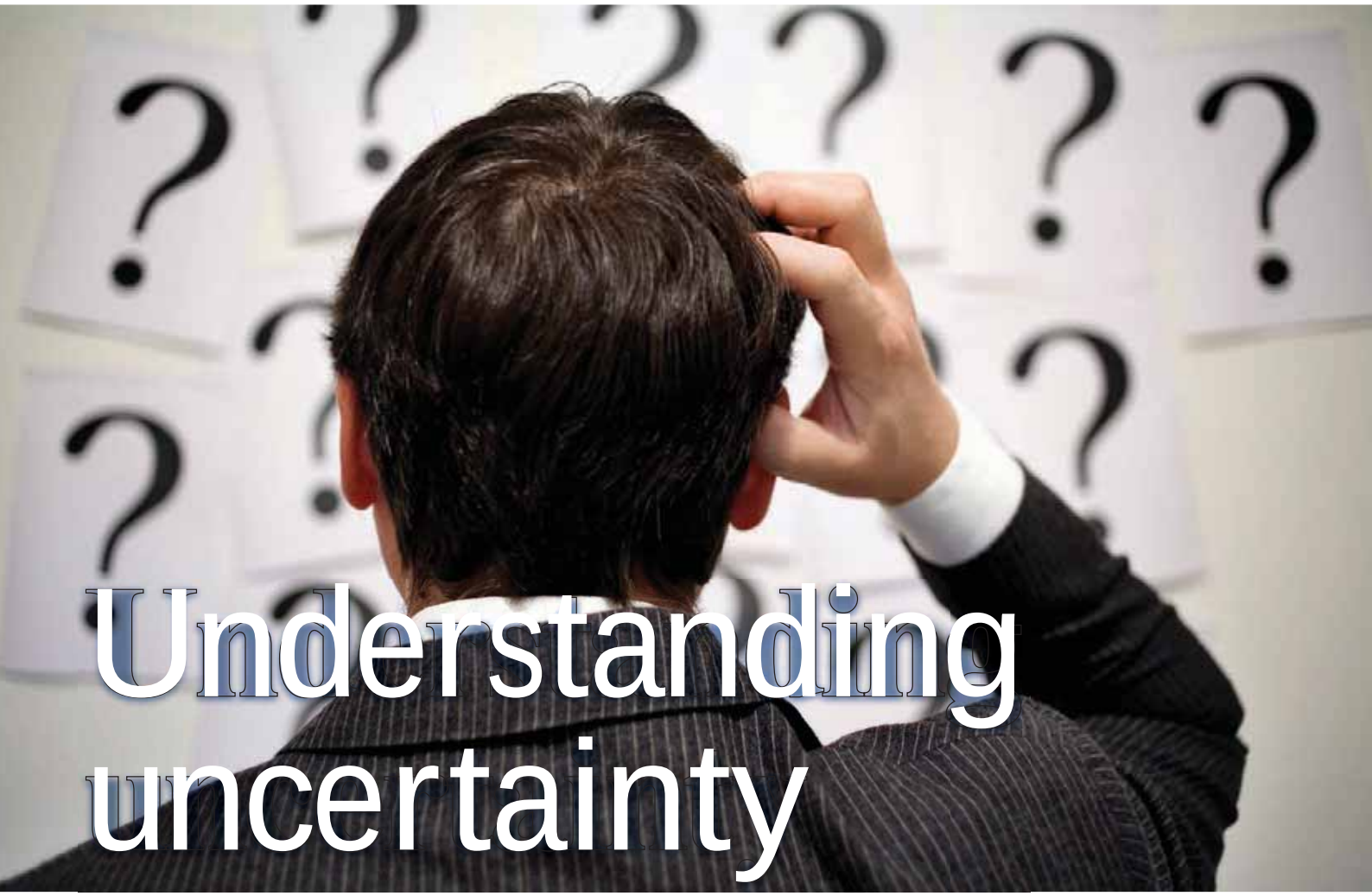

Understanding uncertainty

Catastrophe models have come a long way in 20 years, but big gaps remain in the science and data that sits behind them.

"One must never forget that models are not the world," wrote financial engineers Emanuel Derman and Paul Wilmott in the Financial Modeller's Manifesto. Their statement was a call to action for the financial risk management community following the financial crisis. "Whenever we make a model of something involving human beings, we are trying to force the ugly stepsister's foot into Cinderella's pretty glass slipper. It doesn't fit without cutting off some essential parts. And in cutting off parts for the sake of beauty and precision, models inevitably mask the true risk rather than exposing it."

The banking crisis provides the ultimate cautionary tale in what can happen when you rely too heavily on modelled outcomes. While financial modelling is a different discipline from catastrophe modelling, the problems that led to the banking crisis were down to institutions' misunderstanding of the true nature of the risks they were taking on. Insurers and reinsurers are equally in danger of taking what the catastrophe models say as gospel.

Catastrophe models have become invaluable tools for the insurance and reinsurance industry. The models are computer-based programmes, based on scientific understanding of natural perils, which help underwriters estimate potential losses to their portfolios in the event of a catastrophe. This helps them manage their exposures. The problems arise when large events actually happen. Rarely do real-life events such as September 11, Hurricane Katrina and last year's Hurricane Ike exactly mirror the model outcomes, and this frequently invites criticism.

The backlash after Katrina was particularly strong as insurers and reinsurers reeled from the magnitude of the losses, but not all believe it was justified. Many thought it was a case of the workman blaming his tools.

"I think the models have come a long way and are extremely valuable to us in the industry and, notwithstanding what some people said about Katrina, I almost think some of that commentary was unfair," says Trevor Maynard, emerging risk manager at Lloyd's. "You can't expect models to model all eventualities like failure of levees, because they're binary outcomes that might or might not happen."

Karen Clark, president and CEO of consulting firm Karen Clark & Company and founder of cat modelling firm AIR Worldwide, thinks the problems exposed in the financial crisis are a great analogy of what can go wrong when insurers and reinsurers blindly follow catastrophe model outcomes. "It's a situation where you had lots of very smart people in the backroom, building these models and there was very little vetting of the quality of the data going into the models or the credibility of the output." She quotes Warren Buffet, who famously warned to "beware of geeks bearing formulas".

Having spent two decades as the figurehead of one of the three vendor modelling agencies, it came as a surprise to many when Clark stepped down two years ago to set up Karen Clark & Company. What came as an even bigger surprise was the company's remit – to warn clients against overdependence on the models. But it is because of her pedigree in the modelling profession that Clark thinks she is in a position to help companies fully understand the models' limitations.

"The fundamental structure of the catastrophe models has not changed since the 1980s," she explains. "What has changed dramatically is increasing computer power. Computer power has increased by several orders of magnitude. The problem is that our scientific knowledge has improved, but is generally the same order of magnitude as it was two decades ago."

Inexact science

The models are constrained by the datasets they rely on. For US earthquake models, this data includes information from the US Geological Survey. Both Risk Management Solutions (RMS) and AIR have released updated models for North American quake that take into account advances in scientific research, including the 2008 USGS National Seismic Hazard Maps. The updates mean a reduction of 10% to 25% for the average insurer across all lines of business, according to RMS.

The most important changes will be in California, where modelled loss estimates will decrease by 5% to 10% for most commercial portfolios and a whopping 25% to 35% for most residential portfolios. This change "should be yet another reminder of the uncertainty around the earthquake peril and the catastrophe models", says Clark.

While the modellers need to continue building new research into the models, she believes the science can be oversold. "The problem is in marketing the models – and it is competitive because there is more than one modelling agency out there. There's a lot of talk about new scientific knowledge, but what the users have to understand is most of this new scientific knowledge is new research or a new theory – it's generally not new fact. There are relatively few scientific facts that underlie the catastrophe models. That's why the loss estimates from the different vendor models can vary so widely."

She questions the value of the near-term hurricane models that were released in 2006 to reflect a period of heightened hurricane activity. The updates followed the devastating hurricane seasons of 2004, where four hurricanes made landfall in Florida, and 2005, which saw Katrina, Rita and Wilma bring insured losses of close to $60bn. "Because we had a couple of bad years in a row there was a lot of pressure, but this is another example where we believe the industry has pushed the models beyond their capability to provide credible information," says Clark.

Clark points out that the near-term models will have been wrong three out of four years if the 2009 season turns out to be a below-average year for hurricane activity. At the time of writing, there had been a late start to the season with Hurricane Bill looking threatening but forecast to veer away from the US coastline. "The models can't pinpoint loss estimates accurately at an individual location level and they cannot predict what's going to happen over short time periods," she says. "They were never intended to do that."

"We can't predict if we're even going to be able to have a barbecue at the weekend so we have to understand the limitations of models. It's a chaotic climate system out there and anyone who thinks they're going to predict the weather is sadly mistaken."

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One reason why cat models have seen so little scientific advancement is down to the infrequent nature of catastrophes. Large earthquakes, catastrophic flooding and landfalling category 4 or 5 hurricanes thankfully do not occur with regular frequency. This means scientists have to rely on historical records to assess the perils.

"There's a sense that the science is not at the level that it really needs to be," says Christopher Schaper, chief underwriting officer and head of reinsurance of Endurance's Bermuda operation. "There are several organisations putting forward PhDs and other highly specialised experts to better assess cat risk. The only way to confirm the scientific data embedded in the models and the accuracy of the expected results is for actual events to take place. However, the events themselves are not frequent and therefore it is difficult to verify whether the models are actually performing as expected."

Mind the gap

Underwriters need to understand the limitations of the models they use to make sound decisions. This involves taking stock of the company's own knowledge of the cat exposures sought to be underwritten and using that information in conjunction with the models. Schaper explains, "We develop our own proprietary assessment tools which, along with the models themselves, enable us to better assess the risks we are taking."

This approach is useful when assessing catastrophe exposures in parts of the world that are not well modelled. While peak catastrophe zones like US earthquake and US hurricane have enjoyed plenty of modelling investment, other perils are not as well understood.

"Actual events provide valuable insight into how portfolios behave, which is an essential part of using the models correctly," says Schaper.

Hurricane Ike provided an excellent opportunity to assess catastrophe risk analysis at Endurance. "We decided to evaluate the different parts of our portfolio: those that overperformed, performed as expected, and underperformed. We found that in the portion of the portfolio that underperformed, there were exposures that had certain characteristics and, as a result of that knowledge, we altered our portfolio for the next renewal cycle to reduce some of those exposures within our portfolio," he explains. "It's really important for reinsurers to conduct a formal assessment of their portfolio after each of these events – it's the only way anyone is going to learn – and we do learn quite a bit when these events happen."

"With each event, with each new version, models do get better as our knowledge increases. However, upgrades to models need to stop being seen as destinations of revealed truth, but as mileposts along a continuum understanding."

Hemant Shah, CEO of RMS

Poor data quality is another problem for many companies. Reinsurers rely on the data provided by their cedants, much of which is still collected on legacy systems geared more towards assessing fire hazard than exposure to catastrophes. Reinsurers have a responsibility to view in greater detail the properties they are reinsuring within their portfolio, says Schaper. He explains: "Those insurers and reinsurers that are truly strong firms are always trying to improve both their exposure and scientific data."

The first practical test for catastrophe models came with Hurricane Andrew in 1992. The hurricane, which cost insurers $15.5bn, was a market-changing loss that took many by surprise and prompted industry-wide take-up of the models. The vendor cat modelling agencies responded by improving the sophistication of their systems, while many insurers and reinsurers looked to apply the models to underwriting decision-making in a more formal way.

Reinsurers that originally led the use of cat models were based on Bermuda, many of them backed by investment banks. "They had a different way of looking at risk than the existing traditional reinsurance industry," explains Michael Schrah, executive vice-president and chief risk officer of Endurance Worldwide Reinsurance. "They introduced the use of portfolio theory – RenRe was a pioneer – so that the use of cat models was very different from the traditional approach reinsurers had used before key events like Hurricane Andrew and the Northridge earthquake."

The models evolved but the next real test was on September 11 2001. Both the magnitude of this event and the correlation of classes of business as diverse as property, aviation and fine art, took the industry by surprise. Then in 2005, Katrina offered up some further lessons, including the inability of the models to account for the breached levees in New Orleans and subsequent flooding or accounting for the impact of demand surge. As recently as 2008, Hurricane Ike defied the models' projections for a category 2 storm. It had a wide footprint and took longer than anticipated to disperse as it moved inland.

"What we learned from Hurricane Ike is that the gaps in many of the models are alive and well – even for some of the most predictable types of risk," says Schrah. "Definitely more caveats have been placed upon the use of the models since Hurricane Katrina. Up until that point nobody was willing to publicly say how big the gaps in the models were, but Hurricane Katrina laid bare a lot of issues. I wouldn't say the models have improved tremendously since then – in my view, the same gaps that existed with the models at the time of Hurricane Katrina still exist today."

While most underwriters know the models have limitations, it is not always easy to account for this uncertainty in practice. One issue is rating agencies' and other stakeholders' preference for point estimates, such as probable maximum losses (PMLs) and long return periods, for example, one-in-100 and one-in-250 years. "This requires a level of accuracy that does not exist in the real world," says Schrah. "The industry as a whole has not bought into just how much uncertainty there still is in the cat models in use today. We're being required to treat expected losses as certainties rather than as point estimates on a wide range of possibilities."

The next 20 years

Catastrophe models have evolved considerably in the 20 years since their inception, and are likely to see further adjustments over the next 20 years. Whether the science improves considerably depends largely on what catastrophic events occur, but uncertainties are likely to persist. Models are not forecasting tools, says Maynard from Lloyd's. "We can't predict if we're even going to be able to have a barbecue at the weekend so we have to understand the limitations of models. It's a chaotic climate system out there and anyone who thinks they're going to predict the weather is sadly mistaken."

While models can be adapted to incorporate new information, they will remain limited to assessing long-term probabilities. Unlike the predictive modelling techniques being used to assess future climate, catastrophe models can only go so far in reflecting changing hazard trends. It is possible however, that well-understood climate drivers such as the El Niño/La Niña cycle could be reflected in the model outcomes. The near-term view of hurricane activity now is based on the anticipated warm phase of the Atlantic Decadal Oscillation.

"With each event, with each new version, models do get better as our knowledge increases. However, upgrades to models need to stop being seen as destinations of revealed truth, but as mileposts along a continuum understanding," says Hemant Shah, CEO of RMS. He thinks modellers have a responsibility to better communicate to users what the models do and what they do not do. Better transparency, he hopes, will encourage insurers and reinsurers to look beyond the PMLs and have a more informed dialogue.

"Users need to ask their modellers: 'What are the key assumptions, how reliable are they, and how sensitive is my portfolio to plausible alternative assumptions for key variables? How much uncertainty is there in my risk measurements and how do these uncertainties vary across my book of business? What might the model be missing and what is the extent of the basis risk between the model and its approximations and the idiosyncrasies of the actual exposure? How brittle is my portfolio and what is the risk that I am optimising my strategy to a set of assumptions that could change in the future?'"

Whatever the next big insured loss – whether it is a hurricane that makes landfall on the US Gulf coast or north-east coast or a large Tokyo earthquake – the models will undoubtedly be useful for assessing loss, but unable to capture all the dynamics. As insurers and reinsurers come to terms with the loss and get busy assessing the damage and processing claims, there is also an opportunity to assess their own model performance and make necessary adjustments to portfolios.

But it is the modellers that should lead the way, says Shah. "In many ways, the most important insights about a model are not an appreciation for sophistication of its formulations, but an acute awareness of how wrong it could be and how it is useful despite these limitations. Gaining these insights are more than a shared responsibility between the users and developers of models. More than ever, it is the modellers who need to show leadership to truly internalise a profound understanding that their models need to be far more transparent so that those who use them can use them responsibly." ●

By Helen Yates, a freelance journalist