



Looking beyond the catastrophe model

The Japanese earthquake exposed the limitations of cat models. Here, the industry's founding figure talks to RASAAD JAMIE about how catastrophe-modelling companies can improve the accuracy of their loss projections

THESE days, Karen Clark frequently finds herself having to explain to journalists that her criticism of certain aspects of the catastrophe-modelling sector is not directed at either the catastrophe models or at the risk modellers themselves. The situation largely reflects the rise in the profiles of both Clark and her Boston-based catastrophe risk consultancy, Karen Clark & Company (KC&C) over the past four years. It does, however, matter a great deal to her that she is not perceived to be disparaging an industry she virtually created from scratch in 1987 when she devised the world's first hurricane cat model and founded the first cat-modelling company, Applied Insurance Research (AIR), now AIR Worldwide.

She served as chief executive of AIR until 2007, when she left to set up KC&C. From the very beginning, the company adopted a distinctly independent stance in relation to the risk-modelling industry; it is, notably, not slow to challenge some of the industry's most deeply held assumptions. It is an attitude that very much informs KC&C's annual reports on the performance of the near-term (over the five-year period 2006 through 2010) hurricane models produced by the three major cat modellers: AIR, Eqaecat and Risk Management Solutions (RMS).

Near-term models, Clark says, were introduced in 2006, following the destructive and costly 2004 and 2005 hurricane seasons. In the wake of hurricane Katrina there was a lot of "model bashing", she notes: "It was felt there were a lot of factors the models were underestimating. At the same time, a lot was being written on global warming and its relationship to hurricanes. So the dynamics of the environment were such that the modellers really felt they had to look inside their models and review the different components, and that contributed to introduction of these near-term models in 2006 by all of the modelling companies."

It is a development that reflects the importance of catastrophe risk management for the US insurance industry. Catastrophe claims make up the largest component of property losses today. "In the US homeowners' insurance market, 30% of the premium dollar is taken up by actual and expected catastrophe losses," Clark explains.

The third and final KC&C report, which was published in January of this year, found the near-term models, designed to project insured losses in the US from Atlantic hurricanes, have significantly overestimated losses for the period. The two earlier reports came

to the same conclusion for the 2006 through 2008 and the 2006 through 2009 seasons. Interestingly, all the modelling companies more or less had the same projections for the first year of the 2006 to 2010 near-term period. "All the models pretty much said hurricane activity and losses were going to be 40% above average, which is a huge amount," she says.

Little hard data

As it turned out, hurricane activity for the projection period was well below average. For example, hurricanes making landfall in the US between 2006 to 2010 were 53% below average. The losses, Clark notes, were 70% below average. "We had minimal losses in every year except 2008. So how well did the models do? Our conclusion is they have not demonstrated any skill. They have not shown any ability to accurately project near-term hurricane losses. And that is not surprising because there is very little hard scientific data to support these near-term projections."

She has no doubt the modellers are using the best science available. "But we also know science can lead to numbers that go awry and that is because there is not a lot of data underlying that science. Scientists have the same problem actuaries do – if you don't have a lot of data, you have high uncertainty. So our approach at KC&C is to look at the numbers and at the facts. There are so few facts we at least should be looking at those facts."

One of Clark's central arguments is the problem is not with the models. "The models are great and we are not criticising the modellers for developing the near-term models, which have the purpose of providing their clients with different views of hurricane risk. We totally think that is the right thing to do. However, models are just models. They do the best they can. What is inappropriate is the extent to which the marketing hype oversold the near-term models and the science underlying them."

Global warming

According to Clark, an important factor not being taken into account is that the more sophisticated climate models are projecting a decrease in hurricanes as a result of global warming. "And that is a statement that comes from the Intergovernmental Panel on Climate Change [IPCC] in its most recent report. Now, there is some evidence storms may become more intense over time because of rising sea-surface temperatures. And if that does occur, it is going to be a gradual increase over time. It is not going to be a 40% increase over the course of a year. So we can

all agree this is a development we should be monitoring, but we have to be careful how we implement it in our models."

Clark says all the marketing hype around the near-term models gave the false impression there was a general scientific consensus hurricane losses were increasing and were going to be significantly above average for the period 2006 to 2010. "RMS most aggressively marketed this new model as a replacement for the standard model. Rather than an alternative view, it said all companies should use this model."

For its part, the industry is more or less compelled to take note of Clark's interventions. She is by far the most high-profile and decorated figure in the sector. In addition to a number of industry awards, in 2009 the National Association of Insurance Commissioners appointed KC&C as the lead consultant in developing a recommendation on the scope, timeline and potential costs of building a national catastrophe multi-peril model for personal lines risks in the US. On the international front, she was presented with an award certificate for the 2007 Nobel Peace Prize bestowed on the IPCC, an organisation with which she has worked since 1995. The IPCC chairman, RK Pachauri, said the IPCC had provided certificates of the award only to those who contributed substantially to the work of the organisation over the years since its inception.

Novelty

This is a far cry from the 1980s, when catastrophe risk modelling was such a novelty one of Clark's key roles was to explain its objectives to the wider world, particularly to the insurance industry.

Clark recalls when she was at university in the early to mid-1980s, computers had just started to be used for financial and economic modelling. "I loved using the computer to build models to generate financial information that could be used to make decisions," she says.

After graduation, she worked with a small group of about six or seven people in the research and development department of an insurance company in Boston. "We were internal consultants. Our role was to come up with ways to help this company deal with problems that were not being addressed by traditional actuarial and underwriting techniques. Catastrophe risk, of course, came under that category. This company had significant coastal exposures and I was given the project of finding a better way of calculating the losses it could sustain from a hurricane. That was how it all started. I just

fell in love with catastrophe modelling. One thing led to another and I ended up devoting my whole career to it."

Not surprisingly, it was tough going for the first few years after she set up AIR in 1987. One of the first places she went to was Lloyd's. At that time, there were no prominent Bermuda companies and although there were some very big US companies writing property cat business, it was mainly written from London by the Lloyd's syndicates. One of Clark's first contracts was with the reinsurance broker EW Blanch (subsequently absorbed into Aon Benfield) to develop a catastrophe risk model the company could use for its clients.

Way off

Clark says before she developed the first hurricane model in the 1980s, insurers and reinsurers were grossly underestimating their potential losses by about a factor of 10. "They were way off," she notes.

There were a number of reasons for this. First, there had not been a major storm in a highly populated area for decades. Second, in the mid-1980s, the largest loss the insurance industry had experienced was slightly more than \$1bn from hurricane Alicia in 1983. Third, in 1986, there was a highly influential study by the USAI Industry Research Advisory Council (AIRAC) which focused on the potential for a \$7bn insured hurricane loss. "So that number became the industry benchmark for a worst-case scenario," Clark says. "At the same time, our hurricane model said the insured losses could reach \$60bn. This

was very different from what the rest of the industry was thinking."

Tracking exposures

But, according to Clark, the major reason the industry was underestimating their potential losses by a factor of 10 was because companies had stopped tracking their exposures in hazardous areas, particularly along the coastline. "There had been decades when there were no catastrophe events and the property values had grown exponentially, so by the time hurricane Andrew came in 1992, there were literally trillions of dollars of exposure along the Gulf of Mexico and the US East Coast and insurance companies were simply not aware of the magnitude of their exposures."

Uniquely for the time, Clark's catastrophe model could simulate events and estimate what the damages could be at the present time based on contemporaneous property values. "That was a really important component of the model. As you know, even today that is an issue in terms of the under-evaluation of potential losses," she says.

Hurricane Andrew

The insurance market finally embraced catastrophe modelling after hurricane Andrew hit. "I remember it like it was yesterday. It made landfall at about 5 am on August 24, 1992, a Monday morning. We ran scenarios with our hurricane model to try and give our clients some estimate of what the losses could be and by 9 am that morning we issued a statement that insured losses could exceed \$13bn. Our clients simply did not believe it. Of course, the storm's total losses ended up coming in at more than that, between \$15bn and \$16bn."

Clark was besieged by phone calls, especially from underwriters in the London market who were convinced the maximum loss figure would not be more than \$6bn, particularly as Andrew had made landfall south of Miami. "The response was: 'A few mobile homes and an Air Force base, how much can it be?'" According to Clark, it would take nearly a year after the hurricane made landfall for the industry to fully appreciate the potential of catastrophe modelling. "But it eventually clicked. The industry realised these mod-

els were telling us something very valuable and we needed to wake up and figure out how we can best make use of them."

Rating agencies

The over-reliance on cat models by the rating agencies, particularly their reliance on point estimates, is another important theme for Clark. "The industry has become wedded to these one-in-100 and one-in-250-year numbers. So many decisions are hanging on these point estimates and then, of course, when the point estimates change by 100%, by 200%, everybody is at sea. The rating agencies think they are being consistent because they are using a modelling approach. But different models, different model versions and different levels of data quality all lead to very different numbers.

The rating agencies claim they make adjustments for these differences, but they can't really be sure they are making the right adjustments to be able to compare like with like. So one of the messages of KC&C is the rating agencies certainly need a different approach to be able to effectively compare the financial strength of different insurers." The tendency of the rating agencies, she explains, is to be conservative. "Their responsibility is to give ratings on the financial health of companies, so they are going to be much more focused on the downside, on the question of how badly can this go wrong."

Clark would strongly advise rating agencies to adopt a robust set of transparent scenarios around characteristic catastrophe events (such as the Great New England Hurricane of 1938 in the north-east of the US) to represent catastrophe risk in each peril region.

These benchmark scenarios could be applied to every company's portfolio, so the rating agencies are truly comparing like with like. "Another characteristic event for the New England region could be created by increasing the intensity of the 1938 New England Hurricane by 10% or by the amount scientists think is credible." This is an approach Clark had recommended to the rating agencies previously, but she now thinks, given the turmoil caused by recent model updates, they might be a little bit more open to this idea. "What we have is a set of scientifically defensible scenarios. So while nobody knows what the right answer is in terms of the numbers, we have a set of characteristic events for each peril region that credibly represents the risk," she says.

Clark's view is these characteristic events are robust and are not going to change frequently like the models do.

"And you can monitor the model changes relative to the characteristic event sets. KC&C believes this is the future and is better than what the rating agencies are doing now. At present, a rating agency could be getting information that tells it one company is 100% higher risk than another, when in reality that could be reversed," she claims.

Over-specification

For Clark, the cat-modelling industry is going down the road of over-specification. In trying to model things that cannot even be measured, the loss estimates end up being highly volatile. "The cat modellers talk about scientific knowledge – about what we know. At KC&C, we talk about what scientists don't know. The cat modellers need to do the same so those who use the models can get a sense of the uncertainty in the data on which the models are based. What scientists know is minuscule relative to what they don't know, but it is not necessarily in the modellers' interests to talk about what is not known."

But Clark believes to manage catastrophe risk effectively, you need to have at least an idea of what the range of uncertainty is in different peril regions. She sees the Japan earthquake as a good example of why the industry should look at other information beyond the models. She points out the modelling companies did not have a magnitude 9 event in their Japan earthquake models in the seismic region where the main event occurred. "Nor did they have a large-magnitude earthquake combined with a major tsunami. And they certainly did not have a nuclear disaster," she adds.

"But if you had taken a few smart underwriters before the event and put them in a room for a few days to come up with the most extreme and worst-case scenarios for Japan and given them the historical data relevant to Japan, they probably would have come up with a magnitude 9 or higher magnitude event with an associated tsunami. They would have known approximately every 15 years there is a magnitude 8 or greater earthquake in or around Japan. And while something like this has not had happened in Japan, there have been four earthquakes of magnitude 9 or greater since 1950 along the so-called Ring of Fire – the most seismically active region in the world, of which Japan forms a part – the greatest one being a magnitude 9.5 quake that happened in Chile in 1960."

Clark's underwriters would also have been told large-magnitude earthquakes in Japan have caused tsunami waves of 30 metres high and greater in at least three historically events. "If we gave our group

of non-scientists those facts, I am pretty sure they would have come up with at least a magnitude 9 earthquake, combined with a large tsunami wave, as a worst-case scenario. They may even have thought of the possibility of that [subsequent] nuclear disaster," she says.

Updates

But many model users, she says, are not doing this type of thinking because they have been lulled into this false sense of security, believing the models have figured it all out for them. "The irony of the whole thing is, now we know there could be a magnitude 9 earthquake, what do we do? Are we going to wait for two or three years for the new earthquake models to come out while the modellers update their models? Why can't we have a more open approach, so now we know we can have a magnitude 9 earthquake, we can immediately adjust our risk-management decisions to accommodate that fact. Why do we have to wait several years for the new models to come out?"

One reason why it takes the modelling companies so long to update their models is the models are overly complex. "There are only four major model components but there are a great many variables, so a number of experts and scientists are going to have to do more research. Then they need to get the results of their research incorporated into these complex models and they need to test it. For example, one of the things the scientists are supposed to tell us is what the probability of this magnitude 9 earthquake is. Which, of course, is something they don't know. It's going to be a scientific guessimate. They could call it a one-in-100-year, one-in-500-year or one-in-1,000-year event. So anything the scientists give us will just be best guess because they don't know."

When you think about it, it is a bit crazy. The models, she explains, are in one sense backward-looking tools because they are constantly being calibrated to the last major event, which is usually a couple of years old by the time the new models are released.

Mesmerising

For Clark, the main issue for the industry is the science underlying these models sounds so impressive. "You can go to these presentations and get mesmerised by all the scientific jargon. Companies just get lulled into this false sense of security the modellers have it all figured out to the extent that even when companies look at numbers coming out of the models that are obviously way off, they still feel compelled to use them in many cases. So at KC&C, we inform companies about what really underlies the models in terms of the hard data versus research."

She says the modelling companies create so much marketing hype around every model update they make each update sound like a major scientific breakthrough. "So, there are all these things about what the scientists know but many updates are not based on new factual knowledge. The updates incorporate new research but typically it is research that has about the same level of uncertainty as the previous research. So there is the overselling of the science and the overselling of what scientists know."

Clark says KC&C is helping companies to understand two things: the true nature of catastrophe risk and the limitations of the catastrophe models (ie, what models can be used for and what they cannot be used for). The firm is also focused on helping companies to access information generated outside the cat models so they can be more informed about the scope and potential of their catastrophe losses. The idea is for companies to be less

dependent on the seemingly endless cycle of model updates and loss estimates that swing widely up and down.

To illustrate this, she refers to the latest RMS model update. "One of the biggest changes is the US inland hurricane losses are much higher – of the order of 200% to 300% in some cases. So this is an issue for a lot of companies. But there are a lot of companies saying they had known for a long time the RMS inland hurricane loss estimates were too low and they had been adjusting the numbers themselves. So, you have to ask yourself, if so many people in the market knew the RMS inland numbers were too low, did RMS know that? And if RMS knew that too, then why did it take it so many years to fix it?"

She cites another example in Massachusetts, where a previous hurricane model update dramatically changed the wind footprints for hurricanes in north-east storms. This model change significantly raised the cost of insurance in coastal areas, such as Cape Cod. Reinsurance costs soared. Most of the companies pulled out of Cape Cod, so today most homeowners are in the Fair Access to Insurance Requirements (Fair) Plan and not being written by the private market.

"There are cases of homeowners on Cape Cod who used to pay \$800 for their insurance and are now paying more than \$2,000 for the same property. Now the new model says it is not really as bad as we thought and the coastal numbers are decreasing. What does that say to the homeowners in coastal areas?"

Cat models, she says, ultimately mean real money to real people and that is what people in the industry are missing if they regard a model update as merely another change in the numbers. "It may be fine for reinsurers, but if you are a primary insurer, it is no way to run a business."

Outside the black box

Clark very much sees her present role as thinking outside the "black box" of cat modelling. As far as she is concerned, catastrophe models have been taken about as far as they can go and the industry is at a point where fresh insight is needed. "While cat models are great, they have some significant limitations. We need to develop other approaches and methodologies." This use of credible information and tools other than the cat models is another critically important theme for Clark. "There is nothing that says a cat model is always the best tool so we have to use it. We don't need to limit ourselves to one tool and we can have other approaches."

Cat models, she says, are very good for reinsurers that tend to write a global book of business. "Reinsurers are typically not into the minutiae of every company's portfolio, so they can use these models to obtain a general assessment of their risks. The cat models are very good for that because they are comprehensive. But the problem is they are a one-size-fits-all approach, which gives a very general indication of risk, which may not provide the most credible view of risk for a regional or specialised book of business. But with the cat model everybody is stuck with the same solution. So if you are a primary insurer and you have a very localised or a specific book of business, the model generated loss estimates can be way off. And, at present, there is no way to fix the numbers.

Here she cites the real-life example of FM Global, which writes a portfolio of industrial and commercial facilities. "The catastrophe models just don't work for its business, so it commissioned a modeller to create a special model for it. Now, most companies cannot afford to pay the modellers millions of dollars to create their own model. So why don't we

just have an approach that makes it easier for companies to be able to use their own data and then tailor their risk assessment according to their books of business. That is one area where modelling companies do a better job."

The model estimates can also be off in certain peril regions. Since the models are based on historical data, Clark believes insurance companies should have access to the fundamental information about the historical events in the peril regions in which they write property business. They should have a very visual and very scientific representation of how many significant events have actually happened in the regions.

"Everyone should know those statistics. It is not hard to know them. And these statistics should be generated separately from the models so they can be used to benchmark the output from the models. For example, if I know historically something has happened that would give me a loss of \$2bn today and the model is telling me my largest loss is only \$1bn, obviously the model is off. Or, vice versa, if the largest loss has been \$100m and the model is telling me it is going to be \$10bn, you know it could be up the other way. So we need to look at other information."

In the ballpark

Given Clark's scepticism, just how useful have catastrophe risk models been to the insurance and risk-management industries over the past five years?

Clark says when cat models were first introduced, the industry was way off in its estimation of catastrophe losses. "We were not even in the ballpark. The great thing about the cat models is they have got companies in the ballpark and that has been very valuable. But over the past five years, we have not been using the cat models as if we are just in the ballpark. The way I have expressed it before is that over the past 20 years, the use of the models have improved from a handsaw to a chainsaw. A chainsaw is a great tool but it is not a surgical instrument. And you would not try to do brain surgery with it."

In Clark's view, that is exactly what the industry is trying to do with the models now. "We think we have a surgical instrument with which to make pinpoint calculations. We don't. We have a chainsaw, which is still a saw. So that is the problem. We are trying to push the usage of the model beyond where it can go. It's time we think about other approaches."

Underwriter judgment

She dismisses the argument the models are needed otherwise the insurance industry will be forced to go back to the old way of just relying on seat-of-the-pants underwriting judgment. That, she says, is a big misconception. "If we don't have a cat model, it does not mean we have to go back to the old ways. What has happened over the past 20 years is we have gone from no models and all underwriter judgment to the other extreme: all models and no underwriter judgment. Neither extreme is optimal."

Underwriter judgment, Clark notes, has earned itself a bad name but there are many things about individual risks and accounts underwriters know that a model will never know. "Underwriters have valuable knowledge and expertise that should be part of the risk assessment and management process. It does not have to be an either/or situation. We believe the ideal approach would use the discipline, structure and scientific basis of the cat models but, where appropriate, the knowledge of underwriters, engineers, loss control specialists should be included. Science can do a lot but it can't do everything."

New dawn: Japan earthquake models did not have a magnitude 9 event plus tsunami modelled – despite such an event being well within the realms of possibility



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