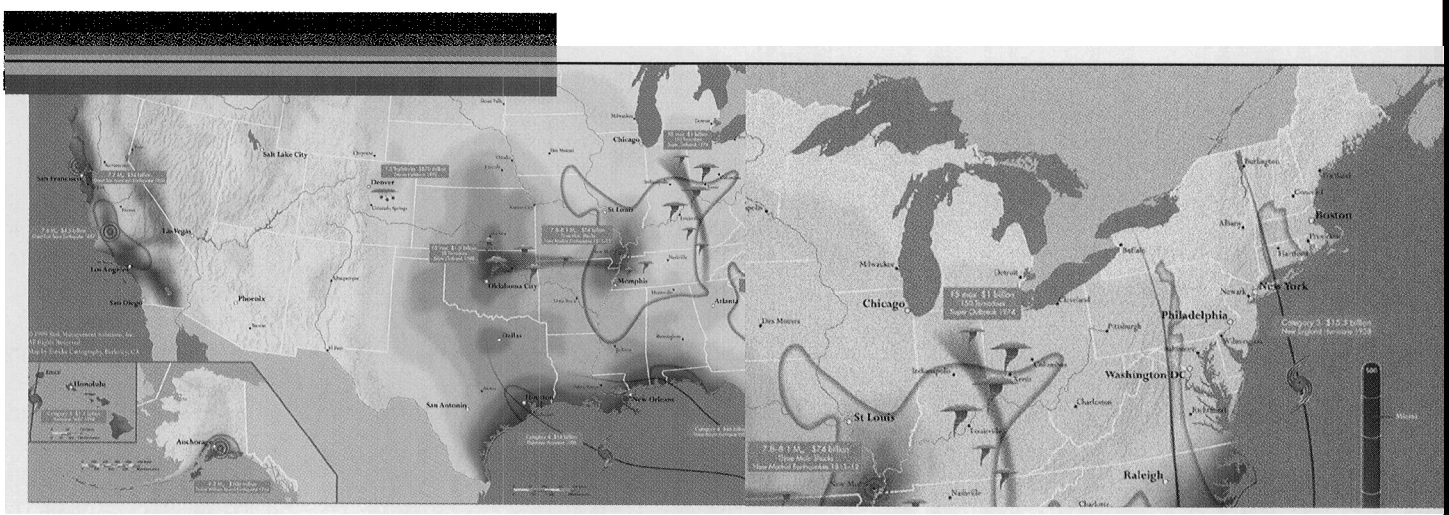

Catastrophe ROUND

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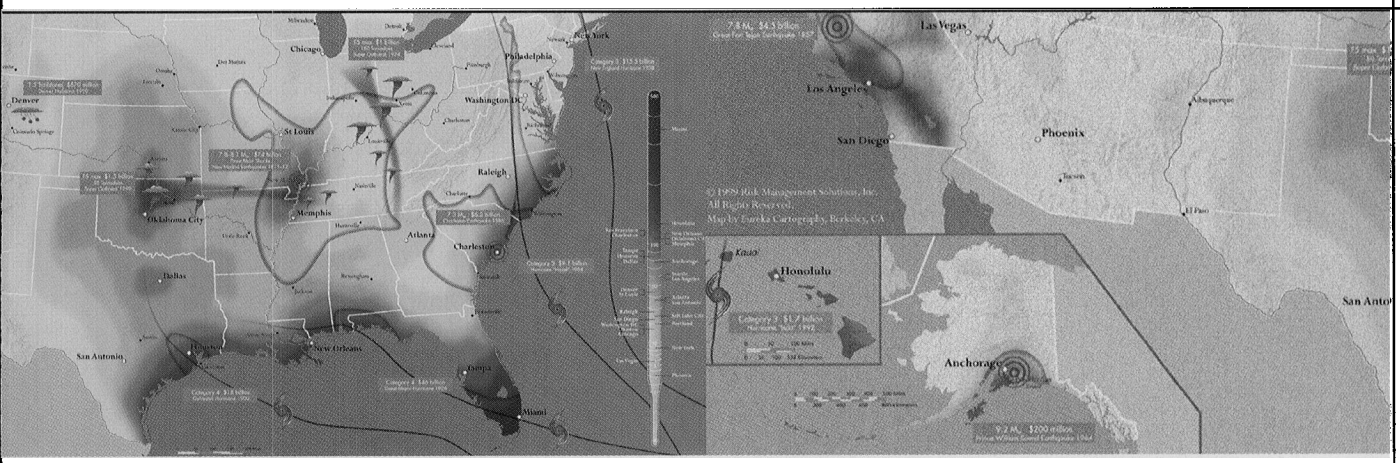
by Jared Wade

Late last year, Springer published *Catastrophe Modeling: A New Approach to Managing Risk*, which analyzes how catastrophe models can be used for assessing and managing risks of extreme events. Spearheaded by Wharton School professor Howard Kunreuther, this book also draws upon the expertise of three leading catastrophe modeling firms—Risk Management Solutions, Inc.; AIR Worldwide Corporation; and EQECAT, Inc.—to examine the role of catastrophe modeling in rate setting, portfolio management and risk financing. *RM* recently caught up with Kunreuther and his associates to discuss the book, what went into it, and catastrophe modeling in general.

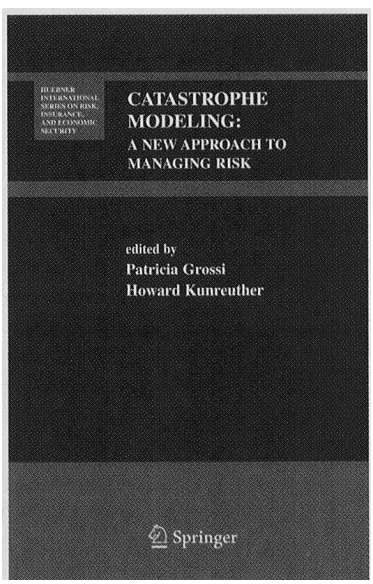


Modeling TABLE

What is the history of the Wharton Project and how did all the different players become involved?

Kunreuther: The project began in June of 1996 when the Wharton Risk Management and Decision Processes Center hosted a conference on information technology and its impact on catastrophic risks. This was part of a celebration of the 50th anniversary of the ENIAC computer at the University of Pennsylvania and the Risk Center was asked to organize a meeting that would link computer technology, science and policy.

At that conference we brought together a group of scientific experts, all three of the modeling companies and insurers and reinsurers who were concerned about how they could provide protection against natural disasters given the catastrophic losses they suffered following Hurricane Andrew in 1992 and the Northridge earthquake in 1994. That was the genesis of the project.



Kuzak: At the time, there were three companies conducting the modeling, but the Wharton School provided an academic and intellectual focus to what was going on in the real-world commercial markets, which was unusual in terms of my perspective. We usually think of academia being the area where research is spawned and then it is developed by the private sector and in this sense it was the other way around; the private sector went out and developed these models and then the academic environment was brought in afterwards to integrate that technology and do even more with it. From that standpoint it was a different way of knowledge flowing in society.

Kunreuther: Because of the neutrality of an academic setting, Wharton School faculty and students were able to work with all three of the companies, utilize their software and compare the different models in a systematic manner. This was mutually beneficial to the research team and to all of the companies.

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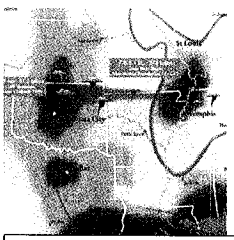
Grossi: I got involved in the program as a graduate student at the University of Pennsylvania. I worked directly with the different models comparing estimates of losses, understanding the assumptions and mathematics underlying each. I interacted closely with the Technical Advisory Committee in terms of models and results and trying to keep proprietary information proprietary, as well as trying to advance some of the research questions of the project. I was fortunate to be involved in such a unique situation, working directly with the three different organizations doing research that was state-of-the-art in catastrophe modeling.

How did the Technical Advisory Committee come about, and how did it help to validate the work that you were all doing with the project?

Kunreuther: Without a Technical Advisory Committee, we would not have felt comfortable disseminating the findings of our research, nor would any of the modeling companies have felt that we had the appropriate peer review of the models.

This Technical Advisory Committee, consisting of scientific and policy experts, met on several occasions and reviewed everything we did on the study. They visited all three of the modeling firms to gain a better understanding of how the models were constructed. At the end of the day, all of us associated with the project felt that the study went through the proper peer review with the experts in the field.



"The project took a life of its own due to the advice from the Technical Advisory Committee and users of the models."

Grossi: In terms of the initial research questions, the Technical Advisory Committee was there to ensure that the models would be an appropriate means to answer these questions. As we went through the project, questions were raised in terms of the usage of cat models because most of their initial uses were in portfolio management, and we wanted to be sure that the Technical Advisory Committee was comfortable with not only the models and our methodologies but the appropriateness of trying to answer such questions through modeling.

Kuzak: One of the valuable things that I drew from interacting with the Technical Advisory Committee, and one of the key aspects attached to risk modeling, is how you deal with uncertainty. The nature of the problem we were trying to analyze is one that is fraught with uncertainties. You are dealing with the mysteries of both meteorology and earth science and obviously uncertainties in the data itself, such as exposure information given and building damage severities. And so obviously, the outside reviewers had some views from their particular disciplines of how to deal with and characterize uncertainty.

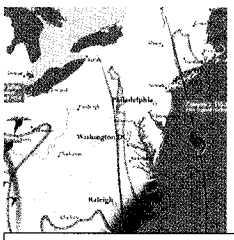
That is really important because part of the risk we are trying to analyze here is perhaps our own naivete about the scientific phenomenon, and a legitimate part of the risk analysis is how much we do not know. In that sense, having the interaction with those outside reviewers gave us some foundation to say "What we are doing with this uncertainty is okay" or maybe there were scenarios where we had to consider it further. I think it is a key point when you go to the outside world because the outside world thinks in terms of a simple number as opposed to a distribution or a variance. That is a major mindset for the general public and even insurance companies to come to grips with—that there is not a single number, there is a range of numbers, they can be characterized, and the range is the amount of uncertainty that we're dealing with.

Kunreuther: The Technical Advisory Committee really was pushing us to do certain things on this project and one of them, as Dennis just pointed out, was in the area of uncertainty. They, in concert with insurers and reinsurers who were engaged in the project, urged us to make comparisons across the models to see whether there were significant differences in their predictions of the likelihood of losses of a given magnitude occurring. Many of the insurers and reinsurers were using all three of the models in determining what coverage to offer and what rates to charge. So the project took a life of its own due to the advice from the Technical Advisory Committee and users of the models.

Lalonde: Initially, it was not what we had anticipated, but it was very valuable having the Technical Advisory Committee because what they did was make the topics we addressed relevant, which really helped us as modelers expand our understanding of how companies were using the models and what additional information they wanted to get out of the model.

Kuzak: There are not many forums for us to have the opportunity to interact with the other modeling companies, and because of the competitive nature and the proprietary aspects of the model, we are limited in ways in which we can do that. This project was one of the few times you could do that. That was important because when we got into the Charleston, South Carolina project we could demonstrate that each of the models will in fact produce different results. And there was obviously keen interest among insurance companies to see what the nature of these differences were.

I think we need forums like that to show people that different models will produce different results. Having all of the models produce the same results is probably a very unusual circumstance because of all the assumptions we make. The idea is to educate the outside world to the fact that these models, which are all credible, can produce different results arising from different assumptions and possibly starting with different sets of data. Clearly, risk and judging risk is a function of looking at variances in models as well.



The project here at Charleston shows different results, and that should be very valuable for the outside world to begin to understand that there are differences in opinion about the risk. This makes risk management a complex subject where you do not just slavishly take a number out of a model and implement it because there are different estimates of that risk as well. As a result, risk management becomes a much more challenging subject, but it is bounded now by different essences of that risk. And that is the new entrance; we are not just waving our hands at the problem anymore, we are getting distinct quantitative answers.

"These models, which are all credible, can produce different results arising from different assumptions and possibly starting with different sets of data."

Kunreuther: On the risk management side, we were studying risk management strategies such as the use of mitigation measures, such as retrofitting structures and the role of new financial instruments, such as catastrophe bonds. We undertook sensitivity analysis to determine under what conditions-specific measures would be attractive or unattractive when viewed either individually or in concert with others.

How has this quantitative approach contributed to the advancement of risk management?

Kunreuther: An important part of the project was to look at the role of a set of policy instruments for managing this risk, insurance being a key one, but also the role that reinsurance, securitization, catastrophe bonds and mitigation can play. The models quantified the likelihood of disaster of different magnitudes and intensities and the losses that could occur from them. We created hypothetical insurance companies and studied their performance in the context of three model cities—Oakland, Long Beach and Miami—under different strategies for managing the risk.

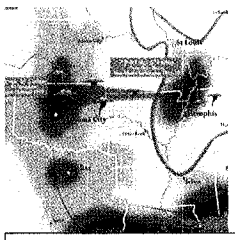
Grossi: I think trying to quantify the risk and understanding the correlation between risk and uncertainty is a key element in thinking about different strategies. Insurance companies and reinsurers had been doing these things for a number of years and to get these models out into the general public was important. At the time, the industry saw this sort of research occurring in academia as important because it validated some of the strategies they had already been using. Since the end of my involvement with the project, our clients have gotten much more sophisticated in the use of cat models and have really been pushing us to do more—to continue advancing the state-of-the-art in cat modeling that this project helped to instigate at the beginning.

Kunreuther: We actually received funding from the National Science Foundation to supplement the research we were doing because this was considered to be state-of-the-art work. We were linking science with policy by combining quantitative modeling based on state-of-the-art knowledge with risk management strategies. This research had not been undertaken in such a systematic manner before this project started.

Kuzak: People are always wondering about the tradeoffs between spending money up front to avoid a risk as opposed to not doing anything, spending premium to insure the risk, or not spending any premium at all and just self-insuring and just rolling the dice. But with the technical framework of the models, one could in fact create situations that would be representative of pre-mitigation conditions and then run scenarios where mitigation efforts of some sort were taken. We could see the reduction in some risk metrics as the result of applying the model to a modified structure. And we could begin to see the net improvement and some expected annual numbers or a loss exceedance curve number and compare that to the amount of capital required to mitigate the project. With that kind of analysis, one can then calculate cost-benefit ratios, for example. In that sense, the model becomes a sort of laboratory to do a what-if analysis, and that was greatly lacking from a public policy standpoint. There is still much more research to be done, but the models provide a way to actually begin to quantify the benefits instead of having some sort of arbitrary decision made by a politician, which may be well-intentioned but very uneconomic. With a model, one can begin to test those hypotheses.

Grossi: Now our clients are gathering much more information today about the specific aspects of different

structures than they have in the past, trying to reduce the uncertainty in their risk potential. They appreciate the importance of trying to understand how structures are built—in terms of whether it has roof mitigation to help withstand hurricane wind forces or if it has cripple wall bracing to mitigate earthquake risk in California. They now try to capture information on mitigation because they understand that it can lower their exposure risk.



"Traditionally, insurers and reinsurers were the primary users of models, but today, Fortune 500 corporations are using the models for insurance-buying decisions."

Kuzak: That really shows the evolution of models from being tools to measure risk to becoming tools to manage risk. And that has happened through educating people on what the models are and how the credibility of the models has increased over time.

What role does modeling now play in the world of catastrophe insurance, cat bonds and other financing methods?

Lalonde: In terms of managing risk and finding new avenues for transferring risk, having a structured modeling approach helped in explaining the science to a broader audience. Taking the models through the rating agency process and having catastrophe bonds rated on this basis was very valuable in establishing credibility for modeling within the broader financial community. Traditionally, insurers and reinsurers were the primary users of models, but today, Fortune 500 corporations are using the models for insurance-buying decisions.

Kuzak: I can recall doing the very first earthquake bonds, when it was more of an educational process. We had the analytical framework in the model, but the problem was how to get investors comfortable with the idea of investing in a catastrophe bond as opposed to investing in an insurance company that underwrites earthquake risk. In some senses, the investor is exposed to that risk in either equity form or bond form, but they had traditionally just assumed that this catastrophic risk was part of investing in equities and never appreciated the fact that that particular risk could really be quantified.

The first time that investors saw this, they were saying "You have got to be kidding me. You can actually do that?" But over time they have gotten quite comfortable with it, and because that class of assets are uncorrelated with other kinds of traditional credit instruments, whether equity or debt, there developed a keen sense from the investor crowd that these assets characterized in catastrophe bonds have a nice appeal to a portfolio of other fixed-income instruments. Catastrophe models were essentially the bridge to get from the science world and turn that into a risk metric that could be understood by people on Wall Street.

In that sense, the models have really created the catastrophe bond market and the market could not exist without the models. As Dave mentioned, the rating agencies never would have rated these bonds without having some underlying analytics. The investors now realize that there is considerable underlying analytics from outside of Wall Street, which typically has its own analytical models. This is the only asset class that I am aware of where the modeling expertise comes from somewhere outside the Street. So there is an application where models have been used not only to help insurers manage risk but they actually help insurers and reinsurers transfer the risk to via cat bonds.

What are the challenges in modeling something as unpredictable as terrorism, and what are some of the advancements you see for the future?

Lalonde: From our approach to modeling natural hazards, we have developed a robust framework that works in dealing with extreme events in general. We work in terms of estimating the frequency and likely location of events and then estimate their intensity, which acts on exposures and results in damage. The damage is then translated to financial loss by applying insurance policy terms and conditions.

With terrorism modeling there is a lot of uncertainty related to the frequency, location and intensity of the attack, but the impact of attacks is well understood. With a structured model framework, we are able to explain the sensitivities of the model estimates and provide companies with an approach to determining insurance rates that have been ultimately approved by insurance regulators.

Kuzak: The framework for the terrorism model began with the thinking we had in the natural hazards area. Obviously, you think about the components of a natural catastrophe model, you come up with frequency and severity and those two together are going to give us some sort kind of an idea of that hazard, whether it is coming from an earthquake, hurricane or flood. When we go into the terrorism world, we can deal with severity from bomb blasts and chemical dispersions, but people say the models are weak because

they cannot deal with the terrorism frequency component. I would say that they are right in that there is a lot more uncertainty, but just because there is more uncertainty does not mean the model has no validity. It has a lot of validity because one can say we agree or disagree on the frequency assumption, but we can begin to look at the metrics coming out of the model if you have different assumptions on frequency incidents. As such, it becomes a powerful tool for risk managers to measure their aggregate risk. In fact, our model is being used by the Department of Homeland Security to look at prioritization of target sites in the United States. So the models do have quite a bit of applicability on the terrorism side with the caveat that we have a lot more uncertainty on the terrorism frequency component. But that's the nature of the problem.

Grossi: A comparison can be made to earthquake risk. In the United States, we have the United States Geological Survey which has its own consensus-based estimates of probabilistic earthquake events, which we can use to build earthquake hazard models. Whereas when estimating the frequency of bomb blasts, there is a lot more individual expert opinion utilized rather than consensus.

Kunreuther: I think one of the challenges in terrorism modeling is that the probabilities are a lot harder to define because you are dealing with human beings who can react to measures taken. In contrast to an earthquake or hurricane where the probabilities can be estimated on the basis of scientific knowledge, terrorists are likely to modify their actions on the basis of what protective measures have been taken by those at risk. Terrorism models do enable one to estimate the direct and indirect consequences of specific scenarios characterizing a terrorist attack. This information is very important to insurers, reinsurers and commercial firms which are trying to determine their exposure to specific risks.

Kuzak: I think that many companies now understand modeling and how they can use the models to answer advancement-structured questions such as what their risk profile is, and what they can do in terms of risk management and mitigation to change their risk profile. But now what companies are looking at is integrating this kind of model into their own corporate models and enterprise risk management programs. RM

Jared Wade is RM's associate editor.