

# CATASTROPHE Modeling

**N**atural catastrophes and extreme weather cause an estimated \$1 billion a week in financial losses in the United States alone. Worldwide losses are also critical to the natural hazard puzzle, as many multinationals realized when the Kobe earthquake struck Japan in 1995. Low frequency, high-consequence events, such as earthquakes, hurricanes, floods, fires and toxic releases, can have severe consequences not only in terms of direct financial loss but also in contingent business interruption, loss of market share and third party liability claims.

by Fouad Bendimerad and Stephen Hom

The impact of increasing catastrophe losses in general, as well as a few major events in the late eighties and early nineties, such as Hurricane Andrew and the Loma Prieta and Northridge earthquakes, have led to the increasing use of computer technology to manage and price catastrophe risk. Insurers and reinsurers have been in the vanguard, but many risk managers are on their heels.

Technology is changing traditional insurance-buying approaches to catastrophe. In the past, risk managers typically estimated the value of exposed assets and purchased coverage based on the total exposure or a percentage of the exposure, reflecting a more or less informed estimate of probable maximum losses. But catastrophe modeling quantifies risk more accurately and opens a broader range of strategies. The result has been a transformation of some leading-edge risk managers into financial managers who actively direct the tradeoffs of risk retention, risk transfer, mitigation/disaster planning and strategic asset planning. ➤



**What is Catastrophe Modeling?**

The first part of the answer involves understanding what catastrophe modeling isn't. Traditional actuarial techniques for understanding risk rely on historical loss experience, which is fine as long as historical losses are an adequate predictor of the future. However, this isn't the case for catastrophes, which occur rarely but carry costly consequences. This volatility is illustrated in Figure 2, a profile of hurricane losses over the past century for a portfolio of locations distributed along the eastern coast of the United States.

The limitations of historical loss data are even more critical for corporations, which generally don't have access to historical insurance loss data other than their own, and whose portfolios have unique geographic distributions, building characteristics and operational linkages. To overcome these limitations, models go beyond the historical record to simulate the entire range of potential catastrophe events and associated probabilities. The models also take into account the unique characteristics of each portfolio, using data from the corporation ranging from basic information on location addresses, values and building types to unique engineering characteristics that capture



the differences in vulnerability for complex industrial or highly protected facilities. The more detailed the data, the more accurate the results.

The model produces a loss curve (see Figure 3) that sums up the exposure of a particular building or portfolio for decision-making purposes. This curve, also known as an exceeding probability curve, shows the probability that losses will exceed various levels in a given year.

**Strategies**

Armed with information from the loss curve, risk managers can explore a range of strategies to determine the

level of risk they are willing to retain. The results may also provide the impetus to initiate a mitigation program to reduce risk retentions or insurance requirements, or put in place disaster contingency plans to minimize business interruption risk. Many companies are also exploring alternatives to traditional insurance and retention programs such as catastrophe bonds, which transfer risk directly to the capital markets.

The ability to mine the loss curve output data for trends and risk drivers is another valuable aspect of some catastrophe models. For example, companies with distributed port-

## The Exceeding Probability Curve

Each point on the loss curve represents a single simulated event. Behind this intuitive curve rests a series of databases, algorithms and calculations that occur in three steps. First, the hazard module calculates the physical peril such as wind speed (for hurricanes) or ground shaking (for earthquakes) at each location. Second, the damage module estimates the damage to structures, equipment, infrastructure or business operations on a loss ratio (i.e., loss/value) based on simulated hazard conditions. Finally, the financial module quantifies financial loss by applying the mean damage estimates and associated uncertainty to the total value at risk, including the impact for particular insurance or reinsurance programs. While this framework was initially developed to quantify catastrophe perils, researchers and consultants have also applied it to other risks associated with business operations.



folios can examine their risk by geographic region or operating unit. They can also explore losses by construction type or occupancy to determine which classes of facilities are at highest risk. At the most basic level, the quantification of risk allows a company to allocate insurance costs across locations or operating units. On a more sophisticated level, required hurdle rates for projects or new investments can be adjusted to reflect the inherent risk and volatility associated with particular regions and perils.

Whether the objective is to ensure earnings stability or to save on the costs of an insurance program, companies can use the model output to reach their financial goals. For example, one company modeled its portfolio of domestic and international properties to assess the adequacy and cost-effectiveness of

their earthquake insurance coverage. The results included a quantification of the portfolio's overall risk due to earthquake peril, a detailed analysis and ranking of facilities subject to the greatest potential losses, and site evaluations of the most problematic locations. By using the model to examine the pure premium associated with their earthquake coverage, the company was able to compare the market price of their insurance coverage to the pure risk involved. They found that their coverage was, in fact, very cost-effective relative to the risk, encouraging them to stick with and expand their insurance program, taking advantage of soft market pricing. With the savings in premiums, the company allocated the budget surplus to mitigation and loss control opportunities identified through the site evaluations.

Other companies are also extending the framework used for catastrophe modeling to a broader array of risks that impact the bottom line. One major utility examined the impact of exchange rate fluctuations, changes in the cost of raw materials, catastrophe-driven distribution failures and weather-related volatility in supply and demand.

This enterprise-wide view of risk allows companies to make more informed decisions about whether to retain risk, transfer it to insurers or hedge it in the financial markets. These projects are typically carried out through a combination of catastrophe model analysis and customized consulting services to quantify and integrate non-catastrophe risks.

Catastrophe modeling tools also allow corporations to collect and maintain better data on property exposures. Companies can improve the quality of information on property address locations and construction details, and capture data on facility changes and renovations. Some models also provide access to location risk data for use in determining whether a property is in a flood zone, how far it is from a major fault, what the local soil conditions are and how far the location is from the coastline.

In the end, however, the right applications for catastrophe modeling depend heavily on a company's business mix and loss exposures. For this reason, corporations typically access catastrophe models through a consulting project with the modeling company. Projects include several phases—evaluating the company's needs, collecting risk data, performing customized data analysis when necessary and running the model. The final product is typically a set of management recommendations and reports that use the exceeding probability curve as the centerpiece for summarizing key risk statistics.

Whether the goal is more cost-effective insurance coverage or a reduction in retained risk, catastrophe models offer risk managers a clear and useful resource in making the right decisions to protect their companies' assets.