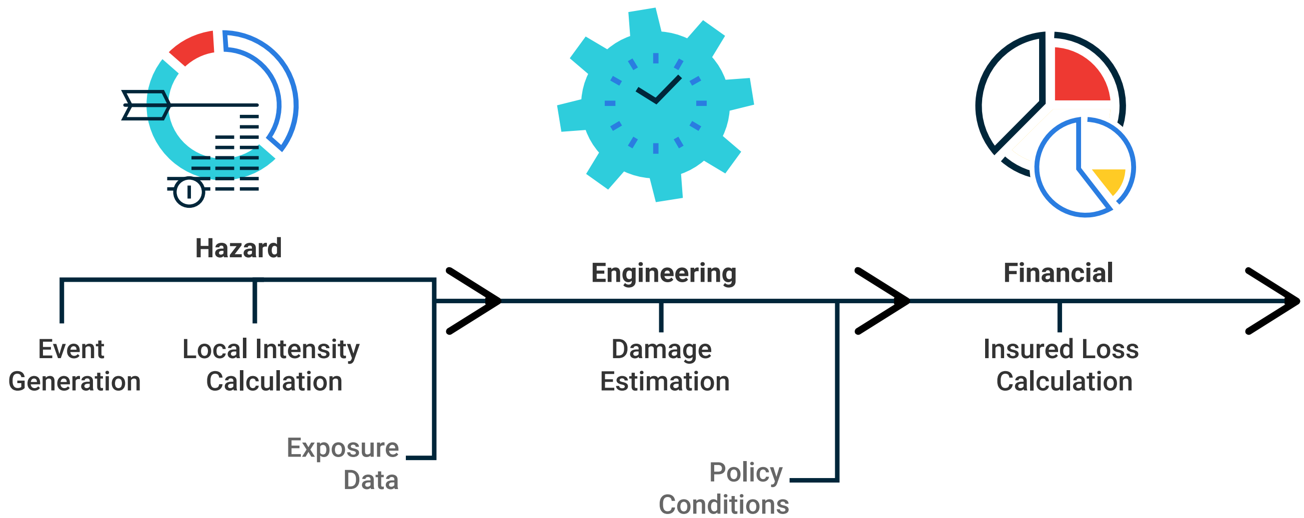
Modeling Extreme Event Risk

Both natural catastrophes—earthquakes, hurricanes, tornadoes, and floods—and man-made disasters, including terrorism and extreme casualty events, can jeopardize the financial well-being of an otherwise stable, profitable company.

Hurricane Andrew, in addition to causing more than USD 16 billion in insured damage, left at least 11 insurers insolvent. In 2011, natural catastrophes—including earthquakes in Japan and New Zealand, flooding in Thailand, and swarms of tornadoes in the United States—incurred insured losses of USD 110 billion, but they did not cause the insolvency of a single company—a testament to the importance of catastrophe modeling.

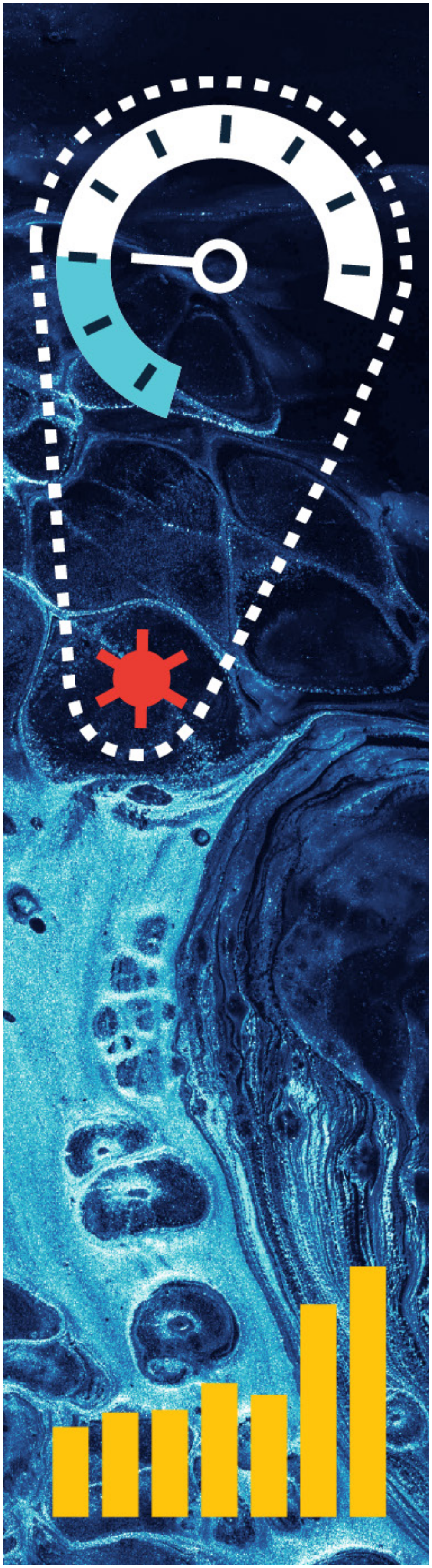


Fortunately, these sorts of occurrences are rare. But it is exactly their rarity that makes estimating losses from—and preparing for—future catastrophes so difficult. Standard actuarial techniques are insufficient because of the scarcity of historical loss data. Furthermore, the usefulness of the loss data that does exist is limited because the landscape of what is insured is constantly changing. The number and value of properties change, as do construction materials and building practices along with the costs of repair. Consequently, the limited historical loss information that is available is not suitable for directly estimating future losses.

In 1987, AIR Worldwide founded the catastrophe modeling industry. Verisk acquired AIR in 2002 and now models the risk from natural catastrophes, terrorism, pandemics, extreme liability events, and cyber attacks, globally. Over the course of 35 years, our models have undergone a continual process of review, refinement, enhancement, and validation, while new models continue to be developed for new perils and regions of the globe. Verisk's probabilistic atmospheric peril models represent the near-term climate on a 0- to 10-year time frame. As the risk continues to evolve, our models will continue to incorporate the latest research on this evolution and our modeled losses will continue to be updated to reflect this changing risk. Catastrophe modeling has become standard practice in the property insurance and reinsurance industries, and is being increasingly adopted by other segments, among them casualty insurers and reinsurers, the financial industry, government, and non-governmental organizations (NGOs).

How Catastrophe Models Are Constructed

Catastrophe models are computer programs that mathematically represent the physical characteristics of natural catastrophes, terrorism, pandemics, extreme casualty events, and cyber attacks. The catastrophe modeling framework illustrated on Page 2 applies to all Verisk property models.



The Hazard Component

The hazard component of catastrophe models answers the questions: Where are future events likely to occur? How large, or severe, are they likely to be? And how frequently are they likely to occur? Large catalogs comprising tens of thousands of computer-simulated catastrophes are generated, representing the broad spectrum of plausible events.

For each simulated event, the model then calculates the intensity at each location within the affected area. For example, for hurricanes, intensity may be expressed in terms of wind speed or storm surge height; for earthquakes, intensity may be expressed in terms of the degree of ground shaking or the number and intensity of fires spawned by the earthquake.

The hazard components of catastrophe models are built by teams of highly credentialed scientists—including meteorologists, climate scientists, seismologists, geophysicists, and hydrologists—whose job it is to keep abreast of the scientific literature, evaluate the latest research findings, and conduct original research of their own. In doing so, they take a measured approach to incorporating the most advanced science.

The Engineering Component

The measures of intensity (again, of simulated catastrophic events) are then applied to highly detailed information about the properties that are exposed to them. Equations called damage functions are developed and used to compute the level of damage that is expected to occur to buildings of different types of construction and different occupancies, or usages, as well as to their contents, and to other lines of business, such as marine, large industrial, auto, and agriculture.

The model's damage functions are developed by highly trained structural engineers. They incorporate published research, the results of laboratory testing, the findings from on-site damage surveys, as well as detailed claims data provided by insurance companies.

The Financial Component

Estimates of physical damage to buildings and contents are translated into estimates of monetary loss. These, in turn, are translated into insured losses by applying insurance policy conditions to the total damage estimates. Probabilities are assigned to each level of loss.

This probability distribution of losses, called an exceedance probability curve, reveals the probability that any given level of loss will be surpassed in a given time period—for example, in the coming year. (The probabilities can also be expressed in terms of return periods. For example, the loss associated with a return period of 20 years has only a 5% chance of being exceeded this year, or in one year out of 20, on average.) Loss probabilities can be provided at any geographic resolution—for the entire insurance industry, for a particular portfolio of buildings, or for an individual property.

The financial components of catastrophe models are developed by statisticians and actuaries with the expertise to analyze the impact of highly complex policy terms for portfolios that may span multiple regions and be exposed to multiple perils.

Model Validation

Verisk catastrophe models are extensively validated. Every component is carefully verified against data obtained from historical events. In addition, when all the components come together, the final model output is expected to be consistent with basic physical expectations of the underlying hazard, and unbiased when tested against both historical and real-time information.

As part of our own due diligence, Verisk also engages in a peer review process. The models are scrutinized by leading scientists and industry experts both during and after model development.

How Catastrophe Models Are Used

The purpose of catastrophe modeling is to help companies anticipate the likelihood and severity of potential future catastrophes before they occur so that they can adequately prepare for their financial impact.

Catastrophe models can be used to address a number of questions, including the location, size, and frequency of potential future catastrophic events. By combining mathematical representations of the natural occurrence patterns and characteristics of hurricanes, tornadoes, earthquakes, severe winter storms and other catastrophes, with information on property values, construction types, and occupancy classes, these simulation models provide information to companies concerning the potential for large losses.

Insurers and reinsurers employ catastrophe models to estimate the loss potential to their books of business and to give them the tools and information they need to manage that risk. Model output is one source of information that companies use to develop and implement a wide range of activities: to set appropriate insurance rates and underwriting guidelines, analyze the effects of different policy conditions, make sound decisions regarding the purchase of reinsurance, and optimize their portfolios.

The models allow “what-if” analyses to be performed to measure the impact of various mitigation strategies, such as adding storm shutters in hurricane-prone areas or retrofitting with cross bracing in areas where earthquake risk is high.

In addition to estimating potential future property damage and losses, the models can be used to estimate possible personal injuries and fatalities and the number of insurance claims.

It is important to note that catastrophe models do not determine insurance companies’ rates. The estimates of potential losses that catastrophe models produce are only one input to the overall process of determining rates. Other components include risk from non-cat events, as well as the companies’ operational expenses, targeted profit margins, and external factors, such as the cost of reinsurance purchases.

Increasingly, organizations outside the insurance industry are employing catastrophe models to assess and manage their catastrophe risk, including government agencies, mortgage lending and other financial services companies, risk pools, and corporations and other owners of high-value real estate.

The Emergence of Casualty Modeling

Casualty events also have the potential to cross many lines of business and produce catastrophic losses, especially in today's interconnected global economies. Casualty models—which include scenarios for historical events as well as emerging and emergent risks—utilize an extensive supply chain network and enable insurers to better monitor their risk accumulation across all types of business. Casualty models cover multiple lines of business and capture risk from a wide range of scenarios, including product liability, financial misconduct, industrial accidents, cyber crimes, and other types of operational risks. Casualty insurers can now benefit from modeling risk, just as property insurers have for the past 35 years.

Global Resilience Practice

Governments also recognize the costs associated with limiting catastrophe risk management to disaster response. Government agencies, as well as nongovernmental organizations (NGOs) are increasingly employing model output as they move from ex-post to ex-ante catastrophe risk management.

Verisk's Global Resilience Practice provides governments and NGOs with solutions to help better prepare for and recover from disasters. Through catastrophe modeling we identify and quantify risks to populations and infrastructure, evaluate mitigation strategies, and inform disaster financing programs. With our three decades of catastrophe modeling experience for the public good, we are making society more resilient.

Meanwhile, the models themselves continue to evolve as new science is vetted, new data and technologies become available, and the user marketplace demands solutions to new problems.

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