Catastrophe Risk Management
How will catastrophe modeling be used in the insurance enterprise of the future?

Catastrophe modeling is a profound technology that has re-shaped the property insurance and re-insurance industries. The evidence is compelling: in 1992, losses from Hurricane Andrew pushed eight insurance companies into insolvency, and several others became technically insolvent, requiring the transfer of funds from parent companies. In 2005, Hurricane Katrina became the largest insured catastrophic loss in history with far less market disruption and insolvency despite following the dramatic 2004 hurricane loss year. While the science of catastrophe modeling is still working to improve the precision and accuracy of models, the presence and usage of catastrophe models was beneficial: improving the financial strength of insurers and consequently providing policy holder compensation for losses incurred from this event.

Catastrophe modeling has become ubiquitous in the property insurance industry. Catastrophe models are embedded into the enterprise risk management practice of insurance companies globally, extending into underwriting and claims management for some of the most catastrophe-prone re-insurers. Analytic risk modeling outputs of catastrophe models have supported the development of the property catastrophe Insurance Linked Securities (ILS) market which has become very important in today’s low interest environment. After contributing significantly to processes and market discipline, the next act of catastrophe modeling in the insurance environment will be to disappear.

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

The fundamental insights from catastrophe modeling will be extended throughout the insurance organization, encompassing underwriting and claims as well as enterprise risk management. Efficiently introducing catastrophe modeling throughout the organization will leverage business process technology and deliver the information advantage that insurers seek.

The first generation of catastrophe modeling required re/insurance companies to adapt to the vagaries of models—gathering risk attribute data (location, construction, occupancy, policy terms and conditions) that often extended beyond the level of data that they had captured. Incomplete model connectivity has led to uncertain integration points and conflict between catastrophe models and business processes, management strategy and technology. The next generation of catastrophe models will be aligned with insurers’ business processes to help meet their business objectives—and recognize the business needs of broadening catastrophe risk management into their underwriting, actuarial and claims activities. Moving the catastrophe model outside of the risk management group has been expensive and proven to be a barrier to integration.

1. Insurance Information Institute, “Hurricane Andrew and Insurance: The enduring impact of an historic storm”, August 2012
Leveraging grid-scale performance, web-services, access to real-time property data and characteristic assets and broadening the perils and how perils are managed delivers a comprehensive view of risk. The different activities in an insurance company (underwriting, enterprise risk management, claims) have different focuses varying from top down (broad and general) to bottom-up (narrow and specific) but the perils that are managed are the same—and systems should reflect this.

Natural catastrophes remain perhaps the most poignant risks to the operations of an insurance company, and the first generation of catastrophe models helped insurers quantify this risk. But the first generation of catastrophe modeling for insurers and reinsurers required the adoption of the insurance enterprise to new analytical models that quantified risk. For some insurers, this required the introduction of catastrophe modeling statistics into their management and control systems producing a system that was difficult to maintain. For other insurers, the catastrophe model became the spine of their enterprise risk management system and their business was effectively controlled by their model vendor. The next generation of catastrophe modeling will include a story of business process integration.

The early adopters of catastrophe models were focused upon capitalizing on information asymmetry—having more information than their policy holders and competition delivered an early-adopter return on the investment. In 2016 both of these advantages have eroded and the follow-up generation of catastrophe models deliver the operational efficiency to minimize adverse selection and moral hazard.
In his story “The Old Man and the Sea”, Ernest Hemingway guides us with the thought “Now is no time to think of what you do not have. Think of what you can do with that there is”. The next story of catastrophe modeling embraces the linkage of information we have today into a unified body to improve our ability to manage and react to catastrophe occurrences. Ideas of the future that are powered by our ability to record, store and analyze data include:

- A real-time underwriting workflow will include the track record of a building—a record of the catastrophe events that have affected it (for example: hail size and date; or earthquake event and local ground motions). Claims processing will incorporate automatic event hazard footprint evaluations—defensively, improving the fraud detection efforts of insurers but also enabling a pro-active policy holder engagement that does not have to wait for the First Notice of Loss.

- Verifiable validate reconstruction valuation estimates, property information available from public sources such as assessor’s and building permit databases improving the quality of catastrophe modeling output by reducing the uncertainty of the inputs.

- Business process integration using web-services, local network or cloud-based computer and uniform data standards empower the insurer by enabling real-time catastrophe loss estimation and management in the organization.

Insurers will maintain the information advantage with a complete set of insurance data: uncertainty will be lowered with the addition of risk characteristics such as reconstruction cost, assessor’s and building permit risk information that are available at the time of underwriting. Connecting to the software will rely upon straight-through processing with computing hosted locally and remotely. Simulation model outputs will enable integration into management reporting without costly adaptations of underwriting systems for the idiosyncrasies of first generation cat models. Simpler interoperability of catastrophe models with existing underwriting, claims and management systems will enable a more current view of risk with simpler integration of scientific changes to the models. The next generation of catastrophe models will connect the entire insurance enterprise: underwriting, enterprise risk and claims management with fast and integrated underwriting risk scores, probabilistic loss modeling and immediate post-event hazard footprints for claims efficiency.
Breaking the Code: 
Diving into the U.S. Earthquake Model Update

MAICLAIRE BOLTON

Catastrophe risk management is grounded on forecasting and evaluating risks, and identifying options to minimize their impact with the goal of assessing risk for adequate allocation of resources and capital reserves. It is essential to not only understand what can happen, but be prepared for the unknown. Peter Drucker summarizes this concept well with his infamous statement: “In an organization, there is no such thing as a pleasant surprise.” This is increasingly relevant in catastrophe risk management. One of the greatest anxieties risk managers possess is the unknown—or the surprises. While natural catastrophe losses can be volatile, they are manageable and it is feasible to account for surprises with rational, credible models to capture these surprises.

Earthquake catastrophe risk management, historically, has been a balance between the probabilistic risk curve and capital allocation based upon a single earthquake event. While a single event provides a clear risk, it is not a complete view of the risk and doesn’t provide the full picture. To go beyond the standard risk curve to identify the full probabilistic risk curve, it is necessary to investigate further and understand where the risk is focused by considering the drivers of risk.

Catastrophe risk management, through models and business solutions, is informed by the combination of the latest science with the latest technology. The better these two components are understood, the more confident risk managers can be in their decisions. For risk managers to be as effective as possible, it is critical to be on the leading edge of technology—with solutions to not only manage their risk, but to provide added insight into the risk. Additionally, there is a balance between understanding the science and technology with management clarity and direction. As science and technology evolve, so must the way risk is managed. The U.S. Earthquake Model from CoreLogic® provides risk managers with a sophisticated tool to drive more enlightened risk management decisions. As a trusted advisor, CoreLogic provides leading edge solutions to minimize the financial impact of risk.

On the Leading Edge

Business solutions for catastrophe risk management strive to mimic a risk, as close to reality as possible. When evaluating earthquake risk, it is critical to understand where earthquakes are occurring (i.e. on which fault) along with frequency and magnitude. As science evolves, the understanding of how earthquakes occur is changing. And with that, business solutions must also evolve.

Catastrophe risk solutions are sensitive to their underlying components and how these underlying components are defined has evolved with a new definition of the hazard. Earthquake science in the U.S. offers a consensus-driven approach from a leading group of earthquake scientists, culminating in the U.S. Geological Survey (USGS) National Seismic Hazard Model. The California component of USGS model is defined through the comprehensive Uniform California Earthquake Rupture Forecast version 3 (UCERF3).

In California, where the risk is the greatest in the country, UCERF3 offers the authoritative estimate of all potentially damaging earthquakes in California, with the definition of the location, magnitude, and frequency of all plausible events. Catastrophe risk models have been based on
UCERF models for many years, with the 2008 version, UCERF2, currently implemented in most models. One of the most significant changes introduced in UCERF3 is to the earthquake fault segmentation. UCERF3 suggests the probability of multi-segment ruptures, in that any earthquake on a fault segment can trigger any adjacent fault segment within a 5km radius, identifying a new risk where events have the possibility of triggering other events either on another part of the same fault or on a nearby fault.

Managing Earthquake Risk

Historically, risk managers have commonly managed their earthquake risk by aggregating the risk to a single fault. With the new understanding of the risk of triggered ruptures on adjacent segments provided by UCERF3, managing risk to a single fault is no longer sufficient to capture the full spectrum of risk. As such, the methodology for managing earthquake risk must fundamentally change to appropriately and rationally measure risk at all levels.

Catastrophe risk modeling is focused on understanding the full spectrum of losses, including the extremes—surprises, and not focused simply on averages. With the CoreLogic model, a high fidelity simulation platform based on several hundred thousand years of simulations, risk managers can not only obtain a rational view of the full spectrum of losses, but additionally, dive into the drivers of risk and understand model sensitivities to allow them to make more enlightened risk management decisions.

The Solution

Leading edge science and technology precipitates leading edge business decisions. When striving for more enlightened risk decisions, one of the most insightful ways of investigating a risk is to dissect the risk to address and examine the individual drivers of risk. Understanding where the risk is concentrated and what the greatest contributors to the risk are adds insight. Visualizing the drivers of risk to manage and measure the risk can help risk managers go beyond standard risk metrics to identify where the risk is coming from and to fully understand if they have diversified appropriately or need additional diversification.

Science and technology are always evolving. Advanced simulation modeling is a more complete way of capturing the evolving technology for integration into the cat risk management workflow. It is a continual improvement process, but with the sum of the latest science and technology informed by management, risk managers can achieve their goal of eliminating surprises while delivering the best answer, encompassing the full spectrum of risk.

As a leading data, analytics and services company, CoreLogic is focused on moving science forward and providing solutions for improved management of risk with both control and transparent understanding.
“Clearer Risk Analytics” support the goal of catastrophe risk management professionals to make better decisions. However, each decision maker may have a different view of what defines “Clearer Risk Analytics”. The operational definition of “Clearer Risk Analytics” can be exposed through questions that explore the differentiation of clear from unclear risk analytics such as:

1. Are these analytic outputs really different or just the same with a different name?
2. How do these analytic outputs help me make better economic decisions?
3. How do I extract insights from the metrics that will help me make more decisions that will lead to greater profitability?
4. Does clearer analytics help me more from a portfolio management perspective or a single risk portfolio perspective as well?

It is possible to evaluate whether model output (reports/metrics/analytics) answer the questions being asked. It is far more difficult to determine the quality of those risk metrics. A fundamental question that should be explored is assessing a risk model is: does this output provide me with dependable and at the same time, actionable results. Is there any way to really assess the clarity of risk analytics? Looking at the target information that is the desired output of the risk model as a signal helps to frame this problem. Signal to noise ratio, defined as the ratio of signal power to noise power, is a concept used to characterize the quality of signal transmission in many different fields. This concept is as apt in helping to differentiate the value of catastrophe risk modeling analytics as it is in describing the quality of an audio tape recording, the comparison of two antennas, or the benefits of AM vs. FM radio technologies. When viewed through the lens of the signal to noise ratio, the answers to any of the questions becomes clearer—the preferable risk analytic is the one with the higher S/N ratio.

Using this as a framework for discussion, the signal is defined most directly as the quantification of the risk analytic of importance to the consumer. Factors strengthening the signal include:

- **Solid scientific underpinnings to a model.** All models should be based on a credible scientifically based representation of the hazard, along with supporting data, but the signal of a risk model is strengthened when
  - The hazard model is well suited to damage prediction. For example, are the model’s hazard parameters highly correlated to structural damage?
  - Does the hazard model capture all relevant phenomena and parameters such as bathymetry for hurricane storm surge, surface friction and filling for hurricane winds, windspeed duration for European windstorm, and soil type for earthquake ground shaking.

There may also be multiple credible views of a given hazard. For these cases, a stronger signal representing a greater depth of dependable information is achieved by a model that provides the opportunity to explore each of the views of risk and consider each on its own. Providing a recommended view of the risk founded on an established scientific view of the hazard represents a strong signal. Providing alternative established views enhances that signal by accepting that there is no absolute truth in estimating future behavior. Does every stock analyst always know whether to buy, sell or hold a stock or do the better ones, often hedge their options? How do you hedge your option with a scientific model? For starters, don’t limit yourself to only one opinion.
Supplementation of the historical record by well-founded research. Without diminishing the critical importance of recorded data to support catastrophe models, it is also important to utilize science to expand the utility of the recorded data beyond a limited 50 to 150 year period. Notably if you think the future will be different than the past. When the history of sufficient reliable recorded data is short in comparison to the time horizons for which the model will be used, the signal is strengthened by using the best available science to extend the historical record.

Recognition and treatment of the uncertainty in the phenomena. Imagine a building trying to fend off the pounding wins of a 100 MPH windstorm. If only one window give way, the damage potential will be so different. Imagine the Tohoku earthquake only reaching a M6 on the Richter scale instead of a M9. Just how different would that tsunami have been? If you don’t account for all the variations and variabilities that cause those variations in the model results, your model will likely produce a low signal.

Conversely the noise increases (decreasing the S/N ratio) when:

- The modeling platform has insufficient resolution to capture with significance the rare but important event. A simulation platform is one method that can be utilized to represent rare (catastrophic) outcomes, considering the potential for any number of events to occur in a given year. If a hypothesized event has a hypothetical frequency of 1/50,000 years, a single representation of that event in a 10,000 year simulation platform will over-represent the probability of that event by a factor of five. However, this event could be an important contributor to the risk in a portfolio—so if that event is NOT included in the simulation platform there will by necessity be an underestimation of risk. High severity low frequency events are particularly prone to these problems. A small simulation set is therefore prone to high noise—is the signal that is being represented skewed by the simulation platform? This issue is further illustrated by the uncertainty associated with catastrophe risk modeling.

- Assumptions must be made in utilizing the model output that have a significant impact on what the resulting view of risk is. When each step of aggregating or adding additional financial conditions on loss output requires the assumption of a loss distribution or the imposition of implied correlation between risk components, each such step represents a degradation in the signal, to the point where in the tail of the curve where these assumptions may have the greatest effect the noise is highest.

- Modeling procedures are required to capture correlated sub-perils that are at odds with the human element of claims settlement procedures. Post processing hurricane caused flood (surge) losses calculated using hurricane policy terms is both time consuming and noise inducing. A platform that can apply the actual policy conditions independently to each sub-peril inherently reduces both the time required to assess the impact of the sub-perils, but also reduces the noise in the resultant loss metrics.

Clearer analytics is not simply a specific report, yet a methodology whereby the output found in the report is finely produced. Only a model that can produce clearer analytics because the signal to noise ratio is optimally tuned will quantify and manage the volatility of the risk that will optimize portfolio results. CoreLogic has spent years fine tuning its reporting methodology, by listening to the increased demands of the risk baring market, for whom the necessity of outshining the competition is in their highest interest.
Combatting Rising Waters

DAVID SMITH

A detailed and granular flood risk model for the U.S. that enables clear portfolio risk management

With average annual economic losses exceeding $50 billion, flood is the top natural hazard in the United States, and the vast majority of the risk remains uninsured. Only about half of the single-family homes within the Federal Emergency Management Agency’s (FEMA) Special Flood Hazard Areas (SFHA) carry flood insurance through the National Flood Insurance Program (NFIP), and outside of these areas the rate of coverage drops to around 1 percent, even though one fifth of all flood insurance claims occur outside of the SFHAs. Private insurance covers the risk for much of the mid and large commercial markets as part of the standard policy form, but flood losses are strongly sub-limited and are often subject to significant deductibles and exclusions. The small commercial market is partially covered by NFIP, also often subject to policy terms which significantly limit the coverage. There is a substantial need for broader insurance coverage of this important peril.

Increased coverage of flood risk has been limited, to a large extent, by two challenges that make it hard to quantify: flood is a high-gradient peril, for which the risk can vary significantly over short distances; and flood risk is strongly dependent on the specific, detailed characteristics of the property. Both of these aspects require much greater granularity of modeling and exposure data relative to more traditionally modeled perils such as earthquake or wind. For example, the specific location of a building within its property parcel can be critical in quantifying the flood risk, as the ground elevation and also the impact of proximity to the relevant flood source can vary substantially over horizontal distances of only a few meters. Flood risk also depends critically on detailed property characteristics such as the first floor elevation, the presence or absence of a basement, the foundation type, various waterproofing aspects, etc.—in addition to primary characteristics such as the occupancy, construction type, year of construction, and number of stories, which control a much larger share of the variations in the risk for more traditionally-modeled perils. With flood, in many cases the occupant of a property may have better risk information than the insurer.

The future of best-practice flood risk management will include a number of key components, including new modeling and analytical capabilities that will enable risk managers to develop a comprehensive understanding of the drivers of risk within their companies’ exposures. First, detailed flood risk models that leverage the large investments already made in assessing flood risk are emerging. The best models will employ high-resolution hazard components, at 10 meters or finer throughout the model, and will incorporate the $4.7 billion federal investment in detailed hydrologic, hydraulic, and engineering studies underlying FEMA flood risk mapping—providing confidence to underwriters, given this consistency with the most widely reviewed and frequently updated flood risk studies, while also extending well beyond the FEMA work in terms of the modeling required to compute the full risk curve at any location. Second, since flood risk depends so critically on detailed property characteristics, the best models will faithfully reflect this reality by incorporating such characteristics in the damage modeling, and by providing smart defaults for such characteristics based on the year of construction, local date of incorporation into the Flood Insurance Rate Mapping (FIRM) program, and so forth—equally important, given the traditionally limited capture of such information in insurance exposure data. Third, the best models will incorporate robust flood event sets reflecting the hydrologically-driven
reality of the correlation aspects of the risk. Finally, since a significant portion of U.S. flood risk comes from hurricanes, the best models will incorporate explicit, detailed storm surge and inland flood footprints along with the wind footprint for each hurricane event, in addition to a robust set of non-hurricane flood events, including flash floods.

Some additional characteristics of the best models will include: transparency via outputs, the ability to identify drivers of risk, consistent point-to-portfolio treatment, and augmentation with remote sensing to get real-time flood footprints and improved characterization of past events. Transparency in the form of detailed outputs providing intermediate calculations such as water depths, 100-year water surface elevations, first floor elevations relative to ground, etc. go a long way towards understanding of, and comfort with, the hazard and vulnerability algorithms and data employed. Providing the ability to identify drivers of risk, e.g. events focused upstream or downstream of a location, events occurring just downstream of a river junction, etc. enables a deeper understanding not only of the modeling but also of the true risk itself, to the extent the model faithfully represents this. Consistent point-to-portfolio treatment, i.e. a single properly-correlated methodology for all analyses from single-site through large multi-location policy to entire book of business, is essential for the risk aggregation and disaggregation necessary for modern risk management. Finally, employing remote sensing to get the best possible characterization of past and real-time events is a powerful way to validate the model and to assist with real-time claims adjustment responses and loss projections.

Flood risk models that deliver clear analytics on both loss and drivers of risk will enable prudent risk management and can lower the cost of underwriting. Robust simulation-based modeling frameworks, paired with detailed and comprehensive hazard and vulnerability models, will provide the ability to consistently quantify contributions to portfolio risk via metrics such as tail value at risk, or TVaR—just as is currently being done routinely with more traditionally-modeled perils such as earthquake and wind. The contributions to overall risk can be quantified and aggregated by corporate units such as branch, division, line, etc.; by geographic breakdowns such as ZIP Code, rating territory, county, state, or region; or really by any meaningful components of the portfolio. Quantification of the contributions to risk can be most powerful in terms of geographic breakdowns aligned with the correlation of the risk, for example by Hydrologic Unit Codes, or HUCs, which align with flood catchments and provide a nested hierarchy for risk aggregation and disaggregation.

There are many potential applications of such analytics, but some of the most powerful relate to allocation of capital or reinsurance costs, or to underwriting strategy. For example, through robust, consistent quantification, underwriting strategy can be driven by seeking to optimize the ratio of premium income to contribution to portfolio risk. Essentially, one version of such a strategy is simply to write more business in HUCs having low correlation with the current portfolio, and the modeling and analytics will point the way.
About CoreLogic

CoreLogic (NYSE: CLGX) is a leading global property information, analytics and data-enabled services provider. The company’s combined data from public, contributory and proprietary sources includes over 4.5 billion records spanning more than 50 years, providing detailed coverage of property, mortgages and other encumbrances, consumer credit, tenancy, location, hazard risk and related performance information. The markets CoreLogic serves include real estate and mortgage finance, insurance, capital markets, and the public sector. CoreLogic delivers value to clients through unique data, analytics, workflow technology, advisory and managed services. Clients rely on CoreLogic to help identify and manage growth opportunities, improve performance and mitigate risk. Headquartered in Irvine, Calif., CoreLogic operates in North America, Western Europe and Asia Pacific.