CATASTROPHE RISK MODEL

USING MODELS TO QUANTIFY, MITIGATE AND MANAGE THE "TRUE RISK" TO PROPERTY

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Losses from natural catastrophes have steadily mounted in the past three decades as businesses operate on an ever more global scale, resulting in both their physical locations and their supply chain networks being at risk from multiple hazards. Natural catastrophes—earthquakes, hurricanes, tornadoes, and floods—and terrorism can have a significant and sudden adverse effect on the financial well-being of an otherwise stable, profitable company. Prudent risk management involves proactively assessing and managing an organization's catastrophe risk. As a result, the use of catastrophe risk modeling has gained widespread acceptance across corporate risk managers, brokers, and underwriters. But is the industry deriving the maximum benefit from the use of the models? Or are there better ways of using these tools that allow for improved catastrophe risk management?

While the issues associated with the use of catastrophe risk modeling tools are relevant to stakeholders throughout the property insurance value chain (corporate risk managers, brokers, underwriters), this article discusses the issues primarily from the broker perspective. Brokers must understand their clients' exposures and operations, communicating what they learn about the risk to insurance underwriters, and then fashion risk management strategies and solutions that meet the risk tolerance and budgets of their clients. Catastrophe risk models are instrumental in assisting brokers with these tasks.

Catastrophe Risk Model Components

Catastrophe risk models are sophisticated computer programs that mathematically represent the physical characteristics of natural catastrophes, exposures, and the engineering interface between the two. The catastrophe risk modeling framework is shown in Figure 1.

The hazard component of catastrophe risk 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 hundreds of thousands of realistic but simulated catastrophes are generated, representing the broad spectrum of plausible events. For each simulated event, the model then calculates the intensity at each exposure location within the affected area.

In the engineering component, the measures of intensity (for example, wind speed, ground shaking or peak ground acceleration, or flood depth) are then applied to highly detailed information about the properties (commonly referred to as the primary and secondary characteristics of the exposure) 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 assets (e.g., buildings, facilities, contents) of different types of construction and occupancies, or usages, for various levels of the hazard intensity.

In the financial component of the

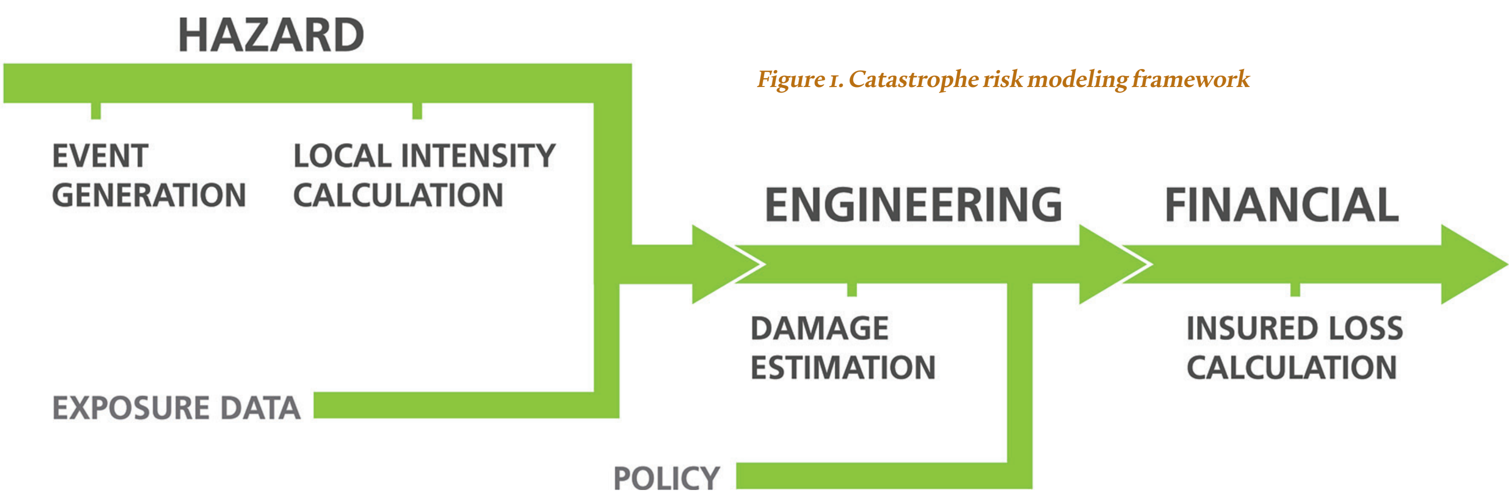

Figure 1. Catastrophe risk modeling framework

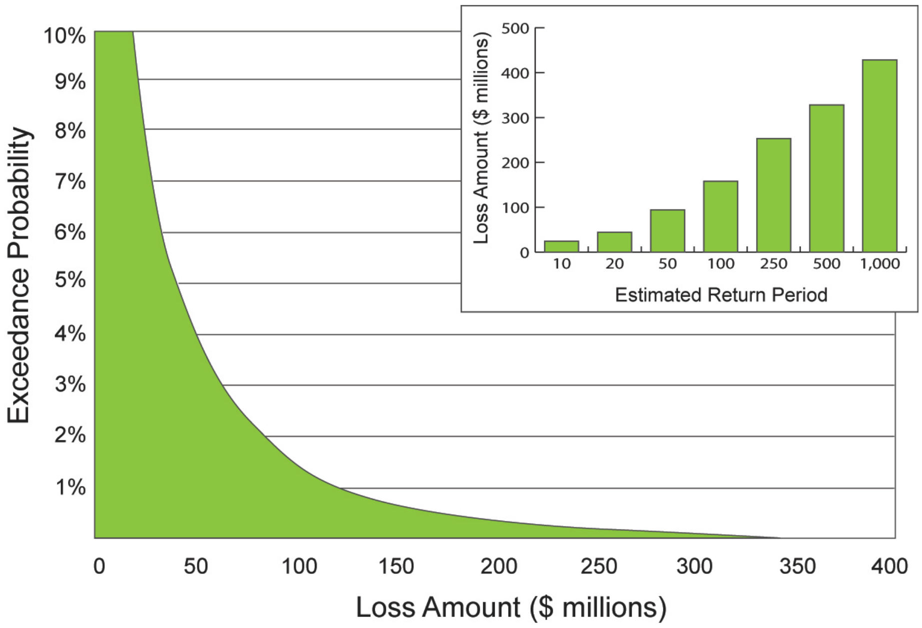

Figure 2. Example of a loss exceedance probability curve

model, estimates of the physical damage to the assets are translated into estimates of monetary loss. Probabilities are assigned to each level of loss. An example of such a result, called the exceedance probability or EP curve, is shown in Figure 2 (the result could be developed for a single building or a portfolio of hundreds of thousands of buildings). The likelihood of experiencing different levels of loss can be directly obtained from such results. (Note that the inverse of the annual exceedance probability can be read as the return period.) For brevity, only this result is being shown; however, catastrophe risk models can generate much more detailed information that can be leveraged to manage and mitigate the risk, including evaluation of "what-if" scenarios, such as the impact of hurricane shutter installation on hurricane losses.

The mark of any good model is not only the science and engineering that goes into building the models, but also the validation of same. Every component of a model is carefully verified against data obtained from historical events and, where possible, through independent peer reviews. In addition, when all the components work 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.

Why Use Catastrophe Risk Models?

Catastrophes 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 historical loss data are scarce. The loss data that are available offer a limited view of insured properties, as the number and value of properties change—along with construction materials, building practices, and the costs of repair. This is one of the reasons why (re)insurance companies have made using catastrophe risk models standard practice.

The purpose of catastrophe risk modeling is to help businesses and companies anticipate the likelihood and severity of potential future catastrophes before they occur so that they can adequately prepare for their financial impact. 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, occupancy classes, and vulnerability of such construction, these simulation models provide information concerning the potential for large losses.

Catastrophe risk models are tools, albeit sophisticated ones that require careful thought about how they can be used to derive the maximum benefit. Consider the full extent of usage of these tools, as shown in Figure 3; clearly, the details required in the model input and output are going to be different depending on whether the tool is being used for a large portfolio

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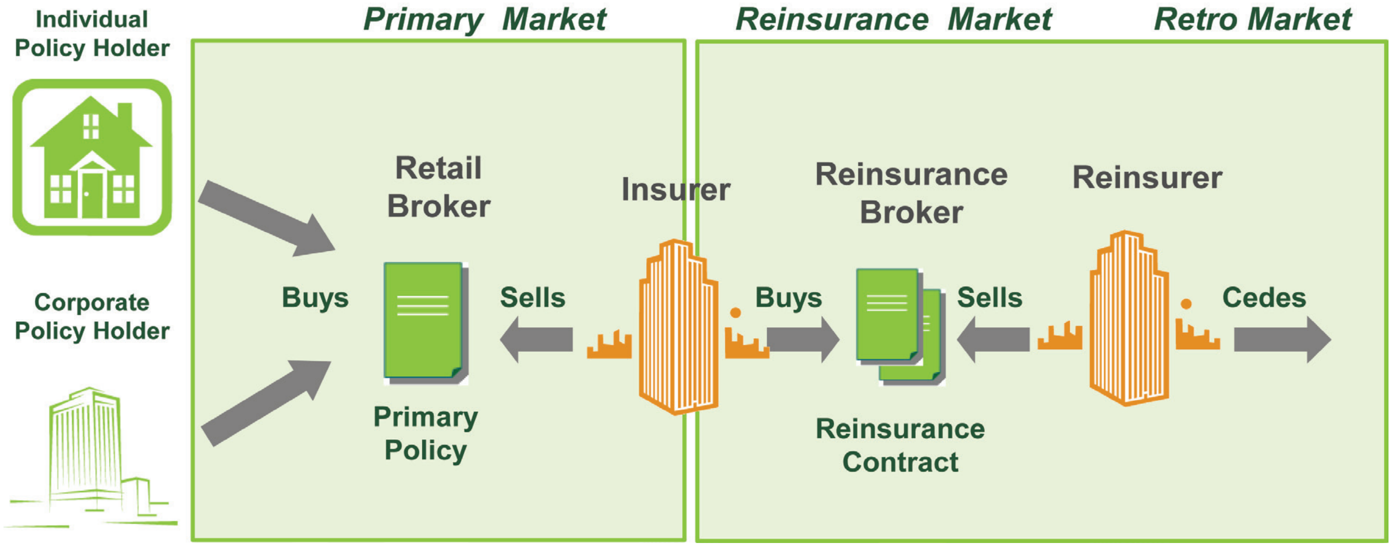


Figure 3. The insurance value chain

of properties for insurance rate-making or reinsurance, or by a corporate risk manager evaluating the risk profile across a handful of locations and perhaps an integrated supply chain network. This is when the skill in identifying the right input, appropriate application, and understanding of the limitations and possible enhancements of these tools comes into play to derive maximum benefit.

"True Risk" for Large Portfolios

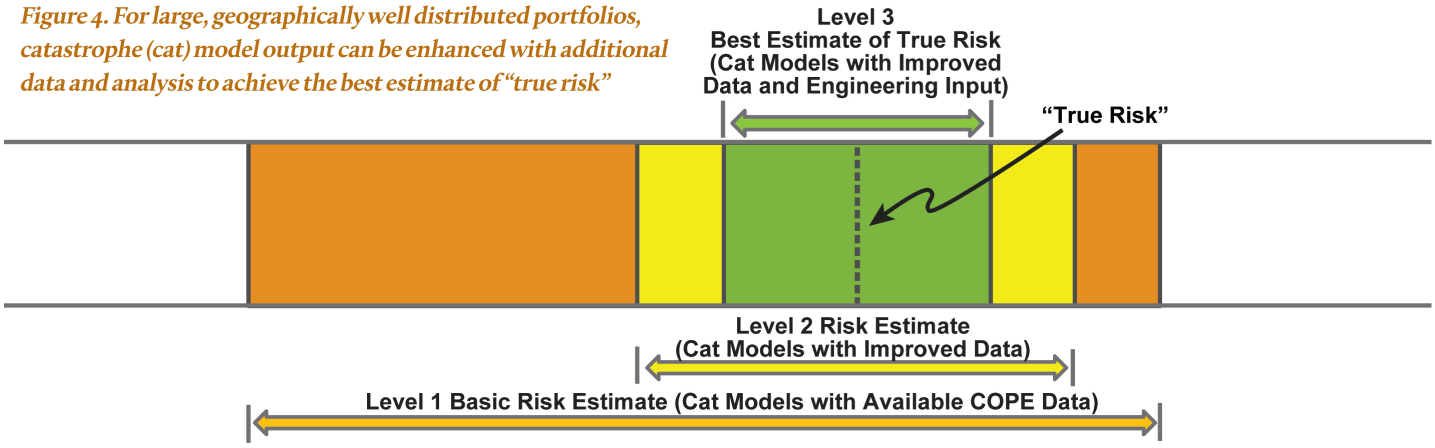
Every exposure has a "true risk." The true risk is the single quantifiable measure of risk that could be arrived at if one were able to eliminate all sources of uncertainty, which, of course, is not possible. The objective of any risk evaluation is, therefore, to obtain the best estimate of the true risk along with a quantification of the uncertainty associated with the estimate. Three levels of evaluation can be utilized for large portfolios that vary according to the degree of detail in the exposure and engineering modules of the models (see Figure 4).

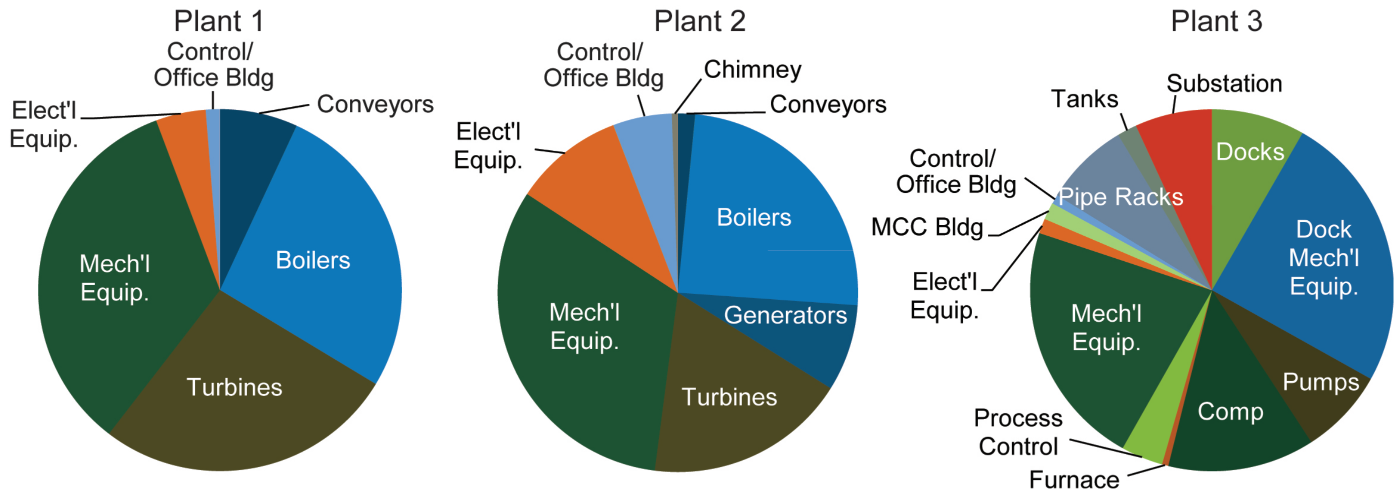
For a large portfolio (in terms of number of assets) comprising a variety of asset classes and spread out over a large geographical area, it may not be necessary (or valuable) to have a good risk estimate for each and every asset; for such large portfolios of properties, the standard level of evaluation is widely used by the industry. This level of evaluation entails using the appropriate probabilistic catastrophe risk models with the available COPE [construction, occupancy, public and private fire protection, and exposure] data and taking a standard risk evaluation approach that involves using the default engineering information within the model to develop risk estimates. For large portfolios, this is an appropriate level of evaluation because the objective is to obtain the overall risk metrics for insurance or (re)insurance purposes.

However, if the large portfolio (in terms of value) comprises a similar set of buildings (for example, a hotel chain, or large retailer) that have strong physical similarities in the characteristics of the assets at risk, or the assets are geographically concentrated (for example, hotels in California, a theme park, or a large industrial complex), the "average" or "default" vulnerability view within the model can be enhanced by improving the exposure data to better characterize the primary and secondary characteristics of assets (input to the catastrophe risk model). Primary characteristics include COPE data as well as height and year built; secondary characteristics include more detailed information, such as roof covering, glazing type, and roof-to-wall connection, among numerous other characteristics. Making explicit, discrete selections for these characteristics not only improves the risk estimate but also reduces the uncertainty in the estimate of risk.

The evaluation can be further enhanced by making improvements in the engineering representation of portfolio-specific characteristics resulting in an asset-specific evaluation of the risk aggregated to the portfolio

Figure 4. For large, geographically well distributed portfolios, catastrophe (cat) model output can be enhanced with additional data and analysis to achieve the best estimate of "true risk"





level. For example, when considering structures that are standardized to some extent, such as hotels or stores in a retail chain, the analysis can take into account specific design details and other characteristics and incorporate them into the tool. The more clarity in the risk estimate, the better the applicability across the entire insurance value chain.

"True Risk" for Small Portfolios

For small portfolios (in terms of number of assets), brokers can begin at the standard level using catastrophe models with available or improved COPE data to obtain a loss estimate. However, this loss estimate could have significant uncertainty. This by no means implies that the standard level of evaluation isn't recommended for small portfolios; it is, but it should be used for specific applications, such as the preliminary risk ranking of the assets within the small portfolio to identify the primary risk drivers and then, as appropriate, subject these primary risk drivers to an advanced catastrophe risk modeling process.

An advanced risk evaluation of a small portfolio can significantly improve the estimate of the "true risk" with site-specific evaluations of the assets—something that is not required nor, in fact, feasible from either a cost or time standpoint for a large portfolio. The advanced evaluation entails gathering exposure-specific data and conducting an engineering evaluation involving: site-specific hazard assessment; better disaggregation of exposure values (in terms of component valuations and damageability); site

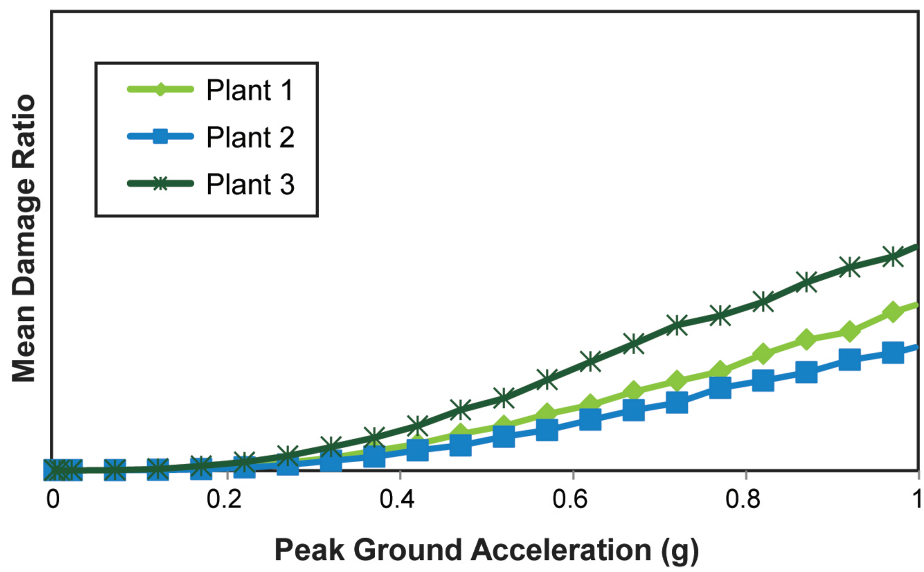
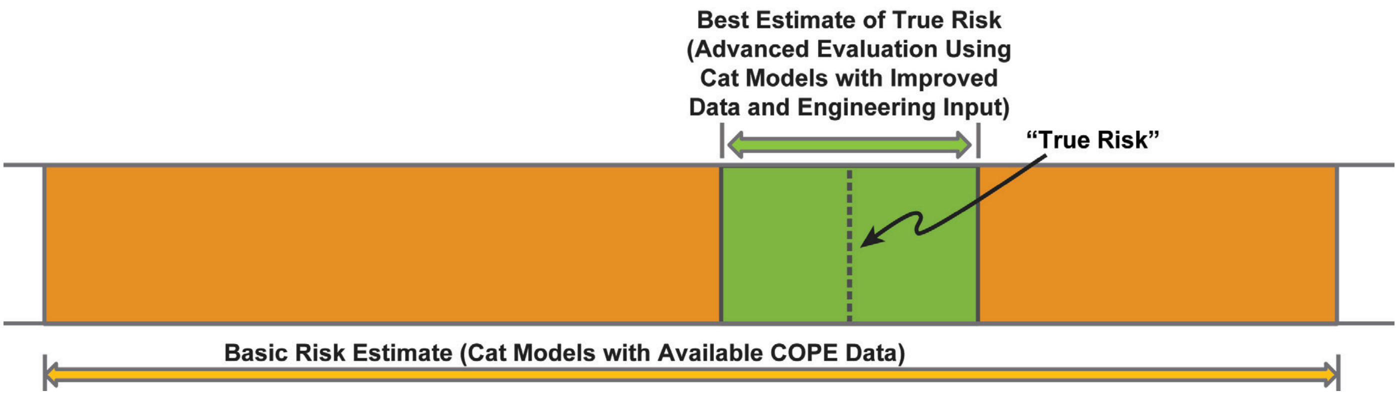


Figure 5. Example of loss profiles for three "similar" power plants

investigations to capture site-specific characteristics; an engineering damageability assessment; detailed process/network/supply chain evaluation for business interruption loss evaluation; and the disaggregation of risk into constituent components—essentially, customizing the various modules of the catastrophe risk model for business- and site-specific data and characteristics. As an example, Figure 5 shows the component make-up for three power plants in close proximity to one another. The standard application of the catastrophe risk model would result in the loss profiles being essentially identical for the three power plants. An advanced evaluation, however, will distinguish between them, as evidenced by Figure 5. This can translate into significant advantages from a risk management and mitigation standpoint.

Such extension of the catastrophe risk models (see Figure 6) are also very applicable when the business wants to achieve a deep understanding of the risk associated with complex, high-value assets that do not lend themselves to standard, portfolio risk modeling techniques—as there is a paucity of historical information on the loss sustained by such assets—or when the asset/hazard falls outside the conventional modeling domain (for example, renewable energy assets, supply chains, theme parks, and perils not conventionally modeled).

The results from these advanced assessments offer a distinct competitive advantage, particularly to brokers who serve clients with unique or highly protected risks. Brokers can leverage the advanced catastrophe risk assessments to increase their own value, as they can provide better risk



mitigation and management solutions, and corporate risk managers can develop a deeper understanding of the drivers of loss. These assessments also provide a strong basis for communication with the decision makers within the organizations and the insurance market.

There is no guarantee that an advanced risk assessment will result in a lower loss value—only that it will result in a more accurate value with less uncertainty and much more detailed information that can be used for risk management and mitigation.

Quantifying Supply Chain Risk

Up until this point, the discussion about advanced assessments has revolved around studying the physical exposures and their vulnerability to various catastrophes. But there is another aspect to quantifying, mitigating, and managing catastrophe risk through advanced assessments that leverage the catastrophe risk models and enhance them through explicit network modeling: quantifying supply chain risk.

A supply chain is in essence a collection of operational points, or nodes, linked based on functional and revenue stream relationships. Simple examples of nodes include a production facility, a supplier, or a distribution center. When all the nodes in a network are identified and appropriately characterized, quantifying the physical damage potential associated with each node is relatively straightforward—as would be done by using the catastrophe risk models. However, traditional methods for quantifying overall supply chain risk have considerable limitations because they are often based on worst-case scenarios and do not include the likelihood or frequency of shutdown, nor do they consider the partial shutdown of a single node or the simultaneous disruption of multiple nodes, within a fully probabilistic framework.

Catastrophe risk models enhanced with detailed network analysis provide the solution because the framework is fully probabilistic. As a result, partial damage and downtime states for all nodes can be simultaneously and explicitly considered. Furthermore, the level of disruption at each location from multiple perils can be accounted for, thus providing a more realistic and reliable view of downtime and loss. In addition, node level reserves, redundancy, and resiliency concepts can be explicitly incorporated into the evaluation to provide the best estimate of the "true risk" to the supply chain from a catastrophe standpoint (see Figure 7).

Closing Thoughts

Facilities are unique. Businesses are unique. Risk tolerances, availability of capital for risk management, C-suite preferences are all unique, too. The way catastrophe risk modeling tools are used for quantifying, managing, and mitigating the risk should also be unique; characteristics unique to the portfolios should be input to result in the maximum benefit being derived from the tools. The tools are universally accepted and with carefully researched input can provide a level of reliability, transparency, and defensibility that can make the difference between ill-informed and well-informed decision making. Brokers are in positions that call for them to understand the applicability of the tools, their limitations, and their potential in protecting their clients' interests—both from a physical risk mitigation perspective as well as financial risk management. Armed with reliable quantitative information, the broker will stand to gain in a crowded field where preserving clients' best interests and retaining their business are paramount.

Figure 6. For small, geographically concentrated portfolios with unique or highly protected risks, an advanced risk evaluation is necessary to achieve the best estimate of "true risk"

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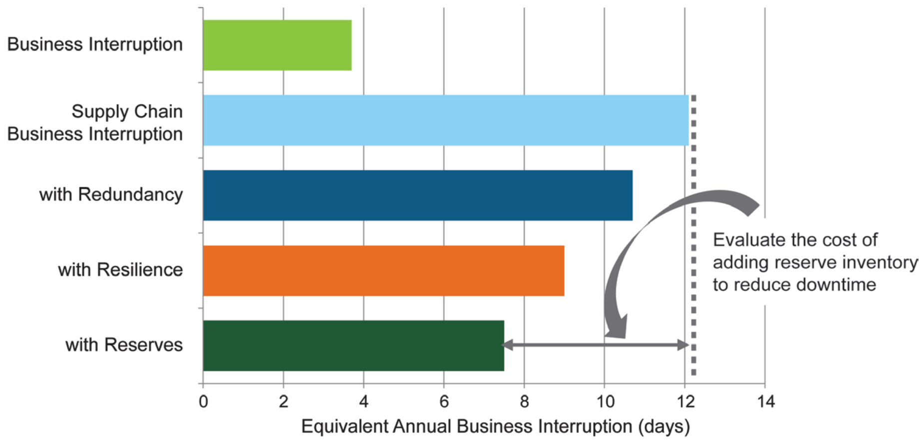

Fig 7. Advanced risk evaluations can be used for assessing and managing supply chain risk