oasis LOSS MODELLING FRAMEWORK

Understanding and managing damage uncertainty in catastrophe models

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Impact Forecasting

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Introduction

Natural catastrophes represent a significant contributor to insured losses worldwide as has been seen by recent Hurricanes Harvey, Irma and Maria causing much damage to the US and Caribbean, alongside the M7.1 earthquake in Puebla, Mexico, and Typhoon Hato striking south China. Catastrophe models help to quantify losses and loss uncertainty but there is still a long way to go, and cat modelling practitioners know that there is no place where our understanding of natural hazards is complete. It's therefore an essential part of catastrophe modelling to understand, quantify and manage uncertainty. The article will attempt to tackle some of of the main sources of the damage uncertainty and how best to deal with it.

What are the sources of vulnerability uncertainty?

Catastrophe modelling is used to assess and quantify the financial risk from natural perils. Hazard, engineering and economic data are used to develop catastrophe models. Limitations in data and assumptions in the model's parameters and methods used affect catastrophe model loss estimates.

Uncertainty appears in both model development (inherent) and catastrophe modelling (extrinsic). In general uncertainty can be characterized as either aleatory or epistemic. Aleatory uncertainty represents the randomness associated with the process. Epistemic uncertainty is the uncertainty due to lack of information or knowledge.

Vulnerability describes the relationship between particular characteristics of a hazard (such as wind-speed, or ground shaking intensity) and the effect that it will have on the damage incurred to a particular risk.

The main sources of uncertainty in the vulnerability component of a model include:

- Quality and quantity of the observed (claims) or analytical / experimental loss data used to develop the damage curves (aleatory uncertainty)
- Variety and characteristics of the methods to develop damage curves such as: empirical, semi-empirical and analytical (epistemic uncertainty)

The extrinsic uncertainty in the vulnerability component similarly involves the quality of the modelling data (insurance portfolio of building values) and capabilities.

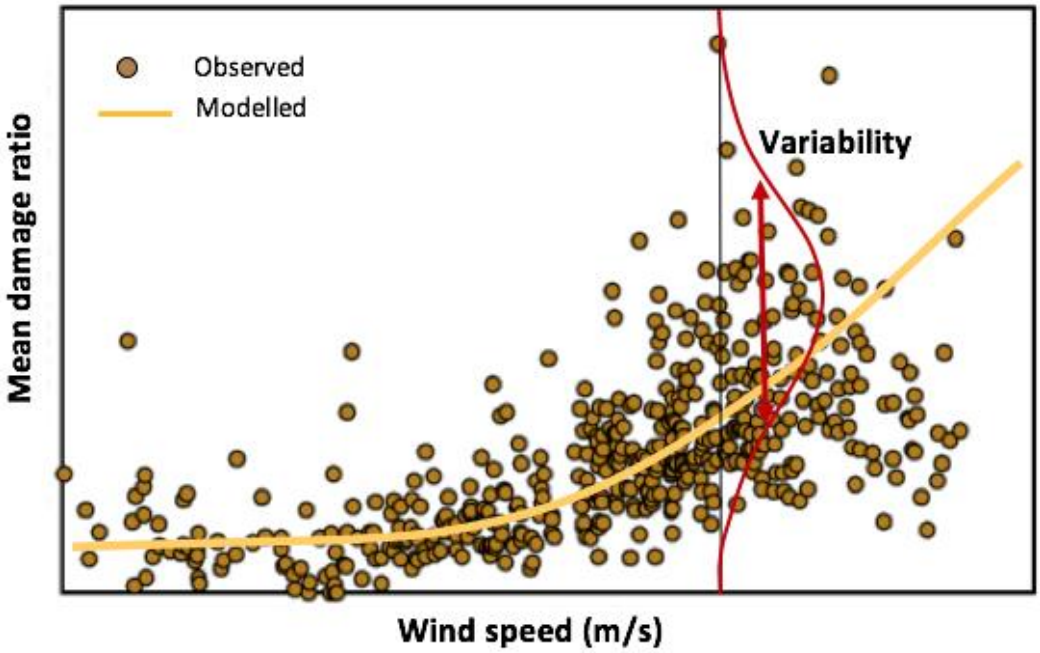

Figure: A damage function representing the relationship between hazard parameter and mean damage ratio (source: Impact Forecasting)

To reduce uncertainty in modelling, detailed claims information with the following characteristics can help to develop more accurate damage curves:

- detailed location of the loss
- building occupancy and structural characteristics
- information regarding the source of loss (main or secondary peril e.g. EQ or Tsunami).

The quantity of such data allows a representative statistical sample to develop the damage curves, to determine its aleatory uncertainty (standard deviation of the mean damage ratio) and to calculate the chance of a loss occurring.

The characteristics of the method to develop the damage curves has its own contribution to the level of uncertainty. Usually the empirical methods provide an opportunity to develop larger database of more generic (structural / occupancy) damage curves incorporating larger uncertainty. By the use of analytical / parametric methods one can develop a limited number of detailed damage curves with reduced uncertainty in the choice of vulnerability function.

The quality of exposure data used in catastrophe modelling is a very important source of extrinsic uncertainty. The level of granularity of the data defined by the number of different vulnerability modifiers contributes directly towards the level of uncertainty. Whilst catastrophe models give a range of options to describe building types and should theoretically reduce uncertainty, there is a view that this may lead to over-engineering of the models for some regions where exposure data and claims data are scarce.

How do the sources of vulnerability uncertainty affect the loss estimate?

Understanding and quantification of the uncertainty is a crucial step in the catastrophe risk assessment. Some examples how the sources of vulnerability uncertainty can affect the loss estimates:

- Lack of information regarding replacement cost and business interruption cost affect the accuracy of the loss estimate of the catastrophe model. For example, the increased cost to repair or rebuild after an event is often taken into account using a demand surge adjustment if possible. This is simply the percentage increase in costs due to the limited supply of construction material and labour immediately following a disaster.

- Partial information on the structural characteristics can also result in an inaccurate estimate of potential damage. For example, most structural engineers would agree that the vulnerability modifiers such as construction type, age, height and occupancy are needed – at a minimum – for the inventory component of a catastrophe model. If more specific information regarding the structure such as its location relative to other structures and previous damage to the structure were available, a more accurate estimate of damage or vulnerability would result.

- The use of generic construction / occupancy damage curves involves uncertainty due to assumptions made by the model developer. Such loss estimates could be biased and potentially not suitable to the portfolio particularities. For example, a model may be developed on a “market” portfolio view and then run on a very specific portfolio which doesn’t reflect the “market” view.

Some of the approaches to understand and manage the uncertainty in the vulnerability component

Catastrophe modellers and exposure managers seek proper understanding of uncertainty and approaches how to manage it. Transparency and open data and software principles allows understanding of the uncertainty through descriptions of: (1) the methods to develop the damage curves; (2) the data used in the development; and, (3) the way of the vulnerability component is implemented.

Quantification of uncertainty strongly influenced by the transparency within a cat model and to the loss simulation methods (damage sampling) in the modern catastrophe modelling platforms. If these components are black-boxes and components can’t be seen, then how can uncertainty be quantified!

The ultimate question would be, can we manage / decrease uncertainty in the vulnerability component? The answer is not straightforward but the efforts again should be directed towards the two main drivers of the uncertainty: the data and the model development methods. The use of good quality data with appropriate granularity is the most important factor to develop the vulnerability component, model the client portfolios and to “control” the level of the uncertainty. The other important factor are the methods and tools used on that matter. The use of regional / local knowledge is one example how we can decrease the epistemic uncertainty that can be also stress tested during the development of the catastrophe model. The validation and calibration of the damage curves using past observations including model back testing can also contribute towards better understanding of the loss estimates and decrease of the epistemic uncertainty. The most sound approach is development of bespoke damage curves for insurers based on their loss history. This may provide the most appropriate tools for benchmarking of the client's requested protection to the market average.

How Oasis might help to manage better the uncertainty in the vulnerability component?

Impact Forecasting have worked with Oasis since its inception. We work with Oasis by adopting their hazard and vulnerability structure and by putting IF models into the Oasis platform.

A key component of the Oasis Loss Modelling Framework is the approach to vulnerability and damage uncertainty. Rather than assuming a mean damage ratio and assuming a beta distribution, Oasis allows an empirical distribution to be developed for the vulnerability component. This allows a model developer to use claims data to develop damage functions which better reflect the real situation. For example, within our European hail/SCS model we've used claims data to determine that the mean damage ratio is not an adequate metric to describe loss. The full range of claims data can be used instead to develop empirical damage functions which have a density of loss rather than a single mean damage ratio and parametric distribution.

By adopting the Oasis vulnerability structure we can better quantify losses in our model. All new IF models follow this same principle and where claims data exist can help to better quantify damage uncertainty.

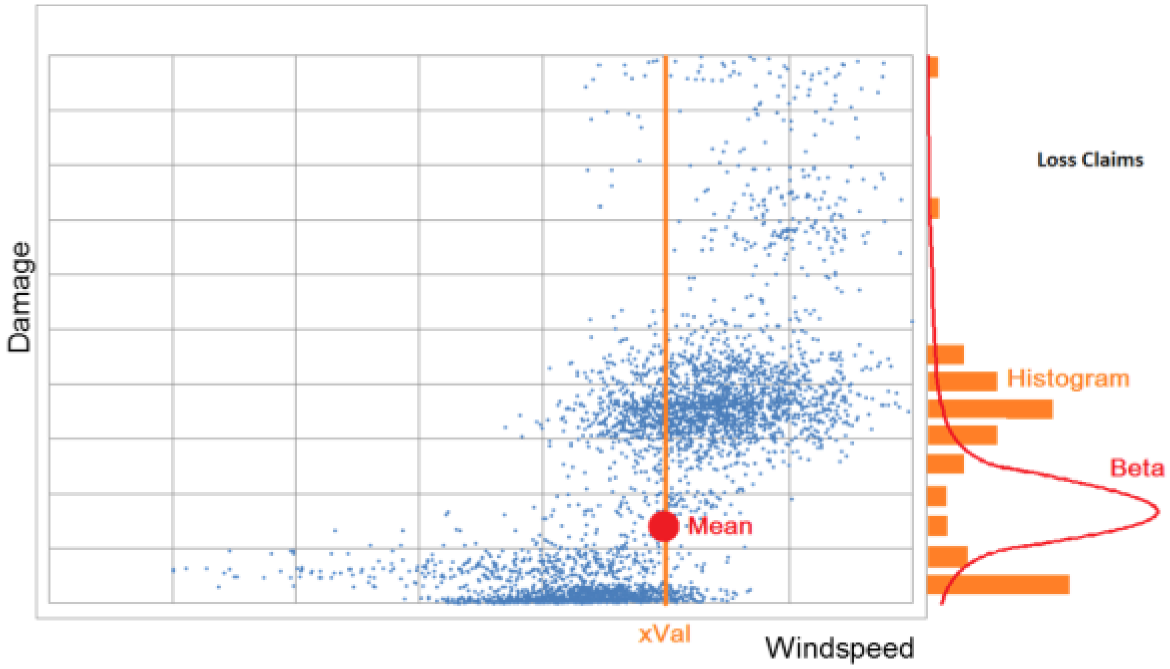

Figure: Showing claims information (blue) dots and how the mean damage ratio and an assumed parametric beta distribution cannot reflect the real-world situation. The Oasis format allows an empirical distribution of damage uncertainty to be developed more accurately reflecting claims data (source: Impact Forecasting)