

## Transferring sensitivity analysis to the re/insurance industry to improve decision-making under uncertainty

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### The challenge

To quantify risk from natural hazards and achieve a robust decision-making process in the re/insurance industry, uncertainties in the mathematical models that underpin decisions need to be efficiently captured. However, the complexity of these models, together with their often proprietary nature, makes a comprehensive, transparent and easily communicable quantification of the uncertainties very difficult.

### What was achieved

We developed several case studies with re/insurance companies and model vendors, which demonstrate the benefit of using Global Sensitivity Analysis (GSA) to help the catastrophe model building process and forming a more robust view of risk. In the specific, a case study with the actuarial pricing team at AXA XL shows how to reach more efficiency in the model validation process by determining the most influential assumptions that deserve extra attention when reviewing the model. The case study also allows to better communicate the underlying model

uncertainty to underwriters and to enhance the credibility of the model results. We also developed a case study with JBA Risk Management on their Global Flood Model. By varying model inputs that are not normally varied in traditional cat models, we achieved an increased understanding of the model behaviour beyond its default set up. Moreover, we visualised the uncertainty in the losses estimated at different return periods in the Exceedance-Probability curve (Figure 1), an insight not usually available to model users, and that allows to adequately communicate uncertainties to decision-makers. Finally, we developed a case study with AXA XL on a third-party wind peril model. It empowers model users to explore the model inputs that they can control, as proprietary models have limited components that can be modified. By exploring the impact of exposure data and the spatial resolution on the estimated losses we could prioritise the investments on better quality data (Figure 2).

This work set the path for the re/insurance sector to improve ownership of the mathematical models they use, by thoroughly understanding where the uncertainties lie in their modelling process, and therefore to make more robust business decisions.

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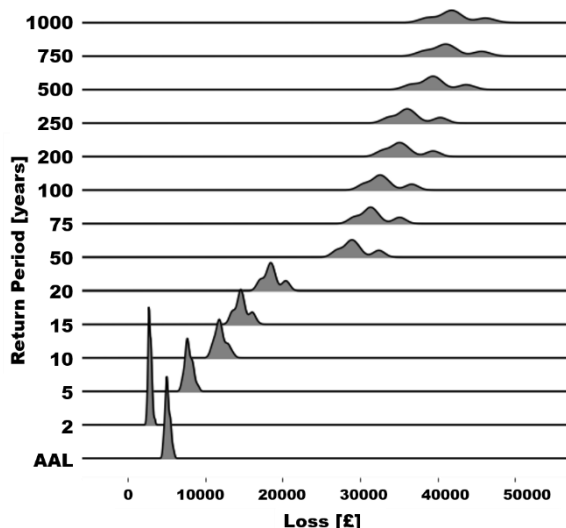
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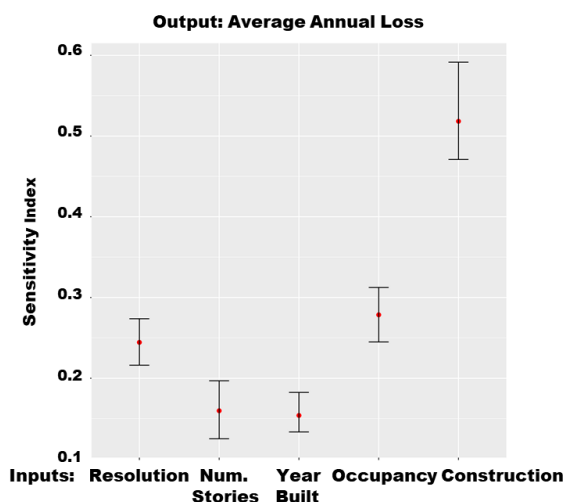
# Improving the understanding and consideration of uncertainty in the re/insurance industry

The knowledge gained through these case studies has been disseminated to the wider re/insurance sector through presentations and workshops at conferences, both academic (e.g. [EGU GA 2020](#)) and industry-

specific (e.g. [OASIS LMF 2019 annual conference](#)) and with tutorials at four major re/insurance companies. All the training material developed is openly available at [www.safe-insurance.uk](http://www.safe-insurance.uk).



**Figure 1.** Distribution of losses by return period (RP) shows increased uncertainty with higher RP (JBA case study).



**Figure 2.** Construction type is the most influential input factor among the primary modifiers investigated (AXA XL case study)

## How we did it

We closely collaborated with AXA XL and JBA Risk Management to understand the major sources of uncertainty in their modelling process, which input factors were feasible and of most interest to investigate in their modelling chain, and how to vary them within sensible ranges. To apply Global Sensitivity Analysis to these models we used the SAFE toolbox (Pianosi et al. 2015) and we developed workflows in R Markdown and Jupyter Notebook outlining the steps of GSA and providing insights to interpret the

results. These workflows are useful both for the companies with whom we collaborated as a blueprint for other applications, and for other re/insurance companies on how they can investigate the uncertainties in their catastrophe models.

## References

Pianosi F, Sarrazin F, Wagener T. 2015. A Matlab toolbox for Global Sensitivity Analysis. *EMS* 70. 80–85 DOI: [10.1016/j.envsoft.2015.04.009](https://doi.org/10.1016/j.envsoft.2015.04.009)

*“Using SAFE, we have gained great insight into the sensitivity of our model losses to uncertainties in the model datasets and analysis options. It has helped to focus our attention by highlighting parameters that matter less, along with those that matter more.” Dr Kirsty Styles (JBA Risk Management)*

*“This collaboration has been extremely useful to AXA XL in developing a systematic framework for assessing sensitivity to model data inputs. We plan to use SAFE further in the future to better understand input variables into catastrophe risk models with the aim of prioritising efforts to improve data quality. We also intend to share the knowledge and insight we have gained with other departments internally.” Catherine Pigott (AXA XL)*