A vulnerability framework for a global flood catastrophe model

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In recent years the precision and skill of global flood hazard models has increased dramatically. This, alongside developments allowing for hazard model conversion to stochastic event sets and the open-sourcing of catastrophe modeling software, have opened up the possibilities of developing detailed and skillful global flood catastrophe models; assessing not just average risk but also the possible impacts of major flood events and the probability distribution of annual losses. In order to realize these possibilities, it is necessary to develop a global vulnerability framework that appropriately represents the state of the art in vulnerability modeling whilst being flexible to user inputs and faithfully representing uncertainties.

Here, we present a framework for implementing a flexible vulnerability module within a global flood catastrophe model. Vulnerability curves are derived for a variety of occupancies (residential, commercial, industrial), for both building and contents losses. The mean loss ratio curves are derived from literature and commercial datasets before being normalized and fit to a family of logarithmic functions of depth, which can be adjusted for varying property characteristics. Uncertainty distributions are parameterised using a 4 parameter beta model and derived from a large insurance claims dataset (~2 million claims).

Finally, using the same large claims dataset, we explore the event-level correlation of the quantiles sampled within our uncertainty distribution. Specifically, we evaluate the extent to which the quantiles sampled of the uncertainty distribution, in a Monte Carlo approach, should be clustered for each event. This is vital for correctly estimating the losses from rare, high-impact events and allows for a realistic representation of vulnerability uncertainty in aggregate loss estimates.