Geophysical Research Abstracts
Vol. 15, EGU2013-5078-1, 2013
EGU General Assembly 2013

Challenges estimating the return period of extreme floods for reinsurance applications

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Mapping and modelling extreme natural events is fundamental within the insurance and reinsurance industry for assessing risk. For example, insurers might use a 1 in 100-year flood hazard map to set the annual premium of a property, whilst a reinsurer might assess the national scale loss associated with the 1 in 200-year return period for capital and regulatory requirements. Using examples from a range of international flood projects, we focus on exploring how to define what the n-year flood looks like for predictive uses in re/insurance applications, whilst considering challenges posed by short historical flow records and the spatial and temporal complexities of flood.

First, we shall explore the use of extreme value theory (EVT) statistics for extrapolating data beyond the range of observations in a marginal analysis. In particular, we discuss how to estimate the return period of historical flood events and explore the impact that a range of statistical decisions have on these estimates. Decisions include: (1) selecting which distribution type to apply (e.g. generalised Pareto distribution (GPD) vs. generalised extreme value distribution (GEV)); (2) if former, the choice of the threshold above which the GPD is fitted to the data; and (3) the necessity to perform a cluster analysis to group flow peaks to temporally represent individual flood events.

Second, we summarise a specialised multivariate extreme value model, which combines the marginal analysis above with dependence modelling to generate industry standard event sets containing thousands of simulated, equi-probable floods across a region/country. These events represent the typical range of anticipated flooding across a region and can be used to estimate the largest or most widespread events that are expected to occur.

Finally, we summarise how a reinsurance catastrophe model combines the event set with detailed flood hazard maps to estimate the financial cost of floods; both the full event set and also individual extreme events. Since the predicted loss estimates, typically in the form of a curve plotting return period against modelled loss, are used in the pricing of reinsurance, we demonstrate the importance of the estimated return period and understanding the uncertainties associated with it.