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National scale high-resolution quantification of fluvial flood risk in Great Britain

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Britain has experienced repeated episodes of widespread river flooding in recent years, with considerable implications for insurance companies. Probabilistic models enable these companies to robustly quantify flood risk. Because flood events are often very localised, the models would ideally incorporate high-resolution flood data, but although such data are increasingly available at a national scale their inclusion has, to date, been a daunting 'big data' challenge. Here, we discuss some of the scientific and technological advancements we have made to develop a detailed probabilistic model which is underpinned by high-resolution flood data.

Return period river flows were first estimated at a large number of locations along the national river network using the Flood Estimation Handbook approach. These flows were then routed across a high-resolution Digital Terrain Model using our 2D hydraulic model, JFlow, to produce 5m resolution river flood hazard maps for the entire county. Our probabilistic model integrates these 'design' hazard data, a state-of-the-art stochastic event set containing tens of thousands of synthetic extreme flow events, a 'built environment' database and 'vulnerability functions' (which relate water depth and damage) to determine the probability distribution of annual river flood losses to insured properties.

Stochastic events were carefully assigned to 'years' in the simulation period, with each year being a plausible version of 'next year'. The flood footprint associated with each simulated event was defined, and event-by-event total damage and insured loss calculated. Precise property locations could be provided as an input, and all calculations were carried out on an extremely fine grid to minimise uncertainties due to data aggregation. Being comprised of large data tables, models of this nature are computationally demanding; to enable full analyses on reasonable timescales, our model was re-coded to run on IBM's PureData for Analytics appliance. The model will also be made available in the Oasis Loss Modelling Framework.

Uncertainty in the results stems from numerous sources. Two are particularly important: i) uncertainty in the magnitude of long return period river flows, and ii) uncertainty in the damage expected given flooding of a known depth. Whilst the former could not be reduced without access to longer records, the latter could be reduced somewhat by further empirical studies.