Assessing the socio-economic impact of flooding in economically developing countries using catastrophe models

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Flooding occurs frequently in Sierra Leone leading to loss of life, disease outbreak and damage to buildings. The effects on the population can be widespread and devastating. Of the total number of people affected by disasters in Sierra Leone in the last 30 years, 90% were affected by flooding. The population of Sierra Leone is particularly vulnerable to flooding due to land reclamation from the sea and swamps and construction of buildings on floodplains. To better understand the impact that flooding has on the risk to life and property, we developed a probabilistic flood model using statistical and physical modelling methods to represent three cities in Sierra Leone. This work was commissioned by the World Bank.

Our model combines methods that are well established in the insurance industry with some that were developed to account for the sparse hydrological and socio-economic data available in Sierra Leone. A flood event set was generated at locations distributed across the country by applying advanced statistics and hydrology to historical rainfall and flow observations. The large-scale spatial extent of each simulated event was produced, along with the severity at each location. The event set was combined with flood maps providing extent and depth information for a range of flood severities. For each event in the event set, the flood depth and extent were extracted from the flood maps to create a catalogue of tens of thousands of realistic future flood event footprints. The resulting event catalogue includes some events that are more extreme or widespread than have been experienced in recent history but are still physically plausible. Vulnerability functions that relate flood water depth to the severity of damage were created for a selection of property types, and for people affected and fatalities. Geographical databases of properties and population were created as part of the wider project and outputs uploaded to Open Street Map for use in other projects.

The probabilistic flood model was run to estimate the number of people affected, number of fatalities and economic property loss associated with the range of flood events modelled. The outputs are now being used to identify the locations with the highest risk of flooding, so regions can be prioritised for intervention. The results can also be used to inform urban planning to avoid development in high-risk zones. A large flood event in August 2017 highlighted an unintended benefit of the modelling for real-time event response and recovery.