



## Flood model for Brazil

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Looking on the impact of flooding from the World-wide perspective, in last 50 years flooding has caused over 460,000 fatalities and caused serious material damage. Combining economic loss from ten costliest flood events (from the same period) returns a loss (in the present value) exceeding 300bn USD. Locally, in Brazil, flood is the most damaging natural peril with alarming increase of events frequencies as 5 out of the 10 biggest flood losses ever recorded have occurred after 2009. The amount of economic and insured losses particularly caused by various flood types was the key driver of the local probabilistic flood model development.

Considering the area of Brazil (being 5th biggest country in the World) and the scattered distribution of insured exposure, a domain covered by the model was limited to the entire state of Sao Paulo and 53 additional regions. The model quantifies losses on approx. 90 % of exposure (for regular property lines) of key insurers. Based on detailed exposure analysis, Impact Forecasting has developed this tool using long term local hydrological data series (Agencia Nacional de Aguas) from riverine gauge stations and digital elevation model (Instituto Brasileiro de Geografia e Estatística).

To provide most accurate representation of local hydrological behaviour needed for the nature of probabilistic simulation, a hydrological data processing focused on frequency analyses of seasonal peak flows – done by fitting appropriate extreme value statistical distribution and stochastic event set generation consisting of synthetically derived flood events respecting realistic spatial and frequency patterns visible in entire period of hydrological observation. Data were tested for homogeneity, consistency and for any significant breakpoint occurrence in time series so the entire observation or only its subparts were used for further analysis. The realistic spatial patterns of stochastic events are reproduced through the innovative use of d-vine copula scheme to generate probabilistic flood event set.

The derived design flows for selected rivers inside model domain were used as an input for 2-dimensional hydrodynamic inundation modelling techniques (using the tool TUFLOW by BMT WBM) on mesh size 30 x 30 metres. Outputs from inundation modelling and stochastic event set were implemented in the Aon Benfield's platform ELEMENTS developed and managed internally by Impact Forecasting; Aon Benfield internal catastrophe model development center. The model was designed to evaluate potential financial impact caused by fluvial flooding on portfolios of insurance and/or reinsurance companies. The structure of presented model follows typical scheme of financial loss catastrophe model and combines hazard with exposure and vulnerability to produce potential financial loss expressed in the form of loss exceedance probability curve and many other insured perspectives, such as average annual loss, event or quantile loss tables and etc. Model can take financial inputs as well as provide split of results for exact specified location or related higher administrative units: municipalities and 5-digit postal codes.