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Cascading rainfall uncertainties into 2D inundation impact models

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Existing precipitation products show differences in their spatial and temporal distribution and several studies have presented how these differences influence the ability to predict hydrological responses. However, an atmospheric-hydrologic-hydraulic uncertainty cascade is seldom explored and how, importantly, input uncertainties propagate through this cascade is still poorly understood. Such a project requires a combination of modelling capabilities, runoff generation predictions based on those rainfall forecasts, and hydraulic flood wave propagation based on the runoff predictions. Accounting for uncertainty in each component is important in decision making for issuing flood warnings, monitoring or planning.

We suggest a better understanding of uncertainties in inundation impact modelling must consider these differences in rainfall products. This will improve our understanding of the input uncertainties on our predictive capability.

In this paper, we propose to address this issue by i) exploring the effects of errors in rainfall on inundation predictive capacity within an uncertainty framework, i.e. testing inundation uncertainty against different comparable meteorological conditions (i.e. using different rainfall products).

Our method cascades rainfall uncertainties into a lumped hydrologic model (FUSE) within the GLUE uncertainty framework. The resultant prediction uncertainties in discharge provide uncertain boundary conditions, which are cascaded into a simplified shallow water 2D hydraulic model (LISFLOOD-FP). Rainfall data captured by three different measurement techniques - rain gauges, gridded data and numerical weather predictions (NWP) models are used to assess the combined input data and model parameter uncertainty. The study is performed in the Severn catchment over the period between June and July 2007, where a series of rainfall events causing record floods in the study area).

Changes in flood area extent are compared and the uncertainty envelope is analysed for the different cases. These results demonstrate how rainfall input uncertainty affects the resultant set of behavioural models and what rainfall products produce robust predictions within an uncertainty analysis framework. This addresses the question of how storm impact models might be improved with next generation NWP models.