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Techniques for efficient high-resolution modelling of urban floodplain inundation

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Floodplain inundation modelling is a vital tool for catchment management, flood risk assessment and mitigation applications. However, growing awareness of the uncertainties underlying both the parameterization and structure of inundation models leads to demands for such models to be used within an ensemble prediction framework. An important step in reaching this goal is to develop reduced complexity models which achieve accurate results while benefiting from a computationally efficient algorithm.

Significant recent advances in this approach have been achieved by directly coupling 1d channel hydraulic models with a raster storage cell approximation for floodplain flows. The explicit dependence of this structure on a digital elevation model (DEM) to parameterize flows through riparian areas allows heterogeneous floodplains to be efficiently represented in the model. Previous applications of this framework have generally used mid-range grid scales (10^1-10^2 m), showing the capacity of the models to simulate long reaches (10^3-10^4 m). However, the increasing availability of precision DEMs derived from airborne laser altimetry (LIDAR) enables their use at very high spatial resolutions (10^0-10^1 m). This spatial scale offers the opportunity to incorporate the complexity of the built environment directly within the floodplain DEM and simulate urban flooding.

This presentation describes a series of experiments designed to test model functionality, stability and efficiency at such increased resolutions. The experiments apply a raster floodplain model to reconstruct a 1:100 year flood event on the River Granta in eastern England, which flooded 72 properties in the town of Linton in October 2001. Data is available in the form of a high-resolution DEM derived from single-pulse LIDAR data supplied by the UK Environment Agency, together with surveyed data and

aerial photography.

At this resolution, inundation forecasts become highly sensitive to the precise representation of floodplain topography. Novel methods of processing the raw data to provide the individual structure detail required are investigated and compared. Model efficiency may also be compromised by the relative speed of the floodwave across individual cells, and methods to ameliorate this are considered. These include the use of a nested-scale model, where an inner urban zone represented at 1-2m scale is embedded within a lower-resolution model application at the reach scale which provides boundary conditions based on recorded flood stage. Other methods considered are reprojection of the inundation pattern from a model run at lower resolution, and the use of a timestep differential between channel and floodplain. Importantly, all such techniques are considered alongside their implications for model stability.

Finally, the high resolution predictions on a scale commensurate with urban structures make possible a multi-criteria validation which combines verification of reach-scale characteristics such as downstream flow and inundation extent with internal validation of flood depth at individual sites.