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Uncertainty in surface water flood risk modelling

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Two thirds of the flooding that occurred in the UK during summer 2007 was as a result of surface water (otherwise known as 'pluvial') rather than river or coastal flooding. In response, the Environment Agency and Interim Pitt Reviews have highlighted the need for surface water risk mapping and warning tools to identify, and prepare for, flooding induced by heavy rainfall events. This need is compounded by the likely increase in rainfall intensities due to climate change. The Association of British Insurers has called for the Environment Agency to commission nationwide flood risk maps showing the relative risk of flooding from all sources. At the wider European scale, the recently-published EC Directive on the assessment and management of flood risks will require Member States to evaluate, map and model flood risk from a variety of sources. As such, there is now a clear and immediate requirement for the development of techniques for assessing and managing surface water flood risk across large areas.

This paper describes an approach for integrating rainfall, drainage network and high-resolution topographic data using Flowroute™, a high-resolution flood mapping and modelling platform, to produce deterministic surface water flood risk maps. Information is provided from UK case studies to enable assessment and validation of modelled results using historical flood information and insurance claims data.

Flowroute was co-developed with flood scientists at Cambridge University specifically to simulate river dynamics and floodplain inundation in complex, congested urban areas in a highly computationally efficient manner. It utilises high-resolution topographic information to route flows around individual buildings so as to enable the prediction of flood depths, extents, durations and velocities. As such, the model forms an ideal platform for the development of surface water flood risk modelling and mapping capabilities.

The 2-dimensional component of Flowroute employs uniform flow formulae (Manning's Equation) to direct flow over the model domain, sourcing water from the channel or sea so as to provide a detailed representation of river and coastal flood risk. The initial development step was to include spatially-distributed rainfall as a new source term within the model domain. This required optimisation to improve computational efficiency, given the ubiquity of 'wet' cells early on in the simulation.

Collaboration with UK water companies has provided detailed drainage information, and from this a simplified representation of the drainage system has been included in the model via the inclusion of sinks and sources of water from the drainage network. This approach has clear advantages relative to a fully coupled method both in terms of reduced input data requirements and computational overhead. Further, given the difficulties associated with obtaining drainage information over large areas, tests were conducted to evaluate uncertainties associated with excluding drainage information and the impact that this has upon flood model predictions. This information can be used, for example, to inform insurance underwriting strategies and loss estimation as well as for emergency response and planning purposes.

The Flowroute surface-water flood risk platform enables efficient mapping of areas sensitive to flooding from high-intensity rainfall events due to topography and drainage infrastructure. As such, the technology has widespread potential for use as a risk mapping tool by the UK Environment Agency, European Member States, water authorities, local governments and the insurance industry.

Keywords:
Surface water flooding, Model Uncertainty, Insurance Underwriting, Flood inundation modelling, Risk mapping.