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Improving flood inundation models of urban flood risk using a porosity-type approach: a case study from Carlisle 2005

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The complexity of flood processes, particularly in urban environments, and the difficulties of collecting data during flood events, presents significant and particular challenges to modellers, especially when considering large geographic areas. As such, flood risk assessment presents a clear dichotomy for practitioners whereby fine scale detail is required over wide areas and as such computationally efficient methods are a necessity. Insurance industry CAT models in particular, attempt to represent a credible range of flood events over large geographic areas and need to resolve property risk accurately within this model structure. Current approaches in industrial applications aim to achieve a compromise between computational burden and detail of description. This paper documents the development and application of simple methods to retain computational efficiency and deliver detailed flood risk estimates over large geographic regions, that can be easily applied within CAT models for the insurance and reinsurance industries.

In particular, this paper presents a sub-grid scale porosity method specifically designed for hydraulic models of urban floods to harness high resolution topographic and topological data sets. This is driven by a trend towards increased granularity of risk definition within urban areas. These methods have been implemented within LISFLOOD-FP, a storage cell model, indicative of similar diffusion wave methods used within industry standard CAT models. The sub-grid scale method is an areal-based approach to incorporating topographic irregularities smaller than the model grid resolution. This technique is shown to significantly increase coarse resolution model performance with respect to observed maximum flood levels and extents from the Carlisle 2005 flood event in the UK. Furthermore, the incorporation of more topographic detail in these coarse resolution models yields more physically realistic friction parameterisations. The porosity approach increases model performance such that the coarse resolution models perform as well as standard model setups at at least half the resolution and thereby yield an order of magnitude reduction in computational burden.