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Validation of a global hydrodynamic flood inundation model against high resolution observation data of urban flooding

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In this work we present further validation results for a hyper-resolution global flood inundation model. We use a true hydrodynamic model that uses highly efficient numerical algorithms (LISFLOOD-FP) to simulate flood inundation at ∼1km resolution globally and then use downscaling algorithms to determine flood extent and water depth at 3 seconds of arc spatial resolution (∼90m at the equator). The global model has ∼150 million cells and requires ∼180 hours of CPU time for a 10 year simulation period. Terrain data are taken from a custom version of the SRTM data set that has been processed specifically for hydrodynamic modelling. Return periods of flood flows along the entire global river network are determined using: (1) empirical relationships between catchment characteristics and index flood magnitude in different hydroclimatic zones derived from global runoff data; and (2) an index flood growth curve, also empirically derived. Bankful return period flow is then used to set channel width and depth, and flood defence impacts are modelled using empirical relationships between GDP, urbanization and defence standard of protection. The results of these simulations are global flood hazard maps for a number of different return period events from 1 in 5 to 1 in 1000 years.

This method has already been show to compare well to return period flood hazard maps derived from models built with high resolution and accuracy local data (Sampson et al., submitted), yet the output from the global flood model has not yet been compared to real flood observations. Whilst the spatial resolution of the global model is high given the size of the model domain, ∼1km resolution is still coarse compared to the models typically used to simulate urban flooding and the data typically used to validate these (∼25m or less). Comparison of the global model to real-world observations or urban flooding therefore represents an exceptionally stringent test of model skill. In this paper we therefore compare predictions from the global model to high resolution observations for two major urban flood events that occurred in the UK over the last decade: Carlisle in 2005 and Tewkesbury in 2007. In the case of Carlisle the validation data consist of ∼150 post-flood observations of maximum water level with a vertical accuracy of ∼10-15cm. For Tewkesbury we have available a series of remotely sensed images of the flood development and recession obtained from a variety of airborne and satellite platforms. For each site we estimate use official estimates of the return period of each event to select the appropriate global flood hazard map and compare this to the high resolution observations using appropriate performance metrics. We then benchmark the performance of the global model against simulations of these floods obtained using bespoke local models driven by ground gauged boundary conditions and with terrain derived from ∼1m resolution airborne LiDAR data.

Sampson, C.C., Smith, A.M., Bates, P.D., Neal, J.C., Alfieri, L. and Freer, J.E. (submitted). A High Resolution Global Flood Hazard Model. Water Resources Research.