Geophysical Research Abstracts
Vol. 20, EGU2018-1250, 2018
EGU General Assembly 2018

Adaptation of a large-scale cascade flood modelling framework to small spatial and temporal scale events for flash floods flow simulation

Iskra Mejia-Estrada, Paul Bates, and Jim Freer
School of Geographical Sciences, University of Bristol, Bristol, United Kingdom (pm15021@bristol.ac.uk)

Analysis of past flash flood events enable and improve understanding and aid identification of hazard prone areas. In the present study, we aim to reproduce the discharge in the river network as a result of heavy, localized rainfall that resulted in a major flash flood event and significant overland flow.

Thorough analysis of flood events can be carried out by implementing a cascade modeling framework that involves meteorological, hydrological and hydrodynamic numerical tools. Given the extensive literature on model structure and input uncertainty, large scale flood simulations can be accomplished using this methodology. However, when it comes to flash flood simulations rainfall input is usually taken from remotely sensed or ground measured data. In this study, outputs from a Numerical Weather Prediction (NWP) model will be compared against rainfall products from ground measurements to drive a hydrological model and study events with a quick onset at a local scale.

The flash flood event in Newcastle in 2012 was selected as case study based on the severity of the impacts and availability of data for model calibration and validation. On the 28th of June, the equivalent amount of rainfall expected during the whole month (∼50 mm) was recorded during a two-hour period, resulting in road network disruption, significant damage to properties and evacuation of one in five residents of the area.

Input information for the hydrological model consists of a 1 m Digital Elevation Model obtained from the Environment Agency (UK), a raster map of river cells obtained from the topography, potential evapotranspiration time series and 10 km gridded rainfall from the Centre for Ecology and Hydrology (UK). The second source of rainfall information is a probabilistic ensemble of five rainfall scenarios obtained with a Numerical Weather Prediction (NWP) model that features explicit representation of convection and parameterizations for sub-grid scale processes. Fifteen-minute discharge data from the National River Flow Archive (NRFA) is used for model validation.

To analyse the hydrological processes linked to the flash flood case study, a semi-distributed model was implemented to reproduce the discharge in the river network. The computational tool, Dynamic TOPMODEL, assumes a topography-driven flow while accounting for the temporal variability of the upslope contributing area above a cell of interest given wet/dry periods. A Monte Carlo approach was implemented to obtain an ensemble of discharge simulations for the period of study.

The present study evaluates the transferability of a robust framework used in large scale flood analysis to short-lived events at high spatial and temporal resolution. By cascading NWP outputs that were produced using the latest techniques of convective rainfall simulation to a hydrological model that can be implemented across several spatial and temporal scales, we link the meteorological and hydrological ensembles thus enabling the propagation of uncertainty. Dynamic TOPMODEL outputs also provide information on the spread of the ensemble during recession periods and model accuracy to represent peak flows, providing valuable insight into the hydrological processes that influence the rapid catchment response.