Geophysical Research Abstracts
Vol. 19, EGU2017-18034, 2017
EGU General Assembly 2017

Influence of urban surface properties and rainfall characteristics on surface water flood outputs – insights from a physical modelling environment

Daniel Green (1), Ian Pattison (2), and Dapeng Yu (1)

(1) Loughborough University, Department of Geography, Loughborough, United Kingdom (d.green@lboro.ac.uk), (2) School of Civil & Building Engineering, Loughborough University, Loughborough, United Kingdom

Surface water (pluvial) flooding occurs when excess rainfall from intense precipitation events is unable to infiltrate into the subsurface or drain via natural or artificial drainage channels. Surface water flood events pose a major hazard to urban regions across the world, with nearly two thirds of flood damages in the UK being caused by surface water flood events. The perceived risk of surface water flooding appears to have increased in recent years due to several factors, including (i) precipitation increases associated with climatic change and variability; (ii) population growth meaning more people are occupying flood risk areas, and; (iii) land-use changes. Because urban areas are often associated with a high proportion of impermeable land-uses (e.g. tarmacked or paved surfaces and buildings) and a reduced coverage of vegetated, permeable surfaces, urban surface water flood risk during high intensity precipitation events is often exacerbated.

To investigate the influence of urbanisation and terrestrial factors on surface water flood outputs, rainfall intensity, catchment slope, permeability, building density/layout scenarios were designed within a novel, 9m2 physical modelling environment. The two-tiered physical model used consists of (i) a low-cost, nozzle-type rainfall simulator component which is able to simulate consistent, uniformly distributed rainfall events of varying duration and intensity, and; (ii) a reconfigurable, modular plot surface. All experiments within the physical modelling environment were subjected to a spatiotemporally uniform 45-minute simulated rainfall event, while terrestrial factors on the physical model plot surface were altered systematically to investigate their hydrological response on modelled outflow and depth profiles.

Results from the closed, controlled physical modelling experiments suggest that meteorological factors, such as the duration and intensity of simulated rainfall, and terrestrial factors, such as model slope, surface permeability and building density have a significant influence on physical model hydrological outputs. For example, changes in building density across the urban model catchment are shown to result in hydrographs having (i) a more rapid rising limb; (ii) higher peak discharges; (iii) a reduction in the total hydrograph time, and; (iv) a faster falling limb, with the dense building scenario having a 22% increase in peak discharge when compared to the no building scenario. Furthermore, the layout of buildings across the plot surface and their proximity to the outflow unit (i.e. downstream, upstream or to the side of the physical model outlet) is shown to influence outflow hydrograph response, with downstream concentrated building scenarios resulting in a delay in hydrograph onset time and a reduction in the time of the total outflow hydrograph event.