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Modelling urban rainfall-runoff responses using an experimental, two-tiered physical modelling environment

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Surface water (pluvial) flooding occurs when rainwater from intense precipitation events is unable to infiltrate into the subsurface or drain via natural or artificial drainage channels. Surface water flooding poses a serious hazard to urban areas across the world, with the UK's perceived risk appearing to have increased in recent years due to surface water flood events seeming more severe and frequent. Surface water flood risk currently accounts for $\frac{1}{3}$ of all UK flood risk, with approximately two million people living in urban areas at risk of a 1 in 200-year flood event.

Research often focuses upon using numerical modelling techniques to understand the extent, depth and severity of actual or hypothetical flood scenarios. Although much research has been conducted using numerical modelling, field data available for model calibration and validation is limited due to the complexities associated with data collection in surface water flood conditions. Ultimately, the data which numerical models are based upon is often erroneous and inconclusive.

Physical models offer a novel, alternative and innovative environment to collect data within, creating a controlled, closed system where independent variables can be altered independently to investigate cause and effect relationships. A physical modelling environment provides a suitable platform to investigate rainfall-runoff processes occurring within an urban catchment. Despite this, physical modelling approaches are seldom used in surface water flooding research.

Scaled laboratory experiments using a 9m2, two-tiered 1:100 physical model consisting of: (i) a low-cost rainfall simulator component able to simulate consistent, uniformly distributed (>75% CUC) rainfall events of varying intensity, and; (ii) a fully interchangeable, modular plot surface have been conducted to investigate and quantify the influence of a number of terrestrial and meteorological factors on overland flow and rainfall-runoff patterns within a modelled urban setting. Terrestrial factors investigated include altering the physical model's catchment slope (0°- 20°), as well as simulating a number of spatially-varied impermeability and building density/configuration scenarios. Additionally, the influence of different storm dynamics and intensities were investigated. Preliminary results demonstrate that rainfall-runoff responses in the physical modelling environment are highly sensitive to slight increases in catchment gradient and rainfall intensity and that more densely distributed building layouts significantly increase peak flows recorded at the physical model outflow when compared to sparsely distributed building layouts under comparable simulated rainfall conditions.