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Observational techniques for constraining hydraulic and hydrologic models for use in catchment scale flood impact assessment

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There is an increase in the use of Natural Flood Management (NFM) schemes to tackle excessive runoff in rural catchments, but direct evidence of their functioning during extreme events is often lacking. With the availability of low cost sensors, a dense nested monitoring network can be established to provide near continuous optical and physical observations of hydrological processes. This paper will discuss findings for a number of catchments in the North of England where land use management and NFM have been implemented for flood risk reduction; and show how these observations have been used to inform both a hydraulic and a rainfall-runoff model.

The value of observations in understanding how measures function is of fundamental importance and is becoming increasingly viable and affordable. Open source electronic platforms such as Arduino and Raspberry Pi are being used with cheap sensors to perform these tasks. For example, a level gauge has been developed for approximately €10 and cameras capable of capturing still or moving pictures are available for approximately €20; these are being used to better understand the behaviour of NFM features such as ponds and woody debris. There is potential for networks of these instruments to be configured and data collected through Wi-Fi or other wireless networks. The potential to expand informative networks of data that can constrain models is now possible.

The functioning of small scale runoff attenuation features, such as offline ponds, has been demonstrated at the local scale. Specifically, through the measurement of both instream and in-pond water levels, it has been possible to calculate the impact of storing/attenuating flood flows on the adjacent river flow. This information has been encapsulated in a hydraulic model that allows the extrapolation of impacts to the larger catchment scale, contributing to understanding of the scalability of such features.

Using a dense network of level gauges located along the main river stem and principal tributaries, it is possible to understand in detail how floods develop and propagate, both temporally and spatially. Traditional rainfall-runoff modelling involves the calibration of model parameters to achieve a best fit against an observed flow series, typically at a single location. The modelling approach adopted here is novel in that it directly uses the nested observed information to disaggregate the outlet hydrograph in terms of the source locations. Using a combination of local evidence and expert opinion, the model can be used to assess the impacts of distributed land use management changes and NFM on floods. These studies demonstrate the power of networks of observational instrumentation for constraining hydraulic and hydrologic models for use in prediction.