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A remote sensing based integrated approach to quantify the impact of fluvial and pluvial flooding in an urban catchment

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Pluvial (surface water) flooding is often the cause of significant flood damage in urban areas. However, pluvial flooding is often overlooked in catchments which are historically known for fluvial floods. In this study, we present a conceptual remote sensing-based integrated approach to enhance current practice in the estimation of flood extent and damage and characterise the spatial distribution of pluvial and fluvial flooding. Cockermouth, a small town in England which is highly prone to flooding, was selected as a study site and the flood event caused by storm Desmond in 2015 (5-6/12/2015) was selected for this study. A high-resolution digital elevation model (DEM) was produced from a composite digital surface model (DSM) and a digital terrain model (DTM) obtained from the Environment Agency. Using this DEM, a 2D flood model was developed in HEC-RAS (v5) 2D for the study site. Simulations were carried out with and without pluvial flooding. Calibrated models were then used to compare the fluvial and combined (pluvial and fluvial) flood damage areas for different land-use types. The number of residential properties affected by fluvial and combined flooding was compared using a combination of modelled results and data collected from Unmanned Areal System (UAS). As far as the authors are aware, this is the first time remote sensing data, hydrological modelling and flood damage data at property level have been combined to differentiate between the flood extents and damage caused by fluvial and pluvial flooding in the same event. Results show that the contribution of pluvial flooding should not be ignored even in a catchment where fluvial flooding is the major cause of the flood damages. Although the additional flood depths caused by the pluvial contribution were lower than the fluvial flood depths, the affected area is still significant. Pluvial flooding increased the overall number of affected properties by 25%. In addition, it increased the flood depths in a number of properties that were identified as being affected by fluvial flooding, in some cases by more than 50%. These findings show the importance of taking pluvial flooding into consideration in flood management practices. Further, most of the data used in this study were obtained via remote sensing methods, including UASs. This demonstrates the merit of developing a remote sensing-based framework to enhance current practice in the estimation of flood extent and damage.