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Experimental study on flood inundation in a river-network-floodplain setup

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Flood inundation forecasting is indispensable for accurate flood risk evaluation, management and for proper evacuation planning in order to alleviate the fatal causalities and property damages. Flood forecasting can be made after several hours simulations in the hydrodynamic models. However, performance of a hydrodynamic model needs to be examined in order to understand the capability of that model to reconstruct that particular event. The capability of a model depends on many factors such as representation of the extent of various physical processes through mathematics, numerical scheme, calibration of parameters and validation data. The models are therefore calibrated and validated with the relevant data obtained from experiments or field measurements or remotely sensed imageries. The model calibration and validation process are also essential to improve model state and structure and the accuracy of prediction. For this, models need highly reliable and credible data. The conventional manual data collection through physical model study is in practice for several decades. However, measurement of spatial and temporal heterogeneity effect over a large physical setup is labour and cost intensive. While remotely sensed data allow us to take into account of spatial and temporal heterogeneity but they are quite often untimely and coarse in resolution. In this regard, data collection from a large scale laboratory setup with the latest approaches is the best alternative. Hence, this paper presents an experimental study in a river-network-floodplain setup using electromagnetic flowmeter, sensors and the automated close range photogrammetry (CRP). The setup typically consists of braided channels with several junctions and undulated floodplains. The inflow discharge is measured by electromagnetic flowmeter placed in the supply pipeline. The inflow to the inlet channel is controlled by valve and the experiments are conducted under steady state condition. As soon as the flow at certain sections crosses the bankfull discharge, the excess water flows on to the floodplain and a flood situation is created. The velocity distribution at various locations are measured using ADV. The point gauges and sensors are used to measure the water depths. A pair of Nikon 5300 DSLR camera are used to capture overlapping images for generating dry bed topography and flood extent during an experiment. The ground control points (GCPs) are surveyed using total station instrument. The bed topography of the setup is reconstructed using CRP with the help of PhotoScan software and using the GCPs. It is found that the generated high-resolution DEM is having the accuracy in acceptable range (RMSE = 3.45 mm). The inundation extent is delineated with the help of eCognition image processing software. The accuracy is compared with the visually interpreted data. The open-source TELEMAC-2D is then calibrated using one set of experimental data. The calibrated model is then applied to simulate other experimental runs. The model accuracy is defined by comparing water depth and velocity at different locations and inundation extent. The statistical analysis show that the TELEMAC-2D predictions are in acceptable range. These experimental data can now be used for benchmarking flow simulation models, especially, flood prediction models.