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Low-cost, open access flood inundation modelling with sparse data: A case study of the Lower Damodar River Basin, India

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In developed nations, flood monitoring and management benefits from a range of high-cost modern data and methods such as high resolution terrain data and digital elevation models, cloud penetrating radar data which defines flood extents and advanced computer modelling software. However, in developing countries, such resources are rarely available. The situation is further compounded by the fact that developing countries often have higher population densities which are even more vulnerable to flood hazards. This paper addresses these issues and presents a methodology for flood modelling which is accessible within the resource constraints which are typical in developing countries. A 20 Km flood prone reach of the lower Damodar River Basin in Northern India has been selected as the study area. This area has been subjected to inundation 4 times during the last 6 years due to water released from a network of upstream reservoirs during intense monsoon rainfall events. Within the study site, topographic data from three sources was available. First, we used SRTM data. Second, 40 cross-sections were surveyed with differential GPS and a handheld depth sounder. These data were corrected and their datum adjusted to that of the SRTM DEM with the precise point positioning (PPP) system freely available from Natural Resources Canada. Third, low-cost Cartosat-1 stereo images were used to produce a DEM with Leica Photogrammetry Suite. The elevation points derived from Cartosat-1 images were then manually edited in a 3D stereo viewing environment to represent the narrow but hydraulically significant features, such as the embankments, roads, smaller depressions and merged with the surveyed points for the channel. The SRTM data over the featureless farmland was also made bare-earth and merged with the rest of the mass points to create a hybrid point cloud. The RMSE of this hybrid terrain data was found to be 1.1 m as compared to 2.4 m for the original SRTM DEM. TELEMAC2D, an open source finite element 2D hydrodynamic model, was used to simulate the flooding events of 2006 and 2009. In the absence of discharge or rating curve, the available stage data at the inlet were converted into discharge using Manning's equation with a measured cross-section of the gauging site. A MODIS image of a 2006 flood event was used for calibration. Validation was done using an IRS LISS-III and a Landsat TM multispectral image of a 2009 flood which shows that the model was able to simulate the overall pattern of the observed flood extent and 63 % of the observed wet areas have been correctly predicted. We have also observed that the newly created terrain data made a marked improvement over the result that was obtained by using the SRTM DEM in its original form. Although the results are not as accurate as the expensive data sets used by Western nations, they are capable of reasonable flooded-area forecasts and are therefore promising in the context of the developing countries such as India.