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1 Reducing uncertainty in coupled hydrologic-hydraulic modelling using remote sensing derived flood area information

M. Montanari, R. Hostache, P. Matgen and L. Pfister

Public Research Centre – Gabriel Lippmann, Grand Duchy of Luxembourg
(montanar@lippmann.lu / Fax:+352 470264 / Phone: +352 470261461

Two of the most relevant components of any flood forecasting system, namely the rainfall runoff and flood inundation models, take advantage of the availability of spatially distributed Earth Observation data. With the advent of microwave remote sensing instruments and their all weather capabilities, significant progress has been made over the past decade with respect to improved hydrologic and hydraulic model calibration and evaluation. However, the usefulness of remote sensing observations in coupled hydrologic and hydraulic models still needs further investigations. Radar remote sensing observations are readily available to provide information on flood extent. Moreover, the fusion of radar imagery and high precision digital elevation models, allows estimating inundation volumes. This research aims at creating a modelling sequence where the outputs of hydrological models ("rainfall-runoff models") serve as boundary condition of flood inundation models and where the remote sensing observation of flood area will help to identify and subsequently correct apparent volume errors in the modelling chain. The methodology consists in coupling simplistic 3-parameter conceptual rainfall-runoff models with a flood inundation model. Assuming the absence of recorded discharges at a series of tributaries, these models are used to compute flood hydrographs at each inlet using hourly rainfall data as input. The flood hydrographs computed by each model serve to determine the local inflows of the hydraulic model.

Calibration of the hydrological models is based on the comparison of flood inundation extent computed by the hydraulic model with remotely sensed flood area observations. It is well known that the inflows from ungauged catchments can be considered as one of the main sources of uncertainties of any flood inundation model. The study thus explores the capability to correct for apparent volume errors using remote sensing derived flood area. Since the performance measures of most flood inundation models are completely dominated by the channel roughness value, a stepped calibration approach needs to be adopted. After calibration of the dominating channel roughness value the sensitivity of the hydrological model parameters increases. This is due to the fact that those model parameters have only a limited local impact and the spatially distributed information on flood extent obtained from remote sensing is needed for calibration. Hence, the strength of the satellite data to enable the usage of local performance measures is fully exploited in this study. The usefulness of the proposed methodology is illustrated with the data collected during a storm event of the Sure River (Grand-Duchy of Luxembourg). It will be shown how the remote sensing information led to a significant reduction of uncertainties in flood forecasting.