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A framework for probabilistic pluvial flood nowcasting for urban areas

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Pluvial flood nowcasting is gaining ground not least because of the advancements in rainfall forecasting schemes. Short-term forecasts and applications have benefited from the availability of such forecasts with high resolution in space (∼1km) and time (∼5min). In this regard, it is vital to evaluate the potential of nowcasting products for urban inundation applications. One of the most advanced Quantitative Precipitation Forecasting (QPF) techniques is the Short-Term Ensemble Prediction System, which was originally co-developed by the UK Met Office and Australian Bureau of Meteorology. The scheme was further tuned to better estimate extreme and moderate events for the Belgian area (STEPS-BE). Against this backdrop, a probabilistic framework has been developed that consists of: (1) rainfall nowcasts; (2) sewer hydraulic model; (3) flood damage estimation; and (4) urban inundation risk mapping.

STEPS-BE forecasts are provided at high resolution (1km/5min) with 20 ensemble members with a lead time of up to 2 hours using a 4 C-band radar composite as input. Forecasts' verification was performed over the cities of Leuven and Ghent and biases were found to be small. The hydraulic model consists of the 1D sewer network and an innovative 'nested' 2D surface model to model 2D urban surface inundations at high resolution. The surface components are categorized into three groups and each group is modelled using triangular meshes at different resolutions; these include streets (3.75 – 15 m2), high flood hazard areas (12.5 – 50 m2) and low flood hazard areas (75 – 300 m2). Functions describing urban flood damage and social consequences were empirically derived based on questionnaires to people in the region that were recently affected by sewer floods. Probabilistic urban flood risk maps were prepared based on spatial interpolation techniques of flood inundation.

The method has been implemented and tested for the villages Oostakker and Sint-Amandsberg, which are part of the larger city of Gent, Belgium. After each of the different above-mentioned components were evaluated, they were combined and tested for recent historical flood events. The rainfall nowcasting, hydraulic sewer and 2D inundation modelling and socio-economical flood risk results each could be partly evaluated: the rainfall nowcasting results based on radar data and rain gauges; the hydraulic sewer model results based on water level and discharge data at pumping stations; the 2D inundation modelling results based on limited data on some recent flood locations and inundation depths; the results for the socio-economical flood consequences of the most extreme events based on claims in the database of the national disaster agency. Different methods for visualization of the probabilistic inundation results are proposed and tested.