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Comparison between fully distributed model and semi-distributed model in urban hydrology modeling

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Water management in urban areas is becoming more and more complex, especially because of a rapid increase of impervious areas. There will also possibly be an increase of extreme precipitation due to climate change. The aims of the devices implemented to handle the large amount of water generate by urban areas such as storm water retention basins are usually twofold: ensure pluvial flood protection and water depollution. These two aims imply opposite management strategies. To optimize the use of these devices there is a need to implement urban hydrological models and improve fine-scale rainfall estimation, which is the most significant input. In this paper we suggest to compare two models and their sensitivity to small-scale rainfall variability on a 2.15 km2 urban area located in the County of Val-de-Marne (South-East of Paris, France). The average impervious coefficient is approximately 34%.

In this work two types of models are used. The first one is CANOE which is semi-distributed. Such models are widely used by practitioners for urban hydrology modeling and urban water management. Indeed, they are easily configurable and the computation time is reduced, but these models do not take fully into account either the variability of the physical properties or the variability of the precipitations. An alternative is to use distributed models that are harder to configure and require a greater computation time, but they enable a deeper analysis (especially at small scales and upstream) of the processes at stake. We used the Multi-Hydro fully distributed model developed at the Ecole des Ponts ParisTech. It is an interacting core between open source software packages, each of them representing a portion of the water cycle in urban environment. Four heavy rainfall events that occurred between 2009 and 2011 are analyzed. The data comes from the Météo-France radar mosaic and the resolution is 1 km in space and 5 min in time. The closest radar of the Météo-France network is a C-band one located at 37 km West.

In this work we compare the hydrological response of two models for the 4 rainfall events first with the available radar data. Then a particular focus is made on the impact of small-scale unmeasured rainfall variability (i.e. occurring at scales below the available one). More precisely scaling properties of rainfall are used to generate an ensemble of downscaled rainfall fields (simply by continuing the underlying cascade process whose relevant parameters are estimated on the available range of scales). An ensemble of hydrological responses is then simulated, and the variability within it analyzed. It appears that the associated uncertainty is significant and should be taken into account. Finally we will discuss the interest of deploying X-band radars (which provide an hectometric resolution) in urban environment and the potential benefits of using these models and small-scale rainfall data for the management of sewerage and retentions basin. Further analysis on these issues will be carried out next year with the installation of an X-band radar near Marne-la-Vallée (located at roughly 10 Km of the studied catchment) in the framework of the RainGain project (European project financed by the Interreg IVB funds).