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Multi-Hydro: a multi-component model for evaluation of the hydrological behavior of peri-urban catchment

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As cities are growing, urbanized areas tend to be settled in locations potentially affected by flooding (either pluvial or fluvial). With more and more people living in these peri-urban areas and therefore vulnerable to the flood risk, it becomes necessary to properly evaluate this risk. This requires to appropriately model the flooding processes in peri-urban areas. In this framework, the European FP7 SMARTeST project aimed to provide tools to stakeholders and affected people so that they can select the best flood resilience protection measures.

In this way, the Multi-Hydro model was developed and improved at the Ecole des Ponts ParisTech. This model consists in an interactive coupling between four modules, each of them representing a portion of the water cycle in urban hydrology. Each module relies on widely validated physically based models contained in open source software packages. The first module deals with rainfall in the framework of Universal Multifractals which relies on the concept of multiplicative cascades. It can either downscale rain gauge or radar data to a desired resolution or generate synthetic rainfall events. The surface module relies on the TREX model (Two dimensional Runoff and EXport, Velleux et al., 2011) which computes the overland water runoff (depth and velocity) according to the land use, the elevation and the soil properties of the catchment. The subsurface module computes the vertical water profile in the soil and relies on the VS2DT model (Variably Saturated and two Dimensional Transport, Lapalla et al., 1987). Both the surface and subsurface modules are fully distributed to that small scale phenomenon can be taken into account. The drainage module computes discharges in the sewer system and is based on SWMM (Storm Water Management Model, Rossman, 2010).

The main input data to the model consists in maps of the elevation, the land use, the soil type and a precise description of the sewer system. This can be a rather complex task to generate this input data. Hence to ensure the transportability of the model from one catchment to the other, a dedicated open source GIS module (MH Assim Tool) was developed to convert commonly available GIS owned by local authorities into input to Multi-Hydro with the correct format. Physical properties of the various land use and soil class can easily be modified and the corresponding changes in the behaviour of the catchment can be assessed with the help of risk map analysis and an advanced statistical analysis tool.

Multi-Hydro has already been implemented on several case studies with size ranging from 0.5 to 5 km2 with various aims ranging from evaluation of the effect of flood protection measures to impact of small scale rainfall variability and analysis of rapid surface runoff on steep slopes. Some examples will be discussed.