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Scales and Complexity of Urban Hydrology

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Cities are complex hydrological systems that bring into play many processes at different space-time scales. The strong variability of urban basins requires nowadays a more massive and more sophisticated data collection to cover a widee range of scales. For instance small scale data remain sensitive to longer term time evolutions, e.g. to the land use or to climate change. The measurements demonstrate that there are so many nonlinear processes intervening and interacting in urban basins that available physically based numerical models are often not appropriate. In fact, the observed multi-scale variability tends to accentuate the necessity for a hybrid multi-scaling hydrologic modelling for urban basins. This presentation discusses some preliminary promising results towards such an achievement. This work contributes to the European project SMARTeST (Smart Resilient Technology, System and Tools), whose main purpose is to assess the measure of resilience at very different scales of urban basins. For these purposes, we use the Multi-Hydro model developed at Ecole des Ponts. Its core couples three numerical physically based models working at rather different scales :
- TREX (Two dimensional Runoff, Erosion and eXport model, Velleux et al., 2006) that computes the distributed surface flows,
- VS2DT (Hsieh, 2000) that computes the water propagation in the soil for non saturated znoes,
- SWMM (Storm Water Management Model, Rossman, 2007) that allows simulating the flows in sewer systems,
as well as a stochastic multifractal rainfall simulator that reproduces reliable heterogeneous rainfall realizations over the whole modelling domain and the whole range of scales.
The modelling system allows, for a given rain scenario, to determine the amount of water flowing on the surface of the soil, the amount of water infiltrate, the load of the sewer system, the level of the water table… the modelling system is tested on well known case studies of Val-de-Marne county, located on the south-east of Paris, The results are exploited to evaluate the scale effects and to attempt to characterize the behaviour of the urban system during the extreme events.