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Urban water-quality modelling: implementing an extension to Multi-Hydro platform for real case studies

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During the last few years, the physically based and fully distributed numerical platform Multi-Hydro (MH) has been developed to simulate hydrological behaviours in urban/peri-urban areas (El-Tabach et al. , 2009 ; Gires et al., 2013 ; Giangola-Murzyn et al., 2014). This hydro-dynamical platform is open-access and has a modular structure, which is designed to be easily scalable and transportable, in order to simulate the dynamics and complex interactions of the water cycle processes in urban or peri-urban environment (surface hydrology, urban groundwater infrastructures and infiltration). Each hydrological module relies on existing and widely validated open source models, such as TREX model (Velleux, 2005) for the surface module, SWMM model (Rossman, 2010) for the drainage module and VS2DT model (Lappala et al., 1987) for the soil module.
In our recent studies, an extension of MH has been set up by connecting the already available water-quality computational components among different modules, to introduce a pollutant transport modelling into the hydro-dynamical platform. As for the surface module in two-dimensions, the concentration of particles in flow is expressed by sediment advection equation, the settling of suspended particles is calculated with a simplified settling velocity formula, while the pollutant wash-off from a given land-use is represented as a mass rate of particle removal from the bottom boundary over time, based on transport capacity, which is computed by a modified form of Universal Soil Loss Equation (USLE). Considering that the USLE is originally conceived to predict soil losses caused by runoff in agriculture areas, several adaptations were needed to use it for urban areas, such as the alterations of USLE parameters according to different criterions, the definition of the appropriate initial dust thickness corresponding to various land-uses, etc. Concerning the drainage module, water quality routing within pipes assumes that the conduit behaves as a continuously stirred tank reactor.
This extension of Multi-Hydro was tested on two peri-urban catchments located near Paris, the Villecresnes (France, 0.7 km^2) and the Le Perreux-sur-Marne (France, 0.2 km^2). As the Villecresnes had been analyzed within several European projects (FP7 SMARTeST, KIC-Climate BlueGreenDream, Interreg RainGain), the robustness of the new extension of MH was firstly tested on this basin by comparing the water quantity simulation outcomes with the results already obtained in previous works. Benefiting from the large datasets that are collected in the framework of the ANR (French National Agency for Research) Trafipollu project, the water quality modelling performance of the extension was then illustrated on the catchment of Le Perreux-sur-Marne.