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HYDRUS-3D flow model to investigate urban vadose zone hydrology

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Stormwater infiltration basins have become a common alternative practice to traditional stormwater pipe networks in urban areas. They are often built in permeable subsurface soils, such as alluvial deposits. These sedimentary deposits are highly heterogeneous and generate preferential flow paths that may cause either rapid or non-uniform transport of contaminants at great depths. The understanding of how subsurface vadose zone heterogeneities transfer contaminant and fluid flow to the aquifer, still remains a challenge in urban hydrology. Thus, the hypothesis of using homogeneous vadose zone deposit cannot be considered valid at the scale of infiltration basin (i.e. 1 ha). Therefore, to asses pollution risk management of groundwater a three-dimensional numerical modelling of fluid flow and solute transport is required. The studied basin, located in Lyon (France), is built in quaternary glaciofluvial deposits, composed of 4 main lithofacies: sands, bimodal sandy gravels, heterometric sandy gravels, and open framework gravels. Geophysical measurements (Ground-Penetrating Radar and Electrical Resistivity) performed on a limited zone of the vadose zone of the basin (400 m^3) were interpreted to define a 3D lithofaciés distribution. Hydraulic properties of each lithofacies were characterized using the Beerkan method, leading to the definition of hydrofacies. A three-dimensional hydrostratigraphic model of the glaciofluvial was then implemented in the finite element program HYDRUS-3D. The modelling results of this work show by using HYDRUS-3D that when the pores are saturated, the open framework gravels causes capillary barrier leading to funneled flows, (i.e. non-vertical water flows along lithofacies interfaces).

Combination of complementary observation methods issued from sedimentology, geophysics and soil hydrology, inputted into a detailed 3D flow modelling, is one powerful way to quantify the environmental risk of a stormwater infiltration basin.