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Dynamic Characterization of Shallow Aquifer Groundwater: A Lab-Scale Approach

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Abstract : Groundwater monitoring is classically performed in a network of piezometers in industrial sites. Groundwater flow parameters, such as direction, sense and velocity, are deduced from indirect measurements between two or more piezometers. Groundwater sampling is generally done on the whole column of water inside each borehole to provide concentration values for each piezometer location. These flow and concentration values give a global 'static' image of potential plume of contaminants evolution in the shallow aquifer with huge uncertainties in time and space scales and mass discharge dynamic. TOTAL R&D Subsurface Environmental team is challenging this classical approach with an innovative dynamic way of characterization of shallow aquifer groundwater. The current study aims at optimizing the tools and methodologies for (i) a direct and multilevel measurement of groundwater velocities in each piezometer and, (ii) a calculation of potential flux of dissolved contaminant in the shallow aquifer. Lab-scale experiments have been designed to test commercial and R&D tools in a controlled sandbox. Multiphysics modeling were performed and took into account Darcy equation in porous media and Navier-Stockes equation in the borehole. The first step of the current study focused on groundwater flow at porous media/piezometer interface. Huge uncertainties from direct flow rate measurements in the borehole versus Darcy flow rate in the porous media were characterized during experiments and modeling. The structure and location of the tools in the borehole also impacted the results and uncertainties of velocity measurement. In parallel, direct-push tool was tested and presented more accurate results. The second step of the study focused on mass flux of dissolved contaminant in groundwater. Several active and passive commercial and R&D tools have been tested in sandbox and reactive transport modeling has been performed to validate the experiments at the lab-scale. Some tools will be selected and deployed in field assays to better assess the mass discharge of dissolved contaminants in an industrial site. The long-term subsurface environmental strategy is targeting an in-situ, real-time, remote and cost-effective monitoring of groundwater.

Keywords : dynamic characterization, groundwater flow, lab-scale, mass flux
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