About the monitoring of groundwater fluxes variations through active-DTS measurements

Olivier Bour*[1], Nataline Simon[2], Maria Klepikova[3], and Nicolas Lavenant[3]

[1]Univ Rennes, CNRS, Géosciences Rennes – CNRS : UMR 6118 – France
[2]Department Urban and Environmental Engineering, Hydrogeology and Environmental Geology, Liège Université – Belgique
[3]Univ Rennes, CNRS, Géosciences Rennes – CNRS : UMR6118 – France

Résumé

Active-Distributed Temperature Sensing (DTS) measurements, which consists in heating a Fiber Optic (FO) cable and in monitoring the temperature elevation, has proven to be very efficient to quantify the spatial distribution of groundwater fluxes in saturated porous media at high resolution with low uncertainties. Here, we investigate the feasibility of active-Distributed Temperature Sensing (DTS) measurements to monitor and quantify groundwater fluxes variations over time, in response to the need of characterizing temporal dynamic of groundwater and the lack of available methods. To test the method, we rely on both numerical simulations and sandbox experiments to assess the sensitivity of temperature elevation to variable flow conditions and our ability to interpret associated temperature variations. Results confirm that the temperature elevation and evolution over time is sensitive to flow conditions and that associated temperature variations can be used to characterize groundwater fluxes variations. First, experimental and numerical results show that when a flow change is followed by a long-enough steady-state flow period the temperature stabilizes independently of previous fluxes conditions. In such case, the stabilization temperature can easily be interpreted to estimate groundwater fluxes using the analytical model commonly used under steady flow conditions to interpret active-DTS measurements. Furthermore, we demonstrate here that, under certain flow conditions depending on the nature of flow variations, the approach offers the possibility of continuously monitoring fluxes variations. For instantaneous flow changes, it is even possible to go further by reproducing temperature signal variations over time by applying the superposition principle to the analytical model. These preliminary tests are particularly promising and open new perspectives for monitoring and/or quantifying the temporal dynamic of groundwater fluxes at different temporal scales including diurnal and short-term periodic fluxes variations.

Mots-Clés: Groundwater flow monitoring, Groundwater dynamics, Heat tracer experiment, DTS

*Intervenant