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# Innovative real-time sensing of flow dynamics in groundwater and sediments to map contaminant spreading

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Groundwater dynamics play a crucial role in the spreading of a soil and groundwater contamination. However, there is still a big gap in the understanding of the groundwater flow dynamics. Heterogeneities and dynamics are often underestimated and therefore not taken into account. They are of crucial input for successful management and remediation measures. The bulk of the mass of mass often is transported through only a small layer or section within the aquifer and is in cases of seepage into surface water very dependent to rainfall and occurring tidal effects.

This study contains the use of novel real-time iFLUX sensors to map the groundwater flow dynamics over time. The sensors provide real-time data on groundwater flow rate and flow direction. The sensor probes consist of multiple bidirectional flow sensors that are superimposed. The probes can be installed directly in the subsoil, riverbed or monitoring well. The measurement setup is unique as it can perform measurements every second, ideal to map rapid changing flow conditions. The measurement range is between 0,5 and 500 cm per day.

We will present the measurement principles and technical aspects of the sensor, together with two case studies.

The first case study comprises the installation of iFLUX sensors in 4 different monitoring wells in a chlorinated solvent plume to map on the one hand the flow patterns in the plume, and on the other hand the flow dynamics that are influenced by the nearby popular trees. The foreseen remediation concept here is phytoremediation. The sensors were installed for a period of in total 4 weeks. Measurement frequency was 5 minutes. The flow profiles and time series will be presented together with the determined mass fluxes.

A second case study was performed on behalf of the remediation of a canal riverbed. Due to industrial production of tar and carbon black in the past, the soil and groundwater next to the small canal ‘De Lieve’ in Ghent, Belgium, got contaminated with aliphatic and (poly)aromatic hydrocarbons. The groundwater contaminants migrate to the canal, impact the surface water quality and cause an ecological risk. The seepage flow and mass fluxes of contaminants into the surface water were measured with the novel iFLUX streambed sensors, installed directly in the river sediment. A site conceptual model was drawn and dimensioned based on the sensor data. The remediation concept to tackle the inflowing pollution: a hydraulic conductive reactive mat on the riverbed that makes use of the natural draining function of the waterbody, the adsorption capacity of a natural or secondary adsorbent and a future habitat for micro-organisms that biodegrade contaminants. The reactive mats were successfully installed and based on the mass flux calculations a lifespan of at least 10 years is expected for the adsorption material.