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Monitoring and quantification of phosphorus fluxes in groundwater with innovative passive sampling techniques

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The impact of agricultural sources carrying excess phosphorus that ends up in the surface water still remains obscure even after implementation of strict regulations codifying fertilizer inputs to control the “surface” runoff. Therefore, focus is now slowly drifting towards exploration of the “sub-surface” pathways. Apart from run-off, excessive fertilizer input can also result in soil leaching causing percolation of phosphorus from soil into the groundwater. In past, phosphorus was envisaged to be “immobile” in groundwater, but with time, the soil-groundwater-surfacewater linkage has started getting more evident. At present, meticulously correct estimations of the impact of soil leaching on the phosphorus mobility in groundwater still don’t exist. This knowledge gap can be attributed to three main factors: (i) the “hidden” quotient of groundwater that makes monitoring its contamination still a big challenge, (ii) the complex chemistry of phosphorus at soil-water interface and (iii) the methods that are currently used for the flux calculations. Erroneous estimation of phosphorus in groundwater arises from simulations since these modelling tools still use phosphorus concentration measurements and estimated Darcy water-flux values as their input parameters. This research will focus on the application of direct flux measurements instead of using estimated flux values.

To characterize phosphorus fluxes, a field study will be performed in the Flanders region of Belgium within the valley of Zwarte-Beek. The field site is characterized mostly by acidic sandy soils with a history of intensive agriculture near the source of its stream. Several conventional and innovative techniques will be used to characterize phosphorus fluxes in groundwater. Screening of existing historical data from Zwarte-Beek will be done for initial well selection from where groundwater samples will be collected. Different parameters including dissolved and total phosphorus will be analysed both in the field (using a colorimetric device) and the laboratory (using ion-chromatography technique). Finally, these analytical results will guide the installation of new monitoring wells where innovative passive flux samplers (iFLUX and SorbiFlux for example) will be installed.

The passive flux samplers are in-situ devices consisting of permeable cartridges filled with parameter selective sorbents (phosphorus for instance) and resident tracers for groundwater flux calculations. When placed in a monitoring well, the samplers intercept the groundwater flow by calculating time-averaged data which is used for both phosphorus and groundwater flux calculations. The residence time of these samplers depend on expected phosphorus concentrations and the groundwater velocity in the region.

The relevance and methodological framework for accurate ortho-phosphorus measurements in groundwater along with analytical results from various field sampling campaigns in Zwarte-Beek will be presented.