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Flux-based environmental management: the future of integrated passive flux measurements in groundwater

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The measurement and interpretation of parameter mass fluxes and discharges is gaining more and more importance. Especially in the frame of soil and groundwater contamination, remediation and related environmental risks, water management and ecosystem management, the interpretation of mass fluxes is essential. Current legislation already includes a mass flux approach today (e.g. EU Water Framework Directive and Groundwater Daughter Directive).

Environmental management actions regarding groundwater pollutions and ecosystem research and management are mostly driven by parameter concentrations. Since concentration estimates are highly uncertain and do not include the fluctuations caused by spatially and temporally varying conditions, decisions about these actions can be improved by also considering parameter mass fluxes (mass of parameter passing per unit time per unit area, or flow rate of these parameters per unit area) and parameter mass discharges (sum of all mass flux measures across an entire plume). The mass that effectively reaches a downgradient receptor, determines the actual situation and risks, and should therefore be monitored. It is essential to determine mass fluxes directly instead of estimating mass flux based on concentration data and estimates of groundwater velocity.

The direct determination of contaminant mass fluxes in soil and groundwater systems is possible with the Passive Flux Meter (PFM) technology. The PFM is a recently developed passive sampling device that provides simultaneous in situ point measurements of a time-averaged contaminant mass flux and water flux. The device, with a suite of tracers, is placed in a monitoring well or borehole for a known exposure period, where it intercepts the groundwater flow and captures contaminants from it. The measurements of the contaminants and the remaining resident tracer can then be used to estimate groundwater and contaminant fluxes.

Today, an increasing demand from different sectors for the combined determination of multiple parameter mass fluxes, has stimulated us to optimize the technology and develop an integrated flux measurement device which targets the combined mass flux determination of multiple parameter types.

The principles of flux-based environmental management will be presented, with a special focus on the application and future of integrated passive flux measurements in groundwater.