



Development of a Passive Sensor for Measuring Water and Solute Mass Flux in the Hyporheic Zone

Michael D. Annable, Leif Layton, Kirk Hatfield, Mark C. Newman, Jaehyun Cho, and Harald Klammler
Engineering School for Sustainable Infrastructure and Environment (ESSIE), University of Florida, Gainesville, Florida, USA

Measuring water, pollutant and nutrient exchange at the groundwater-surface water interface is challenging due to the dynamic nature of the hyporheic zone. Quantifying the exchange is critical to understanding mass balance across this interface. Technologies currently exist to identify groundwater discharge zones and infer estimates of contaminant mass flux based on total contaminant concentration in bulk sediment, though it is generally accepted that freely dissolved concentration in pore water is a better measure of potential exposure. Laboratory and preliminary field testing has been completed to demonstrate a new tool with potential to provide more accurate characterization of water, pollutant and nutrient flux at the groundwater-surface water interface through direct in-situ measurement. The sediment bed passive flux meter (SBPFM) was designed for passively and directly providing in-situ measurements of volumetric water flux and solute mass flux vertically through the upper surface sediment layer and into the overlying water column. The SBPFM consists of an internal permeable sorbent which is impregnated with one or more water soluble tracers (typically alcohols) and is contained in a dedicated drive-point with upper and lower screened openings for fluid intake and exhaust. This configuration generates water flow through the device proportional to the vertical gradient between the sediment bed and the water column. Once the SBPFM has been deployed, the tracers are displaced from the sorbent at rates proportional to the average vertical specific discharge. The mass loss of tracers during deployment can be used to calculate the cumulative water flux. Similarly, the cumulative mass of sorbed pollutants or nutrients provide a direct measurement of the vertical mass flux during deployment. The SBPFM prototype has been tested in controlled laboratory sediment interface models. The results show good agreement between the SBPFM calculated and the applied water and contaminant fluxes through the laboratory aquifer model. Flow reversals are anticipated for tidal sites and sorbent layers within the PFM are segmented and used to determine next flux magnitude and direction averaged over the deployment period. Preliminary field testing is underway focusing on an areas with chlorinated solvent contamination discharging to surface water. The SBPFM is deployed to quantify the net mass discharge of contaminants to a small stream over a short reach. The integrated mass discharge can be compared to concentrations and mass discharge observed in surface water. The SBPFM provides a new tool to assess water and solute flux at point locations and can provide spatial variability that can be integrated to support mass balance studies on segments of surface water reaches.