



Soil and Water Science

Research Brief

University of Florida

Institute of Food and Agricultural Sciences

DIRECT MEASUREMENT OF WATER AND SOLUTE FLUXES USING A PASSIVE SURFACE WATER FLUX METER

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Our research group has recently developed a method for direct measurement of surface water flux (velocity) and solute mass flux using a Passive Surface Water Flux Meter (PSFM). Current techniques for estimating contaminant mass inputs to impaired water bodies from surface waters rely on instantaneous point sampling of concentrations, providing spatial or temporal snapshots. Collection of sufficient time-series flow and solute mass data to adequately reflect this variability is costly and impractical at many sites. Mass-flux based characterization approaches offer advantages over concentration-based approaches by integrating spatial and temporal variability in a single measurement. Measurements of this nature have many applications for the protection of natural aquatic systems, including implementation of Total Maximum Daily Loads (TMDLs), identification of sources contributing to eutrophication, evaluation of nutrient reduction measures, and evaluation of aquatic system restoration efforts.

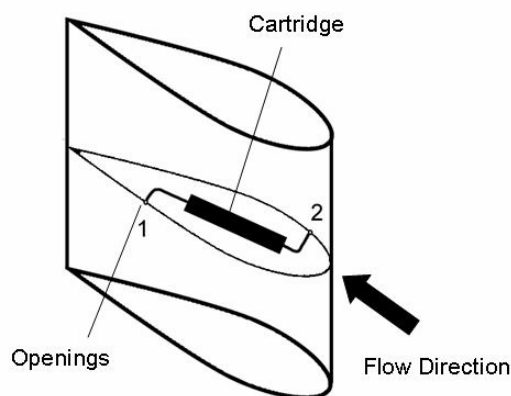


Figure 1. Hydrofoil-shaped PSFM: water enters opening 1 and exits opening 2

The PSFM (Figure 1) is a self-contained, passive (i.e., no moving parts or external power) unit capable of directly measuring water and solute fluxes at a discrete location within a flowing surface water channel. The PSFM consists of a permeable, sorptive cartridge that is connected to openings in the surface of an impermeable, symmetric, streamlined body. When submerged in a flowing system, the profile of the PSFM creates a pressure gradient along the perimeter of the device inducing flow through the cartridge. The cartridge is packed with a sorptive porous media impregnated with a known mass of a resident tracer. This tracer elutes from the

cartridge at a rate proportional to the stream flow, while at the same time sorbing and retaining solutes dissolved in the water. After retrieval, the media is analyzed in the laboratory to determine the mass of solutes sorbed and mass of tracer remaining, enabling estimation of water and solute flux, respectively.

Padowski (2005) performed flume experiments to validate the PSFM theory. Experiments were performed in a rectangular flume at the University of Florida with variable velocities and solute fluxes. The velocities estimated using the PSFM correlated well to true water velocities and differed on average by only 5% (Figure 2).

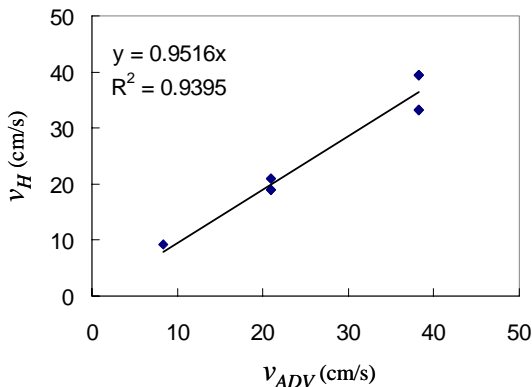


Figure 2. True flume velocities compared with those calculated for a cylindrical PSFM.

Flume solute flux experiments performed with known masses of NaH_2PO_4 also showed good correlation between true solute flux and estimates determined from the PSFM, differing by an average of 4% (Figure 3).

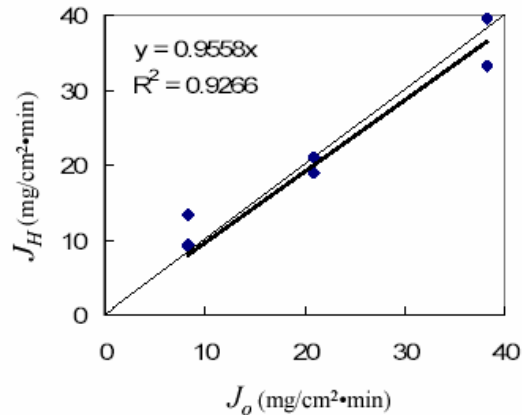


Figure 3. Comparison of true solute fluxes and those measured using the PSFM.

The direct measurement of cumulative water and solute flux using PSFM technology offers the opportunity to greatly simplify solute load measurements compared to current methods. This initial testing has validated that PSFMs show promise for measurement of water and solute fluxes in open channel systems, but practical applications of this technology at real sites will require testing and validation under more complex conditions.

Reference:

Padowski, J.C., 2005. Direct measurement of water and solute fluxes using a passive surface water flux meter, MS Thesis, UF.

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