ESTIMATING RATES OF EXCHANGE ACROSS THE SEDIMENT/WATER INTERFACE IN THE MERCED RIVER, CA USING TEMPERATURE MODELING AND DIRECT MEASUREMENT

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Abstract

The Merced River, located in the San Joaquin River Basin in central California was chosen by the USGS NAWQA (National Water Quality Assessment) Program as one of five study areas to participate in a national study on how hydrological processes and agricultural practices interact to affect the transport and fate of agricultural chemicals in nationally important agricultural settings. Key to achieving this objective is an understanding of how the agricultural chemicals move through each hydrologic compartment, as well as estimating rates of exchange between compartments. Five hydrologic compartments were monitored: the atmosphere, surface water, the unsaturated zone, ground water, and the hyporheic zone (surface water – ground water (sw/gw) interaction).

Study of the sw/gw component utilized temperature as a tracer to estimate rates of exchange between surface water and ground water. Tracking the transport of heat aids the understanding of sw/gw exchange because variations in temperature can be used to trace the heat carried by the flowing water. Analysis of subsurface temperature patterns provides further information about sw/gw interactions when coupled with numerical models that solve equations governing the flow of water and heat through sediments. Estimates of rates of exchange at the sw/gw interface were made by placing a total of 32 high-precision data loggers in both the surface water and at three depths within the streambed of the Merced River at two transects. These transects were 100 meters apart and equipped with 10 piezometers each. Pressure transducers located in stream and below the streambed collected water level data that were used to define boundary conditions. The collected temperature and pressure head data were input into a USGS numerical model, Variably Saturated 2-Dimensional Heat (VS2DH), that uses an energy transport approach via the advective-dispersion equation to simulate heat and flow transport. Estimates of streambed hydraulic and thermal conductivity were input into the model until model simulations “best fit” observed streambed temperatures at depth.

Direct measurements of vertical flux at the sediment/water interface were also made using seepage meters, and these results were compared to the modeled rates of exchange. The use of seepage meters to measure seepage across a sediment/water interface has been traditionally applied to lake and estuary settings, but more recently has been used in small streams and creeks. The size and variation in stream discharge in the Merced River required additional measures in both field and laboratory settings to find the best sampling equipment scenario. Two sizes of seepage meters were deployed side by side in both field and laboratory settings and the results were compared. Collection bags of various thicknesses were connected to the paired seepage meters in a controlled laboratory seepage tank to examine the effects of collection bag thickness on seepage rates. Scouring of the sediment around the seepage meters in the field required fabrication and deployment of flow barriers upstream of the seepage meters.