Using synoptic river surveys to characterize groundwater systems

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ABSTRACT
Synoptic sampling of stream chemistry is a common methodology for estimating the volume of groundwater discharge to a stream over a variety of scales. The principal behind the technique is to find a suitable tracer that is present in the groundwater system at a known concentration, and then infer the amount of groundwater in surface water from the concentration of the tracer in the surface water. The concentration of the tracer in groundwater may encode information on the groundwater system discharging to the stream, such as the groundwater residence time, provenance, quality, and chemical evolution. In many cases, it would be beneficial to know the tracer concentration or distribution of concentrations in groundwater feeding the stream; however, regional scale sampling in groundwater is always limited by the location and amount of groundwater wells. Here, we flip the paradigm of stream tracer surveys, by using stream discharge and chemistry to estimate the tracer concentration of groundwater feeding the stream. Groundwater discharge to the stream can then be estimated using one set of environmental tracers, applied tracers, synoptic stream gauging or other methods, and the concentration of a tracer of interest in the groundwater then estimated using the measured groundwater discharge and river chemistry. In this paradigm, the stream becomes an easily accessible location to sample the distribution of groundwater flow paths discharging to the stream, and thus to estimate the flow-weighted average concentration of tracer in that groundwater. We will develop the theory behind the method and demonstrate its application in several groundwater systems of local to regional scale.