



How many groundwater samples do we need to characterize the pre-event water composition?

Leonie Kiewiet (1), Ilja van Meerveld (1), Jan Seibert (1,2)

(1) Department of Geography, University of Zürich, Zürich, Switzerland (leonie.kiewiet@geo.uzh.ch), (2) Department of Earth Sciences, Uppsala University, Uppsala, Sweden

Hydrograph separation studies usually rely on a baseflow sample or a few groundwater samples to characterize the pre-event water composition. However, the spatial variability in groundwater chemistry can be large and only some parts of the groundwater may contribute to baseflow, so that the baseflow sample may not adequately reflect the pre-event water component. This is problematic if the relative contributions from different groundwater stores change with the expansion and connection of different source areas during events.

During nine groundwater snapshot sampling campaigns during baseflow conditions, we sampled 38 wells in a steep 20-ha pre-alpine catchment in Switzerland. We combined this spatially distributed information with streamflow and precipitation data for four rainfall events to assess the effect of different pre-event water characterizations on two-component hydrograph separation results. The aim was to identify the number of samples required to obtain a reasonable approximation of the shallow groundwater in the catchment. We estimated the pre-event water fraction for each stormflow sample using the two-component hydrograph separation method, where we used either a baseflow sample or a subset of the groundwater samples to characterize the pre-event water composition.

The average isotopic composition of a subset of six to nine wells represented in most cases the catchment average pre-event groundwater composition within one standard deviation. When selecting a subset of riparian wells, the average composition was more enriched than the average groundwater composition. The pre-event water fractions in streamflow were significantly different when using the average groundwater signature, the average riparian groundwater signature or a baseflow sample to characterize the pre-event water composition in the two-component hydrograph separation for all but one event. The differences in the calculated event-minimum pre-event water fractions when using a baseflow sample or a sample from an individual groundwater site to represent the pre-event water component were as large as 23%. The variation in the calculated pre-event contributions to streamflow during the five events when using the pre-event water composition from the different groundwater wells was much larger than for a baseflow sample (maximum range: 0.47 – 1 for the different wells, and 0.70 – 1 when using a baseflow sample). The event average pre-event water fraction was usually lower when using one or a few groundwater wells to characterize the pre-event water composition than when a baseflow sample was used, except for one event for which the average pre-event water fraction was lowest when using a baseflow sample. Increasing the number of wells for the calculation of the average isotopic composition of the groundwater to be used in the hydrograph separation analyses resulted in less variable and lower average fractions of pre-event water per event.

The results from this analysis show that different pre-event water characterizations can result in significantly different estimates of pre-event water fractions. This highlights the need to use spatially distributed information on the pre-event water composition when we perform hydrograph separation analyses and also to be aware of the uncertainties when we use data from a limited number of wells.