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Identifying runoff processes from long term tracer data: do multiple tracers help?

M. Hrachowitz (1), C. Soulsby (1), D. Tetzlaff (1), J. Dawson (1) and S.M. Dunn (2)
(1) School of Geosciences, University of Aberdeen, UK, (2) Macaulay Institute, Aberdeen, UK (m.hrachowitz@abdn.ac.uk)

Runoff processes and flow pathways are thoroughly understood only at relatively few sites where hillslopes and small catchments have been intensively instrumented. In less well-instrumented catchments, the heterogeneity of controls on flow paths, such as climate, soils and topography, make it difficult to infer runoff generation processes from catchment scale observations as emergent behavior may not reflect the detailed processes underpinning it. In this poster, catchment scale behaviour is related to hillslope scale processes at Sourhope, a small experimental catchment in Scotland with a 12 year continuous record of precipitation, soil moisture and stream flow. Moreover, multiple hydrochemical tracer data for weekly precipitation, soil water and stream water samples are available for the same time period. Such data can facilitate the conceptualization of runoff processes using different hydrochemical modeling techniques which integrate hillslope and catchment-scale tracer response. The abundance of tracer data also facilitates well-founded hypotheses on the behaviour of the hydrological system and has the potential to enhance identification of end members that characterize, and allow quantification of the importance of different runoff processes. These can be conceptualized using flow-concentration relations of tracers, multi-tracer mixing plots and Principal Component Analysis (PCA). This showed that simple two component hydrograph separation, with a deep subsurface and a near-surface flow component captured the catchment response reasonably well. Classic three component hydrograph separation, using combinations of two tracers, failed: most of the stream water samples plotted outside the mixing triangle defined by the three end members. However PCA suggested that a third, weakly defined end member was important.

Contributions of three hydrograph components were inferred from the principal components using end member mixing analysis which differentiate a shallow subsurface source and overland flow. Using the three component hydrograph separation technique suggested by Uhlenbrook and Hoeg (2003), the analysis compared multiple realizations, with various tracers, which allowed us to quantify differences in end member contributions. This poster will examine the difference between two and different three component hydrograph separations and the uncertainties associated with each. The information content of long-term tracer data sets in aiding the conceptualization of catchment flow paths to facilitate the prediction of catchment behaviour will be critically evaluated.