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Comparison of tracer and traditional baseflow separation methods: Are they looking at the same thing?

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Traditional baseflow separation of streamflow has been important for over a hundred years as a way of identifying direct runoff by subtraction and relating it to the causative rainfall. Baseflow is generally regarded as sourced from groundwater discharging into streams. A wide variety of mainly graphical methods of baseflow separation have been used and continue to be used in practical and modelling applications. These methods are usually not based on real knowledge of baseflow variations and can be inconvenient to apply to long records. More convenient recent methods of this type are recursive digital filters that can be applied to the streamflow record to extract baseflow hydrographs.

The introduction of tracer separation of components 40 years ago gave actual data-based separations for the first time. They produced a shift in thinking about runoff generation since they showed that baseflow responds rapidly to rainfall just like quickflow, and can even dominate storm runoff events in addition to the low flow periods between events.

Separating streamflow into its components is valuable for understanding the sources and flowpaths of water and solutes in catchments, and in particular determining nutrient flowpaths. Tracers give an objective basis for separating hydrographs, but tracer data is usually quite limited in time even if available for a catchment. A new separation method (the bump and rise method or BRM) gives a filter that mimics tracer separations and can be applied to the whole streamflow record.

This work compares two- and three-component hydrograph separations obtained from tracer studies in the literature with traditional baseflow separation methods and recursive digital filter methods, including the BRM filter. Eight two-component tracer studies were examined from catchments with a wide variety of climatic settings, areas, topography, soils and vegetation. Different methods could be fitted to the tracer separations with different goodnesses, and the BRM filter usually gave the best fits. Graphical baseflow separation methods often gave very poor representations of the tracer separations. More detailed component separations are possible using two tracers with different characteristics thereby giving three-component separations – five such studies were examined. Again the BRM filter gave good representations of all three components (better than the other filters), while the graphical methods could not be applied to three components. It is concluded that the BRM method can usefully be used to extend tracer separation results.

Tracer and traditional baseflow separation methods applied to streamflow give different results. The question is: What water components are being identified by these methods?