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Estimating timescales of baseflow using isotopic time series in rivers

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Isotopic time series are applicable to a large number of hydrologic problems, and have proved valuable in determining the physical parameters of river systems (Gibson et al., 2002). In the early 1960s, the US Geological Survey began monitoring tritium concentrations in river water. Several of these sites have been sampled for 20-45 years. Using a model based on the long-term yearly tritium data, it was possible to model the river basin to obtain values for hydrologic parameters. Estimates of the fraction of water that remained in the watershed for more than one year (termed the baseflow) were obtained and the average mean residence time of this baseflow component was obtained. Baseflow is derived from aquifers that are in close contact with the river. Such aquifers are important systems for determining the water quality and aquatic health of the river basin. In most cases studied, the residence time for the baseflow component was found to be on the order of 1-2 decades (Michel, 1992; 2004; Michel and Schroeder, 1994).

For most systems, there are no long term data sets available for carrying out such an analysis. However, for many sites, records of 2-4 years of monthly data are available during the height of the tritium transient. Using the seasonal signal, measurements of monthly tritium concentrations and flow rates for the river, and estimates of tritium concentrations in precipitation, it is possible to calculate the same parameters derived from the long-term records for many sites. To use this approach requires that a significant seasonal signal be present and that monthly measurements of tritium concentrations in river water be made during the height of the tritium transient. Calculations using this method were comparable to the results obtained from the long-term data sets. This approach can be applied to obtain estimates of the percentage and residence

time of the baseflow for systems where only short data sets during the peak of the bomb-transient are available.

At selected sites, it is also possible to calculate similar information using seasonal stable-isotope data and tritium concentrations measured at the present time. This approach requires that a significant seasonal signal be present in the stable-isotope data. However, frequently this approach yields two or more solutions for the residence time. It is usually possible to constrain the solutions have by using other hydrologic information.

References

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