



Tracer-based assessment of flow paths, storage and runoff generation in northern catchments

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We examine how tracer studies have enhanced our understanding of flow paths, residence times and sources of stream flow in northern catchments. We define northern catchments as non-glacial sites in the temperate conifer/boreal/permafrost zone, focussing mainly on sites in North America and Europe. Improved empirical and theoretical understanding of hydrological functioning has advanced the analytical tools available for tracer-based hydrograph separations, derivation of transit time distributions and tracer-aided rainfall-runoff models that are better able to link hydrological response to storage changes. However, the lack of comprehensive tracer data sets still hinders development of a generalized understanding of how northern catchments will respond to change. This paucity of empirical data leads to many outstanding research needs, particularly in rapidly changing areas that are already responding to climatic warming and economic development. To continually improve our understanding of hydrological processes in these regions our knowledge needs to be advanced using a range of techniques and approaches. Recent technological developments for improved monitoring, distributed hydrological sensor systems, more economic analysis of large sample numbers in conjunction with novel, tracer-aided modelling approaches and the use of remote sensing have the potential to help understanding of northern hydrological systems as well as inform policy at a time of rapid environmental change.