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Is the difference between chemical and numerical estimates of baseflow meaningful?

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Both chemical and numerical techniques are commonly used to calculate baseflow inputs to gaining rivers. In general the chemical methods yield lower estimates of baseflow than the numerical techniques. In part, this may be due to the techniques assuming two components (event water and baseflow) whereas there may also be multiple transient stores of water. Bank return waters, interflow, or waters stored on floodplains are delayed components that may be geochemically similar to the surface water from which they are derived; numerical techniques may record these components as baseflow whereas chemical mass balance studies are likely to aggregate them with the surface water component. This study compares baseflow estimates using chemical mass balance, local minimum methods, and recursive digital filters in the upper reaches of the Barwon River, southeast Australia. While more sophisticated techniques exist, these methods of estimating baseflow are readily applied with the available data and have been used widely elsewhere. During the early stages of high-discharge events, chemical mass balance overestimates groundwater inflows, probably due to flushing of saline water from wetlands and marshes, soils, or the unsaturated zone. Overall, however, estimates of baseflow from the local minimum and recursive digital filters are higher than those from chemical mass balance using Cl calculated from continuous electrical conductivity. Between 2001 and 2011, the baseflow contribution to the upper Barwon River calculated using chemical mass balance is between 12 and 25% of annual discharge. Recursive digital filters predict higher baseflow contributions of 19 to 52% of annual discharge. These estimates are similar to those from the local minimum method (16 to 45% of annual discharge). These differences most probably reflect how the different techniques characterise the transient water sources in this catchment. The local minimum and recursive digital filters aggregate much of the water from delayed sources as baseflow. However, as many of these delayed transient water stores (such as bank return flow, floodplain storage, or interflow) have Cl concentrations that are similar to surface runoff, chemical mass balance calculations aggregate them with the surface runoff component. The difference between the estimates is greatest following periods of high discharge in winter, implying that these transient stores of water feed the river for several weeks to months at that time. Cl vs. discharge variations during individual flow events also demonstrate that inflows of high-salinity older water occurs on the rising limbs of hydrographs followed by inflows of low-salinity water from the transient stores as discharge falls. The use of complementary techniques allows a better understanding of the different components of water that contribute to river flow, which is important for the management and protection of water resources.