Stable isotope tracing of water exchange along a dryland river

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Deuterium and oxygen-18 enrichment in river water during its transit along the Barwon-Darling River, a dryland region in southeastern Australia, is found to occur systematically along evaporation lines with slopes of close to 4 in ^{2}H-^{18}O space. This is largely consistent with expected trends for an open-water dominated evaporating system. When combined with reach balance assessments and derived runoff ratios, this strongly suggests that the enrichment signal and its variability is acquired during the process of evaporation from the river channel itself, as enhanced by the presence of abundant weirs, dams and other storages, rather than reflecting inherited enrichment signals from soil water evaporation in the watershed. Using a steady-state isotope mass balance analysis based on monthly ^{18}O and ^{2}H, we use the isotopic evolution of river water to re-construct a picture of net exchange between the river and its contributing area along eight reaches of the river from July 2002 to December 2003, including the duration of a minor flood event. As expected for a flood-driven dryland system, considerable temporal variability in exchange is predicted. For 65% of all reach-months evaluated the river was apparently gaining water along its course; about 10% of these times it was also undergoing substantial volumetric drawdown. Overall, a broad systematic decline in the percentage of gaining intervals is noted from the upstream to downstream reaches, with most reaches gaining water substantially more than half of the time. One reach, known to be an intensive cotton-growing area, was found to be fairly balanced between gaining and losing periods. While a more detailed analysis is required to carefully verify the quantities of water exchange, a first assessment of monthly runoff ratios for the reach catchments suggests that the inflow estimates are reasonable. The technique, while requiring additional quantitative ground-truthing, demonstrates potential as a non-invasive tool for detecting and quantifying water diversions, one that can be easily incorporated within existing water quality monitoring activities.