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Processes controlling baseflow and climatic warming effects in the Merced River, Sierra Nevada, California

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Present knowledge of mountain hydrology is insufficient for accurate estimation and modeling of groundwater discharge which provides much of the annual streamflow. Sources of streamflow in upper Merced River, a typical river in the Sierra Nevada, were determined using stable isotopes and chemical tracers in order to improve our understanding of hydrologic controls on streamflow and their relationship to changes in the rain/snow regime associated with climatic warming in the region. Samples were collected from streamflow, groundwater, and natural springs from 2003 to 2006. Both stable isotopes and specific conductivity in streamflow showed a strong seasonality, with lower values from April to July during the snowmelt season, higher values from August to October during dry season, and intermediate values from November to March during winter rainfall and snowfall. Two components controlling baseflow (streamflow from August to October) in the Upper Merced River were identified: shallow subsurface runoff from snowmelt infiltration and groundwater from fractured bedrock. Conductivity in baseflow increased rapidly with discharge, following a power law ($R2 > 0.96$, $p < 0.05$), and peaked in October, indicating that the contribution of shallow subsurface runoff to baseflow was significant but decreased rapidly from August to October. Baseflow appears to be very sensitive to the snowmelt timing and regime. From 1976 to 2005, during a period of increasing temperature in the region, streamflow tended to decrease significantly during October ($p < 0.05$) and increase during March ($p < 0.05$). However, total annual precipitation did not change significantly, indicating that the shift in baseflow discharge is a result of the early onset of snowmelt these years. If the trend to earlier snowmelt continues, late summer baseflow in the Sierra Nevada may continue to decrease.