Controls on the isotopic composition of surface water and groundwater and hydrologic implications in the mid Merced River basin, Sierra Nevada, California, USA

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Isotopic composition in stream water, springs, groundwater, and precipitation was examined to understand the controls on the spatiotemporal variability from 2006 to 2008 in the mid Merced River basin (1,873 km^2), Sierra Nevada, California. Mean isotopic values in small tributaries (basin area < 122 km^2), rock glacier outflows and groundwater were correlated with mean basin elevation ($n = 16$, $p < 0.001$), suggesting an isotopic lapse rate of -1.9‰/100 m for δ^2H and -0.22‰/100 m for $\delta^{18}O$ in meteoric water. Evaporation had little effect on the isotopic signature of precipitation, springs, and groundwater, but affected stream water during low flows in summer and fall. The isotopic composition in stream water in the Merced River was most depleted during snowmelt. However, the isotopic composition-elevation relationship in tributaries and the Merced River did not vary much over seasons. A basin-characteristic isotopic value was established for each basin based on the relation between isotopic composition and the mean basin elevation to elucidate hydrometeorologic processes over seasons. It is suggested that flow and flow duration of Yosemite Creek are most sensitive to temperature increase due to its strong evaporation. Based on the isotope-elevation relation, groundwater in Yosemite Valley was recharge from the upper snow-rain transition zone (2,000-2,500 m), suggesting its strong vulnerability to temperature increase, shift in snow-rain ratio and the earlier onset of snowmelt. The information helps advance our understanding of hydrologic responses to climate change in snowmelt-fed river systems in the U.S. West.

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