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Investigating drought vulnerability using stable water isotopes and tritium in a montane system

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We combined measurements of water stable isotopes (d18O and d2H) with measurements of tritium (3H) to track water from precipitation through the subsurface and vegetation. Our study examined drought vulnerability in terms of vegetation water sources and subsurface storage in two montane sites, seasonally, using stable isotopes and tritium. Relative proportions of evapotranspiration sources were determined using two-tracer (d18O and 3H), three component mixing models. The two sites, located in the Southern Sierra Critical Zone Observatory, California, USA, are Mediterranean in climate, straddling the rain-snow transition zone where the upper elevation site receives most of its precipitation as winter snow. Over the study period, summer 2015 followed four years of severe snow drought; summer 2016 followed a slightly below average winter. The lower elevation site experienced severe drought-induced tree mortality over this time. Preliminary results show severe snow drought conditions and summer precipitation affected the proportions of source water used by vegetation due to the ability of vegetation to change sources when new water became available. Both stable isotopes and tritium reflect seasonal shifts in vegetation water sources, as well as species vulnerability and tolerance to drought. Xylem water sampled from Abies concolor (white fir) and Arctostaphylos patula (manzanita) responded the most quickly to changes in available water sources compared to Pinus jeffreyi (Jeffrey pine) and Calocedrus decurrens (incense cedar). Abies concolor and Arctostaphylos patula responded more dramatically to summer soil evaporation by accessing summer rain and deep water sources more quickly. Abies concolor also responded more dramatically to changes in snowpack during winter. During severe drought conditions, Arctostaphylos's ability to tap into a wide range of water sources coincided with drought tolerance (100% survival rate), while mortality for Pinus ponderosa and Calocedrus decurrens exceeded 50% and 70%, respectively.

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