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Stable isotope investigation of water sources for shrubs in naturally regenerating hillslope farmland

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Shrub encroachment into grasslands is a globally represented process, but resulting changes to catchment water fluxes and stores are not yet well understood. We examined how regenerating woody shrubs into a marginal sub-alpine farmland might alter streamflow that support fertile farmlands downstream. We compared isotope values of shrub stem water to soil water pools at various depths within the vadose zone, groundwater, and stream water, to better understand the temporal patterns of water sources for these plants. We also compared our results with soil moisture and meteorological data, and plant water uptake measured using sapflow sensors. Stable isotope data indicated that the shrubs derived the majority of their water from shallow soils (0-10cm depth), during the summer growing season, and the shrub water use found to be negligible in winter. In contrast, groundwater and streams were fed primarily by precipitation that fell during winter months, and passed quickly to deeper soils. The reliance of shrubs on shallow soil water was also supported by reduced sapflow rates as these soils dried intermittently during late summer. Our results indicate that water loss to streams as a result of the early stages of shrub regeneration is likely to be minor. This is important because the same shrubs are costly to remove but have measureable benefits for sediment retention and soil fertility in sub-alpine farms.