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# Tracing recharge zones for spring sources in the mid-hills of Western Nepal using stable isotopes

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Springs are the primary source of water for communities located in the mid hills of Nepal. Increasing evidence of the drying of springs in these areas highlight the need to establish scientific understanding of these spring systems in order to design effective interventions for improving they year-round reliability and climate resilience. Our study marks the first attempt in using stable isotopes of oxygen ($\delta$18O) and hydrogen ($\delta$D) to identify dominant recharge zones for spring systems in Nepal. In total, 422 water samples were collected between August 2015 - March 2017 from two mountainous catchments, Banlek and Shikarpur, located in Western Nepal. Water samples were collected from rainfall at six different elevations, springs in Shikarpur (three) and Banlek (four) and major streams in both the catchment and analyzed for their isotopic composition ($\delta$18O and $\delta$D). It is evident from the isotopic composition of rainfall and the Local Meteoric Water Line (LMWL) that rain fed by the Indian monsoon and winter westerlies vary in isotopic compositions due to the difference in source of the moisture causing the rain and its trajectory. The stable isotope composition of all springs in both catchments behave similarly, exhibiting a seasonal variation and elevation effect. The spring isotopic signature in both catchments falls within the narrow band of -9.55 to -8.06 ‰ for $\delta$18O and -67.58 to -53.51 ‰ $\delta$D across seasons. The spring sources fall close to the Local Meteoric Water Line (LMWL) for the corresponding season indicating strong contribution from rainfall. Based on local vertical isotopic gradient of $\delta$18O and $\delta$D, mean recharge altitude of 2600 to 2700 msl in Shikarpur and, 1000 to 1100 msl in Banlek were estimated for the springs. Springs were also classified as connected to confined and unconfined groundwater. The identified elevation range and spring type is used to design climate interventions for effectively recharging the spring.