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Isotope hydrogeochemical and geomorphological approach for the rejuvenation of drying springs in mountainous region of Gaucher, Uttarakhand, India

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In mountainous region of Gaucher in Uttarakhand, India, springs are the only source of water for drinking and agricultural purposes, and most of them dry up during summer. Environmental isotopes (^{2}H, ^{18}O & ^{3}H) along with hydrogeochemical and geomorphological techniques were applied to identify the recharge zones of the drying springs in this area in order to create artificial recharge by harvesting rainwater for the sustenance of springs. The study shows that the high altitude springs are derived from short flow paths with transit time of about a few weeks, whereas both shorter and longer flow paths contribute to low altitude springs. The transit times of longer flow paths may be more than 3 months. Altitude effect was estimated from the variation of stable isotopic composition in rainwater collected at various attitudes and it is found to be -3.8‰/100 m for $\delta^{2}H$ and -0.6‰/100 m for $\delta^{18}O$. Based on the above inferences, a conceptual model was developed to explain the spring recharge and groundwater flow mechanism in mountainous regions. The recharge altitudes were identified for three valleys using local geomorphology and evaporation-corrected stable isotope data of the springs. They are found to be about 1300 m above mean sea level (amsl) for Valley 1 and Valley 2 and 1000 m amsl for Valley 3. At these altitudes, artificial recharge structures like check bunds and contour trenches were constructed for harvesting rainwater and sub-surface dykes to control the groundwater flow. Subsequent to the construction of the recharge structures, it was observed that after the first monsoon, the discharge rates increased considerably and all the springs became perennial. Also, a few new springs have appeared in Valley 1. Thus the study demonstrates the significance of an integrated use of the hydrogeochemical, geomorphological and isotope techniques for the rejuvenation of drying springs in mountainous regions by rainwater harvesting. The conceptualized model can be valid in other mountainous regions where water resources are limited to springs.

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