

## Tracing the Sources of River Waters Using Stable Isotopes ( $\delta^{18}\text{O}$ and $\delta^2\text{H}$ ) in Two Mountainous Watersheds, Southern Western Ghats, India

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### Abstract

Stable isotopes of oxygen ( $\delta^{18}\text{O}$ ) and hydrogen ( $\delta^2\text{H}$ ) are useful tools to characterize and monitor the hydrological processes in aquatic ecosystems. The present study uses  $\delta^{18}\text{O}$  and  $\delta^2\text{H}$  data from two small catchment rivers such as the east-flowing Bhavani river and the west-flowing Thuthapuzha River in southern Western Ghats to get an insight into the water cycle dynamics and sources of water. The Bhavani River drains through the semi-arid, lee-ward side of the Western Ghats and shows a markedly depleted isotopic composition as compared to the Thuthapuzha River which drains through the humid, windward side of the Western Ghats. The isotopic systematics are strongly influenced by the southwest monsoon (SWM) and the northeast monsoon (NEM) rainfalls. However, during the pre-monsoon (PRM) season, the isotopic composition in these river waters is governed mainly by the baseflow and evaporative processes. Both the river basins experience a higher vapour recycling effect in their headwaters. The NEM rainfall contains a considerable amount of recycled vapour, which is evident from the observed high d-excess values. Whereas the SWM rain events show the dominance of the original sea moisture source. There is a distinct difference in the isotopic ratios and d-excess values between the SWM (d-excess: Bhavani River  $10.29 \pm 1.29\text{‰}$ ; Thuthapuzha River  $10.52 \pm 2.78\text{‰}$ ) and the NEM (d-excess: Bhavani River  $15.15 \pm 0.92\text{‰}$ ; Thuthapuzha River  $12.67 \pm 4.49\text{‰}$ ) seasons, with the predominance of lighter isotopes in the latter period. In general, the seasonal and spatial differences in isotopic composition in the Bhavani River ( $\delta^{18}\text{O}$ : PRM  $-5.42 \pm 1.76\text{‰}$ ; SWM  $-4.16 \pm 0.77\text{‰}$ ; NEM  $-4.73 \pm 0.76\text{‰}$ ) and the Thuthapuzha River ( $\delta^{18}\text{O}$ : PRM  $-4.26 \pm 0.67\text{‰}$ ; SWM  $-2.54 \pm 0.76\text{‰}$ ; NEM  $-2.68 \pm 0.96\text{‰}$ ) indicate that precipitation (atmospheric source) as the major source of water in the monsoon (SWM and NEM) season, while the base flow contribution from groundwater has a major stake in PRM season.

**Keywords:** Stable Water Isotopes, d-excess, Climate Gradient, Base Flow Discharge, Western Ghats, Southwest India.

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