

Stable water isotopes show that the recharge of exploitable water resources strongly depend on heavy rainfall in Réunion Island

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Insular tropical environments hold an intrinsic vulnerability of water resources due to the limited space, isolation and risk of salinization in coastal areas. This holds true for Reunion Island (Indian Ocean) where despite record rainfalls, several agglomerations are impacted almost yearly by droughts and water restrictions. Water management thus requires a good understanding of the water cycle, to assess groundwater recharge dynamics and water storage variability. Here, we use stable water isotopes to trace precipitation, surface water, and groundwater across different elevations in the Rivière des Pluies hydrogeological basin, where continuous data collection began in 2001.

Our study shows that water storage capacity varies across water bodies, with a stronger buffering effect observed at greater depths. The exploitable water resource corresponds to a large deep aquifer with a homogeneous and stable $\delta^{18}\text{O}$ value of -5.21 ± 0.28 ‰ which differs from that of mean rainfalls (-2.66 ± 1.88 ‰). We find that the main driver for oxygen fractionation in precipitations is rainfall intensity, with the season and elevation playing a secondary role. A k-means clustering analysis of rainfall events revealed that those with $\delta^{18}\text{O}$ values of -5.28 ± 1.56 ‰ – similar to that of the exploitable water resource – correspond to high-intensity events (32.0 ± 12.0 mm/h over 3 hours). This shows that intense events are the main contributors to aquifer recharge.

These findings emphasize the vulnerability of water resources due to their dependence on heavy rainfall, which show strong variations yearly and may become even more erratic according to climate change projections. By tracing heavy rainfall, stable water isotopes offer key insights into recharge processes unique to tropical environments, making them a valuable tool for water resource management in these regions.