Climatic controls on aquifer recharge and isotopic signatures in West Africa: insights from stable isotopes and tritium

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Résumé

Understanding recharge mechanisms and groundwater vulnerability is essential for sustainable water resource management in West Africa, particularly in the context of increasing climate variability. This study compiles and analyzes stable isotope (δ^1O, δ^2H) and tritium (3H) data from precipitation, surface water, and groundwater across various climatic zones and aquifer types. A significant portion of the isotopic data was sourced from the Global Network of Isotopes in Precipitation (GNIP) and collected within the framework of three interregional projects (RAF/7/011, RAF/7/019, and RAF/7/021) supported by the International Atomic Energy Agency (IAEA). These projects aimed to better characterize the hydrogeology of the principal shared aquifers in West Africa, particularly in the Sahel region. The results demonstrate that climate conditions, rather than aquifer type, predominantly govern groundwater recharge. Isotopic variability reflects a mixed moisture origin from both the Atlantic Ocean and continental recycling, with spatial patterns shaped by precipitation amount, temperature, and evaporation intensity. Tritium contents confirm modern recharge in some shallow aquifers, particularly in the wetter southern zones, while older or limited recharge is observed in drier northern regions. Climatic phases since the 1960s have distinctly impacted the isotopic composition of groundwater, mirroring changes in moisture sources and atmospheric processes. These findings highlight the strong sensitivity of groundwater systems to climate dynamics and underscore the importance of integrating climatic factors into aquifer management strategies.

Mots-Clés: West Africa, groundwater recharge, stable isotopes, tritium, climate variability, aquifer vulnerability

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