Relationships between rainfall and groundwater recharge in seasonally humid Benin: a comparative analysis of long-term hydrographs in sedimentary and crystalline aquifers

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Résumé

Groundwater is a vital source of freshwater throughout the tropics enabling access to safe water for domestic, agricultural and industrial purposes close to the point of demand. The sustainability of groundwater withdrawals is controlled, in part, by groundwater recharge, yet the conversion of rainfall into recharge remains inadequately understood, particularly in the tropics. This study examines a rare set of 19–25-year records of observed groundwater levels and rainfall under humid conditions (mean rainfall is _˜1,200 mm year– 1) in three common geological environments of Benin and other parts of West Africa: Quaternary sands, Mio-Pliocene sandstone, and crystalline rocks. Recharge is estimated from groundwater-level fluctuations and employs values of specific yield derived from magnetic resonance soundings. Recharge is observed to occur seasonally and linearly in response to rainfall exceeding an apparent threshold of between 140 and 250 mm year–1. Inter-annual changes in groundwater storage correlate well to inter-annual rainfall variability. However, recharge varies substantially depending upon the geological environment: annual recharge to shallow aquifers of Quaternary sands amounts to as much as 40% of annual rainfall, whereas in deeper aquifers of Mio-Pliocene sandstone and weathered crystalline rocks, annual fractions of rainfall generating recharge are 13 and 4%, respectively. Differences are primarily attributed to the thickness of the unsaturated zone and to the lithological controls on the transmission and storage of rain-fed recharge.

Mots-Clés: Groundwater recharge/water budget Benin

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