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Multiple approach for delineating the impact of climate change and land use changes on groundwater quantity and quality in Granitic aquifers of northern Ghana.

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The development of groundwater for safe drinking water and food production offers a huge potential for poverty alleviation in Africa. Recent studies discovered huge groundwater potential in most parts of Africa. However, a key uncertainty is how sustainable groundwater abstraction will be; is it being replenish? If so how much?, from where? and will this change in the future?. This paper aimed to assess the impact of climate and land use changes on groundwater quantity and quality in a semi-arid region of Ghana. In all 617 water levels and 165 groundwater samples were collected and analyzed using an integrated field measurement, hydrochemistry and isotope approach. The mean groundwater levels ranged from 1.24 to 5.46 m. On the seasonal scale, both the Mann-Kendall and Sen's slope estimator showed rising seasonal trends in all the wells except Kabingo. However, on the annual scale, neither significant positive nor negative trends were observed. Forecast for rainfall and groundwater levels using ARIMA models indicates that there will be a significant decline in rainfall at a rate of 4.8 mm/year by 2050. The groundwater levels, however, showed a relatively stable trend to slight increase in most of the wells varying in magnitude across the study area. The $\delta^{18}O$ and $\delta^{2}H$ show that rainfall is the main source of recharge and occurs in events greater than 10 mm with June, July and August as probable months of recharge. The isotope mixing model shows that the surface water contribution to groundwater recharge is extremely variable, ranging from 1.47 ± 0.09% to 51.69 ± 6.04% suggesting the potential for artificial recharge. NO_3^- concentrations in the BH, HDW, and SW were heterogeneous and controlled by localized anthropogenic activities. The hydrochemistry and dual isotope ($^{15}N\text{-}NO_3$ and $^{18}O\text{-}NO_3$) identified manure/sewage as the dominant source of NO_3^- in the groundwater, while the SW showed a complex signature overlapping in the areas of manure/septic, chemical fertilizer, and soil nitrogen. The NO_3^- source contribution based on the mean probable estimate (MPE) using SIAR were in the order sewage/manure > soil nitrogen > chemical fertilizer > precipitation. A conceptual framework summarizing groundwater recharge dynamics is presented.