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Evaluation of groundwater quality in a small coastal aquifer in southern Ghana: A multi-disciplinary approach using hydrogeochemical, statistical and water quality index (WQI)

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Globally, aquifers in coastal environments face unique environmental challenges ranging from increased groundwater abstraction, freshwater salinization, industrial pollution and climate change. In Africa, these problems are exacerbated due to the lack of monitoring, regulation and sustainable water resources management planning**.** Here, we studied the major ion and trace metal compositions of the coastal aquifer system, which underlaid the Sakumo Ramsar Site, a designated Ramsar Wetland Site and a UNESCO World Heritage site in southern Ghana, West Africa. Coupling hydrogeochemical, statistical and water quality index (WQI) analyses with spatial analytical techniques (GIS), our results indicate majority (65%) of the groundwater samples were highly to severely restricted for crop irrigation. Twenty percent of the groundwater in samples fell within the No Restriction (NR) to Low Restriction (LR) categories and are suitable for crop production and human consumption after treatment. The results further reveal groundwater in the catchment were slightly acidic (pH < 7.7) and dominated by Na^+ and Cl^- ions due to their proximity to the sea. Except for the Sakumo Delta, wide variations and high standard deviations of hydrochemical parameters such as $N\text{-}NO_3^-$, SO_4^{2-}, K^+, and Cu were localized and these suggest contamination of the groundwater by human activities. Multivariate Factor analysis (FA) showed good correlation between Ca^{2+}– Mg^{2+}, Ca^{2+}– Cl^-, Na^+–Cl^- and Cl^- –SO_4^{2-} and ionic ratios suggest seawater intrusion, silicate weathering, carbonate dissolution and ion exchange are the main hydrogeochemical processes controlling the groundwater chemistry.