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Deciphering groundwater quality using water quality index (WQI), heavy metal pollution index (HPI) and geospatial modeling in coastal wetlands: The case study of Densu Delta (Ghana)

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Globally, groundwater in coastal areas faces unique environmental challenges ranging from increased groundwater abstraction, freshwater salinization, industrial pollution and climate change. In Africa, these problems are exacebated by the lack of monitoring, regulation and sustainable planning for water resources management. Here, we studied the major ions and heavy metals composition of the groundwater system of the Densu Delta, a designated Ramsar wetland and UNESCO World Heritage site in southern Ghana, West Africa. Using geochemical, isotopes and quality index analyses with spatial analytical techniques (GIS), our results show that half (50%) of the groundwater samples were of good quality for consumption and domestic use. 35% of groundwater samples showed poor quality water for consumption while 2.5 % showed very poor quality. Ten percent of the groundwater sampled was unsuitable for consumption and domestic use. Only 2.5% of the groundwater was of excellent quality. The results also shows that TDS, turbidity, colour, hardness, nitrate and sulphate were above the WHO and GSA guideline values for drinking water. The groundwater chemistry is mainly controlled by dissolution mechanism. Similarly, cadmium, chromium, manganese, lead and arsenic were above the guideline values. The results of Heavy Metal Pollution index (HPI) assessment showed that 12.5% of groundwater in the catchment was heavily contaminated with heavy metals, 47.5% was severely affected and 12.5% were seriously affected by heavy metals. The Metal Index (MI) assessment found that 40% of groundwater were moderately affected by heavy metals, 47.5% were strongly affected and 12.5% were seriously affected by heavy metals. The $\delta^{2}H$ and $\delta^{18}O$ isotopes showed that about 72.5% of groundwater recharges mainly from rainwater while the rest showed traces of both surface water and rainwater. A health risk assessment indicated that all groundwater poses a high health risk to consumers and 17.5% of groundwater are carcinogenic. Therefore, reduced metal concentrations, proper well construction, and comprehensive water quality monitoring to protect public health and prevent future risks.