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A framework combining geophysical and hydrogeological data for protecting groundwater sources in Nigeria

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Abstract

Groundwater is preferred to surface water as a drinking water source because it is less vulnerable to contamination from pathogens and chemical compounds. However, there is an increasing threat to groundwater health globally and in Nigeria resulting from sources such as uncontrolled use of fertilizers, chemicals and saltwater intrusion along coastal aquifers. To avoid high remediation costs and the health hazards associated with contaminated groundwater, it is preferable to protect groundwater sources. Groundwater source protection approaches include imaging aquifer structure, mapping source catchment area, estimating travel time distribution and parameters controlling groundwater flow and solute transport as well as investigating the mechanisms controlling saltwater intrusion. These studies require the use of numerical models parameterized by field parameter estimates. Field estimates of aquifer parameters at high resolution remains a challenge globally and in Nigeria, the quantification of spatially varying hydraulic parameters necessary to reduce uncertainties in groundwater source protection and assess vulnerability has received minimal attention. This research therefore takes a first step in exploring the use of predictive numerical models and field parameter estimates integrating geophysical and hydrogeological methods for protecting groundwater sources from anthropogenic contamination and seawater intrusion. We utilized refraction seismic and electrical resistivity for delineating the aquifer architecture while resistivity provided a proxy for imaging saltwater intrusion and transient groundwater flow. The multi-geophysical data sets aided high resolution estimates of hydrodynamic and hydrodispersive parameters used for calibrating the groundwater flow and solute transport models using MODFLOW, MT3DMS and SEAWAT. In addition to extending the global state of the art on characterizing aquifer heterogeneity at high resolution, this research produces a framework that can aid policy formulation for protecting groundwater resources in Nigeria.

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