Abstract

Groundwater quality assessment is critical for sustainable water resource management in arid and semi-arid regions. This study investigated the spatial distribution and interrelationships among pH, nitrate concentrations, and total dissolved solids (TDS) in groundwater from Mui Basin Block C, Mwingi Central, Kitui County, Kenya. Water samples were collected from all existing 32 sampling points comprising boreholes, shallow wells, and earth dams, representing shallow (1 - 10 m), moderate (10 - 30 m), and deep (>30 m) aquifer systems. Physicochemical analysis was conducted following standard methods, and spatial distribution patterns were mapped using Inverse Distance Weighting (IDW) interpolation in ArcGIS. Statistical analyses, including descriptive statistics, one-way ANOVA, and Pearson correlation, were performed to examine relationships among parameters. Results revealed mean values of pH 7.84 ± 0.89, TDS 964.74 ± 893.76 mg/L, and nitrate 56.11 ± 44.52 mg/L. ANOVA indicated no significant variation in these parameters across different aquifer depths ($p > 0.05$), suggesting uniform hydrogeochemical processes throughout the basin. Strong positive correlations were observed between electrical conductivity and TDS ($r = 0.99$, $p < 0.01$), and moderate correlations between nitrate and salinity parameters. Spatial analysis revealed elevated TDS and nitrate concentrations in the central and southeastern portions of the basin, likely influenced by geological formations, agricultural activities, and limited recharge. The findings indicate that groundwater quality in Mui Basin Block C is primarily controlled by water-rock interactions and anthropogenic inputs rather than aquifer depth, with implications for targeted water quality management strategies in similar semi-arid environments.