ASSESSMENT OF AQUIFER AND GROUNDWATER HYDROCHEMICAL CHARACTERISTICS IN ABEOKUTA METROPOLIS, SOUTHWEST, NIGERIA

BY

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ABSTRACT

The need for reliable and functioning aquifers to provide portable water to the human population is critical to socioeconomic development. This study investigated the aquifer characteristics and hydrochemical properties of groundwater by examining aquifer potential, groundwater quality, and dominant hydrochemical processes influencing water quality in Abeokuta metropolis. Geographical locations and elevations of 200 well sites were determined using a Global Positioning System (GPS). Static water levels and well depths, measured with a water level sounder, were used to create a water level map and as input for an Artificial Neural Network (ANN) model for groundwater level prediction. Groundwater hydrochemistry including physicochemical, bacteriological, and heavy metal parameters were assessed using standard methods. Geophysical surveys employing Vertical Electrical Sounding (VES) with a Schlumberger array were conducted in 200 stations with electrode distances of 1–100 m; to determine key geoelectric parameters: aquifer resistivity and thickness, overburden resistivity and thickness, and coefficient of anisotropy. Principal Component Analysis (PCA), Piper Trilinear Diagram, Gibbs Diagram, and Groundwater Quality Index (GWQI) were applied to the data, which were analyzed using descriptive and inferential statistics. Results obtained identified two aquifer types: weathered and fractured basement. The ranges of aquifer resistivities, thicknesses, and depths were: 1.5–79100 Ωm, 0.6–129 m, and 0.9–137 m, respectively. Protective capacity analysis classified 22% of aquifers as poorly protected, while 21 and 49% were weakly and moderately protected, respectively. Transmissivity and longitudinal conductance maps suggested moderate groundwater potential, with anisotropy values indicating fractured zones suitable for groundwater extraction. The ANN model validation for groundwater level prediction yielded MSE = 0.34 and R = 0.81, indicating high accuracy. The pH values ranged from 5.10–8.92, with locations such as Itoku (9.18), Olomore (9.37), and Sabo (9.18) exceeding the World

Health Organisation (WHO) drinking water guidelines. The Electrical Conductivity (EC) and Total Dissolved Solids (TDS) were highest in Olomore (2020 µS/cm, 1004 mg/L), Rounda 1284 µS/cm, 640 mg/L), and Sabo (1477 µS/cm, 730 mg/L), indicating high mineralization. Heavy metals exceeded the WHO guidelines in several locations: Lead (0.293 mg/L) in Obada, Cadmium (0.004 mg/L) in Sabo, Aluminum (4.757 mg/L) in Olomore, and Manganese (1.587 mg/L) in Rounda, suggesting anthropogenic contamination. Microbial contaminations were widespread, with coliforms and *Escherichia coli* detected, which exceeded the WHO and National Standard for Drinking Water Quality in Nigeria (NSDWQ) limits. The GWQI classified 70% of samples as excellent for drinking, irrigation, and industrial use. Groundwater was predominantly sodium chloride-type in the wet season, indicating high salinity, while the dry season exhibited mixed-type water in Kuto, Sabo, and Osiele. Mineral weathering and anthropogenic activities were major contamination sources, while Gibbs diagrams indicated rock-water interactions and evaporation as key hydrochemical processes. The ANN model predicted TDS with R^2 of 0.98; indicating minimal prediction errors, with strong correlations between TDS and EC (0.99), and TDS and total hardness (0.72). This study found that the area contained weathered and fractured basement aquifers with moderate groundwater potential.