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Groundwater hydrochemical assessment of the crystalline aquifer of Suleja, North Central Nigeria

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Abstract

This research work aimed at assessing the waste dump impacts on groundwater physic-chemical and biological constituents of Suleja environ. Hydrochemistry and groundwater flow mapping techniques were employed during the field work. After the preliminary survey, seven groundwater samples were collected monthly at different locations within the study area; totaling forty three (43) samples during the dry season (between the months of November, 2015 to April, 2016) for standard water quality laboratory analysis. The data sets obtained from the laboratory were subjected to descriptive statistics and correlation matrix to establish their relationship, including water quality index were calculated. The hydrochemical results revealed high mean concentrations of conductivity followed by total hardness, total dissolved solids, alkalinity, temperature and pH (Conductivity > TH > TDS > Alk > Temp. > pH). The minor ionic distributions revealed higher mean concentrations of Sulphate followed by chloride, bicarbonate, carbon dioxide, and nitrate ions ($SO_4 > Cl^- > HCO_3 > CO_2 > NO_3$). The major ionic parametric mean concentrations revealed higher value of calcium followed by magnesium, sodium and potassium ions ($Ca^{2+} > Mg^{2+} > Na^+ > K^+$). The heavy metals ions revealed higher mean concentrations of iron followed by zinc, manganese, and copper during the dry season. The elevated values of chemical oxygen demand and biological oxygen demand observed indicate presence of organic compounds in the groundwater of some area. The observed wide range of standard deviation and variance in some of the parameters are indications that there is substantial difference in the groundwater chemistry within the study area. Hydrochemical result depict high level of average concentration of temperature, sulphate (SO_4), iron (Fe^{2+}) and total hardness (TH) to have range above their standard permissible limit for drinking or domestic purposes water quality (WHO and NSDWQ). Though there are other ionic compounds that show low average level of its content but high level of maximum concentrations such as chloride, COD and BOD. The WQI value for dry seasons is 4.89 which indicate that the groundwater in the area is excellent in quality. Correlation matrix revealed positive relationship between pH, TH (total hardness), SO_4, NO_3, Cl^-, Mg^{2+} and Ca^{2+} and positive connectivity between Na^+ and K^+. All this suggest that major sources of the solute for the groundwater enrichment are from weathering of lithological framework and anthropogenic activities essentially. Groundwater flow mapping revealed that the groundwater of Suleja vicinity is structurally controlled and it equally shows somewhat possibility of high potential of groundwater aquifer which make it suitable for groundwater borehole development.

Key words: Hydrochemistry, Hydrogeology, Water quality Index, Waste dump, Suleja Area.
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Introduction

The groundwater depends not only on natural factors such as the lithology of the aquifer, the quality of water recharge and the type of interaction between water and aquifer, but also on human activities which can alter these groundwater systems either by polluting it or changing the hydrogeochemical cycle (Kanade and Gaikwad, 2011). Water pollution from various sources which always tends to degrade the quality of water in its entirety has become a pressing issue of serious concern, which if left unabated will jeopardize the millennium development goal.

Pollution of groundwater has been reported for a number of urban aquifers throughout the world because of its overwhelming environmental significance. A wide range of pollutants have been recognized including heavy metals, N-species and bacteria. Their impact on groundwater continues to raise concern and have become the subject of past and recent investigations (Khan *et. al.*, 1990; Robinson and Gronow 1992; Gallorini *et al.*, 1993; Fatta *et .al.*, 1999; Ahmed and Suleiman, 2001; Ikem *et. al.*, 2002; Nkwocha *et. al.*, 2008).

Solid waste management in Nigeria has become a complex issue as a result of high population growth, accelerated urbanization and industrialization (Aguwamba 2003). It is estimated that each Nigerian generates about 0.85kg of waste per day totaling about 119 million tons of municipal and industrial waste per annum (Ayatomuno 2004; Cookey 2008). The problem of how to manage these wastes has reached a critical proportion. It become necessary to ascertain the water quality since