

RESEARCH ARTICLE

PHYSIOCHEMICAL ANALYSIS OF SELECTED GROUNDWATER SAMPLES IN PART OF PORT HARCOURT, RIVERS STATE NIGERIA

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ABSTRACT

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The quality of groundwater depends on its physiochemical and microbial characteristics. This study is aimed at analyzing the physiochemical quality of groundwater and was carried out to assess the quality of groundwater samples obtained from five different boreholes within Eliozu (the study area). Total of seven major parameters were analyzed, they are potency of hydrogen (P^H), electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), salinity and concentration of nitrate (NO_3^-) and sulphate (SO_4^{2-}). The results obtained were compared with standards prescribed by WHO, and showed that groundwater samples from these boreholes have P^H value between 3.9 and 4.5 thus, are acidic and not suitable for drinking purposes, electrical conductivity value range from 50 to 208 $\mu\Omega/cm$, BH3 has low organic matter contaminants because its DO value is the least, TDS values is between 66 and 114.4 mg/L which is within the limit desirable for drinking water supplies by WHO, salinity values range from 16.5 to 29.7 mg/L, indicating that BH3 and BH5 have the most suitable water for drinking. The knowledge of this study can be applied in water resources management, hydrological activities and environmental and health management.

KEYWORDS

Conductivity, Salinity, Physiochemical, Eliozu, Groundwater

1. INTRODUCTION

Water is extremely essential for survival of living organisms and the quality of water is of vital concern to mankind since it is directly linked with human welfare. Majority of human population depend on groundwater as their source of drinking water supply. Groundwater is believed to be comparatively much clean and free pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dumps cause groundwater to become polluted and pose health problems (Raja et al., 2002). The problem of groundwater quality is much more acute in the areas which are densely populated, highly industrialized and have shallow groundwater table. The rapid growth of urban areas has further affected groundwater quality due to over exploitation of resources and improper waste disposal practices. Hence, there is always a need for and concern over the protection and management of groundwater quality (Patil et al., 2001). Water is indispensable to all life on earth. In nature, it occurs in oceans, ice and glaciers, underground and on land. However, fresh water is constantly recharged through a process known as hydrological cycle.

It controls the temporal and spatial distribution of water in the form of evapotranspiration, precipitation and runoff (Patil and Patil, 2010). Groundwater recharge is the process by which water percolates down the soil and reaches the water table, either by natural or artificial method. The quantity and rate of groundwater recharge depend on efficient groundwater resources management. Water is the key resource for industrial and economic development. It is used for drinking, recreation,

use in industries and growing of crops. It also plays important role in sustaining the natural system (Mishra and Pandey, 2008). Water is the world's most abundant naturally occurring substance and it is in constant circulation. Without water, life cannot survive, it is absolutely essential to life, not only human but all life, plants and animals (Hussein et al., 2012). Over 97% of the total water supply contained in the oceans and other saline bodies of water and is not readily usable for most purposes of the remaining 3%, a little over 2% tied up in ice caps and glaciers, about 0.62% was found in groundwater supplies, the surface water like lakes and rivers cover about 0.019% and water vapour constitute about 0.001% (Fetter, 1980).

Among the various natural resources, water is an essential input for all social, economic and developmental activities. The status of water resource is related to the type of soil, vegetation cover, human activities and utilization pattern. Water is the only chemical compound on the planet earth that exists in solid, liquid and gaseous state (Chavan and Zambare, 2013). Rainfall is the principal source of groundwater recharge, other sources include recharge from rivers, streams, irrigation water etc. Moisture movement in the unsaturated zone is controlled by suction pressure, moisture content and hydraulic conductivity relationships. The amount of moisture that will eventually reach the water table is defined as natural groundwater recharge, which depends on the amount and duration of rainfall, the subsequent conditions at the upper boundary, the antecedent soil moisture conditions, the depth of water table and type of soil (Fetter, 1980).

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2. AREA OF STUDY

The study area is Elioizu in Obip/Akpor Local Government Area of Rivers State, Nigeria. It is situated between latitude 4° 30' and 4° 55' N and longitude 6° 55' and 7° 00' E within the Niger Delta region of Nigeria as shown in Figure 1. The annual rainfall ranges from 2000mm (inland) to over 4000mm at the coast and the area is characterized by five major geomorphic units namely, dry flatland and plains, Sombrero deltaic plains with abundant freshwater back swamps, saltwater or mangrove swamp (Akpokodje, 2001). This enhances decomposition activities by bacteria, fungi and leaching of contaminants into the aquifer. The area is geographically composed of various quaternary deposits that overlie the stratigraphic units of the area.

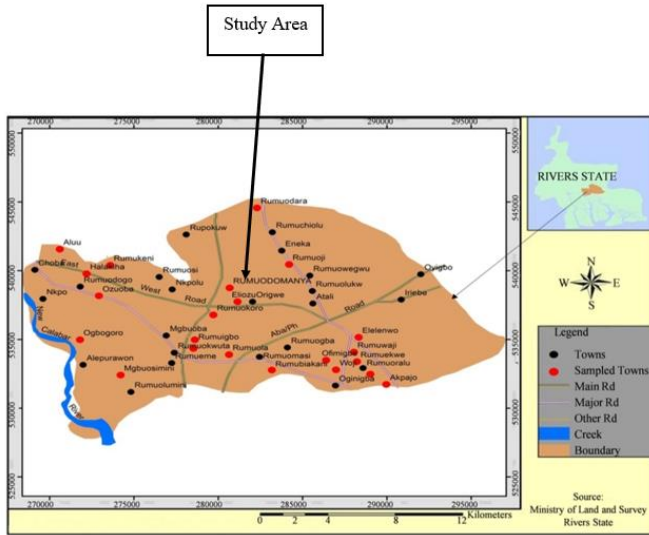


Figure 1: Map Showing the Location of Study Area

3. MATERIALS AND METHODS

The materials used for this study are groundwater samples, analytical reagents (AR), distilled water, plastic canes of three litres capacity, detergent, P^H meter, conductivity meter, mercury in glass thermometer and flame photometer.

3.1 Preparation of water samples

The plastic canes were prewashed with laboratory grade detergent and rinsed with distilled water. The samples were collected in the plastic canes without any air bubble as per standard procedure. The temperature of the samples was measured at the site or location at the time of collection of samples. The samples were kept in the laboratory and maintained at normal room temperature of 25°C. Water samples from five water boreholes (sampling points) located at different points within Elioizu were used for this study. Table 1 shows the sampling locations and source:

3.2 Physiochemical Analysis

Analysis was carried out for various water quality parameters in the laboratory within 24 hours of sampling, using the World Health Organization (WHO) and standard method (APHA, 1995).

Physiochemical parameters examined are potency of hydrogen (P^H), electrical conductivity (EC), total dissolved solids (TDS), salinity, dissolved oxygen (DO), and presence of nitrate (NO₃⁻), sulphate (SO₄²⁻), calcium (Ca), magnesium (Mg), manganese (Mn), iron (Fe), zinc (Zn), copper (Cu), lead (Ld), chromium (Cr) and cadmium (Cd).

S/N	Sampling Location	Source
1	Elioizu	Borehole
2	Elioizu	Borehole
3	Elioizu	Borehole
4	Elioizu	Borehole
5	Elioizu	Borehole

4. RESULTS AND DISCUSSION

The values of the physiochemical parameters obtained the laboratory analysis of the water samples are shown in Tables 2 and 3.

4.1 Potency of Hydrogen (P^H)

P^H is a term used university to express the intensity of acidity or alkalinity condition of a solution. It controls the chemical state of many nutrients, including dissolved oxygen, phosphate, nitrate etc (De, 2002). All the water samples are acidic in nature, having P^H value ranging from 3.9 to 4.5. This is as a due to chemical or heavy metal pollution resulting from industrial activities within the area, chemical dumps, power plants and leaching. Acid water has been claimed to have antimicrobial effects, making it potentially beneficial for skin, hair and washing produce. Although, the World Health Organization (WHO) and United States Environmental Protection Agency (USEPA) recommend that the desirable and healthy P^H value for drinking water is or range from 6.5 to 8.0.

4.2 Electrical Conductivity EC

Electrical Conductivity is a measure of water capacity to convey electric current. It signifies the total number of dissolved salts in water (Goldmann and Horne, 1983). The values of electrical conductivity range from 50 to 208µΩ/cm (micro-ohms per centimeter). Highest electrical conductivity (EC) value was observed in BH1, indicating high amount of dissolved salts. Whereas lowest electrical conductivity (EC) value was observed in BH4, indicating low amount of dissolved salts.

4.3 Total Dissolved Solids (TDS)

Total dissolved solids (TDS) indicates the salinity behavior of groundwater. Water containing more than 500mg/L of total dissolved solids TDS is not considered desirable for drinking water supplies, but in unavoidable cases is also allowed (Sudhir and Amarjeet, 1999). Total dissolved solids (TDS) values range from 66 to 114.4mg/L, thus all the water samples are desirable for drinking.

4.4 Dissolved Oxygen (DO)

Dissolved oxygen (DO) is an important physiochemical parameter in water quality assessment and reflects the physical and biological processes prevailing in the water. The dissolved oxygen (DO) value indicates the degree of pollution in water bodies, dissolved oxygen (DO) values varies from 4.5 to 6.0mg/L. BH₄ has the highest dissolved oxygen (DO) value indicating heavy contamination of the water by organic matter, while BH3 has the least DO value indicating low contamination of the water.

4.5 Salinity

This indicates the amount of salt or saltiness in water. BH2 has the highest salinity value of 29.7mg/L while BH3 and BH5 have the lowest and equal salinity value of 16.5mg/L.

4.6 Nitrate (NO₃⁻)

Groundwater may contain nitrate due to reading of nitrate with the percolating water or by contaminated sewage and waste rich in nitrate. The nitrate content in the sampled water range from 0.07 to 0.28mg/L. BH2 and BH4 has the highest and lowest nitrate values respectively.

4.7 Sulphate (SO₄²⁻)

Sulphate occurs naturally in water due to leaching from gypsum and other common minerals (Manivaskam, 2005). Discharge of industrial wastes and domestic sewage tends to increase its concentration. The sulphate concentration in the groundwater samples range from 0 to 3mg/L. BH1 has the highest value of 3mg/l while BH3 has the lowest or least value of /mg/L. BH4 and BH5 showed no concentration of sulphate.

4.8 Calcium (Ca)

The value of the concentration of calcium present in the groundwater samples are 1.17, 0.34, 0.20, 0.03 and 0.29 for BH1, BH2, BH3, BH4 and BH5 respectively. BH1 has the highest calcium concentration value while BH4 has the lowest concentration value.

4.9 Magnesium (Mg)

The concentration of calcium in the groundwater samples are 0.25, 0.32, 0.24, 0.001 and 0.18 for BH1, BH2, BH3, BH4 and BH5 respectively. BH1 has the highest magnesium concentration value while BH4 has the least concentration value.

4.10 Manganese (Mn)

The value of the concentration of manganese present in the groundwater

samples are 0.15, 0.05, 0.08, 0.03 and 0.06 for BH1, BH2, BH3, BH4 and BH5 respectively. BH1 has the highest concentration value while BH4 has the lowest concentration value.

Table 2: Results of physiochemical parameters for Analysis of Borehole Water Samples

S/N	Sample Identity	Ph	Elect. Cond. ($\mu\text{s}/\text{cm}$)	TDS (mg/l)	DO (mg/l)	Salinity (mg/l)	NO_3 (mg/l)	SO_4^{2-} (mg/l)	Calcium, Ca (mg/l)	Magnesium, Mg (mg/l)	Manganese, Mn (mg/l)	Temp ($^{\circ}\text{C}$)
1	BH 1	4.20	208	114.40	4.60	26.40	0.21	3.00	1.17	0.25	0.15	30.50
2	BH 2	3.90	143	78.70	5.70	29.70	0.28	2.00	0.34	0.32	0.05	31.50
3	BH 3	4.00	121	66.60	4.50	16.50	0.11	1.00	0.20	0.24	0.08	34.60
4	BH 4	4.50	50	27.50	6.00	19.80	0.07	0.00	0.03	<0.001	0.03	29.40
5	BH 5	4.00	120	66.00	5.00	16.50	0.23	0.00	0.29	0.18	0.06	30.50

Table 3: Results of Physiochemical parameters for Analysis of Borehole Water Samples (Insignificant values)

S/N	Sample Identity	Iron, Fe (mg/l)	Zinc, Zn (mg/l)	Copper, Cu (mg/l)	Nickel, Ni (mg/l)	Chromium, Cr (mg/l)	Lead, Pb (mg/l)	Cadmium, Cd (mg/l)
1	BH 1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
2	BH 2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3	BH 3	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	BH 4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
5	BH 5	<0.001	0.423	<0.001	<0.001	<0.001	<0.001	<0.001

5. CONCLUSION

After a careful and successful analysis of the physiochemical parameters of the samples of underground water selected within the study area, the following conclusions are reached:

- All the water samples from the boreholes are acidic in nature with P^{H} value ranging from 3.9 to 4.5, thereby making them not suitable or desirable for drinking purposes.
- The electrical conductivity values of all the water samples are within the accepted or prescribed standard by World Health Organization (WHO). BH4 which has the least electrical conductivity (EC) value of $50\mu\text{S}/\text{cm}$, indicating low amount of dissolved salt or low amount of dissolved inorganic substances in ionized form does not pose much threat of electrocution of persons when electrical current is passed through it compared to BH1 which has highest electrical conductivity (EC) value indicating high amount of dissolved salt or low amount of dissolved inorganic substances in ionized form.
- BH4 shows the presence of heavy contaminants from organic matter because it has the highest value of dissolved oxygen (DO) compared to other boreholes especially BH3 which has the least dissolved oxygen (DO) value.
- Groundwater sample from BH2 is more salty than other because it has the highest salinity value.
- The concentration of Nitrate (NO_3^-) and sulphate (SO_4^{2-}) in the groundwater sample are within the limit of acceptance by World Health Organization (WHO) and United State Environmental Protection Agency (USEPA), thus, making them good for domestic and industrial purposes.

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