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ASSESSMENT OF PHYSICOCHEMICAL CHARACTERISTICS OF BOREHOLE WATER QUALITY IN SECONDARY SCHOOL IN PORT HARCOURT METROPOLIS, RIVER STATE.

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ABSTRACT

This study examined the physic-chemical characteristics of water from boreholes in secondary schools in Port Harcourt Metropolis in order to determine the suitability of such water for human consumption. Analysis of the water quality parameters were conducted and compared with World Health organization standards (WHO, 2006), to know if the water meets the standards stipulated. Some of the parameters examined include pH, total dissolved solid, total suspended solid, chlorine, conductivity among others. All reagents procured for the analysis were of analytical grade quality. The result indicates that most of physical parameters were within the WHO standards for drinking water except temperature while the chemical parameters pH, lead, phosphate and nitrate among others are also within the WHO tolerable limits. But the overall Water Quality Index (QWI) which took care of the characteristics of water as a whole instead of dealing with standards only indicates that the sampled borehole water is polluted calculated value being higher than the critical value of 0.1. The study recommended among others that regular monitoring of borehole water is very important, since the area is prone to pollution due to crude oil exploration.

Keywords: Assessment, Physicochemical Characteristics, Borehole, Water Quality, Port Harcourt Metropolis

INTRODUCTION

All lives on the earth's surface revolve around water for their existence, Water is made up of two compounds of hydrogen and oxygen, water is very vital for the metabolic breakdown of essential molecules like protein and carbohydrate. The bloods in animals and plants sap consist largely of water (Ajibade 2011). Water plays vital role in food transportation and removal of material from the body. Economically, water plays important role in food production, transportation, industries, tourism among others. Human activities have seriously contaminated water resources including boreholes. According to Efe (2001), water resource is one of the environmental resources that are being threatened either from over exploitation or pollution accelerated by human activities. The principle substances that pollute water resources are mainly produced through human activities. In Nigeria, many studies have shown that water resources are mainly contaminated from anthropogenic activities (Akintola & Amadi 2003).

One of the major sources of water available to mankind is the ground water. Groundwater is the fresh water located in the pore spaces of soil and rocks. Such water is from rain water that infiltrated into the underlying rock strata (Wilson, 2012). Groundwater constitutes the main sources of borehole water. It occurs all over the earth's surface and restricted to certain depth of about 750 meters (Ajibade, 2011). Borehole is one of the means of abstracting groundwater for human use. Borehole is simply a hole or shaft sunk into the ground for the purpose of obtaining water from an underground supply. Borehole equally, is one of the major sources of water supply in secondary schools in Port Harcourt Metropolis. It also serves as an important source of water supply for many Nigerian. The quality of water from these boreholes are hardly analyzed nor treated before use hence the quality is not assured. The quality of water is largely dependent on the concentration of biological, physical and chemical contaminants as well as human activities in the area. According to Ray (2011), chemical pollution results from industrial activities while physical pollution can result from erosion and improper disposal of wastes. These sources degrade water quality and make water unfit for human use.

The fact that students of secondary schools in Port Harcourt Metropolis have inadequate pipe born water supply, many schools have been sourcing their daily water needs from boreholes. Hence the importance of safe water supply to health and the overall wellbeing of human beings cannot be overemphasized. Safe drinking water is not just a commodity but a right to all (Ariyo & Jerome, 2009). Uncontrolled industrial processes and indiscriminate dumping of refuse in Port Harcourt Metropolis have continued to threaten the quality of ground water in the study area. There is little or no comprehensive research on the quality of water from boreholes consumed by students in the metropolis. Therefore this study aims at determining the quality of water from boreholes in secondary schools in Port Harcourt metropolis by comparing the borehole water quality with the World Health Organization (WHO) standards (WHO, 2006) and by establishing the water quality index (WQI).

METHODOLOGY

Study area: This study was carried out in Port Harcourt Metropolis, Rivers State. The study area covers 260sq.Km and at the 2006 census had a population of 464,789 persons (National Bureau of Statistics, 2006). The area is located in the south-south region of Nigeria or otherwise known as Niger Delta Region. It is located between Latitudes 4°45'E - 4°60'E and Longitudes 6°50'E - 8°00'E (Wokocha & Omenihu, 2015). Water samples were collected from 18 secondary schools distributed across Port Harcourt Metropolis in Rivers State. The choice of borehole depends on it's from previously chosen locality and wish of the owner to make it available for study.

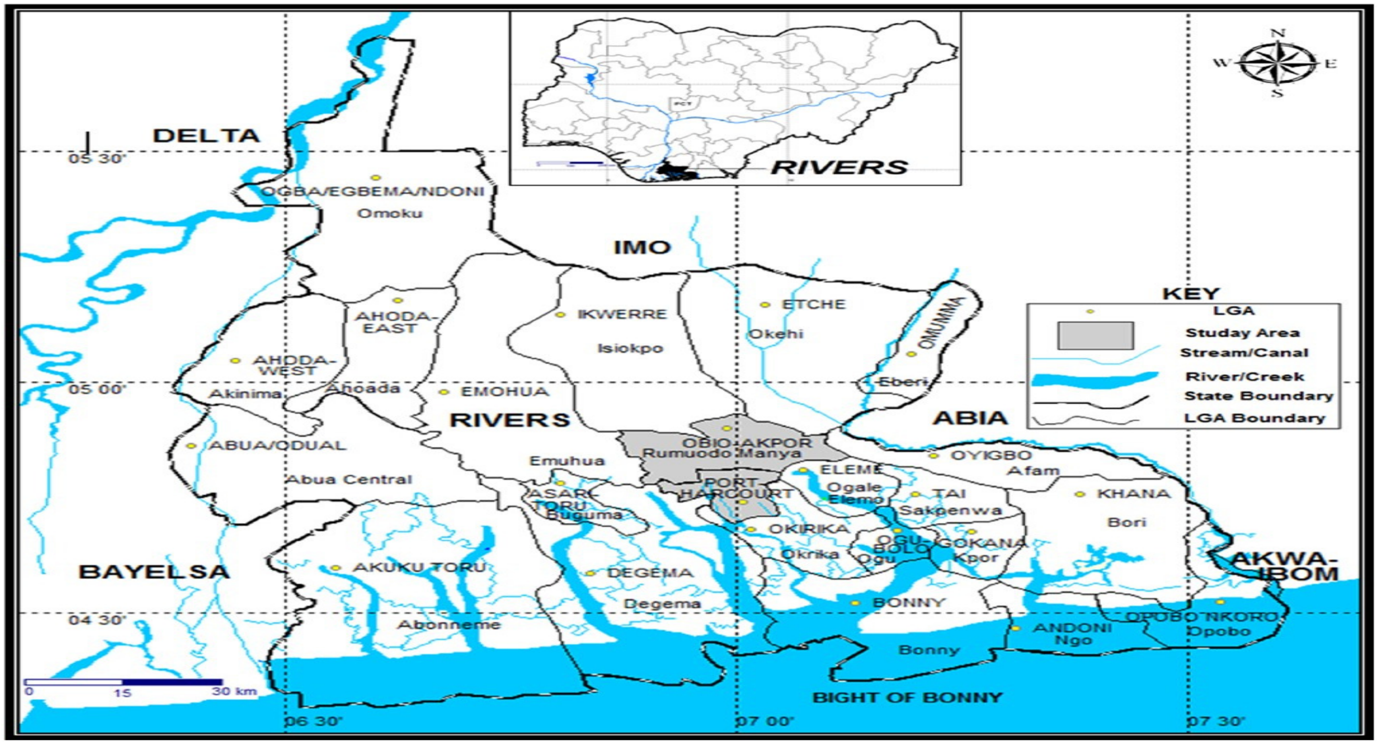

Figure 1.1 Map of Rivers State showing Port Harcourt metropolis.

Water Sample Collection

Water samples were collected from 18 boreholes. Samples of water from the boreholes were collected in properly labeled 2 litre plastic containers. Prior to the collection of the samples, plastic containers were thoroughly washed and filled with 5% HCL and left to dry. Thereafter, each of the containers was washed with the borehole water before harvesting the samples, corked and put in coolers with ice block under temperature of 4°C. The coolers with samples were then transported to the laboratory of Institute of Pollution Studies, River State University, Port Harcourt for physic-chemical analysis and after which the results were used for comparison with World Health Organization standard (WHO, 2006).S

Selected Physicochemical Parameters for Analysis

Selected physical parameter tested for include temperature, total dissolved solid, total suspended solid, odour, colour, appearance and turbidity. While selected chemical parameters include pH, electrical conductivity, sulphate, nitrate, free chlorine, iron copper manganese, lead, zinc, calcium and phosphate.

Laboratory Analytical Technique

All reagents used for the analysis were of analytical grade quality. For the customized reagent, as in HACH methods, reagents used were those within the validity period. Physical parameters were analyzed with the methods prescribed by Iro and Chukwudi (2009). PH was measured using digital HANNA MICRO computer pH meter (model H19025), conductivity was determined with HANNA conductivity meter Model H1 9835. Sulphate and Nitrate were measured by the Turdimetric Alpha-427°c standard method. Metals like copper, Iron and manganese, metal analyses were carried out using Atomic Absorption Spectrophotometer (AAS) (UNICAM model 969 AA), this involve direct aspiration of the water samples into an air/acetylene or nitrous oxides/acetylene flame generated by a hollow cathode lamp at a specific wavelength peculiar only to the metal programmed for the analysis.

Water quality index application (WQI)

Water Quality Index determines the pollution level of water bodies. It was developed by Horton in 965. Mathematically, it is expressed as:

Pij = (max ci/lij)^2 + (mean Ci/L..(1)

Horton used multiple items of water qualities expressed as Ci's and permissible levels of the respective items expressed as a function of the relative values of Ci /Lij

i is the number of ith item of the water quality and j is the number of the j-th water use. Each value of (ci/Lij) shows the relative pollution contributed by the single item. A value of 0.1 is the critical value for each (ci/Lij). Values greater than 0.1 Indicate that the water require some treatment prior to use for specific purpose. Combining the mean value of (ci/Lij) into a common index, values over 1.0 signify a critical condition under which a proper treatment is needed for potable water.

Horton proposed that the pollution index of water can be computed using the multiple items of water qualities and permissible level of the respective items for use. If pij is the pollution index, then:

Pij = F ((ci/Lij), C_2/L_2J, C_3/L_{3j} ....(2)

This is applied in the study of water resources to know the pollution level and treatment expected.

RESULT AND DISCUSSION

Table 1 and 2 gives the mean concentrations of the different parameters of the water samples from the boreholes. For water to be potable, the concentration must not exceed the level prescribed by the world health organization (WHO, 2006).

Table 1: Result of Concentration of Physical Parameters of Boreholes from Selected Secondary schools

Physical Tracer	Unit	Mean concentration Boreholes	WHO(2006)
Temperature	°C	27	25
Odour	Sensory Organ	Odorless	Odorless
Colour	Pt./co	Colourless	15
TDS	Mg/L	52.5	250

Total hardness	Mg/L	6.58	100
Appearance	Sensory organ	Clear	clear
Turbidity	NTU	0	50

Source: Fieldwork /Laboratory Analysis, 2021

From table 1, the result shows that the mean temperature of the sampled water from the boreholes is 27.3°c which is above the 25°c WHO standard for drinking water. High temperature usually encourages the growth of taste and odours which can later produce organism that affect human health by causing intestinal irritation (Ezemonye, 2009). The result equally indicates that the borehole water in the study area is odourles and colourless which are below the 15 pt/co WHO standard. Odour can affect palatability of water as quality water is known to be odourless. Total dissolved solid and total hardness are 52.5 and 6.58 respectively. Both were all below the 250 and 100 mg/l WHO standards respectively. The appearance of the borehole water is clear and the turbidity is 0 which is below the WHO 50 NTU standard for potable water.

Table 2: Result of Mean Concentrations of Chemical Parameters of Selected Borehole Water.

Physical Tracer	Unit	Mean concentration Boreholes	WHO(2006)
pH	u/5cm	4.2	6.5-8.5
Elect. conductivity	MG/L	75.5	100
SULPHATE	MG/L	1.1	250
Phosphate	Mg/l	0	1.0
Potassium	Mg/l	0.018	20
Nitrate	Mg/l	1.7	40
Copper	Mg/l	0.030	1.0
Iron	Mg/l	0.182	0.3
Manganese	Mg/l	0	0.5
Calcium	Mg/l	0.8	7.5
Zinc	Mg/l	0.037	3.0
Free chlorine	Mg/l	5.1	0.30
Lead	Mg/l	0.001	0.01

Source: Fieldwork /laboratory analysis, 2021

From table 2, the result shows that the mean value of pH is 4.2 which is above the 6.5-8.5 WHO value, this indicates that the water is acidic rendering the water unfit for human consumption. This may be as a result of gas flaring which releases obnoxious gases. This result is in line with the findings of Ubuoh et al., (2011). Electrical conductivity which depends on the amount of dissolved ions has a mean value of 75.5 and below 100u/scm WHO standard for drinking water. Suphate has a mean value of 1.1 below the 250 mg/l WHO standard. Phosphate recorded a mean value of 0 which is within the 1.0mg/l of WHO standard for potable water. Potassium has a mean value of 0.018 which is below 20mg/l of WHO STD for drinking water. Nitrate has a mean value of 1.7 below 40mg/l of WHO standard while copper recorded a mean value of 0.030 which is below 1.0mg/l WHO standard. This result is consistent with findings of Dailfular and Sharkour (2013) who stated that rainwater with low pH can raise the level of toxic metal like copper in groundwater.

Iron has a mean value of 0.182mg/l below the 0.3mg/l of WHO STD. High concentration of iron in water affects taste and appearance of water rather than health (Colter & Mahhlor, 2010). Manganese with a mean value of 0 is below the WHO standard of 0.5mg/L. Calcium has a mean value of 0.8 below the 75mg/l of WHO STD, zinc has mean value of 0.037 below 3.0mg/l of WHO STD. Free chlorine with a mean value of 5.1 is above the 0.3mg/L WHO STD. Lead has a mean value of 0.001which is below the 0.01mg/l WHO STD. High concentration of lead in water is capable of reducing growth and development, causing cancer and organ damage in males, including nervous system damage (Yilmaz, 2015).

Table 3: Composition of Pollution Index of Sampled Borehole Water

Water Tracer	Unit	Quality (Ci)	Permissible level (WHO)Li	Ci /Lij
Temperature	0°C	27.3	25	1.09
Colour	Pt/Co	0	15	0
TDS	Mg/L	52.2	250	0.21
Total hardness	Mg/L	6.58	100	0.066

Turbidity	NTU	0	50	0
pH	u/5cm	4.2	8.5	0.49
Elect. conductivity	MG/L	7.5	100	0.08
Sulphate	Mg/L	1.1	250	0.004
Phosphate	Mg/l	0	1.0	0
Potassium	Mg/l	0.018	20	.00009
Nitrate	Mg/l	1.7	40	0.004
Copper	Mg/l	0.030	1.0	0
Iron	Mg/l	0.182	0.3	0.61
Manganese	Mg/l	0	0.5	0.04
Calcium	Mg/l	0.8	75	0.01
Zinc	Mg/l	0.037	3.0	0.012
Free chlorine	Mg/l	5.1	0.30	17
Lead	Mg/l	0.001	0.01	0.1

Source: Fieldwork, 2021

Based on the calculation of water quality index in table, 3 it was observed that the water from boreholes in the study are recorded 19.72 which shows that borehole water in the area is highly polluted with physicochemical tracers because the calculated value is more than the critical value of 1.0 used for the judgment of unpolluted water.

SUMMARY AND RECOMMENDATION

Water as an essential part of human life should be free from contaminants as stipulated by world Health Organization (2006). The aim of water quality assessment has usually been to know the suitability of water for use as compared with water quality standards in order to ensure that it does not exceed the levels which are detrimental to human health. This study shows that the mean concentrations of the physical parameters are within the WHO drinking water standards except temperature. Boreholes water acidity in the area is within the WHO standards. The concentration of phosphate, nitrate and lead among other are within the WHO tolerable limits. The overall water quality index implies that the calculated value of water from the boreholes was more than the critical value, indicating that sampled boreholes contained some levels of pollution which call for water quality management. Water quality index was applied to tackle the characteristic as a whole while WHO deals only with the standards

Based on the observed result, the following recommendations were made:

i) Regular monitoring of borehole water quality in the area in order to check the pollution level as the area is prone to environmental pollution due to oil production activities.
ii) Government and non-governmental organizations should create avenue to let people know that ground water can be polluted, as they generally belief that groundwater is safe for drinking.
iii) There is the need to conduct water quality test on borehole waters before they are consumed.
iv) Rivers state is blessed with rivers and streams that contain water all year round. Therefore government should effectively get involved in the provision of water in the area by treating and reticulating pipe borne water to areas thereby reducing water related health problem and the consequences.

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