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Assessment of Bore Whole Water in Oroworukwu Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Water quality has become a serious issue to economic and social sustainable development, not only because of the imbalance between available scant water resource and dense population, but also the inefficiency of water resources regulation and management. This study is aimed at assessing the quality of borehole water at the study areas and to compare with standards, Water samples were collected from three stations (Mile 1 to 3) at nine points in oroworukwu area of Port Harcourt. Physicochemical parameters were analysed which includes pH, alkalinity, turbidity, temperature, salinity, total dissolved solid, conductivity, chloride, nitrate, and heavy metals. Bacterial analysis done included total coliform count, total fecal count and total heterotrophic bacteria. The results obtained showed a pH ranged of 4.8-5.9 which was below the permissible limit (6.8-7.8) of World Health Organization (WHO) and Nigeria Industrial Standard (NIS). All other physicochemical parameter results were within permissible limits. There were no bacteria detected in the water which indicated that the water was not contaminated. In any case there is a need to treat the water to raise the pH to the acceptable value of WHO and NIS.

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Introduction

Water is a chemical substance that is essential to all forms of life. It is the most important natural resources on our planet. Water is the medium in which the reactions necessary for living functions take place. It is an active participant in many biological processes; it acts as carrier of nutrients in the bodies of living organisms and serves as temperature regulator. Water is employed by man for several purposes such as solvent in industries, irrigation in farming, for recreation, transportation, commerce, and domestic uses [1]. To meet these needs, it must satisfy certain requirements. It is tasteless and odorless liquid at ambient temperature and pressure, and appears colorless.

Sources of water include surface and ground water. Surface water includes river, lake, ocean, etc. Groundwater is all the water that has penetrated the earth's surface from which, with time and suitable locations, it reaches the groundwater storage. Return of groundwater to the surface occurs either naturally by means of springs or subsurface flow toward surface water bodies or artificially through wells and boreholes.

Water quality is the composition of water as affected by natural processes and human activities. It is the constituents dissolved or contained within the water. The factors involved include the physicochemical and biological compositions [2].

Groundwater contamination commonly results from human activities where pollutants, susceptible to percolation, are stored and spread on or beneath the land surface. Typical pollutant sources are industrial wastewater impoundments, sanitary landfills, storage piles, absorption fields following household septic tanks, improperly constructed wastewater disposal wells, and application of chemicals on agricultural lands. The amount of water available for infiltration, either from precipitation or from the wastewater itself, is a primary factor in carrying pollutants down through a soil profile. Water from the surface passes downward through the unsaturated zone and disperses in an aquifer in a manner depending on site conditions. Dispersion of a contaminant is influenced physically by soil porosity and hydraulically by the rate of water movement [3].

Water quality has become a serious issue to economic and social sustainable development, not only because of the imbalance between available scant water resource and dense population, but also the inefficiency of water resources regulation and management. There is no reliable pipe-borne water supply in mile one, mile two and mile three area of rivers state, and as such the majority of the indigenes now depend on bore holes as their major source of water due to proximity and increasing population. The importance of clean, healthy water cannot be overemphasized as it supports life. Any pollution of groundwater in these areas will adversely affect the health of the populace; therefore, it is of paramount importance to assess its quality.

Study Area

The study area covers mile one to mile three of Port Harcourt Local Government Area (PHALGA) in Rivers State (Figure 1). It is an urban area with commercial and automobile activities.

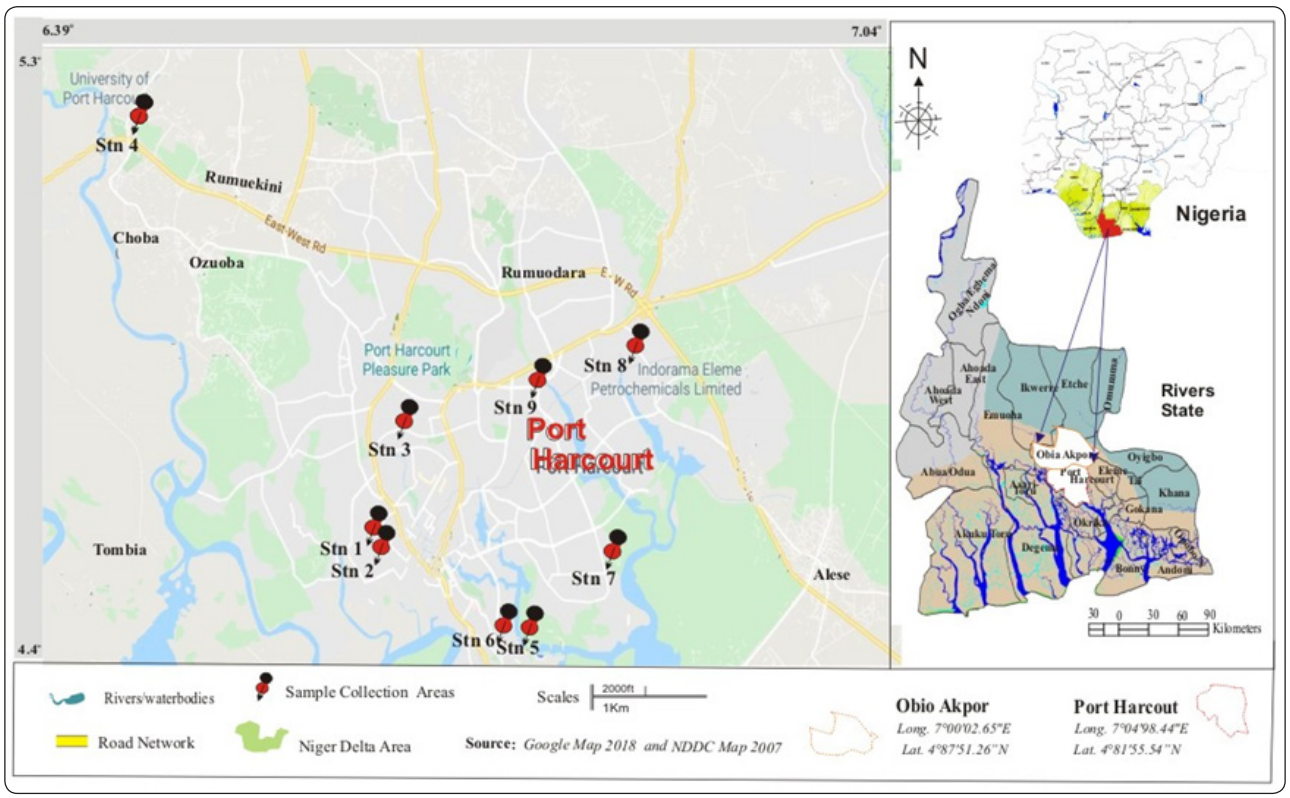

Figure 1: Map of Port Harcourt Showing Sampling Stations

Methodology

Three strategic stations (Miles 1 to 3), with the aid of Global Positioning System (GPS) were identified for collection of water samples from nine boreholes, three from each station. This was done periodically for three months, starting from August to October 2017.

Samples were taken monthly during the morning hours when the water is pumped freshly. All samples were collected with pre-rinsed and well labelled 1L plastic containers. Water samples for heavy metals were collected with 100ml sterile bottle of which five (5) drops of nitric acid was added to prevent the oxidation of the metals. Water samples for dissolved oxygen and biochemical oxygen demand were collected in 2 separate 75ml amber bottles. The DO samples were fixed immediately after collection by adding 5 drops each of winkler I and II reagents while the BOD samples were stored alongside the DO samples after collection before they were taken to the laboratory. Different parameters were measured using standard method of analysis. The total coliform bacteria, total heterotrophic bacteria and faecal coliform bacteria were obtained using the methods described by Brenner et al., [4].

Analytical Methods: The different parameters and standard methods of analysis used are presented in Table 1.

Table 1: Water quality parameters and analytical methods [5].

Parameter	Analytical Techniques
Temperature	Handheld multiparameter(ExTECH DO700)
Salinity	
ElectricalConductivity	
Resitivity	
pH	
Total dissolved solids	
Nitrate	Colorimetry
Phosphate	
Sulphate	UV Spectrophotometer
Total hydrocarbon	
Chloride	Titration
Total Hardness	
Total Alkalinity	
Dissolved oxygen	
Biochemical oxygen demand	5-day incubation at 20°C
Iron	Instrumental, AAS (200 Model)
Bacteria	Methods described by Brenner et al., [4].

Statistical Analysis

All of the statistical analyses were conducted using SPSS, version 20.0 and Excel

Results and Discussion

The results of *insitu* measurements, physicochemical water indicators and microbiological parameters are presented in Tables 2, 3 and 4 respectively.

Table 2: **Measurement**

PARAMETERS		pH	Electrical Conductivity (µS/cm)	Salinity (ppt)	TDS (mg/l)	Temperature (°C)
MILE 1	Site 1	5.30 ± 0.14	126.67 ± 5.86	0.06 ± 0.01	86.13 ± 5.19	26.1 ± 0.3
	Site 2	5.03 ± 0.16	180.00 ± 3.00	0.12 ± 0.06	113.33 ± 8.14	25.73 ± 0.40
	Site 3	4.92 ± 0.11	529.00 ± 55.87	0.24 ± 0.044	394.33 ± 6.35	25.43 ± 0.23
MILE 2	Site 4	5.70 ± 0.20	20.00 ± 1.00	0.01 ± 0.01	12.40 ± 0.50	25.57 ± 0.57
	Site 5	5.52 ± 0.59	21.67 ± 1.15	0.01 ± 0.00	12.70 ± 0.26	25.70 ± 0.44
	Site 6	5.50 ± 0.00	21.00 ± 0.14	0.01 ± 0.00	13.00 ± 0.11	25.30 ± 1.02
MILE 3	Site 7	5.06 ± 0.03	37.67 ± 0.58	0.02 ± 0.01	24.5 ± 0.52	25.77 ± 0.25
	Site 8	5.63 ± 0.06	20.33 ± 0.58	0.02 ± 0.01	18.40 ± 7.64	25.73 ± 0.40
	Site 9	5.02 ± 0.50	63.67 ± 7.57	0.04 ± 0.01	52.57 ± 12.94	25.90 ± 0.26
WHO		6.5 - 8.5	-	-	600mg/l	-
NIS		6.5 - 8.5	-	-	500mg/l	-

Site 1 – 3 (Mile 1), Site 4 – 6 (Mile 2), and Site 7 – 9 (Mile 3)

The pH of the sampled water from bore holes from mile 1 to mile 3 region of PHALGA in Rivers State ranged from 4.68 – 5.9 having a least mean value of 4.92 ± 0.11 at site 3 and highest level of 5.70 ± 0.20 at site 4. These were below the permissible limits of 6.5 - 8.5 WHO (Table 1). This indicates that all the water bore holes are acidic and as such water are not portable for drinking as pH is most important in determining the corrosive nature of water. The lower the pH value the higher is the corrosive nature of the water and consumption of water having low pH over a long period of time may lead to derangement of the acid-base balance in the body system, which may cause metabolic acidosis [6].

The temperature obtained across the nine sites was < 30°C WHO permissible limit. It ranged from 25.3 °C to 26.4 °C. The mean values were all within the limit suggesting that the water is free of colour, odour and taste. Extreme temperatures in water bodies have the potential to decrease the dissolved oxygen, and impact negatively on water bodies.

Total dissolved solid is the sum total of total dissolved solids and total suspended solids. It is a measure of the content of inorganic and organic substances present in water. The total dissolved solids (TDS) of the water under study ranged from 12.40–398.00 mg/l with all mean values across sites below the WHO and NIS permissible limits of 600mg/l and 500mg/l respectively. This is indicative of clear water and low salt level good for domestic and agricultural purposes which does not pose any threat.

Table 3: Physicochemical levels in Borehole Water from the Nine Sites

PARAMETERS		Sulphate	Phosphate	Nitrate	Total Hardness	Total Alkalinity	Chloride	Calcium	Magnesium	Iron
MILE 1	Site 1	1.00 ± 0.01	ND	0.10 ± 0.05	8.53 ± 1.71	12.00 ± 1.00	38.43 ± 3.49	1.73 ± 0.32	1.07 ± 0.15	0.074 ± 0.031
	Site 2	1.07 ± 0.12	ND	0.59 ± 0.37	7.80 ± 0.17	12.00 ± 0.00	45.73 + 2.14	1.50 ± 0.00	0.90 ± 0.00	0.052 ± 0.007
	Site 3	1.30 ± 0.26	ND	1.38 ± 0.14	54.26 ± 3.78	12.00 ± 0.00	104.67±6.64	15.26 ± 0.14	9.31 ± 0.10	0.036 ± 0.006
MILE 2	Site 4	ND	ND	0.31 ± 0.02	3.87 ± 0.12	11.67 ± 0.58	2.17 ± 0.29	0.80 ± 0.00	0.53 ± 0.06	0.014 ± 0.006
	Site 5	ND	ND	0.93 ± 0.24	4.27 ± 0.50	12.33 ± 0.58	2.67 ± 0.58	0.77 ± 0.06	0.57 ± 0.12	0.023 ± 0.002
	Site 6	ND	ND	0.54 ± 0.40	3.87 ± 0.11	12.00 ± 1.00	2.00 ± 0.00	0.83 ± 0.06	0.60 ± 0.10	0.075 ± 0.006
MILE 3	Site 7	ND	ND	0.82 ± 0.20	7.80 ± 0.17	11.67 ± 0.58	3.50 ± 0.50	1.50 ± 0.00	0.93 ± 0.15	0.041 ± 0.008
	Site 8	ND	ND	0.22 ± 0.15	3.87 ± 0.11	12.67 ± 1.15	2.33 ± 0.29	0.77 ± 0.06	0.57 ± 0.11	0.041 ± 0.006
	Site 9	ND	ND	1.07 ± 0.26	7.70 ± 0.00	9.00 ± 1.00	6.10 ± 0.98	1.50 ± 0.00	0.93 ± 0.07	0.014 ± 0.006
WHO		250mg/l	-	50mg/l	100 - 300mg/l	250mgl	250mg/l	-	-	0.3mg/l
NIS		100mg/l	-	50mg/l	150mg	150mg/l	250mg/l	-	0.20mg/l	0.3mg/l

Table 4: Concentrations of Microbiological Parameters

PARAMETERS		Total Heterotrophic Bacteria (THB) (CFU/ml)	Faecal Coliform Bacteria (FCB) (CFU/ml)	Total Coliform Bacteria (TCB) (CFU/ml)
MILE 1	Site 1	0.00 + 0.00	NIL	NIL
	Site 2	10.00 + 10.00	NIL	NIL
	Site 3	10.00 + 0.00	NIL	NIL
MILE 2	Site 4	6.67 ± 5.77	NIL	NIL
	Site 5	2.0 x10	NIL	NIL
	Site 6	2.0 x10	NIL	NIL
MILE 3	Site 7	1.0 x10	NIL	NIL
	Site 8	4.0 x10	NIL	NIL
	Site 9	2.0 x10	NIL	NIL
WHO		<100cfu/ml	0	0-2

Electrical Conductivity is a measure of the presence of dissolved minerals and salts (mineralization of water) such as Cl^-, SO_4^{2-}, Cl^-, Mg^{2+}, K^+, and Na^+ ions and is used as an index to represent the total concentration of soluble salts in water. Electrical conductivity level was least at site 4 and highest at site 3 with mean values of 20.00 ± 1.00 µS/cm and 529.00 ± 55.87 µS/cm respectively. It ranged from 19.00 – 593.00 µS/cm. All values were below the 1000 µS/cm WHO permissible limit.

Salinity is a measure of all dissolved salts present in a sample. It ranged from 0.01–0.29ppt. The mean values of 0.06 ± 0.01ppt, 0.12 ± 0.06ppt and 0.24 ± 0.04ppt obtained at sites 1 to 3 respectively located at Mile 1 all exceeded 0.04ppt permissible limit of WHO. Every other value from sites 4 to 9 was < 0.04ppt. High salinity level in the stream can cause dehydration to the fauna and even humans which can eventually lead to death and can also cause the stream to be unfit for domestic use.

The nutrients, sulphate, phosphate and nitrate levels were also recorded. The sulphate content of the water was below detection limit from sites 4 to 9, that is, Mile 2 and 3. The mean levels of 1.00 ± 0.01mg/l, 1.07 ± 0.12mg/l and 1.30 ± 0.26mg/l obtained for sites 1 to 3 respectively at Mile 1 were all below the respective WHO and NIS limits of 250mg/l and 100mg/l. Nitrate had its range from 0.05–1.52mg/l. The mean levels across all sites were below 50mg/l WHO standard. The very low nitrate level recorded in the areas shows that the groundwater is free from nitrate contamination. Phosphate was not detected at all sites.

Total hardness and total alkalinity ranging from 3.80–57.48mg/l and 8.00–13.00mg/l were below the permissible limits of WHO and NIS standards and as such pose no threat to humans. The chloride content of the water ranged from 2.00–108.70mg/l. This is below the permissible limit, indicating that there was no salt-water intrusion to the ground water.

The iron content falls within the permissible limit, although iron is an essential element in the metabolism of animals and plants, if it is present in water in excessive amount, it forms red oxy-hydroxide precipitate that stains laundry and plumbing fixtures owing to its very reactive nature. Total heterotrophic bacteria were found to be low and within the permissible limit while faecal coliform bacteria and total coliform bacteria were not detected in all the water samples.

Conclusion

The pH across the sites are all acidic. Phosphate was below the detection limit at all sites, Sulphate was not detected from sites 4 to 9 (Mile 2 and 3) while Nitrate levels at all sites were below the permissible limit of WHO standard [7-14].

Recommendations

Since the pH is below the permissible limit, the water should be treated to raise the pH to the acceptable limit.

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