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INVESTIGATING THE QUALITY OF GROUNDWATER IN EZINIHITE MBAISE LOCAL GOVERNMENT AREA, IMO STATE, NIGERIA

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Abstract
Using the water quality index (WQI) technique, this study endeavor aimed to assess the quality of selected groundwater samples from the Ezinihite Mbaise LGA of Imo State. In order to determine their physiochemical characteristics, fifteen (15) hand dug wells water samples have been analysed. In establishing a water quality index, account shall be taken of the factors listed below: pH, hardness, total liquid solids, calcium, fluoride, iron, potassium, sulphate, nitrates and carbonates. Physical and chemical contamination was clearly demonstrated by the high levels of nitrite and pH that were found. Water samples with low pH values of 2.48 to 6.49, below the WHO-recommended range of 6.5 to 8.5, were found. Similarly, significant nitrite concentrations between 3.08 mg/L and 5.70 mg/L were found, above the 3.0 mg/L WHO tolerable limits once again. Inorganic fertilizer awareness and sensitization campaigns, public health education by community-based health workers, and enhanced and/or continued combined environmental measures are anticipated to have a positive impact on groundwater integrity. In order to provide everyone in the area with safe drinking water, the researchers advise that the government build more water filtration plants. They also advise that sewer drains be placed away from water supply drains to prevent waste water from leaching into the ground water and that regular ground water quality monitoring be implemented everywhere.

Keywords: Groundwater, Water Quality Index, Portability, Physico-chemical, Parameters.

Introduction

Indeed, water is an essential element of life on Earth and roughly two thirds of man's body consists of water according to (Friis, 2007). For all of the physiological requirements for survival, including food circulation, digestion and distribution, a person's body requires at most 2 litres of water per day to dispose of waste (Okereke, 2006; Nwankwo, 2003).

According to Rejith *et al.* (2009), in order to sustainably develop, grow economically, maintain society's stability and eliminate poverty, fresh water is vital and finite resources. When millions of women and children spend many hours a day collecting water, the lack of water is linked to poverty and massive economic waste because of health care costs; productivity losses and labour diversion (Shah, 2007). An essential element of the public is safe, high quality drinking water (Friis, 2007). This is because clean water in the right quantity is needed to practice adequate sanitation and hygiene such as hand washing, bathing, flushing toilets, washing cloths and the house etc.; and lack of which exposes the people to a variety of health related problems including water-borne/related diseases like diarrhea, amoebiasis, typhoid, cholera. 1.8 million children die worldwide each year as a result of diarrhea and 443 million school days are lost each year from water-related illness (Shah, 2007).

Groundwater is water that has been stored below ground level in the pore spaces of Water bearing strata and natural reservoirs called an aquifer (Okereke, 2006). According to Friis (2007), an aquifer (or water table) is a layer or section of earth or rock that contains freshwater. For the purpose of classification of aquifer, Okereke, (2006) stated that an aquifer can be unconfined (water table) aquifer or confined aquifer. While the unconfined (or water table) aquifer is underlain by an impermeable geologic stratum, the confined aquifer is underlain and overlain by impermeable formation on which flowing boreholes or well can be drilled.

Moreover, there may be unconsolidated aggregates such as sand and gravel or mixtures of aggregate materials like sandstone and limestone in the aquifer. The groundwater storage and well yield

of sand and gravel aquifers is more prevalent than the sandstone or limestone aquifer, but they are at greater risk for storm runoff contamination (Uma and Egboka, 1986).

Groundwater may be found and harvested by hand pump, drilled borewell or spring water which gushes out of a springs eye naturally at locations where the groundwater table meets steep land slope (Okereke, 2006 and Nwankwo, 2004). Groundwater may be quite pure and safe for drinking and is not so prone to pollution like surface water due to location and occurrence.

Nevertheless, the level of purity depends on the quality of the recharged source (which can be rainwater run-off), and this depends on the quality of the surrounding environments, soil particle size, recharged rate and the nature of geological formation of the place, (Obionu, 2007 and Okereke, 2006)

According to WHO (1993), the natural quality of groundwater is largely controlled by the geology of the aquifer, the length of time water is stored in the ground (the residence time), the climate, and the nature of recharge water.

In rural and urban settlements in the world's most developing countries, groundwater became an alternative source for portable water due to recent problems with access to reliable drinking water and decreasing supply by government agencies. For water to be potable and of good quality, it should be free from chemical and microbial contamination and be accepted to the user in terms of colour, taste and odour in accordance with the WHO guidelines on the Quality of Drinking Water (WHO, 1993). Potable water is needed for domestic purposes such as drinking, personal hygiene, cleaning, cooking, gardening/farming purposes, public utility, toilets, school, and in industries (Lucas and Gilles, 2003).

People in rural settlements are engaged in activities such as agriculture and agrobase industries, while urban settlements are characterised by overpopulation, increased wastewater and sewage generation and industrial activities with their associated problems. A situation where there is inadequate sanitation and a lack of appropriate waste disposal systems arises due to the failure of Social Services, which has not been able to cope with these growth in cities and industries and their produced waste, (Nwankwo, 2004).

The groundwater may be percolated with nutrients and residue from agricultural activities, solid waste landfills, pit latrines as well as industrial discharges from both rural and urban areas thereby changing its physical and chemical quality which is

detrimental to the quality of water, (Adekunle *et al.,* 2007; Nwankwo, 2004). Thus, the groundwater quality is to an extent a good index of the environmental quality status (Okereke, 2006).

According to WHO (1993), the majority of groundwater contains excellent quality water and does not require treatment until it is used for drinking. However, the assessment of the chemical quality of water is useful and important due to the presence of certain natural elements and pollutants which can make groundwater taste or smell unpleasant or even harmful to health.

MATERIALS AND METHODS

The data for the study were gathered from primary sources. Among the information from the main source are the outcomes of laboratory analyses and the equipment that was used on the samples that were collected to set quality parameters. Groundwater samples were collected from ten distinct locations. The chemical features of nitrogen oxide (NO_2), manganese (Mn), hardness, total suspended solids, zinc (Zn), iron (Fe), copper (Cu), alkalinity, turbidity, and color are distinguished from the physical attributes of pH, electric conductivity, and total dissolved solids. The properties and analytical methods are shown in Table 1. Table 2 provides a description of the water samples taken from wells in ten different sites, and Table 4 lists the physical and chemical characteristics of the water sample taken in Ezinihite Mbaise LGA, Imo State.

Table 1: Water quality properties, techniques and equipment.

S/N	Properties	Technique/Equipment
1	pH	pH meter
2	EC	EC meter
3	Total Dissolved Salt (TDS)	TDS meter
4	Turbidity	Turbidity meter
5	Total Suspended Solid (TSS)	Quantitative analysis
6	Alkalinity	Titration
7	Hardness	Titration
8	Colour	Colorimeter
9	Copper (Cu)	Spectrophotometer
10	Nitrogen oxide (N_{o2})	Spectrophotometer

11	Manganese (Mn)	Spectrophotometer
12	Zinc (Zn)	Spectrophotometer
13	Iron (Fe)	Spectrophotometer

Table 2: Water samples from Hand Dug Wells in 15 localities in Ezinihite Mbaise L.G.A of Imo State are described below.

S/N	Wells	Wells Localities
1	HDW 1	AGUNEZE
2	HDW 2	AKABU
3	HDW 3	AMANO
4	HDW 4	AMAZU
5	HDW 5	EKWEREAZU TOWN
6	HDW 6	ELEKENAWASI OBOHIA
7	HDW 7	EZIAMA OPARANADIM
8	HDW8	IHITE AFOROKWU
9	HDW9	ENYIOGUGU
10	HDW10	EZIGARAGU
11	HDW11	LORJI
12	HDW12	MBUTU
13	HDW13	OBETETI
14	HDW14	MBUTU UKWU
15	HDW15	NGURU NWEKE

Sample Assembly

Samples to be subjected for the necessary physiochemical examination have been collected at the laboratory. Using GPS, a global positioning system has also been used to record the latitude and altitude of each sample site. In every of the hand dug wells, meter tape has been used for correct measurement of water levels, total depth and water column. For each of the thirteen essential criteria, water samples have been independently assessed.

Physio-chemical Analysis

A number of physicochemical parameters, e.g. pH, total alkalinity, chloride, sulphate, nitrate, total hardness, calcium, and sulfonic acid, were evaluated, as well as Electrical

conductivity, Dissolved Oxygen, biochemical oxygen demand, Total dissolved solids, Total suspended particulate matter have been assessed. The outcomes were then associated against WHO standards and coordinated.

pH of water

The pH of the solution shall be used to measure the concentration of hydrogen ions in pure water. It's not the same as 0 to 14. In general, water with pH of 7 is considered to be neutral, while acidic and alkalinity waters have been classified as basic when measured at a pH less than 7. Water's pH ranges between six and 8.5 in classical conditions. It has been experimental that water with low pH tends to be hazardous, and water with high pH becomes unpleasant tasting.

Electrical Conductivity (EC)

Unadulterated water is not a great conductor of electrical current and may be an excellent separator. The electrical conductivity of the water will be improved by reducing particle concentration. The quantity of dissolved solids in water is, at the very least, decisive for electric conductivity. Electrical conductivity (EC) really measures the ionic prepare of an arrangement that empowers it to transmit current. In line with WHO measures, the EC's esteem should not exceed 400 Scm.

Hardness

Water can break up a lot of inorganic and some naturally occurring minerals or salts, such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates etc. The colour of the water was changed by those minerals, leaving it with a bitter taste. The benefits and adverse consequences of water exceeding the WHO standard level of 1000 ppm have not been agreed upon. TDS, or total dissolved solids, (TDS), is added to drinking water in a variety of methods, including sewage and municipal mechanical wastewater. TDS testing is therefore used to determine the water's general quality.

Alkalinity

Alkalinity of a solution is its acid neutralizing capacity or the amount of acid required to lower the pH to 4.3. The alkalinity of water is mainly due to salts of weak acids or strong bases such as hydroxides, carbonates, and bicarbonates. These substance act as

buffers to resist lowering of the pH. Alkalinity is an important parameter for effective water softening and corrosion control, selection of appropriate industrial waste treatment system, and keeping the pH in treatment units within acceptable range for effective coagulation. Alkalinity is measured volumetrically by titration with 0.02N H_2SO_4 and is reported in terms of equivalent $CaCO_3$. The WHO measures pegged the alkalinity as it was in terms of add up to broken down solids (TDS) of 500 mg/l.

Magnesium (Mg)

The eighth most abundant element in the soil's hull and the common constituent of water is magnesium. It is essential to the appropriate functioning of life forms, which are found in a variety of minerals such as dolomite, magnesite etc. The body is composed of approximately 25 mg magnesium, 60% in bones and 40% in muscles and tissues. In line with WHO standards, a reasonable level of magnesium in water should be 150 mg per litre.

Calcium (Ca)

Calcium is 5th most inexhaustible component on the soil outside and is exceptionally vital for human cell physiology and bones. Approximately 95% calcium in human body put away in bones and teeth. The tall lack of calcium in people may cause rickets, destitute blood clotting, bones break etc. and the surpassing constrain of calcium created cardiovascular infections. Agreeing to WHO (1996) guidelines its allowable extend in drinking water is 75 mg/l while PSQCA (2002) built up the constrain of 200 mg/l.

Nitrate (No_2)

Nitrates in young children cause one of the most important health problems that influence water quality parameters, especially when it comes to Blue Baby Syndrome. The sources of nitrate are nitrogen cycle, mechanical squander, nitrogenous fertilizers etc. The World Health Organization allows for the highest possible level of nitrate restriction in drinking.

Determination of Water Quality Index (WQI)

The anticipated use determines how important the unique water quality characteristics are in determining the water quality index. The goal of this research project is to

evaluate the standards for water quality in light of the requests for mobility. The first column of Table 3 contains the ten parameters that were selected for this investigation. While the third column provides the unit weights (W_i), the moment column displays the drinking water benchmarks for the parameters. As secondary pollutants, the pH has been assigned the weight of total dissolved solid. One can compute the water quality index (WQI).

Table 3: Water quality parameters with their WHO/Nigerians standard and unit weight

Parameter (Pi)	Standard (Si)	Unit weight (Wi)
Ph	6.5-8.5	0.001
(Total dissolved solid	1000	0.001
Calcium	200	0.005
Fluoride	1.5	0.667
Iron	0.3	3.33
Nitrate	50	0.02
Potassium	100	0.01
Sulphate	400	0.0025
Carbonate	250	0.004
Total hardness	500	0.002

Unit weight of the *i*th parameter (W_i) can be calculated as follows:

Table 4: Physical and Chemical Properties of Water samples in Ezinihite Mbaise LGA of Imo State

Well No.	Ph	(EC) $\mu s/cm$	TDS (Mg/l)	TSS (Mg/l)	Hardness (Mg/l $CaCO_3$)	Turbidity (FAU)	Colour (ptCo)	Alkalinity (Mg/l$CaCO_3$)	(Fe) (Mg/l)	Zn (Mg/l)	Mn (Mg/l	Cu (Mg/l)	NO_2 (Mg/l)
W1	6.57	82.10	59.48	NIL	3.45	2	2	72	NIL	0.27	0.01	ND	5.70
W2	6.51	55.32	38.25	NIL	2.17	3	2	71	NIL	0.19	ND	ND	3.26
W3	6.71	80.43	42.58	NIL	1.43	2	1	83	NIL	0.07	ND	ND	3.23
W4	5.60	35.23	27.72	NIL	1.83	3	2	63	NIL	0.29	ND	ND	3.08
W5	6.49	28.27	26.24	NIL	1.52	4	2	52	NIL	0.09	ND	ND	NIL
W6	6.50	19.55	58.70	NIL	2.34	2	1	38	NIL	0.25	ND	ND	NIL
W7	2.48	16.30	74.15	NIL	2.86	1	1	118	NIL	0.06	0.01	ND	NIL
W8	6.81	110.23	71.31	NIL	1.25	2	1	74	NIL	0.63	ND	ND	NIL
W9	5.54	37.64	36.32	NIL	3.76	3	2	61	NIL	0.47	0.04	ND	3.52
W10	6.49	48.22	27.42	NIL	1.94	2	2	87	NIL	0.24	ND	NDND	3.20
W11	6.52	27.30	29.02	NIL	2.21	1	2	74	NIL	0.27	ND	ND	NIL
W12	6.67	29.82	70.43	NIL	2.50	3	2	71	NIL	0.22	ND	ND	NIL
W13	6.62	34.86	72.84	NIL	2.53	3	1	47	NIL	0.20	ND	ND	NIL
W14	6.54	79.90	41.70	NIL	1.74	2	2	59	NIL	0.43	ND	ND	NIL

W15	6.51	56.34	43.51	NIL	1.53	3	2	63	NIL	0.39	ND		NIL
WHO Standards	6.5-8.5	1000	1000	N/A	100-500	5	15	500	3	5	0.5	1.00	3.00

FAU = Formation Attenuation Unit, $\mu s/cm$ = Micro second per centimeter, **Mg/l** = Milligram per litre, **pt CO** = Platinum-Cobalt Scale

Results and Discussion

This study indicates that the pH is between 2.48 to 6.90. The well water in four boreholes, W4, W7, W9, and W10, were found to be acidic because the four boreholes did not meet the WHO drinking water requirements of (6.5–8.5). This result shows that the acquired electrical conductivity has a range from 16.30 $\mu s/cm$ to 110.23 $\mu s/cm$; this is in line with WHO guidelines.

Total dissolved solids (TDS) vary from 27.42 mg/L to 74.15 mg/L, while total suspended solids (TSS) analysis of the water sample shows no indications of TSS. The ranges of values for the following parameters are found in the water samples W1 and W9: 1.25 mg/L to 3.75 mg/L for hardness, 1FAU and 4FAU for turbidity, 1 and 2ptCO for color, 38 mg/L and 118 mg/L for total iron (Fe), nil for zinc (Zn), 0.07 mg/L and 0.63 mg/L for manganese (Mn), and 0.01 and 0.04 mg/L for Manganese (Mn) and Copper (Cu); not detected for Nitrite (NO_2); high values above WHO standards except in four of the groundwater samples.

Pit latrines and farmlands where inorganic fertilizer including Nitrogen, Phosphorous, and Potassium (NPK) was utilized and located adjacent to the boreholes may have had an impact on this observation.

Discussion

As indicated in Tables 3 and 4, it was found that two characteristics—pH and nitrite—did not fulfill World Health Organization (WHO) standards during the course of this research work. In the short or long term, drinking water from these sources may be detrimental to the health. Toxic substances may become mobile and available for uptake by aquatic plants and animals when groundwater pH is low. The preparation of heavy metals and base cations involves raising the acidity of the groundwater and soil. The two possible soil metals that should raise concerns for human health are aluminum and cadmium. However, additional metals like lead and copper may be present at dangerous levels when acidic groundwater is fed into pipe systems. Elevated amounts of acidity in water can corrode residential pipes and the components that connect them,

as well as create environments that are detrimental to aquatic life and other living things

Conclusions

In the Ezinihite Mbaise LGA of Imo State, both rural and urban towns' ground water quality has been assessed. The majority of WHO guidelines for protecting wells were not followed, leaving the wells vulnerable to potential pollution sources.

Low pH and a high nitrite content were observed as unmistakable indicators of both chemical and physical pollution. Water testing yielded low pH readings between 2.80 to 6.49, which were below the WHO's recommended range of 6.5 to 8.5. Furthermore, elevated nitrite concentrations of 3.08 mg/L and 5.70 mg/L were found, above the 3.0 mg/L WHO-recommended limits once again. It is expected that increased or advanced mixed natural mediations, such as mindfulness training, open health education from community-based health specialists, and awareness campaigns about the sustainable use of inorganic fertilizer, will advance groundwater awareness. While it is recommended to abandon wells located less than 50 meters from a pollution source, wells beyond 250 meters should be constructed and acidic groundwater should be treated with sodium carbonate.

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