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EVALUATION OF GROUNDWATER QUALITY IN ABA NORTH L.G.A OF ABIA STATE, NIGERIA

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ABSTRACT

Using the Water Quality Index (WQI) technique, this research was aimed to evaluate the quality of selected groundwater samples from Aba North LGA of Abia State. The physio-chemical characteristics of test (10) water samples from wells were analyzed. The following factors are taken into account when determining the water quality index: pH, hardness, total dissolved solids, calcium fluoride, iron, potassium, sulphate, nitrate, and carbonate. Physical and chemical contamination was clearly demonstrated by the high levels of nitrite and pH that

INTRODUCTION

Water is an important element of life on earth and approximately two-third of human body is made up of water (Friis, 2007). An average human body needs at least two litres of water per day for all the physiological needs and survival such as food transportation, digestion and distribution; and in the disposal of waste (Okereke, 2006; Nwankwo, 2003). Friis (2007) gave a report that it is possible for a human being to live up to a month without food but that same individual can only survive for one week without water.

According to Rejith *et al.* (2009), fresh water is valuable and finite resource central to sustainable development, economic growth, social stability and poverty alleviation. Water deficit is associated with poverty and massive economic waste (due to cost associated with health spending), productivity losses and labour diversion as millions of women and children spend several hours a day fetching water (Shah, 2007). Safe, high-quality drinking water is an essential aspect of public health (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).

Ground water is water stored below ground level and occurs in the pores of water bearing strata and natural reservoir called 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

were found. Water samples with low pH values of 2.80 to 6.49, below the WHO-recommended range of 6.5 to 8.5, were found. High nitrite values between 3.02 and 4.31 mg/L are also present and were found to be, once more, more than the 3.0mg/L WHO permitted limits. The integrity of groundwater may be improved by enhanced and/or ongoing combined environmental interventions, such as public health education provided by community-based health workers and awareness and sensitization campaigns on the sustainable use of inorganic fertilizer. In order to ensure that everyone in the area has access to clean drinking water, the researcher suggests that governments at all levels build more water filtration plants, keep sewer drains separate from pipe water supply drains to prevent waste water from leaching into groundwater, and regularly monitor groundwater quality everywhere.

Keywords: Groundwater, Quality Index, Portability, Physico-Chemical, Parameters.

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.

In addition, the aquifer may be unconsolidated materials (such as sand and gravel) or consolidated materials such as sandstone and limestone. Sand and gravel aquifers are more prolific than sandstone and limestone aquifers in terms of groundwater storage and well yield but are more vulnerable to contamination from storm runoff (Uma and Egboka, 1986).

Ground water can be found and accessed through the use of hand-pump well, drilled boreholes and spring water (which is ground water that gushes out naturally from the spring eye at the point where the groundwater table meets a 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 settlement engage in activities such as agriculture and agro-base industries while urban settlements are characterized with over-crowding, increase waste (solid and sewage) generation and industrial activities with its attendant problems. With the inability of the social services provided to keep pace with this urban and industrial growth and the waste generated, a situation arises where there is inadequate sanitation and the absence of proper waste disposal system, (Nwankwo, 2004).

Leachates, seepages and run-offs from agriculture activities, solid waste dumpsites, and pit latrines, industrial effluents from both rural and urban settlements may percolate into the groundwater thereby altering its physical and chemical quality and thus compromising the quality (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), most water from aquifer is of excellent quality, and need no treatment before use for drinking. However, there are some natural elements and pollutants which can make groundwater taste or odour unacceptable or even make it harmful to health hence making the assessments of chemical quality of water useful and important.

Materials and Methods

Primary sources were used to produce the study's data. The results of laboratory analyses and the instrumentation used on the samples that were gathered to establish quality parameters are among the data from the primary source. From ten different places, samples of ground water were taken. While pH, electric conductivity, and total dissolved solids are considered physical attributes, nitrogen oxide (N_{O2}), manganese (Mn), hardness, total suspended solids, zinc (Zn), iron (Fe), copper (Cu), alkalinity, turbidity, and color are considered chemical properties. Table 1 presents the properties and analytical techniques. 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 Aba North LGA, Abia 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 Wells in 10 localities in aba North are described.

S/N	Wells	Wells Localities
1	W 1	Umuola Okpulor
2	W 2	Umuola Egbelu
3	W 3	Ogbor
4	W 4	Eziama
5	W 5	Osusu
6	W 6	Umuokoji
7	W 7	Uratta
8	W8	Umuelendu
9	W9	Osusuokee
10	W10	Umuelekpe

Sample Assembly

The samples were taken to the laboratory for the required physio-chemical inspection. The longitude, latitude, and elevation of each sample location were also noted using a Global Positioning System (GPS). Meter tape was used to properly measure the static water level, overall depth, and water column in each hand-dug well. The water samples were autonomously evaluated for each of the 13 key criteria.

Physio-chemical Analysis

Many physio-chemical parameters, including pH, total alkalinity, chloride, sulfate, nitrate, total hardness, calcium, and manganese, as well as electrical conductivity, dissolved oxygen, biochemical oxygen demand, total dissolved solids, and total suspended particles, were appraised. The outcomes were then associated against WHO standards and coordinated.

pH of water

The concentration of hydrogen ions in pure water is measured by the pH of the solution. It differs between 0 and 14. In overall, water with a pH of 7 is thought to be neutral, while water with a pH of less than 7 is identified as acidic, and water with a pH of more than 7 is recognized as basic. pH levels in water classically range from 6 to 8.5. 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 isn't a great conductor of electric current or maybe a great separators. Increment in particles concentration improves the electrical conductivity of water. By and large,

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the sum of broken up solids in water decides the electrical conductivity. Electrical conductivity (EC) really measures the ionic prepare of an arrangement that empowers it to transmit current. Concurring to WHO measures EC esteem ought to not surpassed 400 µS/cm

Hardness

Numerous inorganic and a few natural minerals or salts, including potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates, and others, can be broken down by water. These minerals changed the hue of the water and gave it an unpleasant taste. No consensus has been reached about the benefits or drawbacks of water that surpasses the WHO standard limit of 1,000 ppm. 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 is the nearness of one or more particles in water counting hydroxides, carbonates and bicarbonates. It can be characterized as the capacity to neutralize corrosive. Direct concentration of alkalinity is alluring in most water supplies to steady the destructive impacts of corrosiveness. In any case, intemperate amounts may cause a number of issues. The WHO measures pegged the alkalinity as it were in terms of add up to broken down solids (TDS) of 500 mg/l.

Magnesium (Mg)

Magnesium is the 8th most copious component on soil hull and common constituent of water. It is fundamental for appropriate working of living life forms and found in minerals like dolomite, magnesite etc. Human body contains almost 25g of magnesium (60% in bones and 40% in muscles and tissues). Concurring to WHO benchmarks the reasonable extend of magnesium in water ought to be 150 mg/l.

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 (No2)

Nitrate one of the foremost vital illnesses causing parameter of water quality especially blue infant disorder in newborn children. The sources of nitrate are nitrogen cycle, mechanical squander, nitrogenous fertilizers etc. The WHO permits most extreme reasonable restrain of nitrate in drinking

Determination of Water Quality Index (WQI)

In deciding water quality index, the centrality of the distinctive water quality parameters depends on the expecting utilize. This investigate work looks for to assess water quality criteria based on the requests for portability. The ten parameters chosen for this study are appeared within the to

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begin with column of table 3. The moment column presents the drinking water benchmarks for the parameters, whereas the third column gives the unit weights (Wi). The pH has been alloted the weight of total dissolved solid because they are secondary pollutants. The water quality index (WQI) can be calculated.

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 Aba North LGA of Abia 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	4.31
W2	2.80	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	NL	0.07	ND	ND	3.05
W4	5.60	35.23	27.72	NIL	1.83	3	2	63	NIL	0.29	ND	ND	3.02
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	6.21	18.28	74.15	NIL	2.86	1	1	118	NIL	0.06	0.01	ND	NIL
W8	6.81	102.14	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	5.63	48.22	27.42	NIL	194	2	2	87	NIL	0.24	ND	ND	3.20
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, ***µs/cm*** = Micro second per centimeter, **Mg/l** = Milligram per litre, **ptCO** = Platinum-Cobalt Scale

Results and Discussion

Results

The analysis's findings indicate that the pH ranges from 2.80 to 6.81. The WHO drinking water criteria for four boreholes, W2, W4, W9, and W10, were found to be between 6.5 and 8.5, making the well water acidic. The acquired electrical conductivity values ranged from 18.28 $\mu s/cm$ to 102.14 $\mu s/cm$; this result demonstrates compliance with WHO guidelines.

The total suspended solids (TSS) examination of the water sample reveals no traces of total suspended solids, whereas the total dissolved solids (TDS) ranges from 27.42 mg/L to 74.15 mg/L. The values for water hardness ranges between 1.25mg/L and 3.75mg/L, turbidity; 1FAU and 4FAU, colour; 1 and 2ptCO, alkalinity; 38mg/L and 118mg/L, Total Iron (Fe); nil, Zinc (Zn); 0.07mg/L and 0.63mg/L, Manganese (Mn); was 0.01 and 0.04mg/L in W1 and W9 water samples respectively, while others showed no detection, Copper (Cu); not detected, Nitrite (NO2); 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

In the course of this research effort, pH and nitrite were discovered to be two characteristics that did not meet World Health Organization (WHO) requirements, as shown in Tables 4 and 5. Drinking water from these sources could be harmful to your health in the long or short term. When the pH of groundwater is low, toxic chemicals may become mobile and available for acceptance by aquatic plants and animals. Heavy metals and base cations are prepared by increasing the soil's and the groundwater's acidity. Two potential soil metals to be concerned about in terms of human health are cadmium and aluminum. However, when acidic groundwater is injected into pipe systems, other metals, such as lead and copper, may be at a harmful level. High levels of acidity in water have the ability to erode household pipes and their connected features, as well as to produce conditions that are harmful to sea life and other organisms.

Conclusion

The evaluation of ground water quality in rural and metropolitan settlements of Aba North LGA of Abia State has been done. Most of the WHO standards for wells protection were not adhere to thus uncovering the wells to possible pollution by potential pollution sources.

High level of nitrite and low pH were watched as clear prove of physical and chemical contamination. Low pH values of 2.80 - 6.49 were gotten from water tests which were underneath 6.5-8.5 as suggested by WHO. Moreover, high nitrite concentrations of 3.02mg/L4.31mg/L were detected which were once more higher than WHO suitable limits of 3.0mg/L. It is anticipated that expanded or proceeded combined natural mediations, through open health instruction by community based health experts, mindfulness and sensitization campaigns on the supportability utilize of inorganic fertilizer may move forward groundwater astuteness. Although wells that are less than 50 meters from a source of pollution should be abandoned, successive wells should be built more than 250 meters away from that source and sodium carbonate should be used as a disinfectant for acidic groundwater.

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