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Assessment of Water Quality of Delta State, Agbarho Area, Nigeria

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Abstract

The quality of groundwater depends on various concentrations of physico-chemical and microbiological constituents. The water supply for human consumption is often directly sourced from groundwater without treatment and the level of pollution has become a cause of major concern, hence the basis of which this research work was carried out .The samples were analysed for their physico-chemical parameters, ions, heavy metals and microbial contents which including coliform bacteria and BOD. Standard Laboratory analysis was performed on these samples for these parameters. The results of these tests, its significance and possible implication were discussed and compared with the World Health Organisation standard to know the degree to which the water is potable and save for drinking.

Each of the analyzed physico–chemical parameters, the cations, anions, heavy metal fell below the permissible limit of the W.H.O standard of 1982. The samples are generally acidic with the pH ranging from 4 to 6, consequently should be treated to achieve a neutral pH for potable use. The microbiological content of the water which includes total coliform count and biological oxygen demand (BOD) showed that samples from Oseri, Uvwiamughe, Idirima, Urhoboghara and Ogubane are contaminated with coliform bacteria with their coliform count ranging from 5 to 25/100ml). Also samples from Erhidi, Uvwiamughe, Abavo and Oguname have high BOD content. Thus water from these wells must be disinfected before drinking.

1. **Introduction:** Water is one of the most essential needs of human beings and is the most abundant natural resources on the surface of the earth (Oyinloye and Jegede, 2004). It is the most essential basic necessity of life. However, pure water needed for human consumption does not always occur in nature, due to the presence of dissolved or suspended impurities in most natural water bodies (Goldface, 1999). The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life (Oluduru and Aderiye, 2007). The groundwater is the largest reservoir of drinkable water and due to natural filtration; it is less contaminated as compared to surface water (Aiyesanmi et al., 2004). Water in its original sources can be contaminated by domestic, industrial or agricultural waste. When the contamination is sufficient to render the water unacceptable for its best usage, it is said to be polluted. The quality of surface and subsurface water can be determined through analysis and comparison with the standard set-up by agencies for water of quality standard e.g. World Health Organization. The sources of groundwater pollution include open dumpsites, poorly constructed or maintained landfill, latrines and other waste sites. Each of these can contain a range of pathogens and toxins, including heavy metals that can migrate downward and contaminate aquifers. Industrial pollution of groundwater can come from

dumping of waste water or waste from mining activities and from leakage or spillage from other industrial processes. Mining primarily affects groundwater from leaching of mine tailing piles Agricultural pollution of groundwater comes primarily from overuse of pesticides and fertilizers that can later seeps into groundwater sources. The composition of water differs due to the exchange of ions between the constituents of the water and the earth materials which contain the water. Ions such as hydrogen (H^+), sodium (Na^+), potassium (K^+), calcium (Ca^+), magnesium (Mg^{2+}), bicarbonates (HCO_3^-), carbonates (CO_3^{2-}), chlorine (CL^-) and Sulfate (SO_4^{2-}) are the predominant ions that make up the composition of water. There are other ions, but with lesser concentrations. These ions include oxygen (O_2), methane (CH_4), arsenic (As), boron (B), lead (Pb), and carbon dioxide (CO_2).

Aim of the Research work: The objective of this work is to determine the quality of groundwater in Agbarho, Delta state. To this effect, a total number of ten water samples were collected from different hand-dug wells.

1. Methodology:

Sample Collection and Analysis: A non-systematic sub-surface water samples were obtained from ten hand dug wells from different locations of Agbarho in Delta state. These were subjected to standard methods of laboratory analysis to ascertain the pH, EC, TDS, Salinity, TSS, Turbidity, Chloride, Sulphate, Ammonia, Nitrate, Calcium, Sodium, Manganese, Potassium, Copper, Lead, Zinc Chrominm, Iron, coliform count and biological oxygen demand (BOD). The storage and transport of the samples are vital elements of the sampling protocol (U.S. EPA, 1987).Transport was planned so as not to exceed holding time before laboratory analysis. The samples were stored in a refrigerator before analysis and afterwards treated with different reagents and analytical equipment. The methods adopted for the examination of these parameters are based on that of APHA, (1989). The sample locations are shown in table 1.

Location and Accessibility of the Study Area: The study area, Agbarho, is a town in the Ugheli North local government area of Delta state, Nigeria. It is located near the city of Warri. It lies within latitude $5^0\ 35^1\ 00^{11}$N and longitude $5^0\ 52^1\ 00^{11}$E (figure 1). The area derives its water from the Sombreiro Warri Deltic Plain which overlies the coastal plain sand of the highly prolific Agbada formation. The area has a shallow water table which is encountered at a minimum depth of 20 meters. The area is considerably recharged by rainfall. The area is accessible by major road and foot path.

Table 1: Type and name of sample areas

Sl. No.	Sample Code	Sample Location
1	URH ST	URHOBOGHARA STREET
2	AKP ST	AKPIROROH STREET
3	ERH ST	ERHIDI STREET
4	AHI ST	AHIRIMA STREET
5	OSE ST	OSERI STREET
6	ABA ST	ABAVO STREET
7	OGUN ST	OGUNAME STREET
8	1DI ST	IDIRIMA STREET
9	OGUB ST	OGUBAME STREET
10	UVWI ST	UVWIAMUGBE STREET

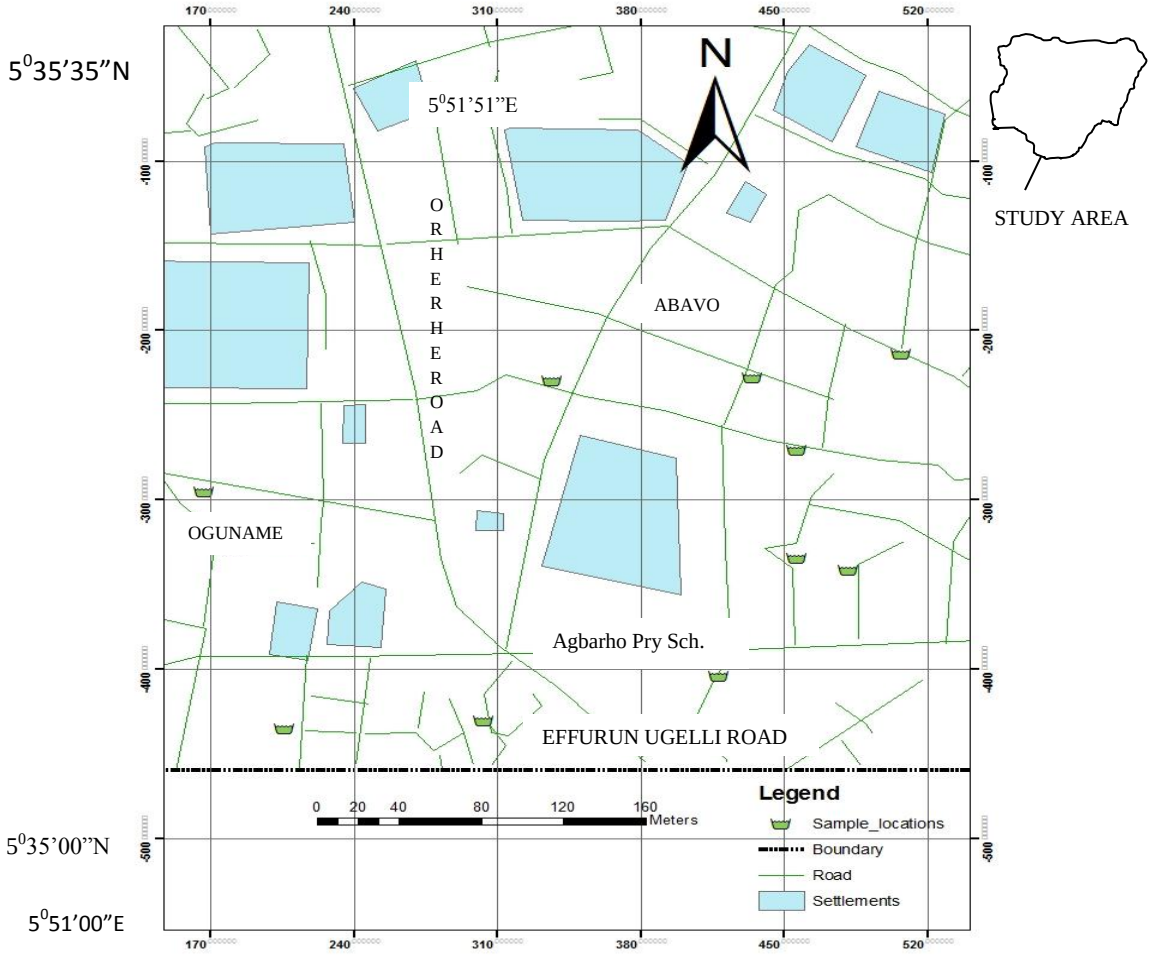

Fig-1: Map of Agarho and environs showing sample locations

2. **Results and Discussion:** The results of the physical and chemical analysis, heavy metals ions and microbiological content of the various water samples are shown in the tables below. Table 2 shows the physiochemical parameters of the water samples. Table 3 shows the heavy metals contents of the analyzed water sample. Table 4 shows the cations and anions contents and table 5 shows the Microbiological parameters of the water samples

Table-2: Physiochemical characteristics of water

Sl.No.	Sample Code	pH (mg/L)	EC µS/cm	TDS (mg/L)	SALANITY (ppt)	TSS (mg/L)	TURBIDITY (NTU)
1	URH ST	6.0	93	46	0.00	0.00	0.00
2	AKP ST	5.6	209	105	0.00	0.00	0.00
	ERH ST	6.0	704	352	0.21	0.00	0.00
4	AHI ST	4.0	182	91	0.00	0.00	0.00
5	OSE ST	5.2	391	196	0.08	0.00	0.00

6	ABA ST	5.0	214	107	0.00	0.00	0.00
7	OGUN ST	5.3	524	262	0.13	0.00	0.00
8	1DI ST	4.0	284	141	0.03	0.00	0.00
9	OGUB ST	4.0	172	86	0.00	0.00	0.00
10	UVWI ST	4.3	442	221	0.10	0.00	0.00
	W.H.O. Standard	6.5-8.5	1400	500	600	>3.0	25

Table-3: Heavy metals results

Sl.No.	SAMPLE CODE	Cu (mg/L)	Zn (mg/L)	Pb (mg/L)	Cr (mg/L)	Fe (mg/L)
1	URH ST	<0.001	<0.001	<0.001	<0.001	<0.001
2	AKP ST	<0.001	<0.001	<0.001	<0.001	<0.001
3	ERH ST	<0.001	<0.001	<0.001	<0.001	<0.001
4	AHI ST	<0.001	<0.001	<0.001	<0.001	<0.001
5	OSE ST	<0.001	<0.001	<0.001	<0.001	<0.001
6	ABA ST	0.002	<0.001	<0.001	<0.001	<0.001
7	OGUN ST	0.002	<0.001	<0.001	<0.001	<0.001
8	1DI ST	0.001	<0.001	<0.001	<0.001	<0.001
9	OGUB ST	<0.001	<0.001	<0.001	<0.001	<0.001
10	UVWI ST	0.001	0.002	<0.001	<0.001	<0.001
	W.H.O. STANDARD	1.5	5.0	0.01	0.05	0.3

Table- 4: The variations of Cations and Anion Parameters

Sl.No.	SAMPLE CODE	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	Chloride (mg/L)	Sulphate (mg/L)	Ammonia (mg/L)	NITRATE (mg/L)
1	URH ST	0.007	0.001	<0.001	0.003	10.497	5.739	0.048	1.362
2	AKP ST	0.023	0.004	<0.001	0.014	25.992	18.606	4.825	2.247
3	ERH ST	0.102	0.021	0.003	0.084	64.980	44.829	0.091	7.964
4	AHI ST	0.021	0.002	<0.001	0.007	45.486	1.709	0.050	5.274
5	OSE ST	0.052	0.010	<0.001	0.031	45.486	32.854	3.699	5.384
6	ABA ST	0.072	0.011	0.001	0.039	25.492	10.114	0.060	4.503
7	OGUN ST	0.093	0.021	0.002	0.052	63.980	49.377	8.884	7.928
8	1DI ST	0.031	<0.001	0.001	<0.001	57.982	2.285	0.000	7.564
9	OGUB ST	0.021	0.002	<0.001	0.009	37.988	44.138	0.000	4.414
10	UVWI ST	0.043	0.012	0.005	0.028	66.979	42.296	2.432	6.741
	W.H.O. Standard	**75**	**0.2**	**NA**	**200**	**200-250**	**250-500**	**10**	**10- 50**

Table-5: Microbiological parameters of the water samples

Sl. No.	Sample Code	COLIFORM (CFU/100ml)	BOD_5 (mg/l)
1	URH ST	17	33.5
2	AKP ST	NIL	<0.05
3	ERH ST	NIL	4.3
4	OSE ST	5	2.0
5	UVWI ST	7	5.4
6	ABA ST	NIL	8.0
7	OGUN ST	NIL	10.0
8	1DI ST	9	3.5
9	OGUB ST	25	<0.05
10	AHI ST	NIL	1.5
	W.H.O. Standard	0	4.0

(a) pH: This parameter measures the hydrogen-ion content in the water. It determines the acidity or alkalinity of the sample. The mean (average) values of pH of the samples ranged from 4.0 to 6.0. The pH levels were below the WHO optimum limits of between 6.5 and 8.5. pH values lower than 6.5 are considered too acidic for human consumption and can cause health problems such as acidosis. Common causes for acidic water are acid rainfall due to atmospheric carbon dioxide and other airborne pollutants, runoff from mining spoils, and decomposition of plant materials. According to Ezeigbo and Aneke (1993), water from Benin City displayed low pH and concluded that the decrease in is as a result of the reaction of rain water with sulfur and nitrogen compounds which cause acid rain to infiltrate the soil.

These samples should be treated to achieve a neutral pH for potable use. The pH values greater than 8.5 are considered to be too alkaline for human consumption.

(b) Electrical Conductivity: This parameter determines the ability of the water samples to carry an electric current. Conductivity values of the samples ranged from 46 to 282 μS/cm. These values are below the WHO permissible limit.

(c) Total Dissolved Solids (TDS): This is a measure of the amount of dissolved material in the water sample. The total dissolved solids of the water samples ranges from 46 (mg/L) to 352 (mg/L). They all fall below the W.H.O standard of 500(mg/L). Hence they are recommendable.

(d) Salinity: This describes the concentration of the mineral content of the water samples. The water samples from URH ST, AKP ST AHI ST, ABA ST, OGUB ST, have their values to be 0.000. The rest of the other values ranges from 0.030(ppt) to 0.210(ppt). They fall far below the W.H.O recommended standard. Hence, they are recommended for drinking on the basis of the salinity content.

(e) Total Suspended Solids (TSS): This is a measure of the particulate matter that is suspended within the water samples. Form the result of the analysis, there is no total suspended solids.

(f) Turbidity: Turbidity relates to light adsorption and scattering in water. High turbidity reduces light penetration. The result of the analysis shows non-detectable turbidity.

(g) Chloride: The concentration of chloride content ranges from 10.429(mg/L) to 66.979(mg/L) which falls below the W.H.O recommended standard. This implies that the well water is much more potable for domestic use.

(h) Sulphate: The result of the analysis shows that concentration content of sulphate ranges from 1.709(mg/L) to 44.829(mg/L). Hence they fall below the W.H.O. permissible limit of 250(mg/L). Therefore, the water samples are recommended on the sulphate basis.

(i) Ammonia: This is a measure of the most reduced inorganic form of nitrogen in water. The value of the ammonia concentration content of the water sample ranges from 0.048 (mg/L) to 8.884 (mg/L). This falls below the permissible limit of 10 (mg/L). Result shows no ammonia for IDI ST and OGUB ST.

(j) Nitrate: This parameter measures the most oxidized and stable form of nitrogen in a water body. The value of this analyzed parameter ranges from 1.326(mg/L) to 7.964(mg/L). The recommended W.H.O standard value is between 10(mg/L) to 50(mg/L). This implies that NO_3^- and NO_2^- are considered to be non-cumulative toxins (Dallas and Day 1993). High concentrations of NO_3^- and NO_2^- may give rise to potential health risks such as methmoglobinemia or 'blue-baby-syndrome' particularly in pregnant women and bottle-fed infants respectively (Kempster *et al* 1997). NO_3^- at elevated concentrations is also known to result in cyanosis in infants. The results of this parameter fall below the recommended standard, hence it is recommendable for use.

(k) Copper: This parameter is measured in either the total or dissolved state in a water sample. Increase quantities of copper make water distasteful to drink. From the analysis, the copper concentration content ranges from <0.001(mg/L) to 0.002(mg/L). Compared to the recommended standard value of W.H.O. which is 1.5(mg/L), the copper content is far below the given standard. Thus the water is recommendable.

(l) Iron: Iron is an essential trace element for the human body. However, a high concentration of iron gives water a bad taste and a reddish colour (Cairn cross, 1990). From the result of the analysis, the possible value of the concentration content of the whole water samples are <0.001(mg/L). The W.H.O maximum permissible limit is 1(mg/L). This indicates that the water sample is fit for drinking.

(m) Lead: From the result of the analysis, the possible value of the concentration content of the whole water samples are <0.001(mg/L). This is far less than W.H.O maximum permissible limit of 0.1(mg/L).

(n) Chromium: The result of the analysis, the possible value of the concentration content of the whole water samples are <0.001(mg/L). This falls below the W.H.O maximum permissible limit of 0.05(mg/L).

(o) Zinc: From the analysis only UVW ST, showed zinc concentration of 0.002(mg/L), the rest samples generally showed values of <0.001(mg/L). This result is below the permissible limit of 5.0(mg/L).

(p) Sodium: The concentration of sodium in the water sample ranges from 0.003(mg/L) to 0.084(mg/L). The IDI ST has its sodium concentration value to be <0.001(mg/L). The given W.H.O. permissible limit of sodium concentration is 200(mg/L). Sodium content is far below the permissible limit for drinking water.

(q) Manganese: the concentration of manganese present in the water samples ranges from <0.001(mg/L) to 0.021(mg/L). These values fall below the permissible limit of W.H.O. standard of 0.2(mg/L).

(r) Potassium: From the analyzed results, URH ST, AKP ST, AHI ST, OSE ST AND OGUB ST, have their potassium content to be <0.001(mg/L). Generally, the concentration of potassium ranges from <0.001(mg/L) to 0.005(mg/L). The permissible limit could not be ascertained Potassium occurs in drinking water at concentrations well below those at which toxic effects may occur.

(s) Calcium: The amount of Calcium content in the water samples ranges from 0.007(mg/L) to 0.102(mg/L). This is far below the permissible limit of 75(mg/L). Calcium and Magnesium are needed by the body in much larger quantities and its lack in the human system will leads to adverse health conditions.

(t) Total Coliform Bacteria: Total coliform bacteria include a wide range of aerobic and figuratively anaerobic, Gram negative, non-spore-forming bacilli capable of growing in the presence of relatively high concentrations of bile salts with the fermentation of lactose and gas by-products when incubated at 350C for 48 hours. The total coliform group of bacteria includes species such as *Enterobacter, Klebsiella, Citrobacter* and *Escherichia.* Some of these bacteria are excreted in the faeces of humans and animals, but many are heterotrophic and able to multiply in water and soil environments. The presences of coliform bacteria in water indicate that the water has been contaminated with the fecal material of man or other animals.

The World Health Organisation guideline stipulated a coliform count of zero (0) per 100 ml. Total Coliform organisms per 100 ml is an indication of some degree of contamination (Health Canada, 2007). The coliform count of the water samples ranges from 0 – 27, in which Akpiroroh, Erhidi, Abavo, Oguname, Ahirima (location 2,3,6,7,10) showed zero coliform count therefore safe for drinking, while locations 1,4,5 and 6 and 9 (Oseri, Uvwiamughe, Idirima, Urhoboghara and Ogubane) are contaminated with coliform bacteria with Ogubane showing the highest coliform count of 25/100ml, consequently not safe for drinking. These wells are located in densely populated areas where the wells are cited close to domestic refuse dumps, pit latrines and stagnant water and drainages. Although it is possible that coliform bacteria, Escherichia coli may still be absent (Shimizu et al, 1980 and Schuber and Tinki, 1998), however, it is still a major concern as this can pose serious health problems like severe stomach cramps, diarrhea and vomiting and even typhoid fever. Serious complications of an *E. coli* infection can include kidney failure.

Biological Oxygen Demand (BOD): Biochemical oxygen demand (BOD) is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. It is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. BOD of the water samples ranged from 1.0 to 33.5 mg/L. According to WHO standard, the permissible limit of BOD in water is 4 mg/L. However, all other samples except Erhidi, Uvwiamughe, Abavo and Oguname fall below the WHO permissible limits of 4 mg/L for drinking water. A high BOD in water means presence of high amount of microorganisms, mainly aerobic bacteria. This results from influence of sewage or effluents from water treatment plants.

3. Conclusion: The results of the analysis of the water samples showed that there is no suspended solid and detectable turbidity. The physico-chemical parameters, levels of metals content and ions (which include cations and anions), were consistent with the World Health Organization Standard for drinking water (W.H.O. 1982). The pH values of the samples were slightly lower than the

permissible limit indicating acidity of the waters. Bacteriological analysis showed that the water samples from Oseri, Uvwiamughe, Idirima, Urhoboghara and Ogubane are contaminated with Coliform bacteria while Erhidi, Uvwiamughe, Abavo and Oguname also have high BOD content. These wells are located either too close to domestic refuse waste, pit latrine, stagnant water or drainages as these streets are the densely populated areas of the town. Sources of contaminants in the area such as indiscriminate disposal of waste can be managed to curb the long-term effect that could emanate from such practices (Soronnadi-Ononiwu and Omoboriowo 2012). This may due to ignorance at the time of citing the wells or wrong attitudes to waste disposal. Due to the fast growing nature of the place, facilities that are meant for few are shared by too many leading to overpopulation and improper waste disposal and sewage management.
It is recommended that water from these wells should be disinfected by boiling or treatment with hypochlorite solution to dispose of these harmful bacteria before drinking. Also Nigerian environmental protection agency should intensify environmental education and implementation of regulations on safe drinking water by enforcing proper citing, construction and maintenance of septic systems to reduce the risk of ground water contamination from coliform bacteria and excess BOD.

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