Physico-Chemical Analysis of Ground Water for Domestic Use in Some Selected Towns in Bayelsa State, Niger Delta Region, Nigeria

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Abstract:
Water is a veritable source of energy to mankind and every other living organism on planet earth. In recent times potable drinking water has been on the front burner of most environmental issue leading to climate change, poor agricultural input, economic and social discuss. Groundwater often called (Borehole water) represents a pivotal portion of readily available drinking water supply chain value both in urban and rural settlements across Nigeria. This research assesses the quality of some selected ground water in Azikoro, Agbura and Otuokpoti Community in Ogbia and Yenagoa Local Government Area of Bayelsa. Eleven physicochemical parameters for groundwater samples were chosen and then analyzed according to WHO guideline. The obtained results showed that pH measurements across the three sampling stations range between 5.97 and 7.03. EC range between 152 $\mu S/cm^3$ and 173 $\mu S/cm^3$. TDS range between 197 mg/l and 223 mg/l. TSS range between 15.4 mg/l and 19.1mg/l. TH range between 158.33mg/l and 192.67mg/l. Cl range between 20.67mg/l and 25.33mg/l. Fluoride range between 0.55mg/l and 1.35mg/l. DO range between 4.18mg/l and 5.69mg/l. NO_3 ranges between 9.48mg/l and 12.97mg/l. Fe range between 1.88mg/l and 2.78mg/l. The results also show that Turbidity concentrations range between 17.3 NTU and 23.5 NTU. The physicochemical parameters of the observe samples when compared with WHO and NSDQW standard indicate that most of the parameters were majorly below the WHO and NSDQW standard meanwhile Fe and Turbidity were above the maximum permissible limits of WHO and NSDQW standard. This is a wakeup call to the three tiers of government and private establishment to forthwith treat properly their wastes water before discarding it, in other to prevent it from percolate into groundwater layers which quenches our endless taste for potable water intake.
Keywords: *Water quality, Groundwater, Physico-Chemical parameters, Pathogens, Azikoro, Agbura, Otuokpoti*

Introduction

Background of the Study

Water is a veritable source of energy to mankind and every other living organism on planet earth. In recent times potable drinking water has been on the front burner of most environmental issue

leading to climate change, poor agricultural input, economic and social discuss. Groundwater often called (Borehole water) represents a pivotal portion of readily available potable drinking water supply chain value both in urban and rural settlements across Nigeria. Bearing in mind its persistent proliferation and obligation to constantly reexamine its quality and health hazards for man overall growth, Aremu et al. (201). Groundwater is intermittently exposed to various anthropogenic activities such as agricultural, domestic, industrial and municipal wastes, etc that deteriorate its quality (Edema et al., 2001 and Girgis et al. 2002). Yet groundwater problems are unresolved leading to high morbidity rate as a result of high physic-chemical properties (Amolo and Kokobaikeme 2023). Bayelsa State is one of the foremost oil producing State within the Niger Delta Region of Nigeria known for it enormous oil productivity. Its residents are plague with heinous issues of physic-chemical pollutants as a result of its geographical location (Egbo and Eremasi 2023). Accounting for the various sources of water here on earth, saline which means water containing dissolved salt (ocean or seas) water and saline groundwater make up about 97% of the water here on earth. Whereas, the remaining 2.5-2.75% is fresh water. Less than 0.01% of it as surface water in lakes, swamps, rivers etc (Sheena & Bhavia, 2018). Groundwater infers to water situated within the pores of rocks and soil which is rarely exonerated from subsurface water, which is relatively linked with surface water and deep subsurface water in aquifer (Edori et al., 2020). The ease of using fresh water globally continue to plunge down as a result of it exhaustive usage on a daily basis for cooking, drinking, agricultural, industrial and leisure activities (Amolo et al., 2022). Naturally groundwater represent virtually more than half of earth drinking water source and by extension used for irrigation functions globally Egbo and Eremasi (2022a). The quality and quantity of groundwater presently is in jeopardy by mishmash of chemical and microbiological infectivity due to man anthropogenic nature which encompasses domestic waste, mineral exploration, salinization and agricultural behavior in term of forestry, irrigation and husbandry, (Mohsin et al., 2013). The scale of rigorousness of groundwater toxic waste depends solemnly on the category of wastes, disposal technique, climatic and hydrologic parameters of the aquifer boost aptitude of the vicinity, Dipankar and Buddaratna (2016). Water conversely could be converted into three basic forms which are liquid, solid and gaseous pending on the climatic conditions. In conglomerate all three forms of water are pivotal to mankind and every other living organism (Edori et al., 2021). Man anthropogenic activities such as agricultural, domestic, industrial, municipal, oil exploration and spillage are the basic cause of water pollution within the corridors of the Niger Delta Region that militates against our continued existence (Oyem et al., 2014). Water quality refers to the chemical, physical and biological characteristics of water rooted on the values of its usage (Islamuddin et al., 2016). High level of physic-chemical properties pollutants from groundwater sources are inimical to our surrounding since it affects the ecosystem at lager (Chindo et al., 2013). Several chemical pollutants have been recognized to cause unpleasant health issues in humans due to lengthened exposure through drinking water (Aniket et al. 2017 and Kolekar 2017). They are composed of both organic and inorganic chemicals including some pesticides. Most of them are poisonous to humans and could affect the aesthetic quality of water. Thus, WHO had propounded permissible limits for most pollutants in drinking water. As a Country Nigeria has its own potable water quality specification in conjunction with the international standard and values. The NSDWQ Quality or Standards of water are coined out of WHO maximum permissible limits for potable drinking water for physico-chemical, Microbiological and radiological parameters (WHO 2011). This research article attempt to promulgate the availability of a cleaner water source for residence of Bayelsa State and Niger Delta at large.

Materials and Methods

Study area

Bayelsa State Comprises of eight (8) LGAs, been the smallest among Committee of State in Nigeria. Its flanked at coordinates 4^0 55'29"N 6^0 15'51"E. Bayelsa State is equitably positioned within the South-South Geopolitical Zone of Nigeria, being the only homogeneous Ijaw State bounded to the North by Delta State, to the East by Rivers State and to the South and West by the Atlantic Ocean. The State Capital occupies a landmass of about 21,100 Km. A swampy, mangrove and tropical rain forest, it is the traditional home of the Ijaw peoples with renowned fishing settlements, the nucleus exporters of palm kernels oil, high agricultural outputs and heavy exploitation of petroleum and Natural gas products in large deposits. Although, bedeviled by several health diseases and poverty (The daily times, 2022).

Materials

Materials used for the preparation and analysis of groundwater samples collection from various sampling stations were burettes, 250ml beaker, conical flask, distilled water, funnel, pipettes, reagents, and 2ml syringe.

Methods

Experimental method

Water samples were collected using pre-washed plastic sampling bottles at 3 different sampling stations namely Azikoro, Agbura and Otuokpoti Community respectively. The samples were collected in triplicate and mix together to form a homogeneous sample. All the samples collected were appropriately labeled and put in a cooler stuffed with ice chest and then transferred to the laboratory for analysis. The containers were pre-cleaned with warm water and soap and rinsed with double distilled water. The glass containers were washed by soaking in aqua regia (3 parts con. HCL and 1 part (HNO3) and rinsed with tap water and finally distilled water.

Sample Collection

Three (3) different sample collection points were identified as shown in Table 2. The main motive of sampling was to collect a true representative samples. The representative infers to a sample that is comparatively proportional of all pertinent components which would be the same as in the material being sampled. Three (3) sampling stations were selected dues to their peculiarity and position. Samples were collected during dry and wet seasons. Ground water samples were collected with plastic bottles. The plastic bottles were pre-washed with deionized water and dried at room temperature. The plastic bottles were rinsed severally with water at the point of collection to ensure sufficient flushing before sampling and thereafter taking to the laboratory in a cooler stuffed with ice chest devoid of unusual change that may arise in the water quality before storing in a refrigerator (4°C) till the analysis was done. Standard methods of analysis were observed as scheduled by American Public Health Association (APHA) (APHA, 2012). pH measurements was performed using Hand held Electronic meter; Hannah D1-4337 and was standardized with standard buffer solution. The Electrical Conductivity (EC) of water sample was determined using Hand held Electronic Conductivity meter Model H1-4103. At the tail end a total of Eleven Physicochemical Parameters was analyzed, these include, pH, Turbidity, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Dissolved solids (TDS), Total Suspended solids (TSS), Total Hardness (TH), Iron (Fe), Chloride (Cl), Nitrate (NO_3), and Fluoride (F), were determined using the WHO guideline for physical and chemical analysis of water quality parameters in the laboratory (WHO, 2011).

Results and Discussion

The physico-chemical parameters analyzed for Ground Water were presented in Table 1.

Table 1: Expressive Statistics on the Physico-Chemical Analysis of Groundwater Parameters

Parameters	Ground Water Sampling Stations						NSDQW Standard (2007)	WHO Standards (2011)
	Groundwater Azikoro, Agbura & Otuokpoti							
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation		
Chloride(mg/l)	20.67	1.53	23.00	2.65	25.33	1.35	250	200 mg/l
EC (µS/cm^3)	157.00	4.36	173.00	6.08	152.00	4.00	1000	500
DO(mg/l)	4.18	0.92	5.25	1.16	5.69	1.22	5	7.5 mg/l
Hardness(mg/l)	158.33	9.97	164.33	9.07	192.67	5.03	150	300
Total Iron Fe (mg/l)	1.88	0.02	2.34	0.33	2.78	0.23		0.3
TDS(mg/l)	223	13	208.67	2.52	197	9.0	500	500 mg/l
TSS(mg/l)	17.9	1.67	15.4	1.15	19.1	0.44	500	500 mg/l
Turbidity(NTU)	19.6	1.35	17.3	0.98	23.5	3.14	10	15 NTU
pH value	5.97	0.15	6.67	0.44	7.03	0.87	6.5-8.5	6.5-8.5
Nitrate (mg/l)	9.48	0.52	12.97	0.39	8.09	0.93	50	45
Fluoride (mg/l)	0.55	0.13	0.65	0.07	1.35	0.08	1.5	0.6-1.5

pH - EC = Electrical conductivity, Cl = Chloride and Fe = Iron TDS = Total dissolved solids, T.H = Total hardness, TSS = Total suspended solids, DO = Dissolved oxygen.

Table 2. Mean variations in water quality parameters by the sites of sampling

Parameters	Azikoro	Agbura	Otuokpoti
Chloride(mg/l)	20.67	23.00	25.33
EC (µS/cm^3)	157.00	173.00	152.00
DO(mg/l)	4.18	5.25	5.69
Hardness(mg/l)	158.33	164.33	192.67
Total Iron Fe (mg/l)	1.88	2.34	2.78
TDS(ms/ppt)	223	208.67	197
TSS(g)	17.9	15.4	19.1
Turbidity(NTU)	19.6	17.3	23.5
pH value	5.97	6.67	7.03
Nitrate (mg/l)	9.48	12.97	8.09
Fluoride (mg/l)	0.55	0.65	1.35

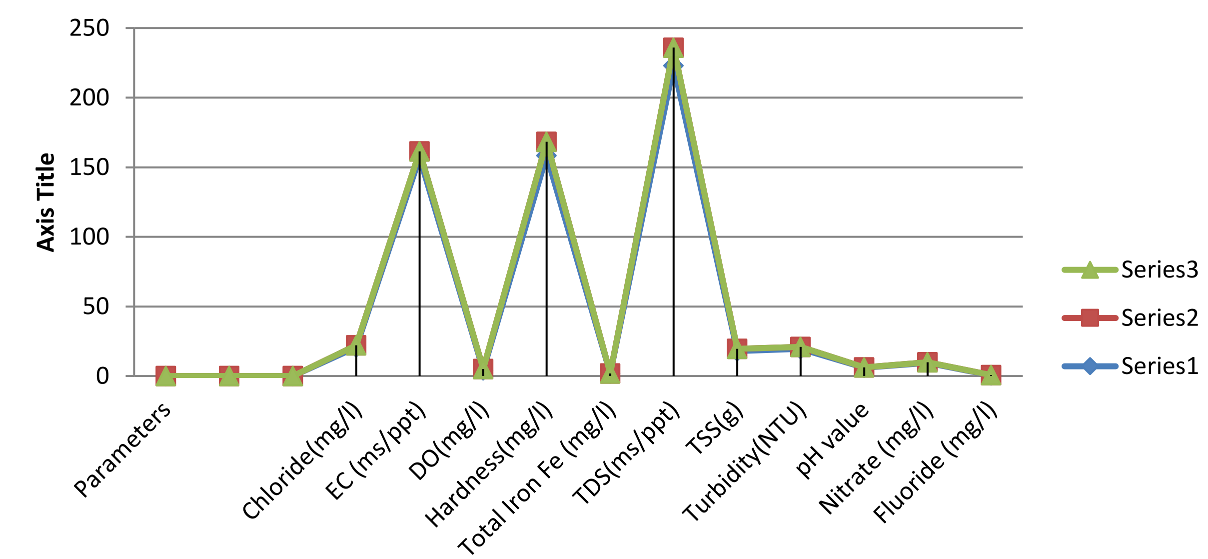

Figure 2. Mean variations in water quality parameters by the sites of sampling

Table 1 explicitly x-rayed groundwater analytical results express in Mean and Standard Deviation of all three sampling stations in comparison with WHO and NSDQW maximum limits. This research was conducted at Azikoro, Agbura and Otuokpoti Communities of Bayelsa State, South-South, Nigeria, which comprises of two (2) Local Government Areas of Ogbia and Yenagoa LGAs. Samples were collected in November for dry season and in July for wet season. Sample collection was done in the early hours of the morning. This was holistically done as a precautionary method of preventing human interference with the waters before the commencement of their normal daily activities for each day in order to stop interference which could adversely impede temperature and total dissolved solids (TDS) content. A total of three (3) boreholes samples were comprehensively analyzed for the following Physico-chemical parameters such as enlisted; pH, Turbidity, Electrical Conductivity (EC), Dissolved Oxygen (DO), Total Dissolved solids (TDS), Total Suspended solids (TSS), Total Hardness (TH), Iron (Fe), Chloride (Cl), Fluoride (F), and Nitrate (NO_3). The nutrient levels were also analyzed to determine the presence and levels of nitrates and chloride in the samples. Thus, the geographical conditions where as well measured, putting into consideration the type and kind of human activities ongoing within the proximity of 100 meters away from the sample sites at the time of sampling since it has high tendency of interference with the level and nature of pollutants. During this study, there was oscillation of pH in the analyzed results which range between 5.97 to 7.03 across the various stations. These observed results across Azikoro, Agbura and Otuokpoti communities during this research finding for pH were within WHO Stipulated guidelines for potable drinking water set at of 6.5-8.5. The results agree with that of Agbaire & Oyibo (2009). Hence, this out rightly lay to rest the overbearing burden problems associated with abrupt concentrations, since it fall within the maximum permissible limit of 6.5 to 8.5 given by NSDWQ and WHO guidelines. Holistically, it has no or minimal health insinuation with respect to pH. It could be inferred that the temperatures of the water distribution chain value of these communities using various means are within the permissible threshold of ambient temperature for both WHO and NSDWQ. Thus, the concentrations of Fluoride were shown to be within the range of 0.55mg/l and 1.35mg/l which was approximately the same with the approved maximum limit of 1.5 mg/l for both NSDQW and WHO but not higher. Contrarily, these results were far much higher than that of Egbo and Ikele (2023) whose work was similar to this research. Whereas, results obtained from table 1 above as shown for Total Hardness, can be construe that there were abrupt increase in concentrations of water hardness from one community to another in that their geographical position differ a bit from each other, Onu (2024). Although far much higher than the maximum permissible limits given by NSDWQ at 150mg/l but still within WHO limit of 300 mg/l. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) values analyzed for groundwater chain value ranges from 197 mg/l and 223 mg/l and 15.4 mg/l and 19.1mg/l respectively. The health implications are not detrimental since the values of TDS were lesser than the permissible limits of 500mg/l and 500 mg/l, for both NSDQW and WHO standard, the low figures obtained for TDS and TSS might be as a result of few industrial discharges within the research locality. The result of the electrical conductivity portray that the EC values for the duration of the study across the various sampling stations collectively as publicized in Table 1, was far below the NSDWQ and WHO maximum permissible limits for human existence. Chindo et al. (2013) on the other hand x-rayed Electrical conductivity as a gauge of hardness, alkalinity value and dissolved solids. He stated that conductivity is proportional to the dissolve solids. The concentrations of Chloride (Cl-) as observed from the analysis were shown to be within the range of 20.67mg/l and 25.33mg/l, which, however were seen to be higher than the results gotten by Edori et al. (2021). Even though, Iron (Fe) concentrations range between 1.88mg/l and 2.78mg/l which was deduces to be far higher than it approved limits of 0.3 mg/l given by WHO Permissible limits for potable drinking water sources (Amolo and Kokobaikeme, 2023). There was a significant trace of Nitrate (NO_3) concentrations across the various sampling stations within the selected communities raging from 9.48mg/l and 12.97mg/l, which were observed to be lower than Edori et al. (2020) and the maximum permissible limit guidance level for WHO. Dissolved Oxygen (DO) recorded concentrations within the permissible limit of WHO (7.5mg/l) maximum limits across the three sampling stations with concentrations of 4.18mg/l and 5.69mg/l respectively. Although far much higher than the required limit as stipulated by NSDWQ (5mg/l) standard. The maximum concentrations of Turbidity was actually recorded at Otuokpoti Community which range between 17.3 NTU and 23.5 NTU which were far much above NSDWQ standard of 10NTU and WHO permissible limits of 15NTU respectively. This abrupt rise in turbidity value of the analyzed water might be relatively due to the occurrence of colloidal and fine particles detached in water. Some of these detrimental effects as a of high turbidity figures is the avoidance on light diffusion, that causes poisonous effect on aquatic flora and fauna and thereby downgrading of water quality.

Conclusion

This research work explicitly scrutinizes groundwater samples collected for some selected physic-chemica parameters. The values of Cl, DO, EC, F, NO_3, pH, TDS, TH, and TSS values analyzed during the cause of this research work conform with the minimum limits guidelines set by WHO. Whereas, the concentrations of Fe and Turbidity range between 1.88mg/l to 2.78mg/l and 17.3 NTU to 23.5 NTU respectively that was above the predetermined guidelines set by WHO and NSDWQ. This is a wakeup call to the three tier of government and private establishment to forthwith treat properly their wastes water before discarding it, in other to prevent them from percolate into groundwater layers which quenches our endless taste for potable water intake.

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