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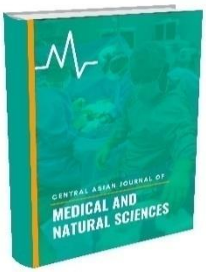

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Hydrochemical Evaluation and Coliform Assessments of Gruondwater for Domestic Use in Ekeki Yenagoa, Yenagoa Local Government Area, Bayelsa State, Nigeria

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Abstract: Seven groundwater samples were taken from seven different boreholes in Ekeki, Yenagaa, Bayelsa State. The goal of this research was to find out if the groundwater was safe for human consumption. We looked at eighteen different physicochemical parameters and compared them to the standards set by WHO in 2011. Findings indicate that electrical conductivity can be as low as 60.40 scm-1 and as high as 238 scm-1, and that pH can range from 480 to 556 millimolar. Salinity in the study area varies from 0.02 to 0.11 mg/l, turbidity from 0.058 to 25.72 mg/l, and total dissolved solids (TDS) from 30.20 to 119 mg/l. The ocean provides these qualities. The anions were tested, and the results showed concentrations of chloride between 3.0 and 21.0 mg/l, sulfate between 3.2 and 5.48 mg/l, and nitrate between 0.135 and 0.329 mg/l. The four most common cations measured in groundwater are calcium, magnesium, sodium, and potassium. There is a wide variation in their individual concentrations: 7.32–12.48 mg/l, 2.65–3.40 mg/l, 4.17–6.34 mg/l, and 0.85–2.41 mg/l. Iron, manganese, and heavy metal concentrations range from 0.32 mg/l to 2.90 mg/l and from 0.01 mg/l to 0.038 mg/l, respectively. Dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand were also calculated (COD). Concentration ranges for these three variables were as follows: 4.83–5.44.8 mg/l, 88–124.8 mg/l, and 119–185.62 mg/l. The water met all of the World Health Organization's criteria for potability except for the iron, turbidity, and biological oxygen demand (BOD) (WHO, 2011). There should be coliform treatment in both the second and third boreholes.

Key words: Groundwater, Coliform count, WHO standard, physio-chemical parameters.

INTRODUCTION

The availability of groundwater is crucial to human survival. In addition to being utilized in agricultural practices and industrial processes, it is the source of drinking water for more than half of the world's population. Surface water in the Niger Delta region of Nigeria has become polluted as a result of ineffective waste management practices and oil spills. Both the availability of clean water to the locals and the quality of the land for agricultural use have suffered as a direct result of this. Both residential and commercial water supplies in Ekeki are heavily dependent on water drawn from wells and boreholes for their day-to-day operations. It is imperative, for the sake of the Ekeki people, to determine whether or not groundwater can be used as a suitable alternative to surface water in a manner that is risk-free.

LOCATION OF STUDY AREA

The community of Ekeki can be found in Nigeria's Bayelsa State, specifically in the Yenagoa Local Government Area. Its coordinates are 0.407909113 degrees north latitude and 0.0070132039 degrees west longitude. It is a community that is extremely well-connected, with a vast network of roads and rivers (Fig. 1). Wet and dry seasons characterize the climate of the Ekeki Community, which is similar to that of a tropical rainforest. The wet season, which lasts from April to October, is characterized by heavy rainfall. November through March is the dry season, when temperatures are high and precipitation is rare. The average annual rainfall in the Ekeki area is close to 4000 millimeters. Most of the precipitation falls during the rainy season, but it can also fall during the dry season. The wettest time of year is the rainy season. Ekeki has an average annual temperature of 30 degrees Celsius and a high level of humidity. Tertiary time saw the formation of the Niger Delta Basin, where modern-day Ekeki now sits. The basin was formed due to a combination of subsidence and sediment deposition (Short and Stauble 1967). After several transgression and regression cycles, the Atlantic Ocean deposited these sediments on land (Reyment 1965). The geology of the Ekeki region is largely determined by the Benin Formation, a coarse sand unit with lenses and clay bands. The sand is made up of particles of varying sizes because it has not been sorted very well. A multi-aquifer system has formed as a result of the mixing of sand and clay found in the area (Murat 1970). According to Amajor (1991), the Benin Formation is the most important stratigraphic unit in the Niger Delta region in terms of the aquifers that it contains. This information was gleaned from analyzing the rock's composition. The sand matrix that makes up the Benin Formation is permeable, which means that it does not restrict the movement of liquids like water through it. This property is what gives the Benin Formation its name. The lenses and clay bands that can be discovered within the Benin Formation are examples of confining layers. Aquifers are the underground reservoirs that are responsible for storing water; these layers help to keep them underground. A steady supply of groundwater is made available to Ekeki as a result of the existence of multiple aquifer systems in the area. This is an extremely valuable resource. The term "potable water" refers to the water that can be consumed by humans, while "irrigation water" and "household water" are both types of uses for groundwater.

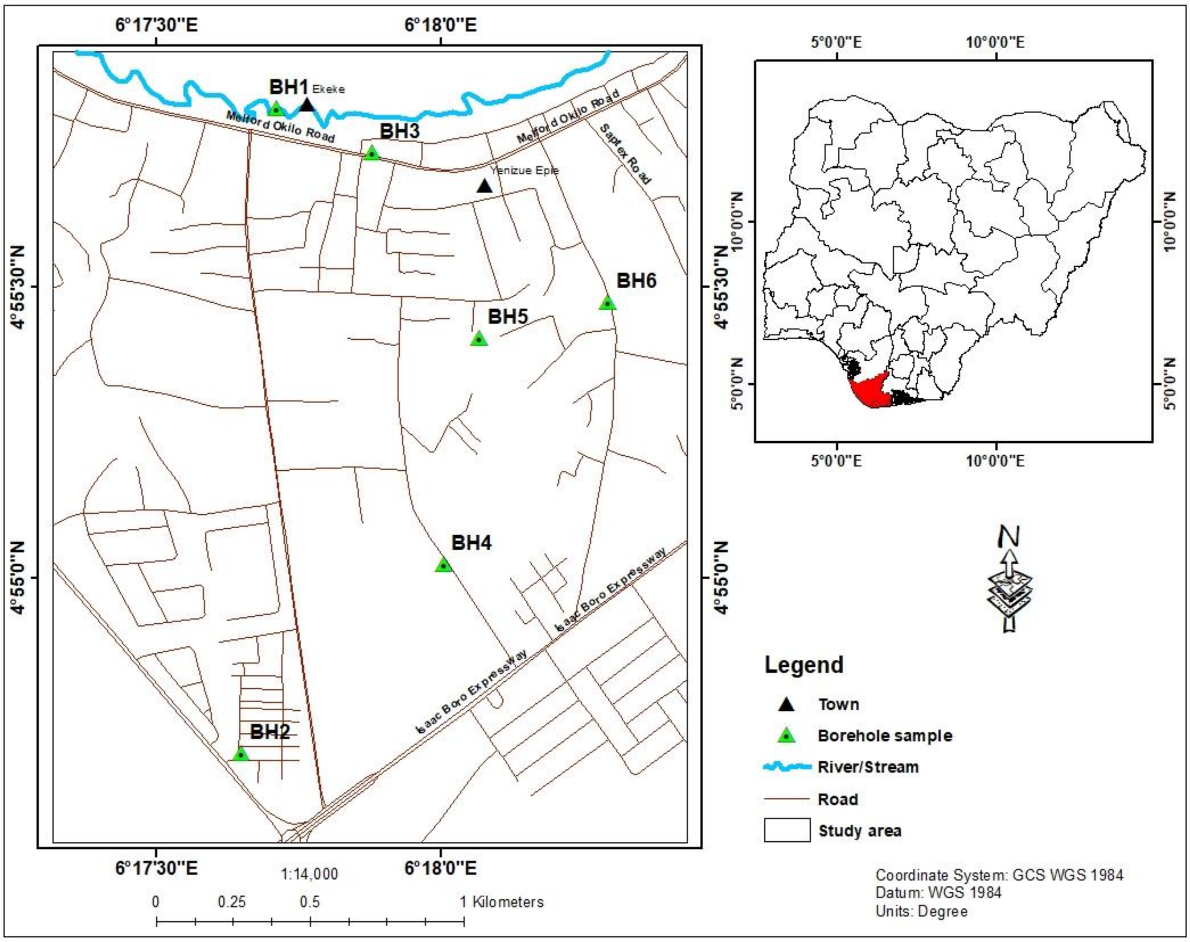


Fig 1: Map showing the study area

METHODOLOGY

All of the water samples that were analyzed for this investigation were gathered in a manner that was compliant with the criteria and analysis methods that were sanctioned by the World Health Organization (WHO) in 2011. This was done to ensure that the obtained results could be trusted, and it succeeded admirably in this regard. In this investigation, groundwater samples were taken from seven separate boreholes. The sink was left open for five to fifteen minutes to drain the accumulated water before samples were taken. At the wellhead, the samples were placed in sterile plastic bottles for transport. In order to prevent any oxidation of the liquid that was already contained within the bottles, the corks were inserted into them as soon as the bottles were filled. The samples were then stored in a refrigerator at four degrees Celsius until they were brought into the lab for analysis.

Field Methods

The samples of groundwater were taken and processed in the field using the following methods:

A portable, previously calibrated meter was used to take readings of the sample's temperature, pH, and electrical conductivity (EC) on the spot.

Each sample's turbidity was measured on-site with a portable, previously calibrated turbidimeter.

We measured the concentration of dissolved oxygen (DO) in each sample in the field using a portable, calibrated DO meter.

Laboratory Methods

The following analytical procedures were carried out in the laboratory on the groundwater samples:

Ion chromatography was utilized so that the major ions could be identified. These ions included calcium, magnesium, sodium, potassium, chloride, sulfate, and nitrate.

Inductively coupled plasma mass spectrometry (ICP-MS) was utilized in order to ascertain the levels of trace metals (iron and manganese).

The membrane filtration method was utilized in order to ascertain the total coliform.

RESULTS AND DISSCUSSION

The temperature has an average value of 300 °C in the study area. The unit started by WHO is "ambient." pH concentrations in the study area range from 5.34 to 5.44. Borehole 7 has the lowest value of 5.32, while borehole 5 has the highest value of 5.44. These values show a slightly acidic to basic pH in the area. The WHO value for this parameter is 6.5–8.5.

Conductivity figures in the study area range from 235-238 mg/l. Borehole 1 has the lowest value of 235 mg/l, while boreholes 1 and 4 have the highest values of 238 mg/l. WHO permissible value for conductivity for drinking water: 400 mg/l

TDS concentrations in the study area ranged from 117 to 12 milligrams per liter. The 117 mg/l found in bore hole 6 was the lowest of any of the holes. The maximum concentration was discovered in well 4 (120 mg/l). The World Health Organization established a threshold of 1000 mg/l in their report from 2011. This means the water can be safely consumed at home and other similar establishments.

Nitrate (NO3) levels in the area under study average between 0.20 and 0.22 mg/l. Borehole 5 has the lowest concentration, at 0.20 mg/l, while boreholes 2 and 7 have the highest, at 0.21 and 0.219 mg/l. WHO established a threshold of 10.0 mg/l in 2011. This indicates that the concentrations discovered in the groundwater samples are reasonable. Nitrate ions are a biochemically absorbable form of nitrogen that plants can use to synthesize the amino acids that form the structural backbone of proteins.

The area that was looked into had iron levels that were between 2.75 mg/l and 2.9 mg/l, which were all higher than the 0.30 mg/l limit set by the WHO in 2011. It's not safe for human consumption, so don't go drinking that water. As the element with the highest abundance in the Earth's crust and the second highest abundance in groundwater, the metal iron is ubiquitous. The oxygen-carrying red blood cells need iron to function properly.

The chloride concentration in the research area ranges from 20.0 mg/L to 20.58 mg/L. The observed values are considerably below the World Health Organization's (WHO) threshold of 250 mg/l. The water appears to be fit for both drinking and cooking. Chloride can enter the water supply through naturally chloride-rich rocks, agricultural runoff, industrial wastewater, oil well effluent, and treatment plant effluent. Chlorine has the potential to alter the flavor of food and cause metals to rust. Too much chloride in the water is fatal to fish and other aquatic organisms.

Bore hole 1 had 3.18 mg/l of manganese and bore hole 5 had 3.42 mg/l of manganese; overall, manganese concentrations in the study area ranged from 0.032 mg/l to 0.038 mg/l. We found concentrations below the WHO's recommended maximum of 50 mg/l. This means that the water is safe for drinking and cooking. Damage to the nervous system may result from manganese overdose.

Groundwater samples in the study area have BOD concentrations greater than the 2011 World Health Organization (WHO) limit of 30 mg/l. A high biochemical oxygen demand (BOD) indicates highly polluted water, while a low BOD indicates that the water is suitable for human consumption. The values suggest that the groundwater is not suitable for human consumption, so people should avoid it.

The measured DO concentrations in the study region are between 4.2 and 4.8 mg/l. The World Health Organization (WHO) recommends a DO level of 6.5 to 9.5 mg/L. The water's high quality makes it safe to consume. Since aquatic organisms need oxygen to breathe, the oxygen level in the water may decrease when they are present. Dissolved oxygen levels above 14 mg/l are considered unhealthy for fish and other aquatic organisms. Photosynthesis, aeration, and diffusion are some of the processes that bring oxygen from the air into the water

Table 2: Result of Physiochemical Analysis of Groundwater Sample (Mg/L)

S/N	Sample Code	GPS Coordinates	Ph	SA1	COND	TURB	TDS	TSS	$N0_3$	Cl	SO_4	Ca	Mg	Na	K	DO	BOD	COD	Mm	Fe	C0lif0rm
1	BH_1	4° 54' 46" N 6° 17' 41" E	5.38	0.11	238	25.72	119	2.52	0.217	20.0	4.54	13.45	3.18	7.24	1.56	4.87	12.46	185.58	0.034	2.84	10
2	BH_2	4° 54′ 30″ N 6° 17′ 42″ E	5.40	0.10	237	25.70	118	2.50	0.219	21.0	4.52	13.57	3.40	7.78	1.70	4.85	12.48	185.68	0.036	2.82	15
3	BH_3	4° 55′ 00″ N 6° 17′ 41″ E	5.42	0.09	236	25.68	118	2.48	0.215	19.0	4.56	13.68	3.20	7.36	1.60	4.83	12.44	185.62	0.038	2.86	12
4	BH_4	4° 55′ 03″ N 6° 17′ 43″ E	5.36	0.12	238	25.70	120	2.50	0.218	19.58	4.54	13.50	3.26	7.48	1.50	4.80	12.45	185.70	0.036	2.84	9
5	BH_5	4° 55′ 06″ N 6° 17′ 41″ E	5.44	0.10	235	25.72	119	2.52	0.20	20.25	4.27	13.55	3.42	7.55	1.64	4.89	12.39	185.60	0.034	2.86	8
6	BH_6	4° 55′09″ N 6° 17′ 41″ E	5.38	0.13	236	25.65	117	2.48	0.217	20.0	4.56	13.68	3.20	7.60	1.70	4.90	12.36	185.68	0.038	2.84	9
7	BH_7	4°55′12″ N 6°17′42″E	5.32	0.11	237	25.71	118	2.54	0.219	21.0	4.50	13.65	3.36	7.40	1.60	4.56	12.50	186.20	0.032	2.88	5
	Range		5.32-5.44	0.09 - 1.30	235 - 238	25.65 - 25.72	117-120	2.48-2.54	0.20-0.219	20.0-20.58	4.27-2.56	13.54-13.68	3.18-3.48	7.24-7.78	1.50-1.70	4.56-4.90	12.50-12.59	186.20-186.70	0.032-0.038	2.82-2.88	5-15
	WHO 2011		6.5-8.5	200-250	400	5 NTU	1000	500	10	250	250	100	50	200	20	6.5-9.5	3.0	250-400	0.1-0.5	0.3	10

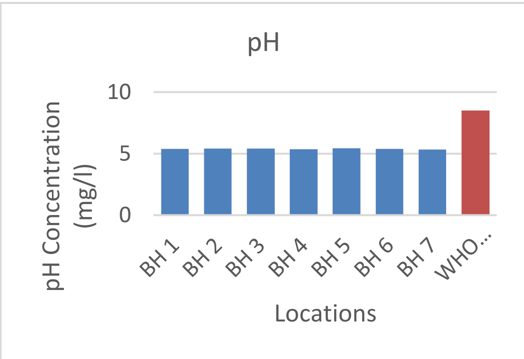


Fig.2: pH Graph

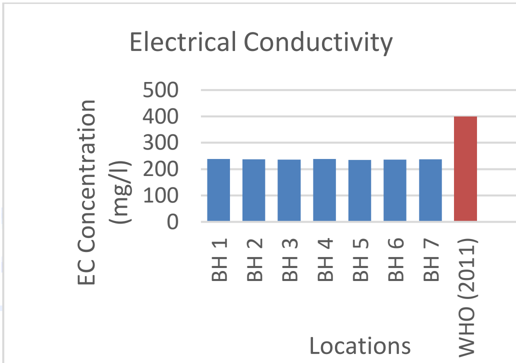


Fig.3: Conductivity graph

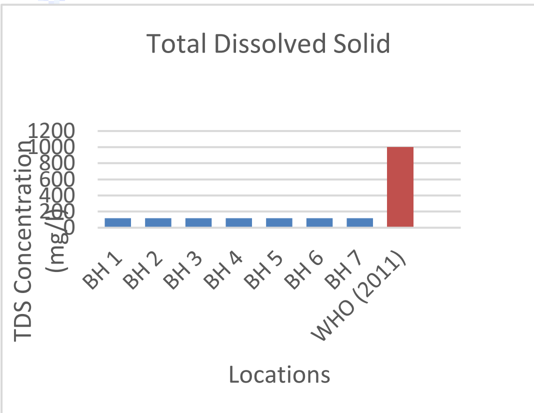


Fig. 4 (TDS) Graph

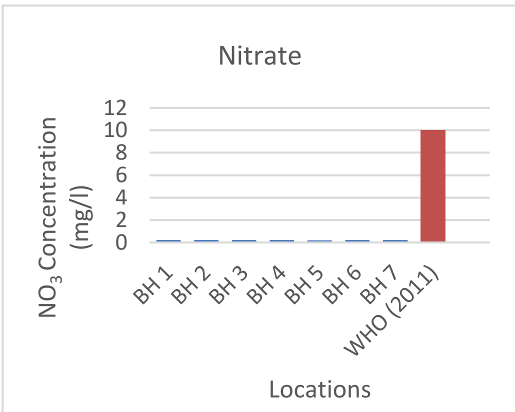


Fig.5: Nitrate (NO_3) graph

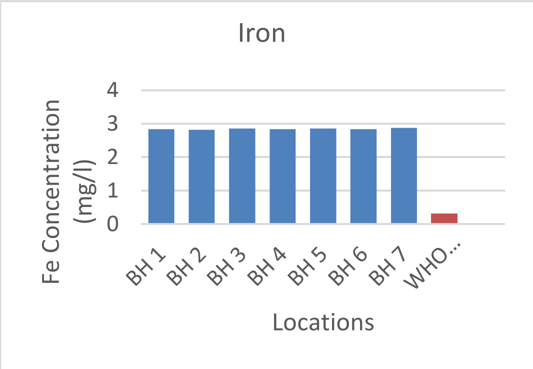


Fig.6: Iron Graph

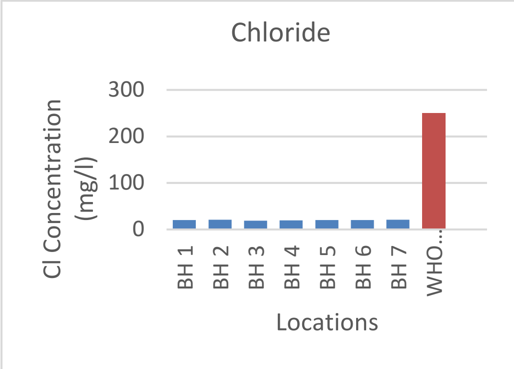


Fig.7: Chloride Graph

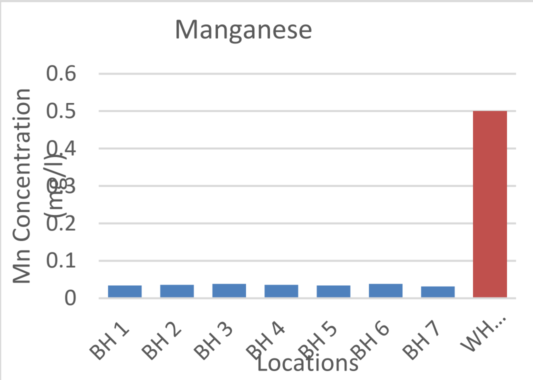


Fig.8: Manganese graph

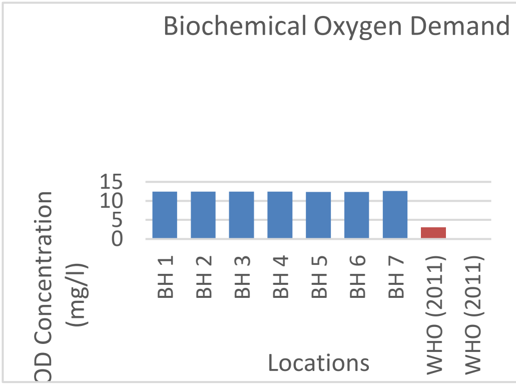
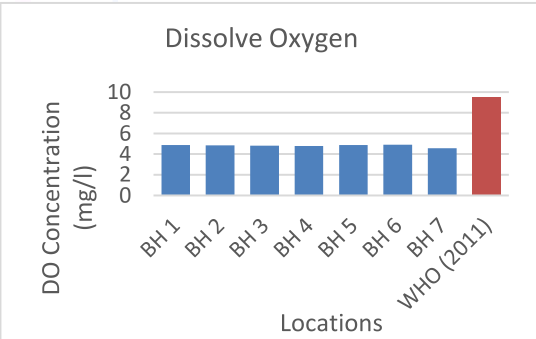


Fig.9: graph BOD



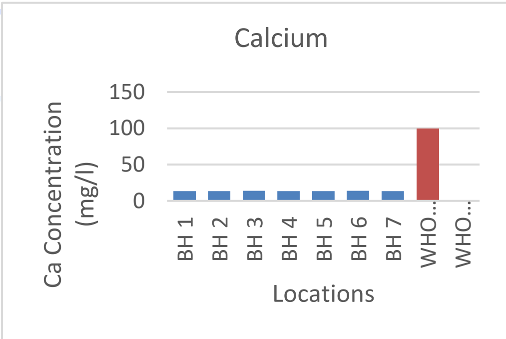


Fig.10: DO Graph Fig.11: Calcium Graph

Calcium concentrations in the Ekeki borehole have been measured to be between 13.52 and 13.68 milligrams per liter. These concentrations are well below the maximum allowable by the World Health Organization (2011) of 60 to 120 mg/l, so it is safe to drink. Soap has a more difficult time lathering in calcium-hardened water. By decreasing the amount of calcium and magnesium in the water, a water softener makes the water more pleasant to drink and easier on the skin.

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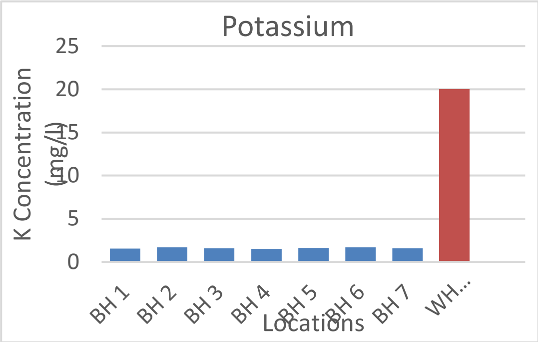

Fig.12: Potassium Graph

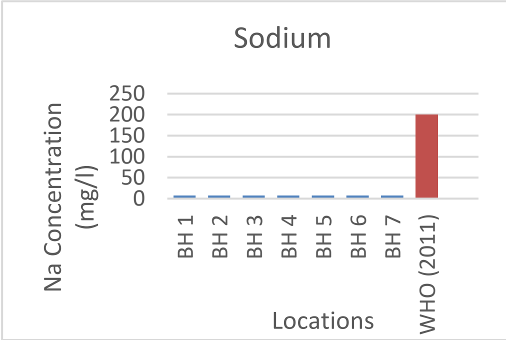

Fig.13: Sodium Graph

Potassium concentrations in Ekeki bore holes range from 1.4% to 1.7% by volume. The water is safe for consumption in homes and other similar settings because the levels are below the WHO (2011) recommended maximum of 20 mg/l.

Bore holes in Ekeki have been found to contain between 6.8 and 7.8 milligrams of sodium per liter. The water is safe to drink because the measured concentrations were well below the WHO's (2011) advisory range of 20-200 mg/l.

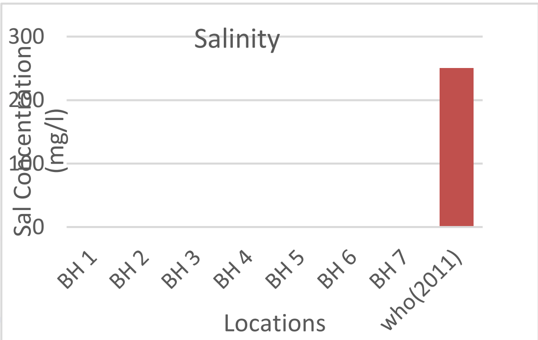

Fig.14: Salinity Graph

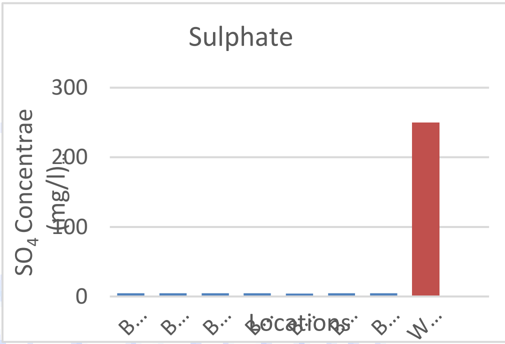

Fig.15: Sulfate graph

The average concentration of salt in the water in the study area is 1.30 mg/L. The observed values are significantly lower than the WHO's recommended upper limit of 250 mg/l. This indicates that the water is suitable for human consumption in a variety of settings. Salinity in water may come from rainfall and the weathering of rocks; salt remains after the ocean has retreated. Salt concentration in rainfall areas is higher in coastline areas than hindered land.

Sulfate concentrations in the study area range from 4.1 to 4.6 mg/l. The measured concentrations are lower than the maximum allowable level of 250 mg/l established by the World Health Organization in 2011. A high level of sulfate in the water may make the taste bitter. High sulfate levels may corrode copper plumbing lines. Sulfate mineral water can be used for the treatment of chronic inflammation and irritation of the respiratory tract. Sulfate can be used for food preservation. Sulfate gets into water from mines and smelters, kraft pulp, and rocks and soils.

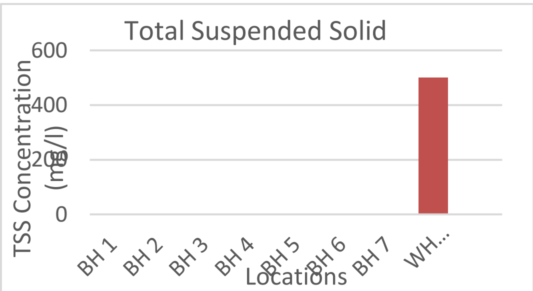

Fig.16: TSS Graph

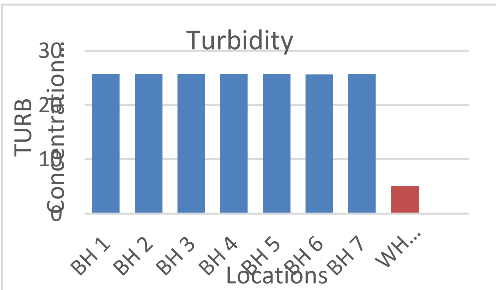

Fig.17: Turbidity Graph4

The range of allowable total suspended solids (TSS) concentrations in water is 2.48–2.54 mg/l. The concentrations of TDS that were measured are much lower than the 500 mg/l limit set by the WHO in 2011. This ensures that water in residences and other similar settings is fit for human consumption. TDS and TSS levels above a certain threshold indicate that the water is not fit for human consumption because of the risk of skin and lung irritation and fainting.

The turbidity in the area under observation ranges from 25.6 to 25.74 NTU. According to the World Health Organization, this level is unsafe for human consumption in drinking water. WHO (2011): Five NTUs is the maximum allowed in potable water. The standard for measuring turbidity is the nephelometric unit (NTU). The presence of harmful microorganisms in water can be determined by its turbidity.

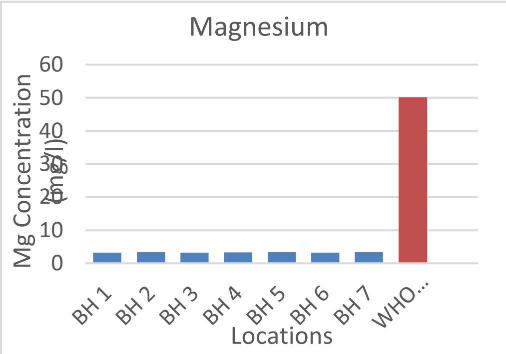

Fig.18: Magnesium Graph

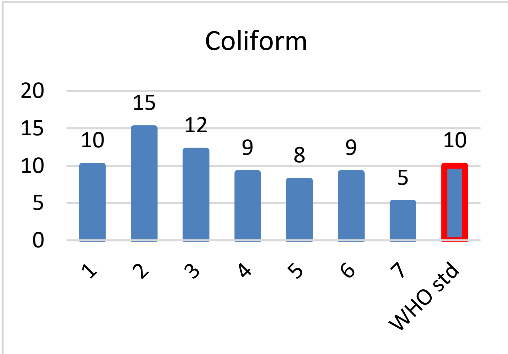

Fig.19: Coliform graph

The average magnesium concentration in the study area is 3.5 mg/l. Results are below the World Health Organization's 2011 target range of 10–30 mg/l. The water can now be used for both drinking and cooking without fear of illness. . Magnesium increases hardness in water, making soap not foam well. Hardness can lead to digestive problems in humans. Magnesium oxide can be used for water treatment. Magnesium hydroxide removes heavy metals from water and improves alkalinity. The addition of water softener makes water soft. Groundwater picks up magnesium ions from soils and rocks.

Coliform counts in the study area range from 5 to 15. Bore hole 5 has the lowest concentration of coliform, while bore hole 2 has the highest concentration. WHO stipulated a value of 10. Water boreholes 2 and 5 are not for drinking.

CONCLUSION

In 2011, the World Health Organization (WHO) established guidelines for safe drinking water, and most of the parameters measured in groundwater samples collected from the Ekeki Community in Nigeria were found to have concentrations that were well below those guidelines. However, coliform bacteria, iron, turbidity, and biochemical oxygen demand were all found to be above acceptable levels in the contents of some boreholes (BOD).

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