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PHYSICOCHEMICAL AND BACTERIOLOGICAL ASSESSMENT OF GROUNDWATER QUALITY IN UGHELLI AND ITS ENVIRONS, DELTA STATE NIGERIA

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ABSTRACT: Groundwater samples were collected from Otovwodo-Ughelli and environ with the aim of assessing groundwater quality of the area. Twenty (20) water samples from Boreholes (BH) (six) and Hand dug wells (HDW) (fourteen) were randomly sampled and were analysed for different physiochemical and bacteriological parameters. The following 16 parameters have been considered viz: pH, Electrical Conductivity, temperature, Total hardness, Total Dissolved Solids, dissolved oxygen, Biological Oxygen Demand, phosphate, sulphate, chloride, nitrate, calcium, sodium, chloride, magnesium and Total Suspended Solids. On comparing the results against drinking quality standards laid by World Health Organization and Nigeria Industrial Standard, it was found that the water quality parameters were not above the (WHO, 2011 and NIS, 2007) permissible limit. Microbial analysis reveals the presence of coliform and E.coli in two hand-dug well (HDW7 and 13) and one borehole well (BH20). These contaminations are perhaps traceable to have originated from human activities (Septic tanks, latrines, dumpsites) and have affected the quality of groundwater in Otovwodo-Ughelli. From the Piper trilinear diagram, the dominant ionic specie is alkali bicarbonate water type, with bicarbonate as the predominant ion ($Na^+ + K^+$) - HCO_3^-.

KEYWORDS: Groundwater, Pollution, Ughelli, Nigeria Industrial Standard and WHO Standard.

1 INTRODUCTION

Water has always been an important and life-sustaining drink to humans and is essential for the survival of all known organisms (Greenhalgh, 2001). About 80% of the earth surface is covered by water out of which only a small fraction is available for consumption. The rest is locked up in oceans as salt water, polar ice caps, glaciers and underground (Lamb, 1985). Groundwater is already used throughout the world through wells and boreholes. Groundwater is a reliable source of water supply, because it is often unpolluted due to restricted movement of pollutants in the soil profile (Dara, 1995). Groundwater is both important to the rural and urban dwellers. The three (3) main problems man contend with is, little water, too much water and polluted water (Ayoade, 1988, and Adebola, 2001). Water which is a vital resource of life is increasingly being polluted in wake of modern civilization, industrialization, urbanization and population growth, poor land use system, agricultural activities, that had led to fast degradation of our ground water quality as well several other anthropogenic activities that are impacting on the environment (Adeyeye et al., 2004).

The desirability of water resources evaluation becomes most evident when it is recalled that the resource is heavily impacted by both natural and anthropogenic pollution incidences (Akakuru et al., 2013). Moreso since water is necessary for the daily activities of animals and humans, however increase in population has led to increase in demand for potable water; inhabitants of the area depend solely on groundwater for domestic and other uses (Eyankware et al., 2014) .In the same vein, both the quantity and quality of water are affected by an increase in anthropogenic activities and any pollution either physical or chemical causes changes to the quality of the receiving water body (Aremu et al., 2011). Chemical contaminants occur in drinking water throughout the world which could possibly threaten human health. This has led to the assessment of groundwater potability of Ughelli.

This study aims at assessing the physicochemical and bacteriological assessment of groundwater quality in Ughelli, Ughelli North local government area of Delta state.

1.1 Location And Climate Of Study Area

The study area lies between longitude $6^0$05'E to $6^0$22'E and latitude $5^0$35'N to $5^0$50'N. The study area is Otovwodo-Ughelli, Delta State.

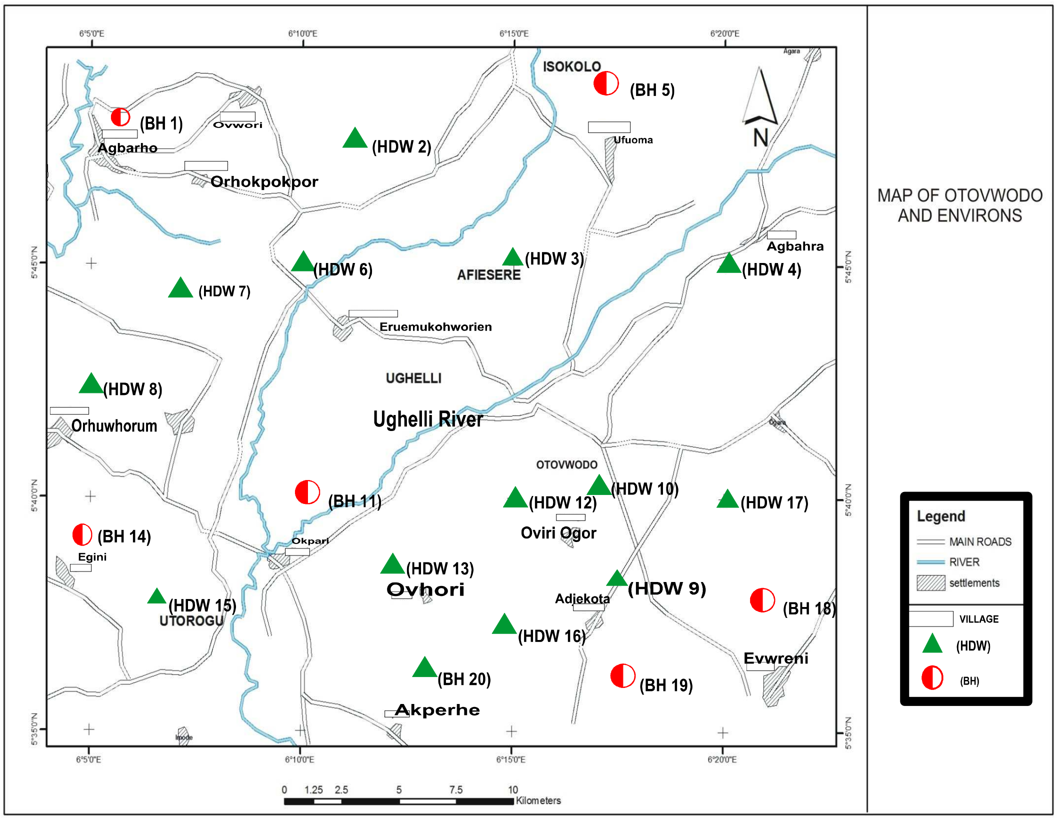

Figure 1: Map of Otovwodo and Environ Showing Borehole and Hand-dug well Site.

2 Geologic Setting

The subsurface geology of the Niger Delta basin to which Otovwodo-Ughelli belongs is well established as shown in Figure.1. The basin fill is made up of three Formations, namely from the oldest to the youngest Akata, Agbada and Benin Formations. The Akata formation is composed of continuous shale and about 10% sandstone. The shale is believed to be over pressured and under-compacted. It ranges from Eocene to Recent and was deposited under marine conditions. Agbada Formation comfortably overlies the Akata Formation (C.S Nwajide, 2006; Murat,1970; Asseez, 1989; Short et al., 1967; Frank et al., 1967). It is a parallic sequence of alternating shale and sandstone with variable age ranging from Eocene in the north to Pliocene/Pleistocene in the south, and Recent in the Delta surface. Its lateral equivalent at the surface, the Ogwashi-Asaba Formation and Ameki Formation are of Eocene – Oligocene age. The continental Miocene-Recent Benin Formation conformably overlies the Agbada Formation. It is composed of 90% sands and about 10% shale/clays; the sand ranges from gravelly, coarse to fine grained (Akpoborie et al., 2011).

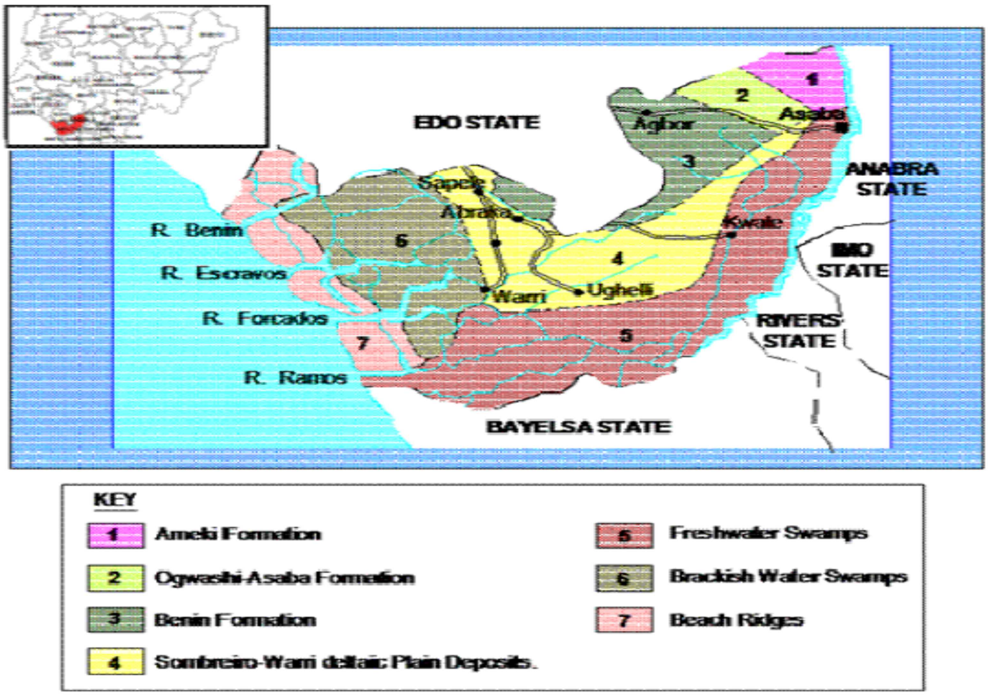

Figure 2: Geological Map of Delta State (Adapted from NGSA, 2004).

3 METHODOLOGY

3.1 MATERIALS AND METHODS

Samples collection twenty drinking water samples were collected from different drinking water sources viz., tap, borehole and hand-dug well, Ughelli in autoclaved bottles (1 litre capacity) under aseptic conditions. The pH of the sample was measured immediately after sampling and stored in refrigerator for further assessment of their physiochemical and bacteriological examination.

3.2 PHYSICOCHEMICAL ASSESSMENT

Physical and chemical parameters of water samples were tested by using multi parameter water testing kit method APHA, 1989. Various physicochemical parameters: PH, temperature, Total dissolved solid (TDS), Electrical conductivity, DO, BOD, Total hardness, Calcium, Magnesium, Sodium, Total Dissolves solvent, Chloride, Bicarbonate, Sulphate, Phosphate and Nitrate

3.3 BACTERIOLOGICAL ASSESSMENT

The bacteriological examination of water samples were assessed by MPN test and total plate count method (Batterman et al., 2000). Total plate count can indicate the total count of bacteria in water, purification treatment efficiency, and the polluted degree of pipes. Too high total bacterial the water has already been polluted by microbes (Batterman et al,, 2000). Therefore, total plate count is an important parameter indicating whether the drinking water has been polluted by microbes, and can be used essentially to assess the disinfection effect. Drinking water with a total plate count of 100–500 Cfu/ml will harm the health of human beings APHA, 1998.

4 RESULT

Table 1. Result of the Physicochemical Analysis of Water samples

Sample code	pH	Temp	TDS	Electrical Cond	DO	BOD	Total Hardness	Ca	Mg	Na	TSS	Chloride	Bicarbonate	Sulphate	Phosphate	Nitrate
		(°c)	(mg/l)	(µs/cm)	(mg/)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
BH1	6.41	29.2	7	14.01	3.20	1.10	1.74	5.21	0.05	0.17	6.13	3.06	1.93	0.16	BDL	BDL
HDW2	6.58	29.3	20	39.60	4.00	2.00	8.95	0.68	0.03	2.02	5.37	10.55	6.49	0.85	0.07	0.01
HDW3	6.05	29.4	68	136.60	3.70	1.70	27.72	9.52	1.19	6.63	7.19	38.76	15.25	1.76	0.06	0.02
HDW4	6.73	29.6	4	8.90	3.90	1.80	1.12	0.29	0.05	1.11	6.54	2.78	1.17	0.33	0.01	BDL
BH5	6.91	29.7	87	122.8	3.60	2.10	32.41	15.98	1.41	9.62	7.23	37.04	13.40	2.89	0.14	0.03
HDW 6	6.98	29.4	18	34.90	3.00	1.20	9.13	2.14	0.72	2.23	7.84	9.13	4.52	1.65	0.08	0.05
HDW 7	6.22	30.2	51	101.20	4.20	1.60	26.18	11.07	1.95	7.71	7.19	20.05	10.18	2.28	0.12	BDL
HDW 8	7.01	29.6	136	271.01	4.50	2.20	41.76	18.42	2.29	11.08	6.12	52.56	30.71	4.42	0.49	0.05
HDW 9	6.18	31.6	13	24.77	3.60	2.80	7.19	3.06	0.27	1.28	6.18	5.06	2.15	0.49	BDL	BDL
HDW 10	6.65	31.9	10	18.96	4.10	1.80	3.38	1.43	BDL	0.11	7.08	2.56	1.68	0.06	BDL	0.01
BH11	6.17	31.2	63	119.74	3.50	1.50	19.74	8.83	0.91	12.72	6.85	28.34	11.82	1.53	0.11	0.03
HDW 12	6.36	29.2	27	51.33	3.60	2.00	7.95	3.06	0.56	6.36	9.24	15.60	9.40	0.94	0.02	BDL
HDW 13	6.13	32.1	23	43.72	4.40	1.80	6.43	2.92	0.37	4.51	12.75	11.30	7.51	0.68	0.05	0.02
BH14	6.55	29.2	142	284.3	3.70	1.60	54.91	23.85	6.14	16.34	5.86	65.82	24.12	7.16	0.81	0.02
HDW 15	6.83	29.1	68	104.60	3.40	1.30	29.76	14.13	3.61	9.86	6.21	22.09	12.41	3.19	0.67	0.02
HDW 16	6.72	29.6	7	13.50	3.80	1.20	1.94	0.42	0.08	0.17	11.68	3.12	2.75	0.21	0.03	BDL
HDW 17	6.40	29.3	24	47.70	3.30	1.10	13.04	3.97	0.74	3.68	6.39	10.81	5.50	0.93	0.11	0.02
BH18	6.64	29.5	5	10.60	3.80	1.90	1.36	0.29	0.13	0.09	5.17	2.95	1.54	0.16	BDL	BDL
HDW19	6.45	29.6	10	20.70	4.30	2.20	3.49	0.68	0,11	0.61	8.32	4.13	3.42	0.29	0.03	0.01
BH20	6.53	28.9	22	44.10	3.60	1.20	10.31	5.21	1.27	5.03	7.18	12.78	6.15	1.32	0.10	0.06
NIS (2007)	6.5-8.5	Ambient	500	1000	-	-	150	100	0.2	200	30	250	500	100	-	50
WHO, (2011) Permissible Limit	6.5-8.5	24	500	1000	7.5	6-9	250	200	250	500	10	200	100	200	10	50

***HDW**- (Hand-dug well), **BH**- (borehole), **mg/l**- (Milligram per litre). **TSS**-(Total Dissolved Solid), **BOD**-(Biological Oxygen Demand), **DO**-(dissolved oxygen) and **TSS**- (Total Suspended Solids)*

BH1= Close Mr. Eyankware Compound in Agbarho community ,HDW2= Orhokpokpor , HDW3= Afiesere ,HDW4=Agbahara ,BH5= Isokolo, HDW6= Isokolo II , HDW7= Afiesere II ,HDW8= Orhuwhorum , ,HDW9= Adjekota ,HDW10= Ehrue Estate, Otovwodo , BH11= Upper Agbarho street Otovowodo, HDW12= Oviri Ogor ,HDW13=Ovhori, BH14= Egini ,HDW15=Utorogu ,HDW16= Adjekota ,HDW17= Oviri Ogor II , BH18= Evwereni ,HDW19= Evwereni II and BH20= Akperhe

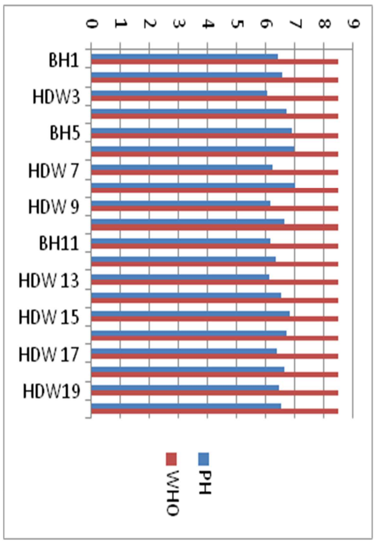

Figure 3a: A Graphical Representation of pH Against (WHO,2011)

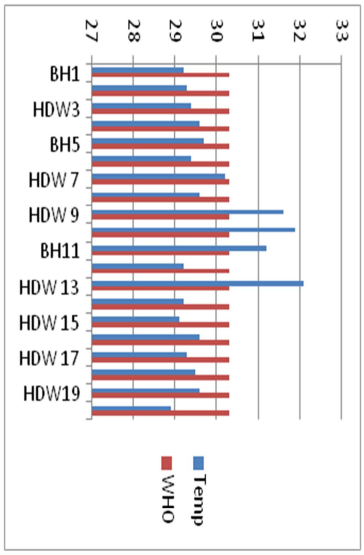

Figure 3b : A Graphical Representation of Temperature Against (WHO, 2011)

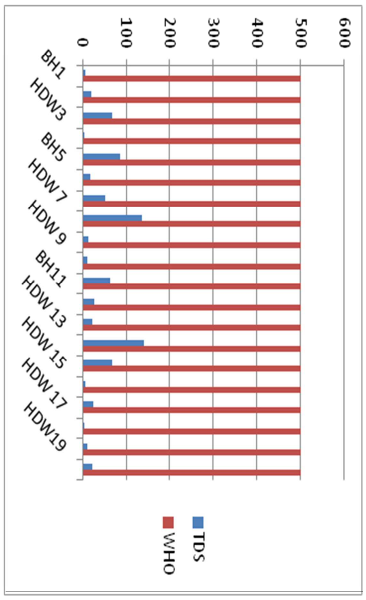

Figure 3c: A Graphical Representation of TDS Against (WHO, 2011)

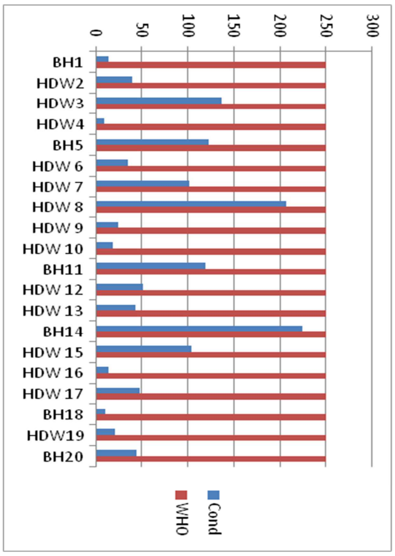

Figure 3d: A Graphical Representation of Conductivity Against (WHO, 2011)

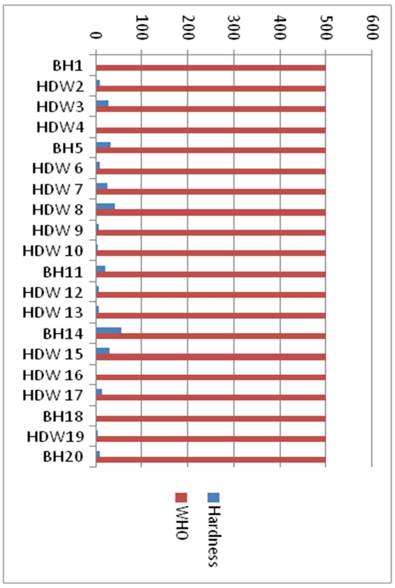

Figure 3e: A Graphical Representation of Hardness Against (WHO, 2011).

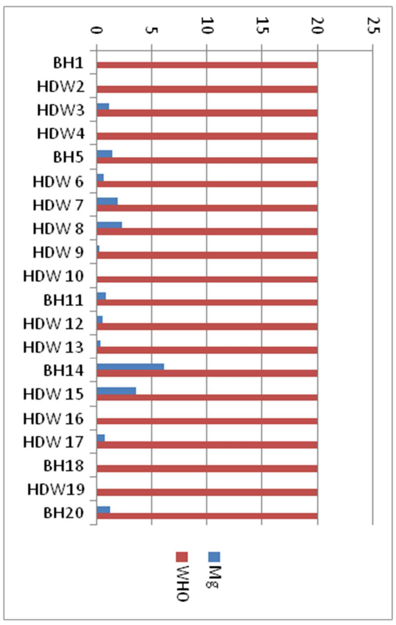

Figure 3f: A Graphical Representation of Magnesium Against (WHO, 2011).

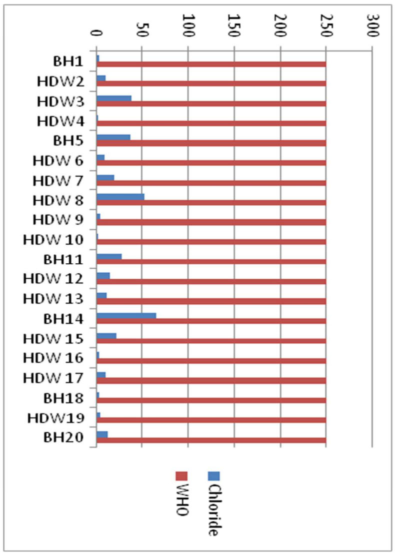

Figure 3g : A Graphical Representation of Chloride Against (WHO, 2011).

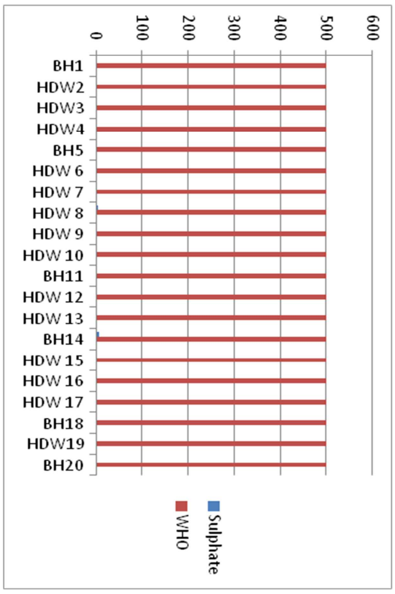

Figure 3h: A Graphical Representation of Sulphate Against (WHO, 2011).

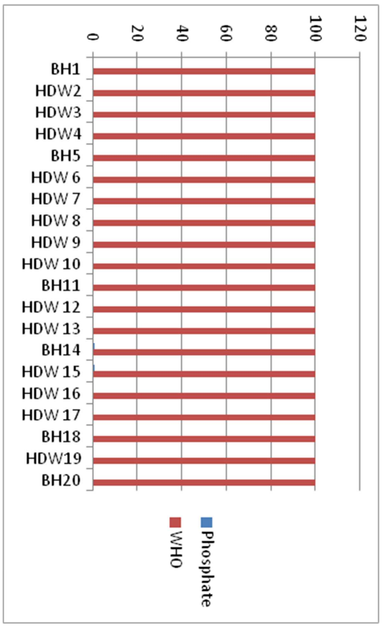

Figure 3i: A Graphical Representation of Phosphate Against (WHO, 2011).

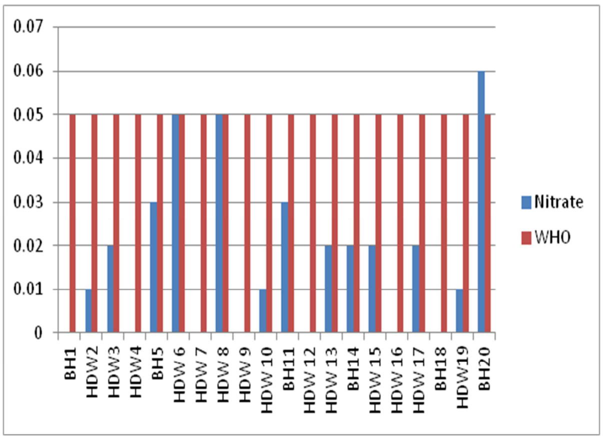

Figure 3j: A Graphical Representation of Nitrate Against (WHO, 2011).

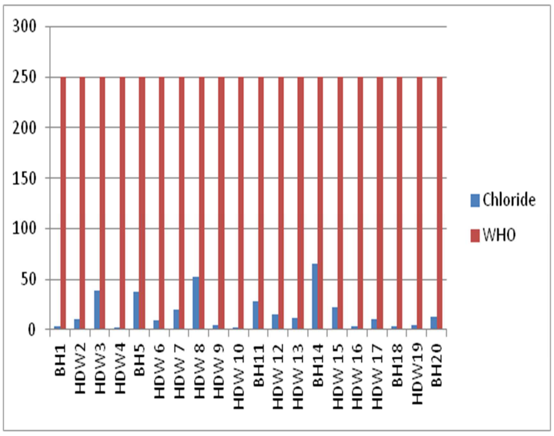

Figure 3j : A Graphical Representation of Chloride Against (WHO, 2011).

4.1 Result Of Microbiological Analysis

Table 2. Showing Result of Bacteriological

Sample Code	Total E.Coli count	Total Coliform
	MPN/100ml	MPN/ml
BH1	0	0
HDW2	0	0
HDW3	0	0
HDW4	0	0
BH5	0	0
HDW6	0	0
HDW7	1	4
HDW8	0	0
HDW9	0	0
HDW10	0	0
BH11	0	0
HDW12	0	0
HDW13	1	4
BH14	0	0
HDW15	0	0
HDW16	0	0
HDW17	0	0
BH18	0	0
HDW19	0	0
BH20	0	1
HEALTH IMPACT	Indication of faecal contamination	Urinary track infections, bacteraemia, meningitis, diarrhoea, (one of the main cause of morbidity and mortality among children), acute renal failure and haemolytic anaemia

5 Discussion

For pH , temperature, electrical conductivity their value ranges from (6.05-7.01, 28.9-32.1^{o}c and 8.90-284µs/cm) respectively. There values falls below the (WHO, 2011 and NIS 2007) permissible limit as shown in Fig.3a, Fig.3b, Fig.3d. For total dissolved solid (TDS), Total hardness, Bicarbonate, Biological Oxygen Demand (BOD) and dissolved oxygen (DO) value ranges from (4. 0- 142, 1.12 - 54.91, 1.17- 30.71 mg/l and 3.00 - 4.50 mg/l) respectively. There values falls below the (WHO, 2011) permissible limit as shown in Fig. 3c, Fig. 3e, Table.1, Table.1 and Table.1. While for magnesium, Chloride, Nitrate, Sodium, calcium, Phosphate and sulphate their value ranges (0.03- 6.14, 2.56 - 65.82, 0.01 - 0.06, 0.09 – 16.34, 0.29 – 23.85, 0.01- 0.81 and 0.10 -7.1)mg/l respectively. There values falls below the (WHO, 2011 and NIS 2007) permissible limit as shown in Fig. 3f, Fig. 3g, Fig. 3i, Table.1, Table.1, Fig. 3i and Fig. 3h respectively. And finally for Total Suspended Solids (TSS) value ranges from5.37-12.12.75mg/l values falls below the (WHO, 2011) permissible limit. Microbial analysis reveals the presence of coliform and E.coli in two hand-dug well (HDW7 and 13) and one borehole well (BH20). These contaminations are perhaps traceable to have originated from human activities (Septic tanks, latrines, dumpsites) and have affected the quality of groundwater in the study area.

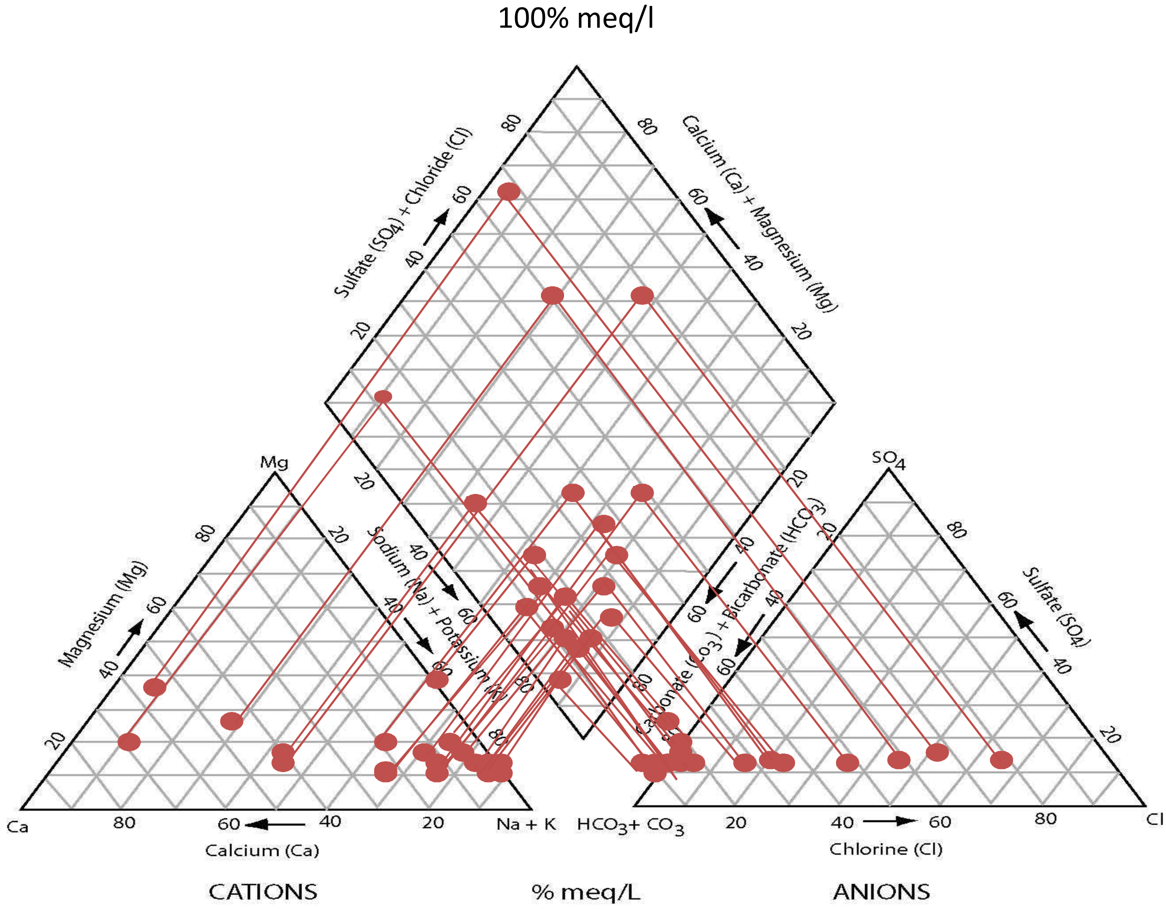

Figure 4: Piper trilinear diagram showing the water types of the groundwater sources in the study area.

The hydrogeochemical composition of water varies considerably. From the Piper trilinear diagram, the dominant ionic specie is alkali bicarbonate water type, with bicarbonate as the predominant ion ($Na^+ + K^+$) - HCO_3^- as shown in Fig. 4. The dominance of alkali bicarbonate water type could be attributed to the infiltration of carbon dioxide rich rainwater derived from the atmosphere and input of alkali salts from anthropogenic sources.

6 CONCLUSION AND SUMMARY

The information given about Ughelli and environs is to assess the portability of the subsurface water and the findings are as follow;

- The physicochemical analysis shows that some parameters fall below (WHO, 2011) acceptable limit for drinking water. Magnesium and Calcium are well below (WHO, 2011) standard.
- The heavy metal analysis shows little abnormal concentration of lead in BH5, HDW17, BH18 and BH20. Though they are slightly above the permissible limit. Arsenic was not found at all in any of the sample. The heavy metal distribution is averagely acceptable in the area.
- Except for three sample sites (HDW7, HDW13, and BH20), the area is free of bacteriological count.

- There is low level of calcium and magnesium, with the above conclusions, the groundwater of Otovwodo and environ are generally soft. Both calcium and magnesium are essential to human health, inadequate intake of either nutrient can impair health.

That the pH of the area comfortably meets the standard of Federal Environmental Protection Agency Standard (FEPA) but varies in that (WHO, 2011) standard. The pH is averagely acceptable, it can be deduced that most of the contamination are from dumpsites, leaking septic tank and pit latrines located in the area.

7 RECOMMENDATION

Having assessed the quality of the water samples from subsurface water in the area, the following recommendations are put forward to enhance the quality of drinking water;

1. Pipes and casing that can withstand corrosion should be encouraged.
2. Wells should be sited (7-10m) away from septic tanks and other source of contamination.
3. Hand dug wells and boreholes should be well cased.
4. Proper management of both liquid and solid wastes from domestic activities should be practised.

Habitants of the area should be advised to embrace good hygiene habits and keep sanitary environment clean. Building modern toilets for good use**.**

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