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Hydrochemical Analysis of Ground Water Potential in Onicha - Ukwuani, Ndokwa Land Area of Delta State, Nigeria

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ABSTRACT

The determination of hydrological parameters is of primary importance in assessing the potential of groundwater reserve in a given area. The present study was initiated by a desire to determine the availability of sufficient and good quality water for a proposed expansion of the human and industrial establishments without jeopardizing the existing domestic water supply in Onicha-Ukwuani. Water samples were collected from fifteen locations evenly distributed within Onicha Ukwuani and analyzed for twenty-three (23) parameters. The contrast of the result obtained with the WHO standard revealed that the water sample in the study area contains higher concentrations of iron than the WHO recommended limit of 0.3 mg/L. This indicates that iron bearing minerals are common in the study area. The well water in the area require treatment to reduce the level of iron content in them. Consequently, exposure of the water to air for oxidation to take place could cause ferrous oxide in them to oxidize to ferric oxide and these would precipitate as rust colored ferric-hydroxide that stains plumbing fixtures, laundry and cooking utensils and properly filtered. Furthermore, the free carbondioxide should be allowed to enter the groundwater system so as to reduce the P^H of the water. Apart from the acidic condition and the high iron content, none of the parameters studied exceeded the stipulated standards showing that the water is potable if treated for high iron concentration and acidity.

Keywords: Hydrochemical, groundwater, potable, quality, Ike-Onicha, Eweshi, Amoji, Ugiliamai and Ibabu.

INTRODUCTION

Water is of fundamental importance to life; that is both plants and animals particularly man. It is very vital in maintaining life processes and growth. The inhabitants of Onicha – Ukwuani are mostly subsistence farmers who depend on the slow running water from the creeks, streams, and hand-dug wells for their domestic water needs. In order to have a reliable and good quality source of drinking water, many communities, private individuals, and age grades embarked on borehole projects. Virtually all the borehole projects were executed for and on behalf of the ever growing population of Onicha-Ukwuani without geophysical surveys and hydrochemical analysis of the water.

Therefore, one of the major problems faced by most communities in Onicha-Ukwuani is the access to a secured, safe and sufficient source of fresh Water. Potable water has no substitute and is not only a basic necessity to life but essential for human existence on earth; its proximity has a great influence on human activities such as domestic, agriculture, recreation and its provision limits the setting up of villages and towns to places where there is an existence of supply (Shankar, 1994; Huisman, 1966 and Neilson, 1991).

Groundwater is commonly understood to mean water occurring beneath the earth surface that is water occupying the voids within a geologic stratum (Deborah, 1996). Groundwater is not static but flows through the rock. The ease with which water can flow through a rock mass (permeability) depends on a combination of the (porosity) sizes of the pores and the degree to which they are interconnected (Budermeier and Schloss, 2000 and Nelson, 1991). Most local groundwater supply in Onicha Ukwuani kingdom comes from unconfined aquifer made up of loosed soil materials such as sands, gravels and flood plain deposits left by streams and rivers (Oseji et al, 2005; Oseji et al, 2006; Oseji, 2009).

Groundwater usually flows towards and eventually drains into streams, rivers, lakes, creeks, ponds and boreholes. The flow of groundwater in the aquifer does not always reflect the flow of water on the surface. It is therefore necessary to know the direction of groundwater flow and take steps to ensure the land use activities in the recharge areas will not pose a threat to the quality of groundwater (Freeze and Cherry 2002).

Furthermore it is important to know if the groundwater system is a recharge or discharge system that is a gaining or loosing type. The quality of water is also affected by the quality of groundwater entering the system of water supply in the borehole (Shwille, 2000).

Hence the need for hydrochemical analysis cannot be overemphasized in not only having access to secured, safe and sufficient source of fresh water supply but in getting background information on the most abundant parameters and access groundwater quality in Onicha-Ukwuani and hence determine the suitability of water within the region for domestic, agricultural and industrial purposes.

LOCATION OF STUDY AREA

Onicha Ukwuani Kingdom is located in Ndokwa West local government area of Delta State. It comprised Ike-Onicha, Eweshi, Ugiliamai, Amoji and Ibabu communities. It is in the South Eastern part of Delta situated in the South-South region of Nigeria and lies between latitude latitudes 5^0 83^1 N to 5^0 87^1 N and longitudes 6^0 25^1 E to 6^0 45^1 E. Onicha-Ukwuani is bounded in the North by Utagba-Uno; the South by Ogume and Utagba-Ogbe Communities; the East by Afor and Utagba-Ogbe communities; and in the West by Ebedei and Umukwata communities. The area is accessible by network of roads and footpaths that are not tarred. However, the Kwale/Ogwuashi-Uku express road to Asaba is the major tarred road within the study area. Onicha-Ukwuani is in an area of low-lying sedimentary terrain, generally flat and has gentle slope. The vegetation is that of the tropical rainforest belt characterized by dense vegetation cover consisting of evergreen forest of tall trees with undergrowth of climbing plants that are closed together along the streams and creek channels and this normally typifies primary vegetation while the presence of grassland with sparse trees and shrubs typified the secondary vegetation pattern within the vegetation belt.

The superficial deposits of the top loamy soil reveal an overlying range between loose and smooth sandy soil to clayey soil formation and this gave the sediments its characteristics off-white to grey color. The location map of Onicha-Ukwuani in Ndokwa West and her neighboring communities is presented in fig 1.

GEOLOGY OF ONICHA-UKWUANI

The study area Onicha-Ukwuani is within the Niger-Delta Basin. The Niger-Delta Basin in this paper applies to the entire 3-Dimensional bodies of continental, transitional and marine deposits formed by sediments from Rivers Niger and Benue. The continental deposits form the land area otherwise called the sub-aerial region. The marine deposits are the water filled region otherwise called the sub-aqueous region. The transitional deposits form the swampy (mangrove) regions (Hospers, 1965; Ejadiavwe, 1981)

The structure of the continental geologic framework directed Rivers Niger and Benue towards the present site of the Delta, hence the geology of Niger-Delta, like other parts of the earth has undergone different changes right from the tectonic setting through the paleogeographic evolution to the present day. This development of the Niger-Delta has been dependent on the balance between the rate of sedimentation and subsidence. The balance and the resulting sedimentary patterns appear to have been influenced by the structural configuration of tectonics of the basement (Evany et al, 1979)

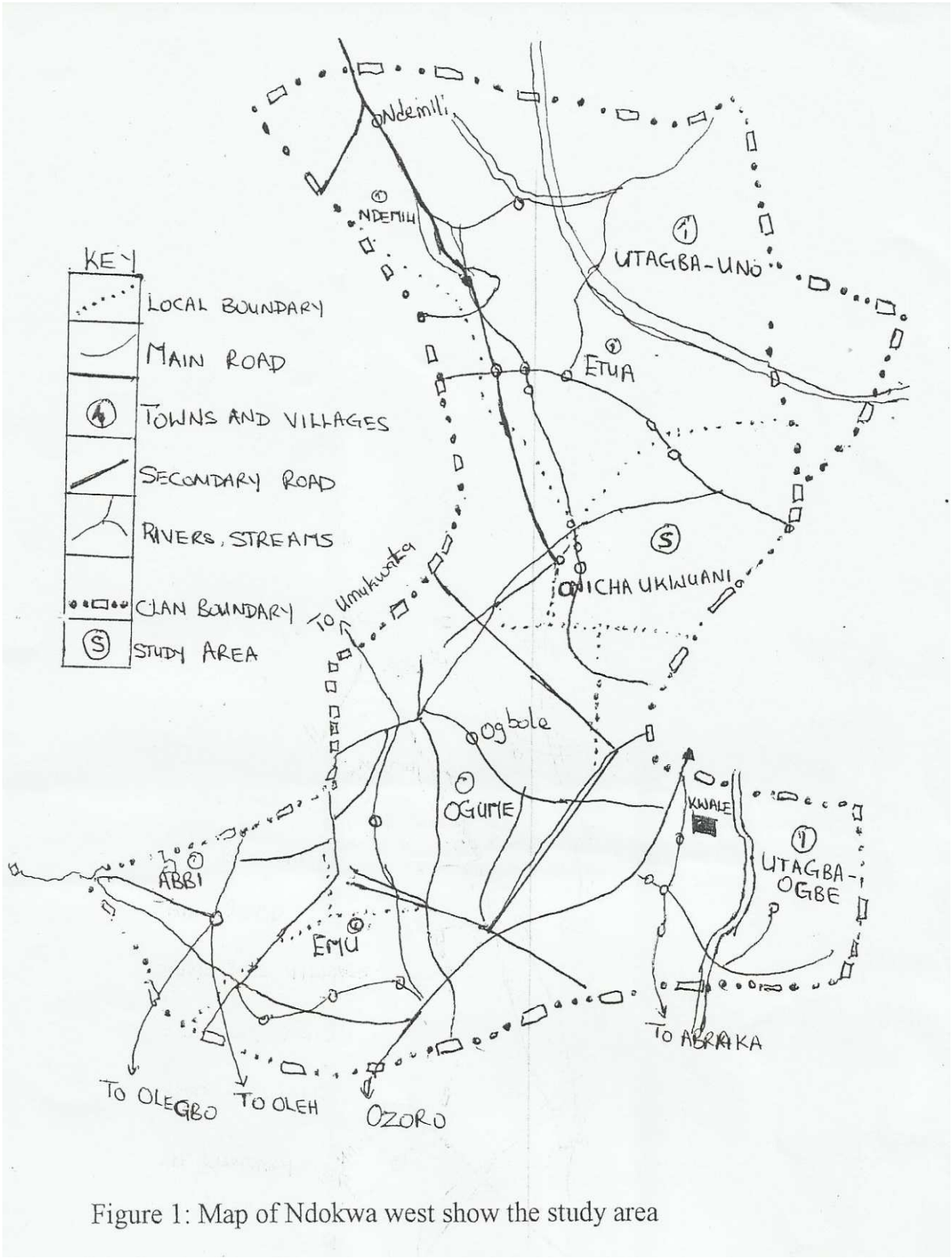

Figure 1: Map of Ndokwa west show the study area

The geology and geomorphology of the Niger-Delta have been described in detail by various authors (Allen, 1965; Akpokodje, 1979, 1987; Assez, 1970, 1976; Avbovbo, 1970; Oomkens, 1974; Burk, 1972; Rement, 1965; Short and Stauble, 1967)

The subsurface geology of the Niger-Delta consists of three lithostratigraphic units (Akata, Agbada and Benin formations), which are in turn overlain by several of Quaternary deposits. The top soil observed in Onicha-Ukwuani is cameo colored sand (not pure white but with a very pale grey

AKATA FORMATI0N

The Akata formation consist of low density, high pressure, deep marine with plants remains at the top particularly near the contact with the overlying Agbada formation. The Akata sequence is typically over pressured (short and stauble 1967)

AGBADA FORMATION

The Agbada formation consist of alternating deltaic sand, shale and stones that is made up of an upper predominantly sandy unit with minor shale intercalations and a lower shale unit which is thicker than the upper sandy unit (short and stauble 1967)

BENIN FORMATION

The Benin formation consist of poorly cemented sand medium to coarse in size grain gravel, locally fine grain, poorly sorted, and bears lignite streaks and wood fragments. The environment deposition is probably contaminated (Kogbe 1981)

METHODOLOGY AND DATA ACQUISITION

Water samples were collected from fifteen (15) locations evenly distributed within Onicha-Ukwuani and analyzed for twenty-two (23) parameters. The samples were collected in to fifteen (15) plastic jerry cans of 2 liters each with covers. These jerry-cans were thoroughly rinsed with the water to be collected and then well stopped. Water samples were collected from open wells by means of rope and bucket (bail method). In each case the bucket was allowed to sink some distance without disturbance so as to get a clear representative of the water in question. Once the jerry can is filled with water, it is covered and labeled to minimize oxygen contamination and the escape of dissolved gasses. The need for correct sampling is to ensure the reliability of data acquired from the representatives of the water under investigation.

As much as possible, samples were analyzed soon after collection. Analyses were carried out mainly along the methods described in (Apha 1975 and Apha 1980) and were stored in stored in accordance with the recommended preservation methods and holding period as given by (Schofield, 1980).

Table 1: The methods of Analysis used in the study

PARAMETER	ANALYTICAL METHODS
Temperature	Thermometer
Conductivity	Conductivity meter
PH	PH meter
Hardness, Mg^{2}, Cl^{-}, SO_4^{2-}	Titration
Iron, Lead, Mn, Cu.	Calorimetric
NO_3^{-}, PO_4, TDS	Gravimetric
Na^{+}	Flame photometer
Color	Spectrophotometer
COD	Spectrophotometer

Parameters such as temperature, conductivity, P^H were determined in the field due to their unstable nature. Temperature was measured with a mercury filled thermometer. Conductivity was estimated with a mark V electronic switch gear conductivity meter. P^H was estimated with a P^H meter. The hardness, magnesium, chloride, Sulphate of the water samples were determined by titration. Iron was determined calorimetrically. Nitrate, phosphates, total dissolved solids (TDS) were determined gravimetrically. Analyses were done in waterwell services limited with registration number and e-mail RE: 131, 665 waterwell.loss@alpha.linkserve.com respectively

Summary of the analytical methods used in this study is shown in Table 1.

The hydrochemical data of the groundwater obtained in Onicha-Ukwuani were compared not only with the World Health Organization standards for drinking water as stated in the WHO, 1984; WHO, 1971 and FEPA, 1991 (table 2) but the classification of water based on the hardness as stated by Freeze and Cherry, 1997 (table 3), while according to Hem, 1970 and Hem, 1985, groundwater is classified according to its total dissolved solid contents as shown in table 4

TABLE 2: WHO standard for drinking water (WHO, 1984; WHO, 1971; WHO, 1995 and FEPA, 1991)

PARAMETER	WHO Guidelines
Temperature ^{o}C	NS
Conductivity (Ns/cm)	750
P^{H}	7.0 – 8.5
Total iron	0.3
Total Hardness (mg/L)	100
Total Dissolved Solid	500
NO^{3-} (mg/L)	50
CL^{-} (mg/L)	200
Mg^{2+}(mg/L)	50
SO_4^{2-} (mg/L)	200
Phosphate(mg/L)	NS
Pb(mg/L)	0.05
Cu^{4+} (mg/L)	1.0
Turbidity (Tu)	5
Colour Hazen Unit (HU)	Clear
Sodium	200
C.O.D	-
Dissolved Oxygen	-
Total Akalinity	50 – 100
Chromium	0.03
Biochemical Oxygen Dissolved (mg/l)	5.0
Manganese	-
Zinc	5.0

NS means Not Stated.

TABLE 3: Classification of water based on Hardness {Freeze and Cherry, 1977}

HARDNESS RANGE	DESCRIPTION
0 - 60	Soft
61 - 120	Moderately hard
121 - 180	Hard
More than 180	Very hard

TABLE 4: Classification of water according to it total dissolved solid content (Hem 1970 and Hem 1985)

DESCRIPTION	CONCENTRATION RANGE
fresh water	less than 1,000 mg/l
moderately saline water	3,000 - 10,000 mg/l
solid water	10,000-35,000mg/l
brine water	greater than 35,000 mg/l

RESULTS AND DISCUSSION

The Hydrochemical data of the groundwater in Onicha-Ukwuani are presented in tables 4 and 5 respectively. The temperature of the water in Onicha-Ukwuani varied from 27.52^0 c to 29.00^0 c with an average of 28.26^0 c and this is within the limits of the room temperature.

Conductivity value ranged from 75.32 NS/cm to 83.00 NS/cm with an average value of 119.16 NS/cm in the water. Conductivity usually indicates the presence of unstable ions.(Johnson, 1975). The groundwater has high conductivity and the values indicate that the borehole water is in contact with more inorganic constituents.

The P^H value of substance usually ranges from 0 to 14. Pure water falls on a neutral P^H of 7. Anything excessively below this P^H is acidic and above is alkalinity meaning there could be a slight fall or increase but not in excess. Groundwater usually falls on the acidic side that is less than 7, hence P^H can be used to determine the level off acidity and alkalinity in water, high acidity suggests low alkalinity and level and has a narrow range of tolerance. These changes can be caused by an increase in decomposing matter dead fish or leaves which causes lower P^H or more acidity conditions. In Onicha-Ukwuani, the P^H value ranged from 5.12 to 6.70 with an average of 5.91. This result revealed that groundwater in the study area is acidic. The acidity is probably due to the presence of organic matter in the soils. Hence free carbon dioxide from the atmosphere should be allowed to enter the groundwater system as rain water percolates underground and reduces the P^H of the water.

TABLE 5: Hydrochemical data of the Groundwater in Onicha – Ukwuani

Wells & boreholes	Temp. ^oC	Conductivity (µohm/cm)	PH	Total Iron (Fe) (ppm)	Total Hardness	Color Hazen unit (HU)	Turbidity (NTU)	Total dissolved solid (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Sulphate (mg/L)	C.O.D (mg/L)
OBIUKPO Onicha-Ukwuani	28.00	150.00	5.71	7.31	0.60	60.00	0.18	69.73	0.10	0.27	0.41	2.11
UGILIAMAI 1 Onicha-Ukwuani	28.00	151.00	5.73	7.39	0.62	62.00	0.20	69.79	0.12	0.23	0.38	2.14
UGILIAMAI 2 Onicha-Ukwuani	28.00	95.50	5.80	4.15	1.35	56.00	0.13	40.14	1.32	0.10	1.15	2.19
IBABU Onicha-Ukwuani	27.91	160.00	5.93	7.27	0.81	60.00	0.15	58.40	0.13	0.25	0.40	2.10
AMOJI 1 Onicha-Ukwuani	27.92	163.00	5.85	7.22	0.76	63.00	0.17	57.80	0.10	0.27	0.37	2.09
AMOJI 2 Onicha-Ukwuani	28.00	80.59	6.70	0.10	2.15	49.00	NIL	10.08	3.15	0.03	2.20	2.51
IKE-ONICHA 1 Onicha-Ukwuani	27.80	160.00	5.78	7.40	0.69	56.00	0.16	59.30	0.14	0.25	0.41	2.12
IKE-ONICHA 2 Onicha-Ukwuani	27.90	162.00	5.69	8.21	0.77	58.00	0.18	57.60	0.12	0.23	0,43	2.11
IKE-ONICHA 3 Onicha-Ukwuani	28.00	120.00	5.76	3.58	1.21	70.00	0.12	48.50	1.21	0.11	1.19	2.20
IKE-ONICHA 4 Onicha-Ukwuani	28.00	131.00	5.94	3.49	1.25	67.00	0.12	47.80	1.20	0.13	1.17	2.23
IKE-ONICHA 5 Onicha-Ukwuani	29.00	158.00	5.84	8.16	0.68	59.00	0.12	55.80	0.16	0.25	0.37	2.10
IKE-ONICHA 6 Onicha-Ukwuani	27.52	156.00	5.90	7.59	0.72	75.00	0.23	54.90	0.14	0.22	0.35	2.13
EWESHI 1 Onicha-Ukwuani	27.61	80.16	5.92	0.57	2.10	65.00	0.10	40.51	1.92	0.05	1.50	2.35
EWESHI 2 Onicha-Ukwuani	27.61	79.54	5.69	0.30	2.15	63.00	0.14	42.19	1.78	0.07	1.48	2.30
EWESHI 3 Onicha-Ukwuani	28.14	75.32	5.12	6.10	1.00	57.00	0.22	61.20	0.15	0.33	1.52	2.19
RANGE OF VALUE	**27.52 – 29.00**	**75.32– 63.00**	5.12-6.70	**0.10-8.21**	**0.60-2.15**	**49.00-75.00**	0.10-0.23	**10.08-69.79**	**0.10-3.15**	**0.03-0.33**	**0.35-2.20**	**2.09-2.51**
WHO	**NS**	**750**	**7.0– 8.5**	**0.3**	**100**	**Clear**	**5**	**500**	**50**	**NS**	**200**	**-**

The cations determined in this study include Iron, sodium and. Magnesium.

Iron is a reactive chemical and pure iron tarnishes rapidly in air or water, iron is an essential metal to the human body, it is needed for body build up in biological system because of its ability to form complexes and to exist in different oxidation states. The blood pigment hemoglobin contains iron. The ratio of iron in water depends on the oxygen concentration in the water, the P^H and other chemical properties of water. High concentration of iron in water causes reddish brown stains on white porcelain enameled ware, fixtures and fabrics. Water containing iron tends to impact unpredictable colors and therefore it is unsatisfactory for industrial purposes. The values of Iron in the water are in the range of 0.10 mg/l to 8.21mg/l and that of Sodium is 6.49 to 12.50 mg/L respectively. The value

of Iron is above the standard value for drinking water and sodium value is below the standard value as stated in (WHO, 1991; WHO, 1984; WHO, 1971; WHO, 1995 and FEPA, 1991) for drinking water.

The average concentration of magnesium in the water is 1.15 mg/L. This average, even the minimum value (0.15 mg/L) or the maximum value (2.15 mg/L) are too low to make the water not suitable for domestic or agricultural use but for industrial use.

Total Hardness ranges from 0.60 to 2.15 mg/L in concentration indicating that the water is soft when compared with the WHO standard for drinking water. This shows that the water is suitable for domestic use and hence will form lather easily with soap

TABLE 6: Hydrochemical data of the Groundwater in Onicha – Ukwuani

Wells & boreholes	Dissolved oxygen (DO)	Total Alkalinity (mg/L)	Sodium (ppm)	Lead (ppm)	Chromium (ppm)	Biochemical Oxygen Dissolved (mg/L)	Chloride (mg/L)	Magnesium (ppm)	Manganese (ppm)	Copper (ppm)	Zinc (ppm)
OBIUKPO Onicha-Ukwuani	5.02	11.80	6.51	0.006	0.04	0.09	5.18	0.17	0.04	0.005	0.01
UGILIAMAI 1 Onicha-Ukwuani	5.04	11.50	6.49	0.004	0.06	1.06	5.20	0.22	0.02	0.004	0.01
UGILIAMAI 2 Onicha-Ukwuani	5.09	11.50	10.00	0.002	0.01	0.49	5.39	0.58	0.10	0.001	0.01
IBABU Onicha-Ukwuani	5.01	10.70	7.41	0.007	0.05	1.03	5.21	0.23	0.05	0.004	0.01
AMOJI 1 Onicha-Ukwuani	5.03	11.90	6.59	0.004	0.03	1.05	5.18	0.21	0.07	0.007	0.01
AMOJI 2 Onicha-Ukwuani	5.20	4.70	10.20	<0.01	0.02	0.02	5.80	2.15	0.04	<0.01	NIL
IKE-ONICHA 1 Onicha-Ukwuani	5.01	10.70	6.47	0.003	0.06	1.08	5.20	0.17	0.02	0.005	0.01
IKE-ONICHA 2 Onicha-Ukwuani	5.05	11.60	7.10	0.005	0.08	1.05	5.17	0.25	0.06	0.002	0.01
IKE-ONICHA 3 Onicha-Ukwuani	5.10	8.40	10.41	0.010	0.01	0.32	5.42	0.61	0.15	0.008	0.01
IKE-ONICHA 4 Onicha-Ukwuani	5.08	9.50	11.16	0.020	0.12	0.58	5.38	0.63	0.13	0.003	0.01
IKE-ONICHA 5 Onicha-Ukwuani	5.03	12.13	8.52	0.050	0.05	1.07	5.15	0.26	0.03	0.002	0.01
IKE-ONICHA 6 Onicha-Ukwuani	5.05	11.56	8.45	0.030	0.07	1.04	5.13	0.29	0.08	0.006	0.01
EWESHI 1 Onicha-Ukwuani	5.13	6.19	12.30	<0.01	0.05	0.05	6.08	1.10	0.15	0.005	0.02
EWESHI 2 Onicha-Ukwuani	5.11	6.10	12.50	<0.01	0.05	0.05	6.13	1.08	0.12	<0.01	0.01
EWESHI 3 Onicha-Ukwuani	5.00	12.20	7.50	<0.01	0.13	1.05	10.50	0.15	0.04	<0.01	0.01
RANGE OF VALUE	**5.00-5.20**	**4.70-12.20**	**6.49-12.50**	**<0.01-0.05**	**0.01-0.13**	**0.02-1.08**	**5.13-10.50**	**0.15-2.15**	**0.02-0.14**	**<0.01**	**0.01-0.02**
WHO	**-**	**50 - 100**	**200**	**0.05**	**0.03**	**5.0**	**200**	**50**	**-**	**1.00**	**5.0**

All the water in Onicha-Ukwuani is tasteless and odorless. The colour indices ranged from 49.00 to 75.00 Hazen units. The value correlates well with the Turbidity value of 0.10 – 0.23 NTU. This is shown by the turbid and brownish appearance of the water. The water are more turbid in the rainy season than in the dry season at which time, they appear to be relatively clear

Total Dissolved Solids (TDS) range in value from 10.08 to 69.79 mg/L. This is far below the stipulated value of 500 mg/L (WHO, 1991; WHO, 1984; WHO, 1971 and FEPA, 1991) for drinking water hence the water is not harmful in view of this parameter. This water is suitable for irrigation.

Biochemical oxygen demand (BOD) is one of the most valuable measures of the quality status of any water. It is also a measure of organic matter in the water determined by the oxygen consumed by the micro-organisms in the metabolic decomposition of their substrate dissolved organics (Faluyi and Assez, 1981), The values obtained were 0.02 to 1.08 mg/L and when compared with (FEPA, 1991), it is less than the doubtful value of 5 mg/L. In view of this parameter, the water is good.
The anions determined in this study include Chloride, Sulphate, Nitrate, and Phosphate. The Chloride value ranged from 5.13 mg/L to 10.50 mg/L. These values are below the 200 mg/L stipulated standard for drinking water. The sulphate value ranges from 0.35 to 2.20 mg/L, these values are much lower than 200m g/L which is the stipulated value by W.H.O for drinking water. The level of phosphate ranges from 0.03 to 0.33 mg/L. The minimum value of nitrate is 0.10 mg/L while the maximum value is 3.15 mg/L. Hence the value of the parameters indicates that the water is not injurious.

The contrast of the result obtained with the WHO standard revealed that the water sample in the study area contains higher concentrations of iron than the WHO recommended limit of 0.3 mg/L. This indicates that iron bearing minerals are common in the study area. The well water in the area require treatment to reduce the level of iron content in them.

Consequently, exposure of the water to air for oxidation to take place could cause ferrous oxide in them to oxidize to ferric oxide and these would precipitate as rust colored ferric-hydroxide that stains plumbing fixtures, laundry and cooking utensils and properly filtered. Furthermore, the free carbondioxide should be allowed to enter the groundwater system so as to reduce the P^H of the water.

Fig 2: Water treatment to plant for domestic purposes

Apart from the acidic condition and the high iron content, none of the parameters studied exceeded the stipulated standards showing that the water is potable if treated for high iron concentration and acidity..

Water samples collected from existing wells in Onicha-Ukwuani were analyzed and the water is found to be acidic, soft, low in dissolved constituent and has high iron content when compared with the World Health Organization Standard for drinking water.

CONCLUSION

The results revealed that water Onicha-Ukwuani is not only soft and low in dissolved constituents but acidic and has high iron content.

Recommendation
It is recommended that polyvinyl chloride (PVC) pipes and several tanks should be used for the treatment of the water in to reservoirs respectively. Furthermore, it is recommend that the water should be exposed to the atmosphere for oxidation to take place as shown in fig 2.

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