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Water quality assessment of Otun and Ayetoro Area, Ekiti State, Southwestern Nigeria

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ABSTRACT

The study areas (Otun and Ayetoro) are situated in Moba Local Government Area of Ekiti State, and lies within latitudes 8°75' N and 9°15' N and longitudes 5°60' E and 6°00' E respectively. The study area also falls within the basement complex of south western Nigeria. The dominant lithologies include migmatites, granite gneisses, quartzites, charnockites and granites. Physical, chemical and bacteriological evaluation of hand-dug wells in the study areas were carried out to ascertain its suitability for human consumption and domestic usage. Water samples were collected at random from different localities in the study areas. Ten hand dug wells water were sampled for their physical, chemical and bacteriological properties and were compared with WHO (1993) standards. The physical parameters showed that pH ranges from 5.2 to 7.1 which is slightly acidic to alkaline, temperature is 25°C and it is uniform throughout the samples, while colour is 5Hu. The chemical parameters revealed that turbidity value ranges from 3.7 to 7.3 NTU, dissolved solids (5.0 to 7.6 mg/L), total dissolved solids (5.0 to 7.6 mg/L), total alkalinity (30 to 180 mg/L), Ca^{2+} (28 to 72 mg/L), Cl^{-} (50 to 120 mg/L), silica (10 to 14 mg/l), Fe^{2+} (0.01 to 0.05 mg/L), Mn^{2+} (0.01 mg/L), total hardness (120 to 200 mg/L), NO_3^{-} (15 to 75 mg/L) and *E. coli* (2 to 35 mg/L) which is very high and above WHO (1993) recommended standard value. However, the pH values of some of the water samples conform to World Health Organization standard except sample labelled L 10, which could be as a result of the presence of some contaminants like sulphur or ammonia compounds that might have furnished hydrogen ion into the water. However, the shallow wells met the requirements for human and domestic consumption with minimum scientific treatment.

Keywords: Moba, Otun, hand-dug wells, lithologic units, WHO, contaminants.

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INTRODUCTION

The utility of water is limited by its quality which may make it unsuitable for particular purposes. Assessment of water quality is therefore an important aspect of water resources survey. Available data on water quality of water is generally stable overtime as it is predominantly determined by chemical composition of the rocks serving as aquifers. Water quality depends on the physical, chemical and bacteriological composition of water (Ayoade and Oyebande, 1978). The quality of water is an indication of the natural and artificial conditions and processes occurring upstream of the part that is sampled for quality determination. The composition of the precipitation falling on the drainage area sets the initial chemical quality of the water but this is soon changed by interaction with vegetation, soils and impervious surfaces. In a completely natural situation, the changes can be detected by increased concentration of dissolved and suspended materials resulting from the solution of aerosols previously deposited on vegetation and impervious surfaces. Evaporation and the suspension of particulate matter, both organic and inorganic, is picked up by the water as it flows over the surface. Normally, the natural addition of dissolved and suspended materials does not adversely affect future beneficial uses of the water in the receiving stream because many of these impurities enhance the desirable qualities of water for

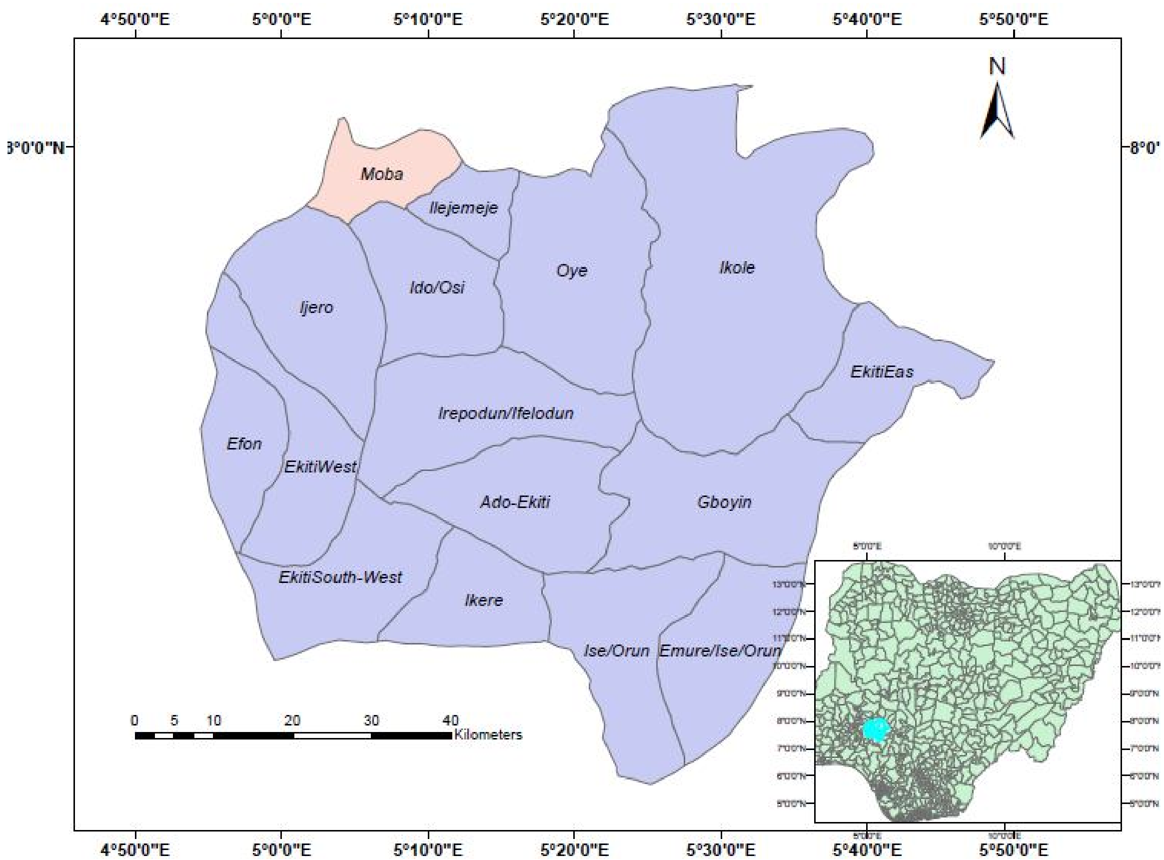

Figure 1. Location map of the study area.

specific end uses. Some natural influences may however impair stream water quality for domestic use when surface runoff passes through densely wooded area or marshy lands, the water may acquire a partial colour or may be highly coloured and acidic because of the presence of humic acid (WHO, 1993). A lot of studies abound in the literature on water quality assessment and development and also on heavy metal pollution on water sources. Such works include Ajibade et al. *(*2008), Adegoke-Anthony and Owolabi (1988), Abimbola et al. (2002) and Edet and Offiong (1998b). All concluded that there was the need to monitor water quality on regular basis. This is because the increase in concentration of trace elements in potable water, microbial contamination from faecal coliform and *E. coli* and influence of filths, unguided wastes and sewage disposal will increase the threat to man's health and life. Other literature exists on the development and application of index methods for water quality assessment. Some of these include the work of Joung et al. (1979), Nishida et al. (1982) and Prasad and Boesse (2001). This paper focuses on the physical, chemical and bacteriological properties of hand-dug wells in Otun and Aiyetoro towns since nothing has been done in the past to determine the suitability of these wells for human and domestic consumption.

Location and accessibility of the study area

Otun and Ayetoro Ekiti is a town in Moba local government area of Ekiti State. It can be located within latitudes 8° 75′ N to 9° 15′ N and longitudes 5°60′ E to 6°00′ E (Figure 1). Neighboring towns include Ikun, Igogo, Ikosu, Ewu, etc. The study area is also accessible by roads and footpaths.

Topography and drainage

The relief of the study areas consists of isolated hills and inselbergs that surrounded the town. The hills have a varied elevation between 300 to 450 m. The highlands are situated at the four cardinal points of the two towns and are separated by lowlands. The major river that drains Otun and Ayetoro Township is river Okunrun (Figure 2), others are river Agbo-Oku and Ogbugbo. Most of the tributanes such as Agbo-Oku, Ogbugbo are seasonal.

Regional geologic setting

The study area lies within the Precambrian of

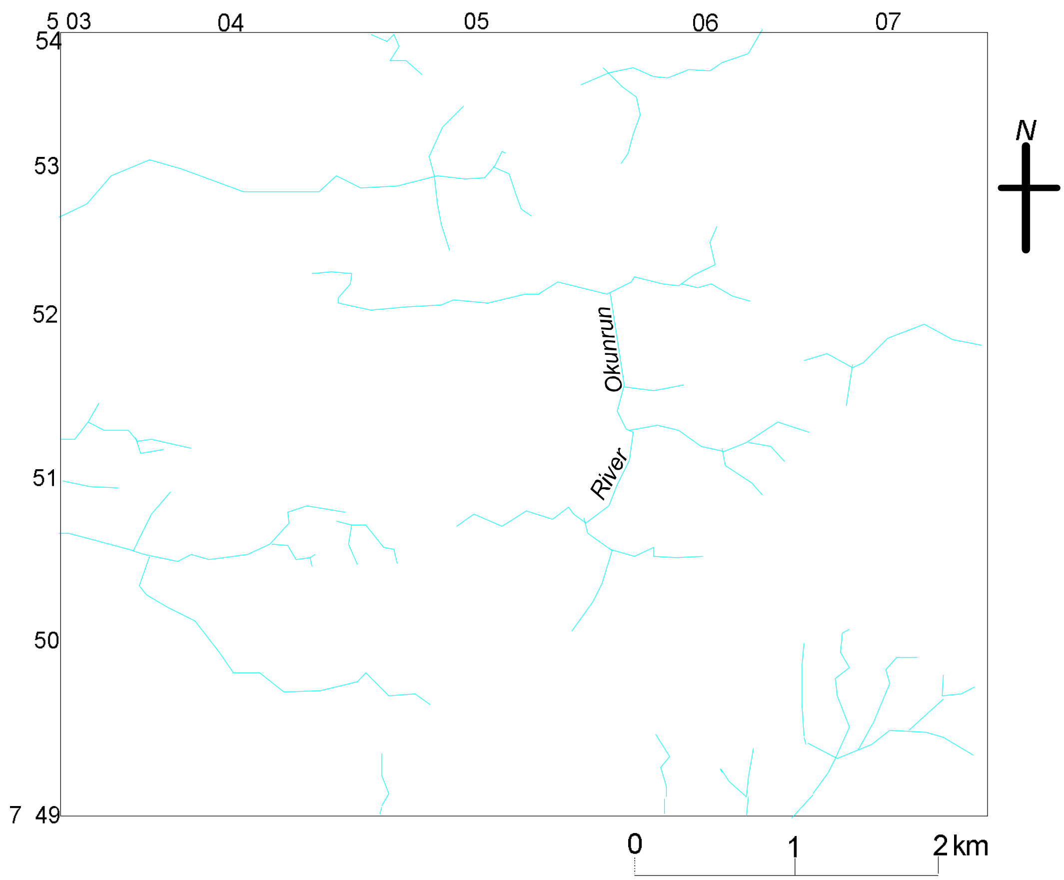

Figure 2. Drainage map of the study area.

southwestern Nigeria, which is a part of the Basement Complex of Nigeria. The study area is mostly underlain by crystalline rocks. These rocks have been grouped into four lithologic units by Dada (2006) as follows:

i) Migmatite-Gneiss-Quartzite Complex;
ii) The Schist Belts;
iii) Pan African Granitoids
iv) Unmetamorphosed minor acid and basic rocks

Local geology of the study area

Otun and Ayetoro Ekiti is dominated by crystalline rocks referred to as the basement complex. The sequence of geological units in the study areas are summarized below. Older granite and quartzite are not well exposed, the quartzites are weathered and they are exposed by road cut, they have simple mineralogy where quartz is the principal mineral. Other accessory minerals in the rock include muscovite, tourmaline, sillimanite and biotite. The quartzites mapped in the study area are the schistose types. The granites occupy the southern-eastern part, their texture ranges from fine grained to coarse grained and they exhibit both intrusive and replacement characteristics in the area under investigation (Figure 3). The charnockites occur as intrusives and are scattered over a wide area and they form an elongated north-south trending lithology. The pegmatites are simple in mineralogy and they occur as dykes on the granites in the study area.

Hydrogeological setting of the study area

The hydrogeology of the basement complex of Otun and Ayetoro Ekiti depends on the presence of decomposed material usually called overburden, which possesses sufficient thickness and have lateral extent to serve as water reservoir in addition to the presence of joints, fracture and faults in the basement (fresh) rocks. The crystalline rocks of the basement complex of Otun and Ayetoro Ekiti contains available ground water in large quantities but the capacity of each well or borehole is often low due to extreme anisotropy and the resultant very low value of transmissivity of the aquiferous materials within and as such, the capacity of wells invariably do not reflect the total ground water potentials of the area within the basement complex terrain or it varies widely because of the anisotropy of the bedrock,

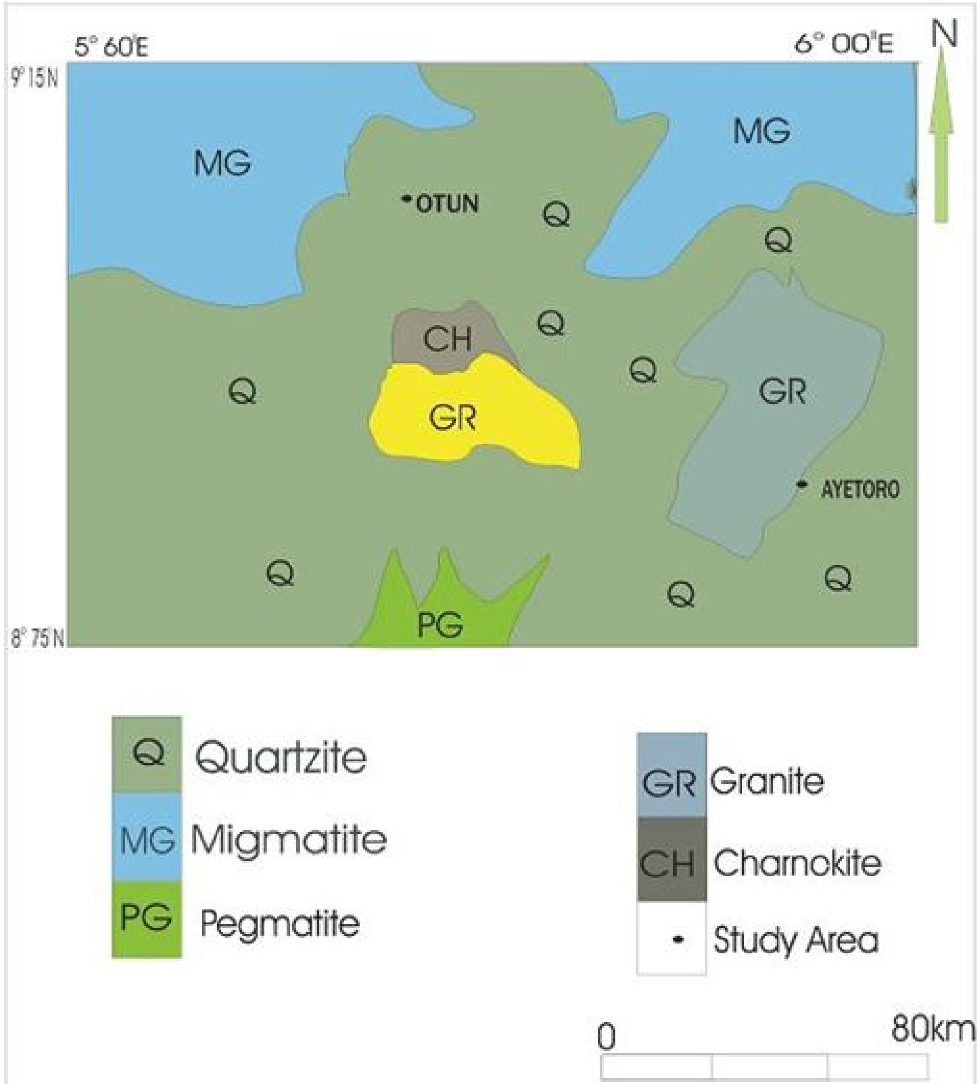

Figure 3. Geological map of the study area.

the thickness and the type of regoliths which playsan important role in ground water balance. The storage of ground water in the basement complex is made possible by interconnected joints and fissures such that alternation of permeable and impervious strata especially when folded, faulted and jointed from underground water resources and natural water works of great variety where the catchments is sufficiently high. The water slowly migrates through the most permeable formations towards places of lower elevation and discharges into stream and rocks. The circulation and storage of water depends on the following factors namely; hydraulic barriers of the boundaries, geology and lithology, hydrogeologic structures such as groundwater and aquifer thickness and extent, hydraulic parameters (porosity, permeability and stability). Following the instituted weathered profiles developed in the study area (Figure 4), the major soil types found include lateritic soil, alluvial soil, sandy soil and some extent clayey soil.

MATERIALS AND METHODS

A total of ten (10) groundwater samples collected mainly from hand dug wells in the in two different localities in Ekiti State namely; Otun and Aiyetoro respectively were analysed. Standard procedures for sampling were followed and at each sampling point certain physical parameters such as temperature were measured, odour, taste, and color were noted. Other physical parameters such as electrical conductivity and pH were measured using portable electrical conductivity cell and pH meter respectively.

Analysis of the collected water samples for their major cation and anion components was carried out at the Federal Ministry of Agric and Water Resources; Regional

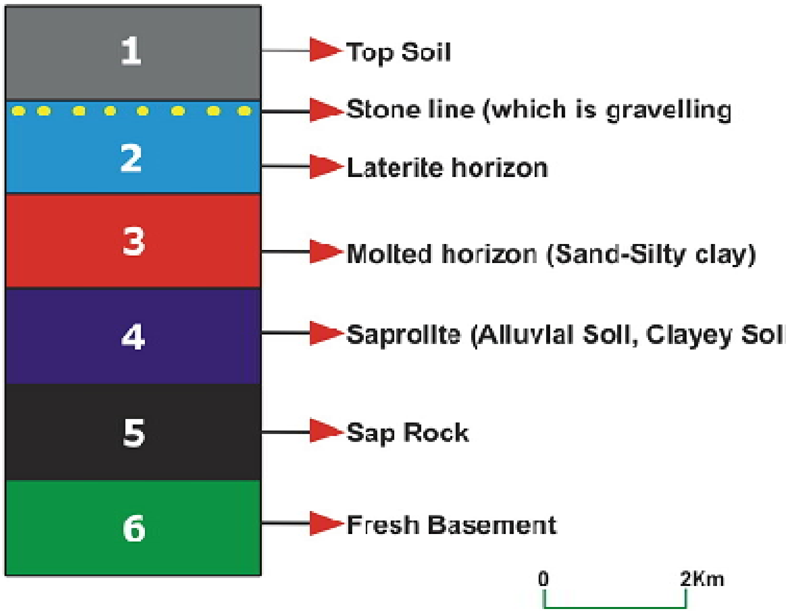

Figure 4. Weathering profile of the study area.

Table 1. Result of physico-chemical analysis of hand dug well water samples (*n* = *3*).

Samples	Unit	LI	L2	L3	L4	L5	L6	L7	L8	L9	L10	Aver.	St. dev.
pH	-	6.4	6.3	6.8	6.7	6.4	6.9	6.4	7.1	6	5.2	6.42	0.54
Turbidity	NTU	4.2	4.6	4	6.5	4.9	3.7	3.9	5	7.3	4.8	4.89	1.16
EC	mg/L	5.4	5	5.2	7.1	7	6.1	7.6	6.1	5.7	6	6.12	0.87
TDS	mg/L	424	430	572	682	524	424	520	425	420	524	494.5	86.94
Total alkalinity	mg/L	180	120	120	120	160	120	100	120	30	180	125	43.53
Total hardness	mg/L	120	150	100	200	200	180	180	180	120	150	158	35.53
Ca	mg/L	64	28	30	32	28	28	30	37	72	55	40.4	16.76
Cl	mg/L	130	50	50	65	60	55	60	120	72	60	72.2	28.69
Si	mg/L	12	10	14	10	10	12	10	12	10	12	11.2	1.40
Fe	mg/L	0.05	0.03	0.01	0.02	0.05	0.02	0.01	0.05	0.02	0.01	0.027	0.02
Mn	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
NO_3^{2-}	mg/L	15	50	15	25	15	25	50	75	25	50	34.5	20.47

L = locations of water samples.

Water Laboratory in Akure, Ondo State. Also the samples were subjected to bacteriological analysis to determined *Escherichia Coli* (*E. coli*) and total bacterial counts.

RESULTS AND DISCUSSION

The results of the physicochemical parameters of samples from the different sampling points are as shown in Table 1.

Colour, odour and tastes

The objectionable physical qualities of hand dug water samples in the studied area such as tastes and odours are within the W.H.O acceptable limits. Although the result of colour determination in all the samples analyzed is 5 CU. When compared to W.H.O (1993) standards, the colour is above W.H.O (1993) standard (3 CU) thus the hand dug well water samples are not fit for drinking.

Acidity (pH) and total alkalinity

The pH content of the water samples in the area ranges from 5.2 to 7.1 (Average = 6.24) but the total alkalinity of the water samples range between 30 and 180 mg/L (Average = 125) (Table 1). The water samples from the study area were slightly acidic in nature, suggesting that the activity of the hydrogen ions in water samples of the area were more than that of the hydroxyl ions. This low pH may be due to the release of chemical gasses, e.g. sulphur-dioxide, nitrogen dioxide, carbon monoxide and carbon dioxide from bush burning, combustion (organic and inorganic), vehicular emission and industrial wastes that generates acidic rains and water, which infiltrate into the ground and lowers the pH of the water. Besides, decaying vegetation could also produce some amount of tannic (weak) acids (Ayoade and Ibitoye, 2012). The pH of the water has high positive correlation with EC, TDS and nitrate nutrient concentration of the studied water from hand dug wells.

Typically, the obtained pH values in this study fall below the World Health Organization standard of 7.0 to 8.5 and the water quality ranges 6.5 to 8.5 for drinking water and water meant for full contact recreation (WHO, 1984, 1989; Genevieve and James, 2006). When pH values less than 6.5, causes corrosion and the subsequent release of metals such as lead, zinc, and copper from pipes and plumbing fixtures into water, these substances can be toxic to humans (Lehr et al., 1980 as cited in Ayoade and Ibitoye, 2012). The average total alkalinity of the water samples from the studied areas is above the recommended limit from drinking water (Tables 1 and 3). The values of pH of the water samples analysed stands evidence for the same. This is attributed to the presence of bicarbonates, carbonates and hydroxides of calcium, magnesium, potassium and sodium which consecutively may be influenced by underlying geology or algal activity (Abimbola et al., 2002). Accordingly, the parameters do give concern and it could make the water unsuitable for drinking but for direct domestic use.

Electrical conductivity (EC) and total dissolved solid (TDS)

The electrical conductivities and total dissolved solids of the well water generally vary between 5.2 and 7.6 mg/L (average = 6.12) and 420 to 682 mg/L (average = 494.5) respectively (Table 1). It is a direct reflection of the salinity, which is also a function of the salt content of the samples. The electrical conductivity and total dissolved solids in the hand dug well water samples were low and fall within permissible limits of (NAFDAC, SON and WHO, 1993) (Table 3). This is due to the lower concentrations of cations and anions in the water samples analyzed. Since electrical conductivity is an indicator of how salt-free, ion-free or impurity free a water sample is (Aktar et al., 2010). The low content of electrical conductivities of the water samples could also be attributed primarily to the geology of the areas. Hand dug wells in the areas underlain with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not ionize (dissolve into ionic components) when washed into the water. The correlation coefficients reveal some relevant hydrochemical relationships; the pH has high positive correlation with EC, TDS and nitrates (Table 2). The total dissolved solid has positive correlation with Si but weak or negative correlations with other nutrients concentrations in the water samples. This positive correlation of Si suggests it may have been derived from rock. A negative correlation between most of these nutrient concentrations (Table 2) suggests that they are not of the same source but could have been derived from ion exchange processes between the water and rock (Issa et al., 2014).

Turbidity and total hardness

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Turbidity values in water samples were generally low with no definite trend, especially in borehole and well samples. Turbidity decreases clarity of water and result from the finely divided impurities regardless of sources from which it may be present in water. As turbidity is a function of total suspended solids, the well samples also recorded highest values of turbidity, essentially due to high level of suspended solid such as clay and other fine particles in the water samples (Ayoade and Ibitoye, 2012). The turbidity values in the water samples range from 3.7 to 7.3 NTU.The values of the turbidity recorded in sample no. 1, 2, 3, 7 and 10 fall within the W.H.O permissible limits, while others samples have greater values above the WHO standard. Hand dug well water sample 1 (from location 1) recorded very high turbidity value greater than others (4.2 NTU), but it is still fall within W.H.O permissible standard (Tables 1 and 3).

The total hardness value in the well water analyzed ranges from 100 to 200 mg/L (Average = 158) (Table 1). This is very high compared to WHO standard for calcium and magnesium which is 75 and 20 mg/L respectively (Table 3). The highest values of hardness were recorded in wells from locations 4 and 5 at Oke-Aafin and Ile Balogun (200 mg/L) respectively in Otun Ekiti. Turbidity has high positive correlation with chloride, iron and nitrate but the total hardness has positive correlation with nutrient concentration such as turbidity and chloride (Table 2). This suggests that the nutrients concentration is from the same source.

Cation analytical results

Calcium and manganese

Calcium concentrations range between 28 and 72 mg/L

Table 2. Correlation coefficient *r* for the different physicochemical variables from the studied hand dug well water samples.

Parameters	pH	EC	TDS	Total alkalinity	Turbidity	Total hardness	Ca	Cl	Si	Fe	Mn	NO_3^2
pH	1	0.83	0.978	0.627	0.548	0.502	0.103	0.538	0.577	0.362	.[a]	0.925
EC	0.83	1	0.153	0.955	0.812	0.007	0.355	0.7	0.141	0.813	.	0.828
TDS	0.978	0.153	1	0.691	0.607	0.427	0.31	0.26	0.896	0.256	.[a]	0.478
Total alkalinity	0.627	0.955	0.691	1	0.111	0.707	0.725	0.535	0.354	0.341	.[a]	0.871
Turbidity	0.548	0.812	0.607	0.111	1	0.931	0.17	0.905	0.143	0.996	.[a]	0.867
Total hardness	0.502	0.007	0.427	0.707	0.931	1	0.098	0.756	0.117	0.562	.[a]	0.445
Ca	0.103	0.355	0.31	0.725	0.17	0.098	1	0.161	0.967	0.854	.[a]	0.733
Cl	0.538	0.7	0.26	0.535	0.905	0.756	0.161	1	0.626	0.026	.[a]	0.604
Si	0.577	0.141	0.896	0.354	0.143	0.117	0.967	0.626	1	0.758	.[a]	0.798
Fe	0.362	0.813	0.256	0.341	0.996	0.562	0.854	0.026	0.758	1	.[a]	0.941
Mn	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]
NO_3^2	0.925	0.828	0.478	0.871	0.867	0.445	0.733	0.604	0.798	0.941	.[a]	1

[a]Cannot be computed because at least one of the variables is constant. ** Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 3. Physical and chemical characteristics combined standards for drinking water (WHO, 1993).

S/N	Parameters	NAFDAC maximum allowable unit	SON standards	WHO standards	
				Highest desirable	Maximum permissible
1	Colour	3.0 TCU	3.0TCU	3.0TCU	3.0 TCU
2	Odour	Unobjec	Unobjec	Unobjec	Unobjec
3	Taste	Unobjec	Unobjec	Unobjec	Unobjec
4	PH at 20°C	6.50 - 8.50	6.5 - 8.5	7.0 - 8.9	6.5 - 9.5
5	Turbidity	5.0 NTU	5.0 NTU	5.0 NTU	5.0 NTU
6	Conductivity	1000 µs/cm	1000 µs/cm	900 µs/cm	1200 µs/cm
7	Total solids	500 mg/L	500 mg/L	500 mg/L	1500 mg/L
8	Total alkalinity	100 mg/L	100 mg/L	100 mg/L	100 mg/L
9	Phenolphthalein alkalinity	100 mg/L	100 mg/L	100 mg/L	100 mg/L
10	Chloride	100 mg/L	100 mg/L	200 mg/L	250 mg/L
11	Fluoride	1.0 mg/L	1.0 mg/L	1.0 mg/L	1.5 mg/L
12	Copper	1.0 mg/L	1.0 mg/L	0.5 mg/L	2.0 mg/L
13	Iron	0.3 mg/L	0.3 mg/L	1 mg/L	3 mg/L
14	Nitrate	10 mg/L	10 mg/L	10 mg/L	10 mg/L
15	Nitrite	0.02 mg/L	0.02 mg/L	0.2 mg/L	3 mg/L
16	Manganese	2.0 mg/L	0.05 mg/L	0.1 mg/L	0.4 mg/L
17	Magnesium	20 mg/L	20 mg/L	20 mg/L	20 mg/L

Table 3. Continues.

18	Zinc	5.0 mg/L	5.0 mg/L	0.01 mg/L	3.0 mg/L
19	Selenium	0.01 mg/L	NS	0.01 mg/L	0.01 mg/L
20	Silver	-	-	NS	NS
21	Cyanide	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.07 mg/L
22	Sulphate	100 mg/L	100 mg/L	250 mg/L	500 mg/L
23	Calcium	75 mg/L	75 mg/L	NS	NS
24	Aluminium	0.5 mg/L	NS	0.2 mg/L	0.2 mg/L
25	Potassium	10.0 mg/L	10.0 mg/L	NS	NS
26	Lead	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L
27	Chromium	0.05 mg/L	0.05 mg/L	0.05 mg/L	0.05 mg/L
28	Cadmium	0.003 mg/L	0.003 mg/L	0.003 mg/L	0.003 mg/L
29	Arsenic	0.01 mg/L	0.01 mg/L	0.01 mg/L	0.01 mg/L
30	Barium	0.05 mg/L	0.05 mg/L	0.05 mg/L	0.07 mg/L
31	Mercury	0.001 mg/L	0.001 mg/L	0.001 mg/L	0.001 mg/L
32	Antimony	NS	NS	-	0.02 mg/L
33	Tin	-	-	-	1.2 mg/L
34	Nickel	-	-	-	0.02 mg/L
35	Total hardness	100 mg/L	100 mg/L	100 mg/L	500 mg/L
36	Sodium			200 mg/L	200 mg/L

NS = Not stated.

with an average of 40.4 mg/L (Table 1). Calcium show high positive correlation with total alkalinity, Si, Fe, and NO_3^{2-} but a low positive correlation with pH, Fe and TDS (Table 2). Manganese has constant concentrations in the water samples with an average value of 0.01 mg/L (Table 1). Calcium concentrations in all the water samples fell into the category of high class water which is not stated in WHO (1993) standards. The high level of calcium is an indication of water hardness in the hand dug well water samples. Consequently, the hand dug well water samples may be suitable for drinking but not well suitable for laundry purposes due to formation of insoluble scum with soap. Besides, hard water is not suitable for household cleaning purposes due to the formation of scale in kettles. Manganese falls within the W.H.O permissible standard for drinking water (Table 3).

Iron and silicon

Iron concentrations range between 0.01 and 0.05 mg/L with an average value of 0.027 mg/L (Table 1). It has high positive correlations with EC, turbidity, Ca, Si and NO_3^{2-} in the hand dug well water samples (Table 2). Iron concentrations in the hand dug well water samples fall within permissible limits of (NAFDAC, SON and WHO, 1993) guidelines for drinking water (Table 3). Silicon concentrations in the hand dug well water samples range from 10 to 14 mg/L with an average value of 11.2 mg/L (Table 1). Silicon concentrations show high positive correlations with TDS, Fe, Ca and NO_3^{2-} in the hand dug well water samples (Table 2).

Anion analytical results

Nitrate and chloride

Nitrate is considered as the most highly oxidized form of nitrogen compounds is commonly present in surface and groundwater because it is the end product of aerobic decomposition of organic nitrogenous matter (Igbinosa and Okoh, 2009). Nitrate concentrations in the hand dug well water samples range from 15 to 75 mg/L with an average value of 34.5 mg/L (Table 1). Nitrate show high positive correlation with pH, EC, total hardness, turbidity, Ca, Si and Fe concentrations in the hand dug well water samples (Table 2). Nitrate concentrations in the hand dug well water samples is above the maximum permissible limit for drinking water (WHO, 1993) (Table 3).

Chloride concentrations in the hand dug well water samples range between 50 and 130 mg/L with an average value of 72.2 mg/L (Table 1). Chloride shows high positive correlation with EC, turbidity and total hardness in the hand dug well water samples (Table 2). Chloride concentrations in the studied hand dug well water samples fall within maximum permissible limits of W.H.O for drinking water (Table 3).

Figure 5 shows the water types obtained from the Aquachem piper plot for the hand dug well water samples, of which the dominant or major types were determined. The most probable geochemical process responsible for the development of the hydrochemical character is the dissolution of minerals in the various basement rocks underlain the studied areas. Magnesium (Mg^{2+}) is sourced from the breakdown of some

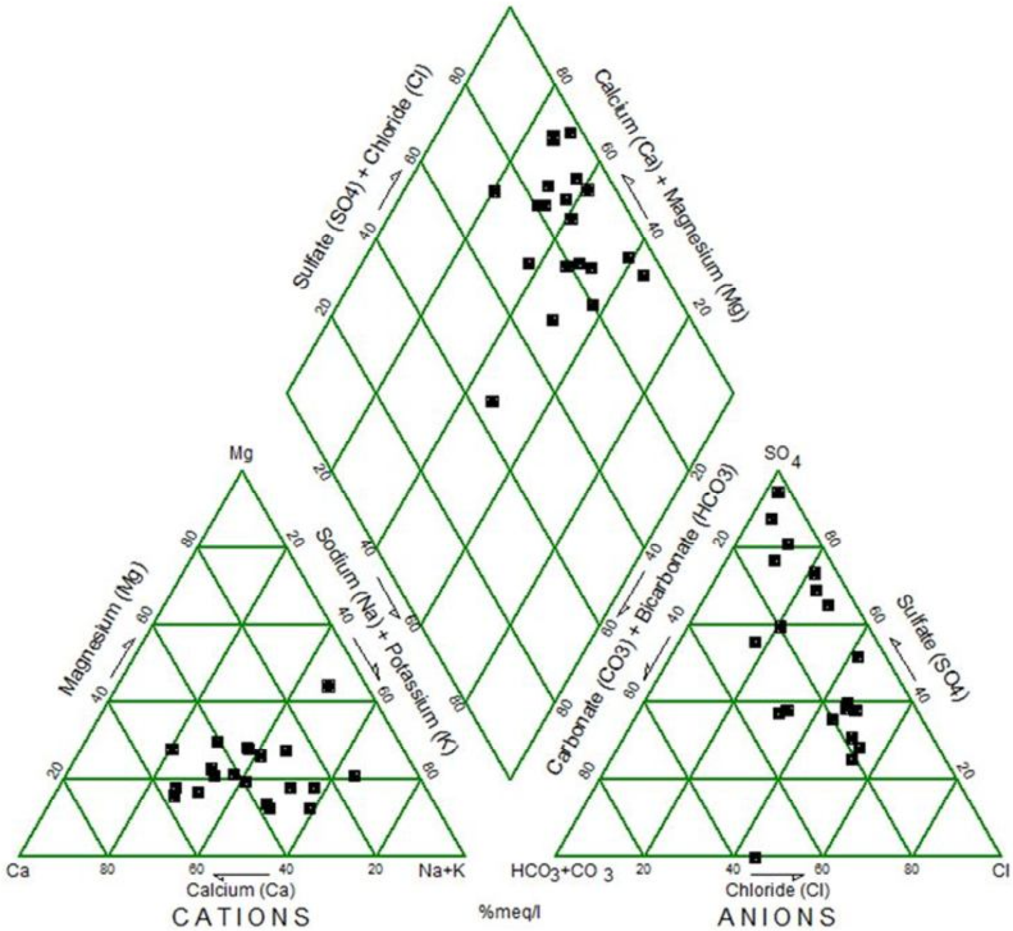

Figure 5. Piper trilinear diagram showing chemical character for the hand dug water samples from the study area.

mineralogical components such as hornblende, pyroxene and olivine in the basement rocks from the study areas (Raji and Alagbe, 1997; Issa et al., 2014). Besides, the evolution of bicarbonate (HCO_3) may be attributed to the CO_2-charged recharge (Issa et al., 2014).

Bacteriological result

The World Health Organization (1993) recommended that the number of bacteria and coliform count should be zero per colony. Notwithstanding, the total coliform organisms, MPN/100 ml, maximum limits is 5000 (tolerance limits) as per ISI-IS 2296 (1982). Therefore the hand dug well water is safe for drinking. Table 4 shows result of bacteriological analysis of well water samples.

CONCLUSIONS

Physico-chemical analysis of hand dug wells water samples in the studied areas has shown that the groundwater is slightly acidic with an average pH value of 6.24. This slightly acidic nature causes corrosion and the subsequent release of metals such as Pb, Zn and Cu from pipes and plumbing fixtures into water, these substances can be toxic to humans. The mineralization of the water (TDS) has an average value of 494.5 mg/L, slightly below its acceptable limit of 500 mg/L of World Health Organization (WHO). This suggests that the groundwater is fresh. The low content of electrical conductivities (EC) of the water samples could also be attributed primarily to the geology of the studied areas. The groundwater in the area is largely classified as Mg-HCO_3-Cl and Mg-HCO_3 water types using Piper trilinear diagram. The turbidity values recorded in sample labeled L1, L2, L3, L7 and L10 fall within the W.H.O permissible limits, but others have greater values above the WHO standard.

A negative correlation between most of these nutrient concentrations suggests that they are not of the same source but could have been derived from ion exchange

Table 4. Result of bacteriological analysis of well water samples.

Sample no.	Colony convent (ml)	Most probable no. of coliform 1000ml	Most probable of coliform 1000 ml	Most probable of coliform 1000 ml	Total	MPN/100 ml
	Growing of nutrient	1 bottle of 50 ml	5 bottles of 10 ml	5 bottles of 1 ml		
Amututu well, L1	14	1	3	0	8	80
Odowa, L2	11	0	2	2	2	22
Otunsabo market, L3	28	1	2	2	20	72
Ile Balogun, L4	24	1	2	3	18	73
Okeafin, L5	40	1	4	4	35	94
Ira Otun, L6	26	1	2	2	14	72
Otun Park, L7	16	1	3	3	8	83
Ayetoroile Oba, L8	24	1	3	3	10	83
Ona-IdoAyetoro, L10	26	1	1	3	14	63
Aver.	23.22	0.89	2.44	2.44	14.33	71.33
Stdev.	8.71	0.33	0.88	1.13	9.51	20.52

processes between the water and rock. The geology of the area revealed that the rocks found in the area are mainly quartzite, migmatite, pegmatite, granite and charnockite rocks. It was discovered from this work, that topography and nature of the soils in the studied area influenced the water level fluctuation. Therefore, the only possible recharge into these wells is through infiltration which is in turn controlled by some other factors such as surface run off and seepages from nearby wells. In conclusion, all the water samples analyzed needed to undergo purification and treatment to meet the requirements of good water supply with minimum scientific treatment.

RECOMMENDATIONS

The following recommendations are hereby made from the outcome of this research: (i) Hand dug wells constructed should be properly ringed and covered to avoid the washing of surface particle into the wells during rainy season. (ii) The hand dug wells should be treated with chlorine and alum from time to time to keep the water fit for human consumption. (iii) The well water should be boiled before drinking. (iv) The hydrogeological mapping and groundwater quality assessment of the areas should be carried out. (v) There should be proper disposal of industrial and household waste.

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