Assessment of Physico-chemical And Trace Metal Parameters of Reticulated Borehole Water In Abeokuta Metropolis Ogun State, Southwestern Nigeria

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Abstract- Borehole water quality services rendered to the people of the community within Abeokuta Metropolis were assessed. The study aims at determining the concentration of physico–chemical and trace metal parameters present in the water been supplied. Thirty (30) water samples were collected with a sterilized bottle from borehole taps and were labelled according to sampling location. The chemical parameters analysed are Hydrogen ion Concentrate (pH), temperature, conductivity (EC), total dissolved solids (TDS), total alkalinity, total hardness and major cations which includes sodium (Na), calcium (Ca), magnesium (Mg) and potassium (K) as well as major anions comprising of bicarbonate (HCO_3), chloride (Cl), sulphate (SO_4) and nitrate (NO_3) and were later taking to the Laboratory for chemical tests. The spatial locations of each sampled point were determined with the use of handheld GPS and further analysis was carried out to derived the location map. The result of the laboratory analysis showed that all physiochemical and trace metals values fall within the standard limits of the Standard Organisation of Nigeria (SON) and World Health Organisation (WHO). The results of the correlation analysis showed positive and strong significant relationship between parameters studied.

Keywords: Physiochemical parameters, Anions and cations, Correlation Analysis, Significant relationship

I. Introduction

Water is necessary for man's developmental health as well as animals and plants growth. Many developing countries are facing changes of ground water potential which leads to other source of portable water. The preference for ground water to surface water must be due to the purification of the latter prior to distribution [1]. Although it is easily accessible from lakes, rivers streams and springs, but borehole water are of better quality. Access to water is widely accepted the world over as a basic human right. A reticulated borehole water system is water system that pumps water to a reservoir from which it is distributed to other standing pipes with a community. The Dublin Conference in 1992 asserted that "it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price" [2].

The contamination of drinking water by diseases-causing micro-organisms (pathogens) remains the most widely recognised and important acute threat to human health. [3]. Water for human consumption must be free from all objectionable odours, turbidity, taste, enteric pathogenic bacteria or their indicators and must not fluctuate in its quality.

The human body is made up of 55% to 78% water depending on body size [4]. To function properly, the body requires between one and seven liters of water per day to avoid dehydration; the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though most advocates agree that 6–7 glasses of water (approximately 2 litres) daily is the minimum to maintain proper hydration [5]. Drinking water quality has a micro-biological and a physico-chemical dimension. There are thousands of parameters of water quality. In public water supply systems water should, at a minimum, be disinfected - most commonly through the use of chlorination or the use of ultra violet light - or it may need to undergo treatment, especially in the case of surface water. For more details please see the separate entries on water quality, water treatment and drinking water.

WHO, 1997 [6] stated that about 2.3 billion people worldwide have mortality and morbidity associated with water related ailments

Ion exchange systems use ion exchange resin- or zeolite-packed columns to replace unwanted ions. The most common case is water softening consisting of removal of Ca^{2+} and Mg^{2+} ions replacing them with benign (soap friendly) Na^+ or K^+ ions. Ion exchange resins also used to remove toxic ions such as nitrate, nitrite, lead, mercury, arsenic and many others. [7, 8, 9, 10).

It is worthy of that the total alkalinity value of water is an indication of the acid – neutralizing ability and is determined by how much carbonate, bicarbonate and hydroxide is present. Excessive alkalinity values may cause scale formation, the water may also have a distinctly flat, unpleasant taste [11]. pH as a primary standard parameter has no health implication [12].

An elevated TDS concentration is not a health hazard. It may be an indicator of the concentration of dissolved ions which may cause the water to be corrosive, salty or brackish, resulting in scale formation [11].

Although a very TDS concentration is not a health hazard as TDS concentration is a secondary drinking water standard and is more of an aesthetic rather than a health hazard. [11].

Orewole, et al., 2007 [11] stated that total dissolved solids (TDS) comprises inorganic salts (principally calcium, magnesium,

potassium, sodium, bicarbonates, chloride, and sulphates) and some amounts of organic matter that are dissolved solids while total alkalinity value of water is an indication of the acid – neutralizing ability of the water and is determined by how much carbonate, bicarbonate, and hydroxide is present.
Ca and Mg are essential elements needed in good quantity by the human body while Ca is used in teeth and bone formation; it also plays an important role in neuromuscular extractability, and for good functioning of the contractibility and also for blood coagulability [13].
The Scientific Committee for Food and the Committee on dietary reference intake has recommended a daily Ca intake of between 700 and 1000mg for adults. Although Ca alongside Mg is a major contributor to water hardness, however calcium is important for strong teeth and healthy bones. It also plays an important role in neuromuscular extractability and for good functioning of the conducting myocardial system, heart and muscle contractibility and also for blood coagulability. [13]. High chloride content in drinking water may indicate possible pollution from human sewage, animal manure or industrial wastes while high sulphate concentrations though not a significant health hazard, can cause scale formation and may be associated with a bitter taste in water that can have a laxative effect o humans and young livestock [11].

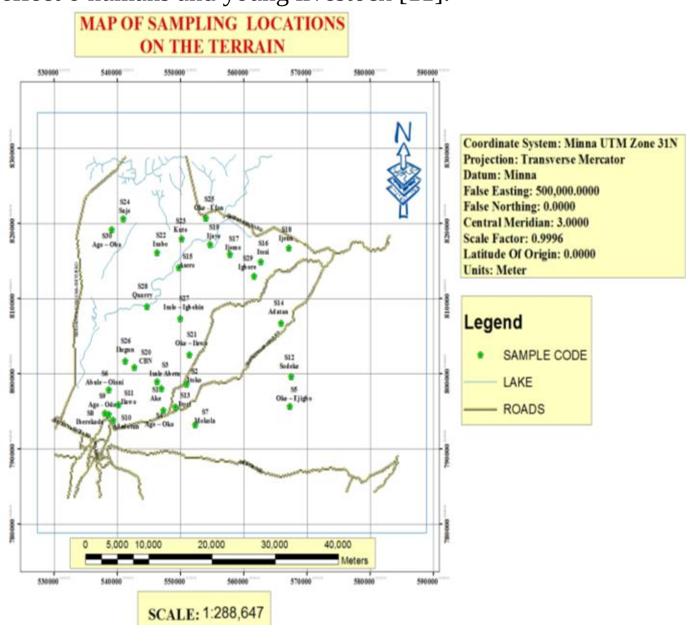

Figure 1: Map showing the sample locations in the Study Area.

III. MATERIALS AND METHOD.

Materials Used

- **i.** Plastic funnel (used to collect the water from the taps)
- **ii.** Sterilized plastic bottles (used to collect water samples)
- **iii.** White paper tape (used to label each bottle with respect to their sample location)
- **iv.** Global Positioning System (GPS) (used to determine the spatial locations and three dimensional coordinates (x,y,z) of sampled locations.
- **v.** Thermometer (used to obtain the temperature of each water sample)

The result of the analysis revealed chloride levels to be within the maximum acceptable limit of 250mg/l by [14] this was not a surprise as high chloride content in water could indicate possible pollution from human sewage, animal manure or industrial waste [11].
The health implication of high concentration of Cu is gastrointestinal disorder while that of Cr is cancer [12].
Nkono *et al*, 1998 [15] stated that K that ranged from 1-3mg/l has no health-based in drinking water standards. Therefore, this study assesses the physio-chemical parameters, heavy metals and trace element within Abeokuta Metropolis Ogun State, Nigeria compared to SON and WHO standard limts.

II. DESCRIPTION OF STUDY AREA

The study area "Abeokuta" Ogun State, Nigeria was founded by the Egbas in 1830. Abeokuta Metropolis lies between geographic location of Latitude 7^0 5' N to 7^0 20' N and longitude 3^0 17' E to 3^0 20' E. Abeokuta has a population growth rate of 3.5 % of the total population of the state. Abeokuta has a total annual rainfall of about 1270mm and the altitude is about 300m above mean sea level.

- **vi.** The pH/EC/TDS meter (used to obtain the values of pH, conductivity and total dissolved solids)
- **vii.** Measuring cylinders and beakers (used during digestion for measuring both samples and chemicals)
- **viii.** 100ml plastic bottles (used to convey digested samples from point of digestion to point of analysis.
- **ix.** Atomic Adsorption Spectrophotometer (AAS) (used to determine the values of heavy metals)
- **x.** Flame photometer (used to determine the values of major cations.

Sampling Procedure/Data processing

Reconnaissance survey of the study area was carried out in other to familiarise with the study area as well in order to be able to design adequate sampling strategy. After the reconnaissance, the field observation followed by collecting thirty (30) water samples with a sterilized bottle from borehole taps. Sample bottles were labelled according to sampling location for easy identification and proper collation of results. The chemical parameters analysed are pH, temperature, conductivity (EC), total dissolved solids (TDS), total alkalinity, total hardness and major cations which includes sodium, calcium, magnesium and potassium as well as major anions comprising of bicarbonate, chloride, sulphate and nitrate and were later taking to the Laboratory for chemical tests. Image of the study area was georeferenced from the coordinate x,y,z of all sampled point and digitized using Google earth imagery (Pro) and processed using ArcGIS 10.2 software figure 1.

Statistical Methods

EVIEWS 9 version statistical software was used to analysed the results of the laboratory test to show the inter-relationship (correlation) between parameters studied. Pearson correlation 'r' statistics at 2 tailed significant levels was used. The 'r' statistic value for 'r' at 1% = 0.463, and at 2% = 0.423. These values were compared with the computed analysis table (3 &4) to determine their correlations.

Chemical Analysis Procedures

Atomic Adsorption Spectrophotometer

Atomic absorption spectroscopy (AAS) determines the presence of metals in liquid samples. The instrument measures the change in intensity.

Determination of Total Alkalinity

A 50ml of the water sample was put in a conical flask. 2 drops of phenolphthalein was added to the sample which gives an orange colour. The solution was titrated against H_2SO_4.

Total alkalinity = titre value x 20

Determination of Total Hardness

The method used involves the use of disodium ethylene diamine-tetraacetate (EDTA) in the examination of water. The titre value was taken and multiplied by 20 to give the total value in mg/l.

Determination of Calcium Hardness

50ml of the sampled water was taken into a conical flask. 2ml of 0.1N NaOH was added to standardize the sample water and afterwards, Ig murexide indicator was also added. The sample result give purple colour and then it was titrated against EDTA titrant to give a lilac colour. The titre value was taken and it was multiplied by 20 to give calcium hardness in mg/l.

Calcium Hardness = titre value ×20

Determination of Magnesium Hardness

Total Hardness in water is mainly caused by the presence of calcium ion and magnesium ion, magnesium hardness can be gotten by simply subtracting the value of the calcium hardness from the total hardness i.e.

Magnesium hardness = total hardness – calcium hardness

Determination of Sodium and Potassium

Flame photometry was used in the determination of sodium and potassium in the water samples. Therefore, for sodium, conversion factor is;

$$200\text{mole/litre} = \frac{4\text{mole/litre}}{50}$$

While that of potassium is

$$10\text{mole/litre} = \frac{0.2\text{mole/titre}}{50}$$

Therefore actual concentration is then measured and the value multiplied by the conversion factor for each substance. The instrument is then shut off by reversing the setup order after use [16].

Determination of Chloride

This involves the use of silver nitrate as titrant and potassium chromate as indicator. The titre value is then read and multiplied by 5 to give the result in mg/l.

Determination of Bicarbonate

25ml of the water sample was pipetted into a 250ml conical flask. To the solution, 3 drops of methyl orange indicator was added and then titrated against HCl until the solution turns from orange to red.

Calculation:

$$HCO_3\ (\text{mg/l}) = \frac{\text{Titration value x 0.1 x 1000 x 61}}{\text{ml of the sample taken}}$$

Determination of Sulphate

EDTA method was used to determine the sulphate present in the water sample. First, the total hardness of the water sample is determined by titration with EDTA. The time taken for the titration should not exceed five minutes from the time that buffer solution was added (Ademoroti, 1996).

Calculation

$$\text{Sulphate } (SO_4^{2-}) = 961\,\frac{(V_2 + V_3 - V_4)\ \text{mg/l}}{V_1}$$

where, V1 = Volume of sample taken (ml)

V_2 = Volume of N/50 EDTA equivalent to the hardness in 1ml of the sample (ml)

V_3 = Volume of N/50 barium chloride solution added (ml)

V_4 = Volume of N/50 EDTA used in the final titration (ml)

Determination of Nitrate

The NO_3 value was determined by extrapolation from calibration curve [16].

Calculation:

$$NO_3\ (\text{mg/l}) = \frac{NO_3 \text{ read from curve x D}}{\text{ml of sample}}$$

D = dilution factor for the sample

IV. RESULTS

The entire result of the research is given in Tables (1 – 4). The results include those of the physico–chemical and trace metal analysis. The result for temperature ranged from 25.9^{0}C and 27.2^{0}C, while the result of pH ranged from 5.68 – 7.46 the minimum and maximum pH recorded at Asero and Sodeke respectively. The EC result ranged from 117µS/cm - 210µS/cm while that of TDS was between 65mg/l and 111mg/l. Total alkalinity and Total hardness had values ranging from 9mg/l – 34mg/l and from 28mg/l -58mg/l (table 1). Table 2 present the results of the major cations and it revealed that Na and Mg values ranging from 4mg/l – 15mg/l and 13mg/l – 42mg/l respectively. Ca values ranged from 18mg/l – 44mg/l while K values ranged from 0 – 9mg/l. For anions, HCO_3 was not detected in any of the water samples. SO_4 ranges from 7.27-355.66mg/l and also recorded the highest concentration among the anions at Quarry sample 28 (S_{28}). NO_3 values ranges from between 0.019mg/l and 0.218mg/l. Cl values ranged from 15mg/l – 48mg/l. SO_4 values were considerably higher (except for 14 samples S_{1-3}, S_{7-11}, S_{14-15}, S_{24-26}, & S_{29}).

Table 3 presents the correlation analysis of physio-chemical parameters of the study. From the results, TDS showed positive and strong significant relationship with EC with (r = .956), Total Alkalinity also showed positive and strong significant relationship with EC and TDS with (r = .726, .694). Others showed low and negative correlations. Table 4 presents the results of correlation coefficient matrix of the trace metals. From the results it showed that SO_4^2 is correlates with Ca^2 with (r = .500), Total Hardness showed significant relationship with Ca^2,

Mg^2 mg/l, SO_4^2 with (r = .558, .525, .423). Others showed weak, low and negative correlations table (3 & 4). Chart (1&2) presents the trend in variation between the physiochemical parameters; temp, pH, EC, TDS and Total Alkalinity and chart 2 presents trend in variation between trace metal parameters; total hardness, Na^+, Mg^{2+}, Ca^{2+}, K^+, NO_3^-, Cl^{2+}, HCO_3^-, SO_4^2. Figure 2 presents the contour plot and 3D surface contour plot of sampling locations. Figure 3 presents the terrain slope in 3D wireframe of sampling locations.

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Table 1: Sampled Locations, Coordinates and Laboratory results of Physio Chemical parameters of the study area

Sample Code	Sample Location	Northing (m)	Easting (m)	Elevation	Temp. ^0C	pH	EC µS/cm	TDS mg/l	Total Alkalinity mg/l
S_1	Ake	798049	547043.3	307	26.2	6.65	119	67	9
S_2	Itoko	798636.3	551029.5	313	26.2	6.36	130	71	13
S_3	Isale Abetu	798969.5	546367.7	274	26.2	7.10	133	73	26
S_4	Ago – Oko	795163	547383.3	249	26.7	7.09	126	69	11
S_5	Oke – Ejigbo	795707.7	567348.7	291	26.7	7.12	125	71	10
S_6	Abule- Oloni	797919.1	538763.2	274	26.7	7.08	124	70	9
S_7	Mokola	793233.5	552415.1	215	26.2	7.26	111	71	12
S_8	Iberekodo	793866.5	539471.7	169	26.1	7.22	128	69	10
S_9	Ago - Odo	794633.6	538735	123	26.2	7.16	126	74	11
S_{10}	Adedotun	794725.3	538121.6	153	26.2	7.38	123	72	11
S_{11}	Ilawo	795924.4	540236.8	147	26.1	7.32	125	71	9
S_{12}	Sodeke	799638.4	567558.1	168	26.2	7.46	127	70	10
S_{13}	Itori	795625.4	549284.4	205	26.7	7.21	124	73	12
S_{14}	Adatan	806729.5	565954	339	26.3	7.22	139	76	12
S_{15}	Asero	814172.3	549848.6	492	26.3	5.68	210	111	34
S_{16}	Itesi	814924.1	562816	330	26.8	6.75	128	72	14
S_{17}	Ijemo	815870	557879	322	26.8	7.11	138	75	18
S_{18}	Ijeun	816741.6	567228.3	206	26.6	7.12	122	69	21
S_{19}	Ijaye	817156.1	554811.8	217	26.6	7.27	119	68	15
S_{20}	CBN	800839.4	542778.1	218	26.9	7.13	131	75	10
S_{21}	Oke – Ilewo	802567.2	551516.1	217	26.7	6.77	135	76	9
S_{22}	Isabo	816134.1	546351.7	223	26.5	7.14	128	71	11
S_{23}	Kuto	817949.6	550243.3	187	26.8	7.16	132	72	12
S_{24}	Saje	820612.5	541075.1	271	25.9	7.30	117	65	12
S_{25}	Oke - Efon	820717.3	554102.8	263	25.9	7.33	119	67	9
S_{26}	Ilugun	801728.7	541366.8	225	26.3	7.28	123	71	9
S_{27}	Isale-Igbehin	807355.8	550039.4	165	27.2	7.15	119	72	12
S_{28}	Quarry	808947.4	544733.5	148	27.2	7.16	130	76	9
S_{29}	Igbore	812988.2	561684.1	215	27.2	7.17	123	73	13
S_{30}	Ago – Oba	819198.5	539237	225	26.9	7.19	120	72	9
Mean				**238.37**	**26.51**	**7.08**	**128.47**	**72.73**	**12.73**
minimum				**123**	**25.9**	**5.68**	**117**	**65**	**9**
maximum				**492**	**27.2**	**7.46**	**210**	**111**	**34**
SON				**-**	**-**	**6.5-8.5**	**1000**	**500**	**150**
WHO				**-**	**-**	**6.5-8.5**	**500**	**1000**	**100**

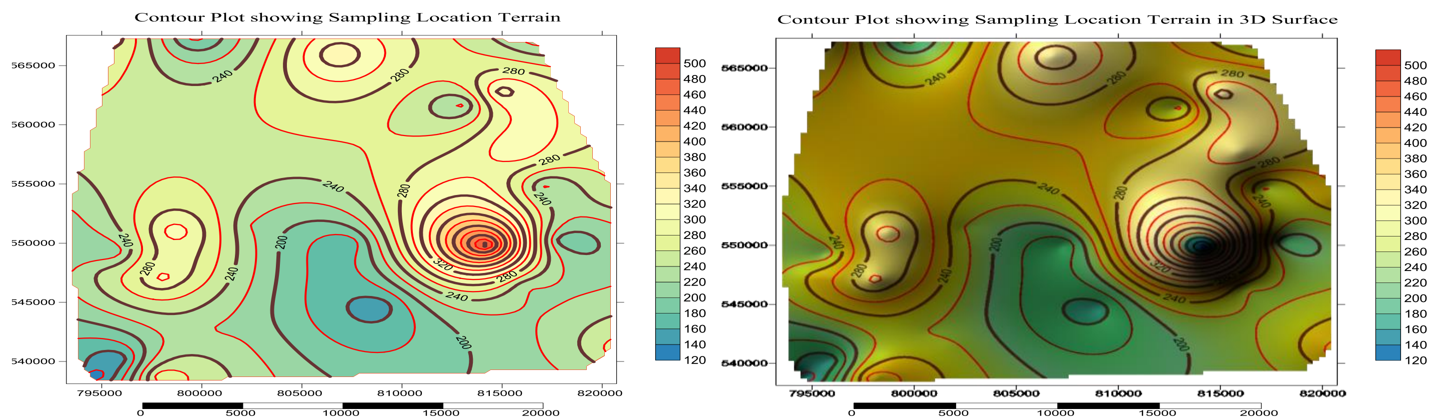

Figure 2: contour plot and 3D surface contour plot of sampling locations

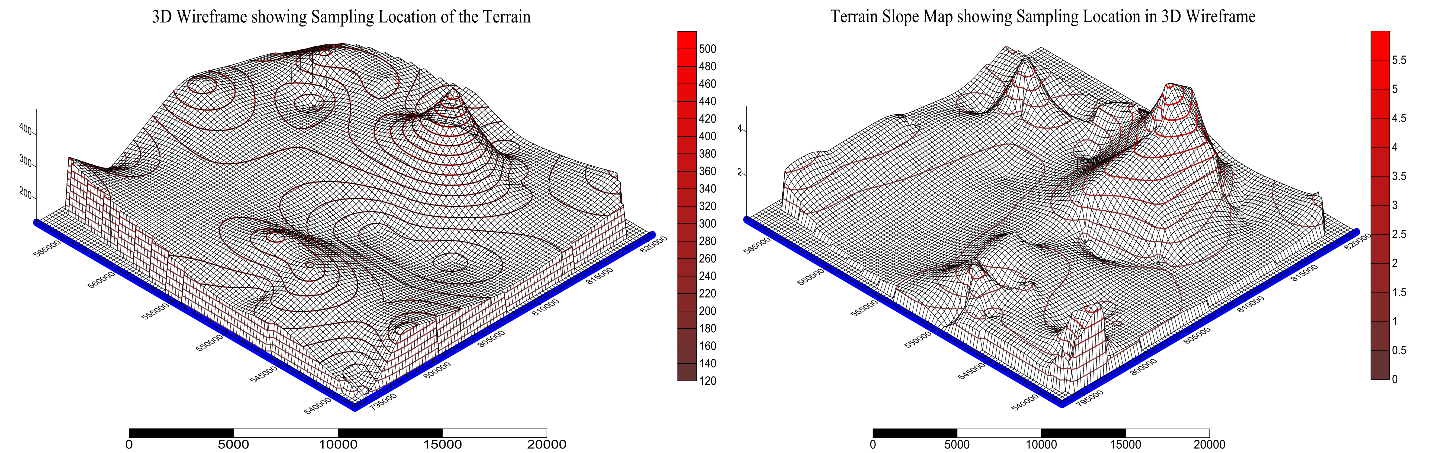

Figure 3: Terrain slope in 3D wireframe of sampling locations.

Table 2: Laboratory analysis of Trace Metals of the study area

Sample Code	Sample location	Total Hardness mg/l	Na^+ mg/l	Mg^{2+} mg/l	Ca^{2+} mg/l	K^+ mg/l	NO_3^- mg/l	Cl^- mg/l	HCO_3^- mg/l	SO_4^2 mg/l$^-$
S_1	Ake	45	5	24	27	2	0.125	17	-	122.64
S_2	Itoko	45	5	18	31	4	0.081	16	-	162.18
S_3	Isale Abetu	40	6	26	29	3	0.123	15	-	125.53
S_4	Ago – Oko	36	13	17	32	0	0.116	19	-	271.22
S_5	Oke – Ejigbo	32	11	19	28	2	0.121	19	-	268.32
S_6	Abule – Oloni	31	9	21	29	0	0.132	16	-	265.09
S_7	Mokola	52	4	27	33	4	0.102	17	-	211.56
S_8	Iberekodo	48	6	22	37	4	0.109	16	-	167.22
S_9	Ago - Odo	42	5	16	34	-	0.114	18	-	210.03
S_{10}	Adedotun	54	6	25	36	3	0.121	19	-	172.44
S_{11}	Ilawo	46	6	21	28	2	0.032	21	-	181.35
S_{12}	Sodeke	58	4	40	26	2	0.019	24	-	332.11
S_{13}	Itori	48	7	14	39	-	0.153	28	-	291.60
S_{14}	Adatan	51	6	24	36	3	0.106	26	-	198.54
S_{15}	Asero	28	14	13	18	9	0.104	48	-	7.27
S_{16}	Itesi	42	11	19	28	4	0.148	22	-	333.04
S_{17}	Ijemo	47	10	21	37	-	0.162	23	-	312.45
S_{18}	Ijeun	45	9	24	29	0	0.076	25	-	270.77
S_{19}	Ijaye	50	12	32	26	-	0.132	29	-	251.34
S_{20}	CBN	53	14	35	35	2	0.140	22	-	323.20
S_{21}	Oke – Ilewo	52	11	38	41	0	0.119	18	-	338.07
S_{22}	Isabo	43	10	42	33	-	0.124	19	-	292.75
S_{23}	Kuto	49	13	40	36	2	0.116	23	-	321.28

S_{24}	Saje	41	7	37	24	3	0.218	15	-	171.68
S_{25}	Oke - Efon	44	8	31	31	2	0.107	18	-	172.50
S_{26}	Ilugun	48	7	29	35	4	0.118	21	-	218.73
S_{27}	Isale – Igbehin	55	14	33	34	-	0.127	24	-	333.05
S_{28}	Quarry	56	15	27	37	2	0.186	20	-	355.66
S_{29}	Igbore	55	9	32	42	0	0.138	26	-	216.08
S_{30}	Ago – Oba	48	10	30	44	3	0.068	27	-	350.48
Mean		**46.13**	**8.90**	**26.57**	**32.5**	**2.0**	**0.118**	**21.7**		**241.61**
minimum		**28**	**4**	**13**	**18**	**0**	**0.019**	**15**		**7.27**
maximum		**58**	**15**	**42**	**44**	**9**	**0.218**	**48**		**355.66**
SON Standard		**150**	**200**	**0.2**	**50**	**-**	**50**	**250**		**100**
WHO Standard		**100**	**200**	**0.4**	**200**	**<20**	**10**	**250**		**250**

Source: Laboratory Analysis.

Table 3: Correlation coefficient matrix of physio-chemical Parameters of the study area

	EC scm	pH	TDS mg/l	Temp (0c)	Total Alkalinity mg/l
EC s_cm	1				
ph	-0.765	1			
TDS_mg/l	0.956*	-0.733	1		
Temp (0c)	-0.030	-0.000	0.080	1	-
Total Alkalinity mg/l	0.726*	-0.588	0.694*	-0.070	1

* and **Represents 0.010 and 0.020 at two tailed significance level

Table 4: Correlation coefficient matrix of Trace Metal Parameters of the study area

	Ca^2 mg/l	Cl mg/l	K mg/l	Mg2 mg/l	Na mg/l	NO_3 mg/l	$SO4^2$ mg/l	Total Hardness mg_l
Ca2 (mg/l)	1							
Cl (mg/l)	-0.201	1						
K (mg/l)	-0.353	0.367	1					
Mg2_	0.191	-0.184	-0.256	1				
Na (mg/l)	0.044	0.407	-0.077	0.132	1			
NO_3 (mg/l)	0.092	-0.148	-0.076	0.023	0.355	1		
SO_4^2 (mg/l)	0.500*	-0.147	-0.544	0.393	0.416	0.084	1	
Total Hardness_mg/l	0.558*	-0.106	-0.256	0.525*	-0.109	-0.085	0.423**	1

* and **Represents 0.010 and 0.020 at two tailed significance level

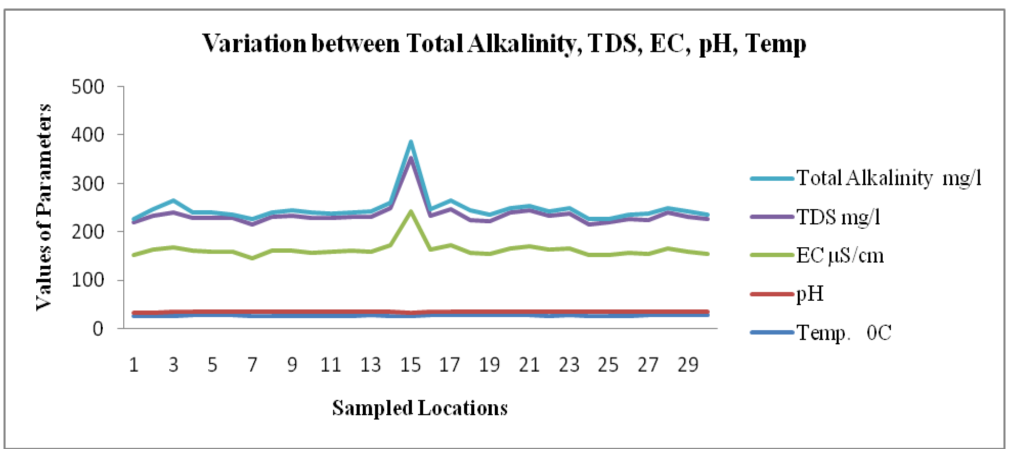

Chart 1: Trend in variation between physiochemical parameter studied

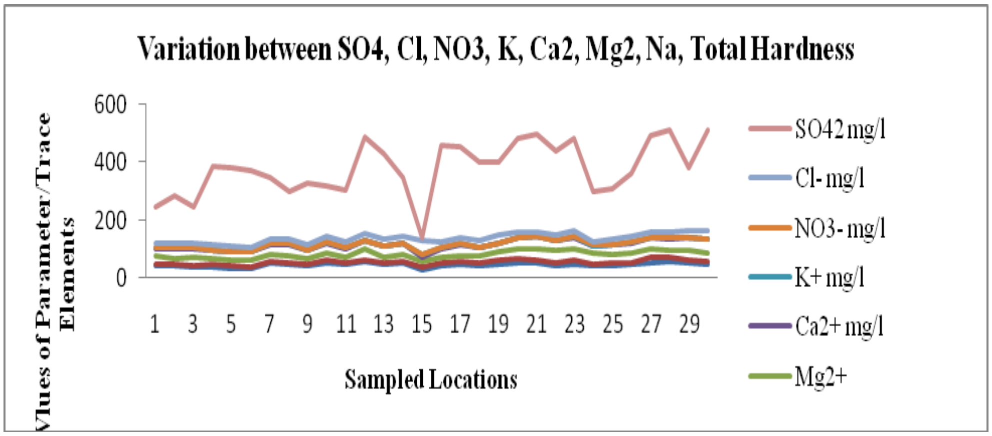

Chart 2: Trend in variation between trace metal studied

Discussion of results

The results is of the PH from the study were compared with SON standards for drinking water quality (6.5 – 8.5), the values for pH were all found to be within the maximum acceptable limit except for sample 15 ($S_{15)}$ in Asero which recorded a value of 5.68 lower than the SON standard. The pH value of water samples suggests that they tend towards acidity where the Ph value was 5.68 and tend towards alkalinity at 7.46. However, this does not give a cause for alarm since pH as a primary standard parameter has no health implication [12]. pH as a primary standard parameter and has no health implication [12]. The range of values for EC and TDS 117µS/cm - 210µS/cm and 65mg/l and 111mg/l also fell within acceptable limit of (1000µS/cm and 500mg/l respectively) set by SON. An elevated TDS concentration is not a health hazard as TDS concentration is a secondary drinking water standard and is more of an aesthetic rather than a health hazard. It may be an indicator of the concentration of dissolved ions which may cause the water to be corrosive, salty or brackish, resulting in scale formation [11]. The values for total hardness and total alkalinity fell within the allowable limit of 150mg/l set by SON and 100mg/l by WHO respectively while excessive alkalinity values may cause scale formation, the water may also have a distinctly flat, unpleasant taste [11]. Ca ranges from 18 mg/l -44 mg/l. Considering the results for Na and Mg, Na values were below the maximum acceptable limit of 200mg/l set by SON however the values for Mg were outrageously higher than the 0.2mg/l and 0.4mg/l set by SON and WHO respectively. Although Mg alongside Ca are major contributors to water hardness, Mg is an essential element needed in good quantity by the human body [13], therefore this does not give a cause for alarm. Ca had values that were within the acceptable limit of 50mg/l set WHO [11], however there is no health-based drinking were standards for K [15]. Very low concentrations were recorded for NO_3 which is very good; it had values between 0.019mg/l and 0.218mg/l. The health implication associated with high concentrations of NO_3 especially in young children is the blue baby syndrome also known as Metamoglobinemia which can cause death in the children while high chloride content in drinking water may indicate possible pollution from human sewage, animal manure or industrial wastes [11]. Cl values ranged from 15mg/l – 48mg/l. SO_4 values were considerably higher (except for 14 samples $S_{1\text{-}3}$, $S_{7\text{-}11}$, $S_{14\text{-}15}$, $S_{24\text{-}26}$, & S_{29}) that are lower than the SON and WHO limits of 100mg/l and 250mg/l though, there is no health impacts recorded for high sulphate intake [12]. High sulphate concentrations though not a significant health hazard, can cause scale formation and may be associated with a bitter taste in water that can have a laxative effect of humans and young livestock [11]. The high occurrence of sulphate is attributed to the Aluminium Sulphate ($AlSO_4$) used as a coagulant in water treatment. NO_3 and Cl both had values that were within the acceptable limits of 50mg/l and 250mg/l by SON and WHO respectively. Excessive alkalinity values may cause scale formation, the water may also have a distinctly flat, unpleasant taste [11]. At 98% and 99% confidence level, significance relationships exist between parameters of physiochemical and trace metal studied. High correlations show that the parameters are derived from the same source [17].

V. CONCLUSION

The physiochemical and trace metal parameters of borehole water tap in thirty locations in Abeokuta were investigated. The results of the study showed that all bore tap water in all sampled locations were of good quality and portable for drinking as the values of physiochemical parameters were within the Standard Organisation of Nigeria SON and World Health Organisation WHO acceptable limit standard. Breaking of reticulated pipe, waste dump, geological formation, seepage of surface runoff, are likely the major sources contamination as some trace metals showed high value. It is therefore necessary to take cognizance of the aforementioned major source of contamination.

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