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RESEARCH ARTICLE

HYDROGEOLOGICAL AND GROUNDWATER EVALUATION OF ADEKUNLE AJASIN UNIVERSITY CAMPUS, AKUNGBA-AKOKO, SOUTHWESTERN NIGERIA

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ABSTRACT

In assessing the quality of water within the Adekunle Ajasin University, Akungba Akoko, Ondo state Southwestern Nigeria, 12 representative samples were analysed from 3 hand dug wells. 3 streams and 6 boreholes for their physical and chemical parameters. The result show that the appearance of water samples varied and they were all clear. Turbidity ranges from 0.050-0.195NTU which indicate that the samples turbidity are below the W. H.O guideline of 5.0NTU. Conductivity ranges from 0.04 (mho/cm) to 0.11 (mho/cm), for hand-dug wells the 0.02 (mho/cm) to 0.05 (mho/cm) and for stream's the conductivity ranges from 0.02 (mho/cm) to 0. 08 (mho/cm).The chemical parameters analyzed for the samples include pH, total dissolved solids, total Hardness, and concentration of ions. The total dissolved solid is highest in borehole 1 with a value of 700ppm while stream 2 and hand dug well 3 has the lowest value of 100ppm respectively. The Total Hardness is highest in borehole 4 with value of 77.78 and lowest in borehole 3 with value of 16.70. The value of the calcium concentration in the water samples range from 7.21mg/1 to 40.08mg/1. The W.H.O recommended minimum and highest desirable levels are 75m/1 and 200mg/I respectively The magnesium concentration of the samples ranges from 2.43mg/1-41.31mg/l. According to the World Health Organization permissible limits for minimum and maximum values are given as (50mg/1 and 150 mg/l),The results of the analysis compare favourably with the standard practice, the pH value also suggests that most of the water samples are slightly acidic but only a sample falls within the alkalinity range, the geology of an area influences groundwater chemistry while the activity of human influences the quality of groundwater.

KEYWORDS

Water, quality, WH0, Chemical parameters

1. INTRODUCTION

Water is one of the most important and precious substances to human life, as its aids many processes within the human body and makes up more than 70% of the body. People generally require about 2. 5litres of water every day for consumption, while the average amount of water use domestically day by day is about 19.0litres (Hamill and Bell, 1986). Water exists in nature in many forms rain, clouds, snow, ice, and fog. However, strictly speaking, chemically pure water does not exist for any appreciable length of time in nature, even while falling as rain, water picks up small matter from the atmosphere i.e during precipitation. Then as it flows over through the surface layer of the earth, it dissolves some and carries with it almost everything which is dumped into it. These added substances may be arbitrarily classified as biological, chemical (both organic and inorganic), physical and radiological impurities. Others include industrial and commercial solvents, agricultural pollutants such as fertilizers and pesticides, and microorganism such as bacteria, algae and viruses. These impurities give water bad taste, colour, odour, or cloudy appearance and can also give rise to hardness, corrosiveness, staining of frothing. They may damage plants (such as high percentage of sodium in water that can cause. problem of adsorption for plant), and transmit diseases which can account for about 90% of death in children under the age of five such as E. coli.

Quality water means different things to different people, Home owners are primarily concerned with domestic water problems related to colour, odour, taste and safety to family health, Chemists and Engineers working for industry are concerned with the purity of water as it relates to scale deposition and pipe corrosion. Regulatory agencies (such as W.H.O) are concerned with setting standard and guidelines to protect public health, Farmers are interested in the effect of irrigation water on the chemical, physical and osmotic properties of the soil, particularly as they affect or influence the crop yield.

One means of establishing and assuming the purity and safety of water is to set standards for various contaminants i.e. standards that are based on the principle of sound science because water quality is sometimes difficult to determine. Naive people might think that cleanliness of water is dependent on its clarity, and if it is cloudy or coloured, the water is dirty or polluted, but quality determination is not that simple. The way to determine the quality of water is to collect and analyze the samples, collate and analyze the resultant data and compare its relationship with that of standard guidelines (e. g. WHO guidelines). Prior to this fact, the water quality within Adekunle Ajasin university in Ondo state is to be determined using various field and laboratory techniques.

A group researchers estimated on the physical parameters of the samples: (colour, appearance, pH, turbidity and conductivity) as well as the chemical parameters (cations and anions), and the biological contents of the water samples (Ariyo et al., 2005). Some researchers worked on the quality of groundwater in parts of South-Western Nigeria concluding that the chemistry of groundwater and its relationship with bedrock geology is

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strong and this is reflected on the extent of chemical perturbations (Elueze et al., 2001). Aladejana [4] concluded after his work in Akoko south-west Local Government Area of Ondo state that there are two classes of water which are traceable to Basement Complex exchange processes and weathering of surrounding rock (. Omolade [5] resolved that water quality in Akure North calls for attention due to results he obtained from assessing the water quality (Omolade, 2006).

There is little work done on the hydrogeochemical investigation on groundwater in Akungba area, therefore, references are made to similar work done on the hydrogeochemical investigation of surface water and groundwater around Ikare area of southwestern Nigeria Basement Complex (Olatunji et al., 2005). Conclusions from study on Ikare area shows that the relationship between the bedrock geology and chemistry of groundwater is quite strong and is reflected on the extent of chemical perturbation. Geological factors have been determined either directly or indirectly, the type and content of chemical constituents of the water as well as their distributions, Groundwater in the area falls within permissible limit.

The quality of water in an area is an indication of the natural and artificial conditions and processes occurring upstream of the point that is sampled for a quality. The composition for the precipitation falling on the drainage area sets the initial chemical quality of the water, but this is soon changed by interacting with vegetation and soil. Therefore, the geological structure and vegetation characteristics of Akungba-Akoko are primary determinants of the type of chemical and physical changes that the water in the area undergoes prior to its entry into major streams in the area.

The fact that water quality means different thing to different people is of importance, Homeowners are primarily concerned with domestic water problem related to colour, sour taste, and safety to family health, as well as the cost of detergent. Farmers are interested in the effect of irrigation waters on the chemical, physical and osmotic properties of soils particularly as it influences production. It should be noted that chemically pure water does not exist for any appreciable length of time and that in the scope of this work, interest in water quality relates to how the surface and underground water available to the people affects lives of the inhabitant. Quality of water is determined by comparing minerals or contaminants present, with the standard set by the world health organization. The parameters to be determined include; the cationic and anionic properties, suspended solid, pH, micro-organic content and comparing it with the world health organization (W.H.O) guidelines for drinkable and domestic water. This study lay emphasis mainly on hydro-geological mapping of Akungba-Akoko environment with particular emphasis on the investigation of ground water quality and surface water quality.

2. Description of The Study Area

The study area is located within the Adekunle Ajasin University Campus, Akungba Akoko. It is situated in the North Eastern part of Akungba town which is located geographically in Akoko-South West local government area of Ondo state. It lies between latitude 7°22'27'N - 7022'30'N and longitudes 5° 45 20" – 5o 45'35" as shown in Figure 1. It is situated within the Basement Complex of the South-Western part of Nigeria and it has an altitude peaking above 372m above the sea level. Adekunle Ajasin University Campus Akungba Akoko is underlain predominantly by the granite gneiss, grey-gnesis, charnockite and other intrusives. Granite gneiss form the largest rock type on the study area (Figure 2). They are highly foliated, exhibiting bands of light-coloured minerals and dark coloured minerals. Quartz and feldspars make up the light-coloured minerals, while biotite (ferromagnesian minerals) makes up the dark coloured or mafic minerals. Grey gneiss forms the second largest percentage of the rock types. The major minerals found in the grey gneisses are biotite and quartz. Grey gneisses are hilly in nature and they occur along the sport complex within. They were formed due to the metamorphism of the pre-existing rocks.

Granite gneiss form the largest rock type on the study area. They are highly foliated, exhibiting bands of light coloured minerals and dark coloured minerals. Quartz and feldspars make up the light coloured minerals, while biotite (ferromagnesian minerals) makes up the dark coloured or mafic minerals. Charnockite rocks are composed of (greenish) minerals, quartz, biotite, feldspar and minor traces of muscovite Qaurtzofelspathic and quartz veins as well as pegmatite intrusions occured as intrusions which cut across the major rocks types. Its colour ranges from light brown to yellowish brown. It is composed chiefly of quartz minerals with a medium-course grained texture (Rahaman and Ocan, 1978; Rahaman, 1988). Geographically Adekunle Ajasin university campus is relatively hilly surrounded by mountains covered by thick to light dense vegetation.

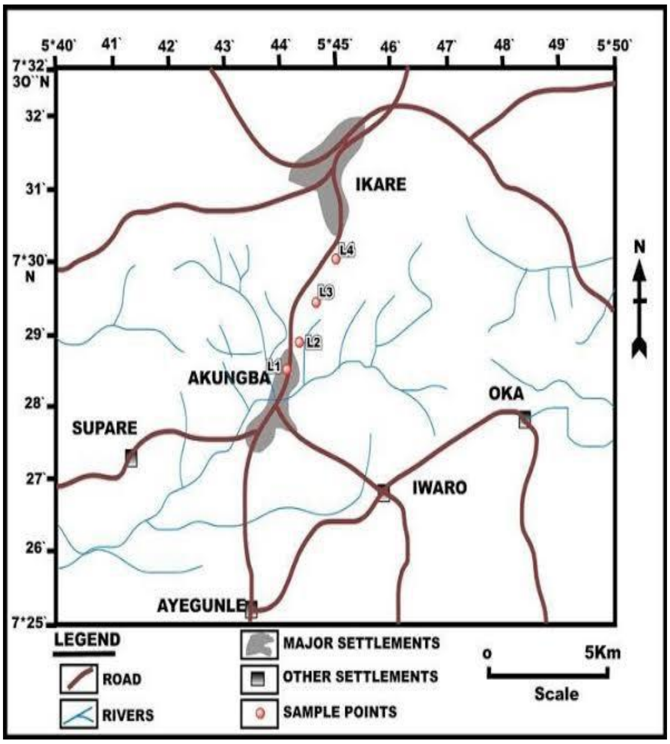

Figure 1: location and accessibility map of Akungba-Akoko.

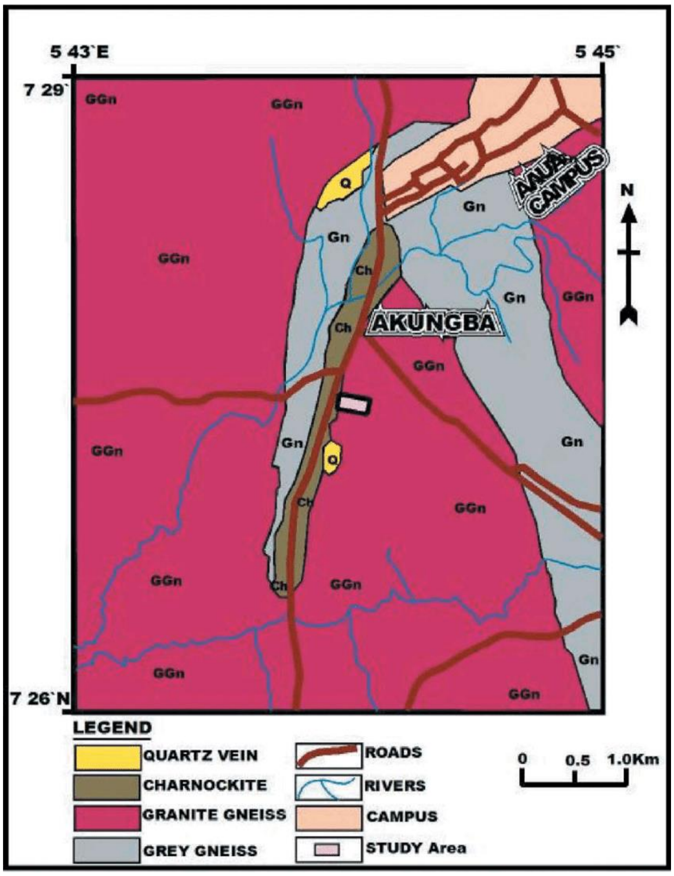

Figure 2: Local geology of the Study area (Source: Department of Earth Sciences AAUA)

The climate of the study area, Adekunle Ajasin University Campus, Akungba, falls within the tropical rain forest and it is characterized by two main seasons, the wet and the dry season (Figs. 3 and 4). The wet season start in April and last till October while the dry season usually comes between November and March. The study area experiences harmattan during December to January due to the influence of North-East trade winds. The annual temperature lies between 25°C and 29°C with little variation in most time of the year. The mean annual rainfall is about 1,600mm with its peak around July.

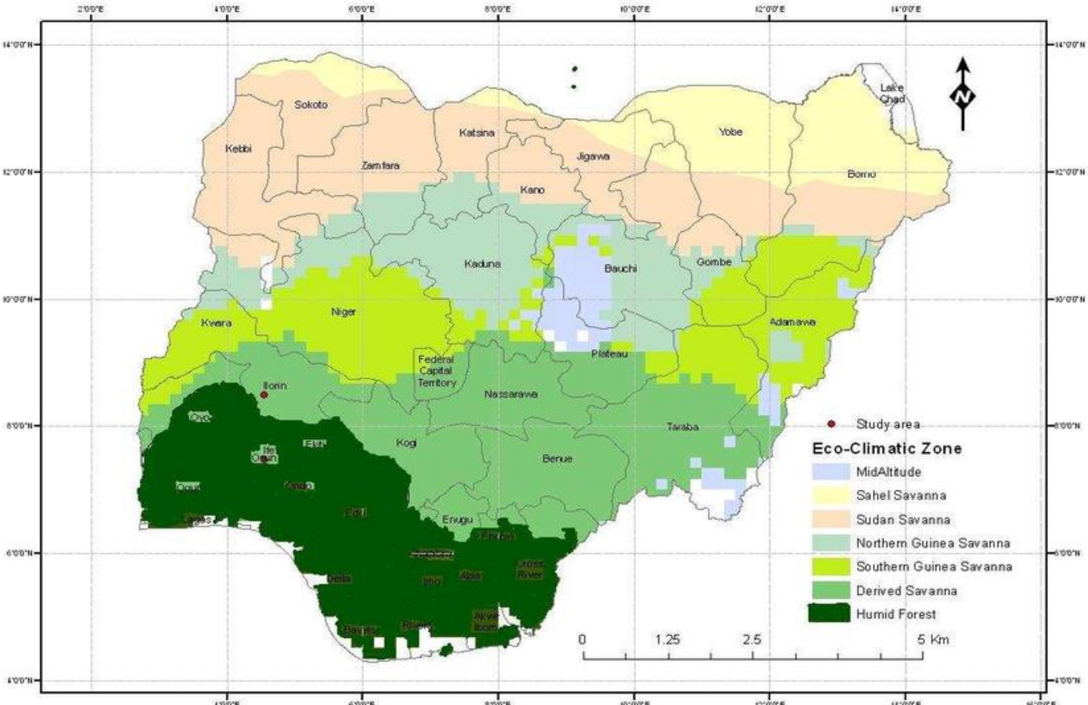

Figure 3: Climate Map of Nigeria showing the Study Area [9].

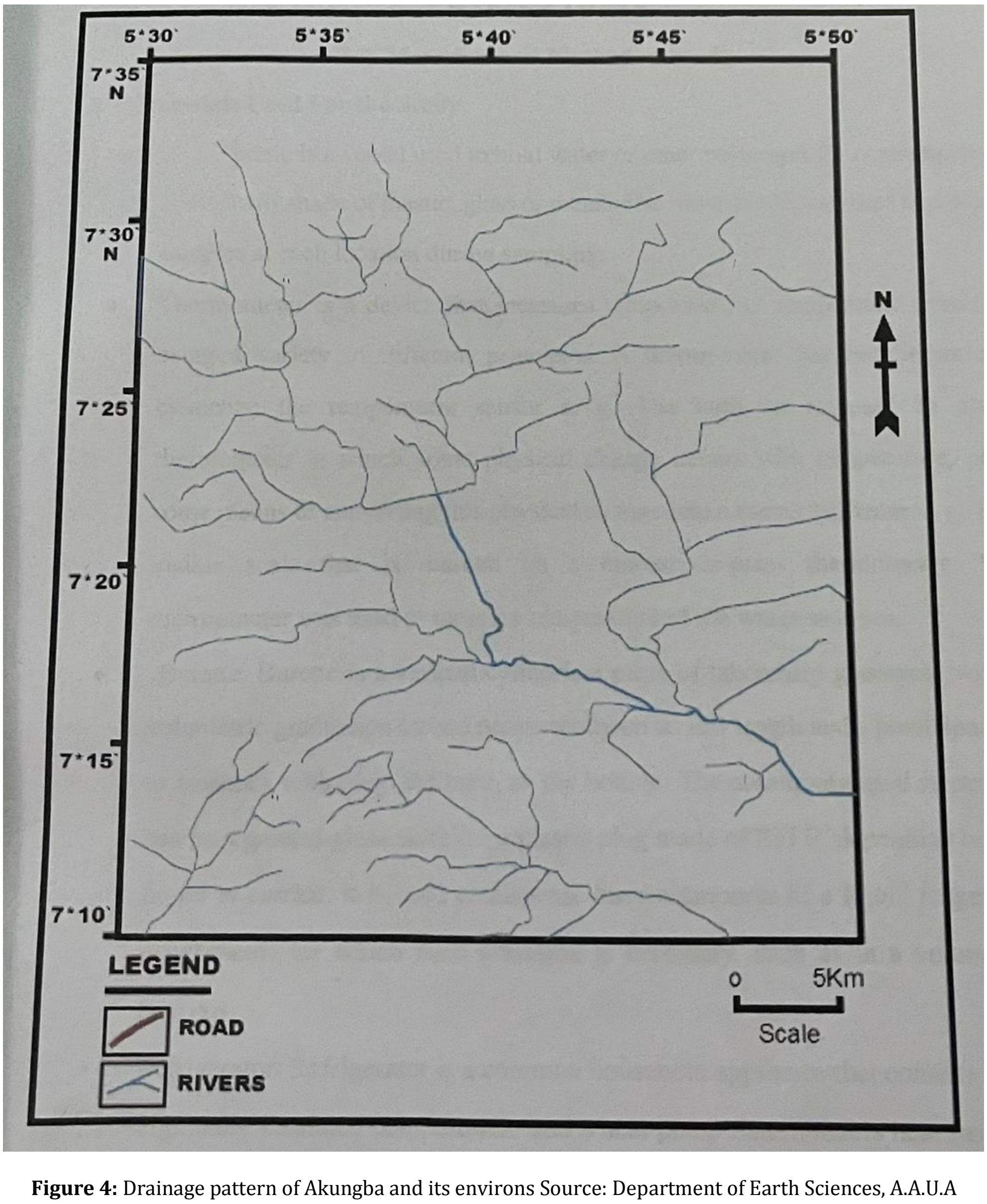

Figure 4: Drainage pattern of Akungba and its environs Source: Department of Earth Sciences, A.A.U.A

3. Materials and Method of Study

3.1 Materials

Water bottle is a vessel used to hold water or other beverages for consumption. It is usually made of plastic, glass or metal. The water bottle was used to collect samples at each location during sampling. Thermometer is a device that measures temperature or temperature gradient using a variety of different principles. A thermometer has two important elements; the temperature sensor e. g. The bulb on mercury in glass thermometer in which some physical change occurs with temperature, plus some means of converting this physical change into a numerical value e. g. The visible scale that is marked on a mercury-in-glass thermometer. The thermometer was used to measure temperature of the water samples.

Burette: Burette is a vertical cylindrical piece of laboratory glassware with a volumetric graduation etched permanently on its full length and a precision tap, or stopcock with plug and bore, on the bottom. The commonly used stopcocks can be a ground-glass barrel or a plastic plug made of PTFE, depending on the liquid to carried, it is used to dispense known amounts of a liquid reagent in experiments for which such precision is necessary, such as in a volumetric analysis.

Refrigerator: Refrigerator is a common household appliance that consists of a Thermally insulated compartment and a heat pump that transfers heat from the inside of the fridge to its external environment so that inside of the fridge is cooled to a temperature below the ambient temperature of the room. So, the refrigerator reduces the rate of spoilage.

pH Meter: pH meter is an electronic device used for measuring the pH (acidity or alkalinity) of a light (though special probe are sometimes used to measure the pH of semi-solid substances). A typical pH meter that consists of a special measuring probe (a glass-electrode) connected to an electronic meter that measures and displays the pH reading.

Distilled Water is water that has many of its impurities removed through distillation. Distillation involves boiling the water and then condensing the steam into a clean container. Distilled water is also commonly used to top off lead acid batteries used in cars and trucks. The presence of other ions commonly found in tap water will causes a drastic reduction in an automobile's battery life span.

Conical Flask is used to hold chemicals and to make chemical. It is used to heat substances, can be stirred and swirled without the risk of spilling and reduces the loss of the evaporation because of the narrow neck.

3.2 Methods of Study

The study involves two methods

3.2.1 Field Investigation

This involves sighting of wells, boreholes and streams in the study area. The field investigation led to the collection of samples at different locations under standard conditions. Sampling was carried out in the month of September 2018. A total number of twelve water samples were collected under standard sampling techniques. They comprise of three hand-dug wells, six boreholes and three streams. The water samples were collected in water samplers under clean sampling procedures. The samplers were ringed with the sample (water) and collection proceeded thereafter. The samples were properly labeled to avoid mix up in the location names. The samples were also covered to avoid contamination, and the samples were then taken for analysis at Department of Earth Sciences, Adekunle Ajasin Akungba Akoko and Central Research Laboratory Adekunle Ajasin University Akungba Akoko Ondo State.

3.2.2 Laboratory Analysis

The laboratory analysis was carried out at the Central Research Laboratory Adekunle Ajasin University Akungba Akoko Ondo State. The conductivity meter bridge (electrolyte conductivity cell) was used in the determination of water sample conductivity. The pH meter was used in the detection of the various pH of the water samples. Other equipment's used include. pH meter burette, conical flask, measuring cylinder, crucible and a refrigerator.

The various tests were carried out on all samples to determine both the physical and chemical parameters.

3. 3 Location of the Sampling points.

The Table 1 shows the latitudinal and longitudinal coordinates at which the twelve samples were collected in the study area. As well as other parameters measured at the sample locations.

Table 1: Showing the latitude and longitude of the sampling points with their respective elevation

LOCATIONS	LATITUDE	LONGTITUDE	ELEVATION (ft)
1	N7°28'16"	E5°45°03"	1251
2	N7°28'15"	E5°44°11"	1227
3	N7°28'21"	E5°44°24"	1136
4	N7°28'26"	E5°44°16"	1125
5	N7°28'12"	E5°44°01"	1180
6	N7°28'12"	E5°44°07"	1146
7	N7°28'11"	E5°44°14"	1143
8	N7°28'11"	E5°44°13"	1183
9	N7°28'11"	E5°44°10"	1168
10	N7°28'15"	E5°44°15"	1240
11	N7°28'14"	E5°44°96"	1214
12	N7°28'16"	E5°44°07"	1169

3.4 Precautions taken during Sampling

Certain precautions were taken during the sampling procedure, to ensure that the samples were not contaminated. These include: thoroughly rinsing water sampling equipment at each location; the samples were properly labelled to avoid mix up of locations; ensuring that samples were not contaminated were taken immediately to the laboratory after collection.

3.5 Analysis of samples

3.5.1 Physical analysis

The physical characteristics for all twelve samples were analyzed. The characteristics include the pH, temperature, electrical conductivity, turbidity and total dissolved solids.

3.5.2 pH

The pH is the measure of hydrogen ion. The concentration of hydrogen ion (H') in the water sample was determined by the use of a PH meter.

Apparatus used: pH meter, distilled water, and conical flask.

Procedure: During the analysis in the laboratory, the pH meter was warmed up for about 15-20 minutes. Then, the electrode was removed from distilled, rinsed with fresh distilled water and wiped dry to eradicate all unwanted contaminants. The meter was then standardized using 25° c. The knob of the pH meter was switched off and the electrode was removed from the second buffer and rinsed properly. After rising, it was wiped with soft tissues. The electrode was inserted into the water sample and the knob was switched on, thereafter the reading was taken on the scale

The electrode was then rinsed again and immersed in distilled water. The samples" PH was determined potentiometrically with a glass-electrode and calibrated potentiometrically into pH buffer solution of NaCO3 (Ogunsanwo and Mands, 1999). The glass electrode is permeable only to H* ion and the potential developed at this electrode depends on the H concentration. The potential is measure by comparing it against the reference electrode of known potential (i.e PH buffer of 7. 0).

3.5.3 Temperature

Temperature is the measure of the degree of hotness or coldness of water.

Apparatus used: thermometer.

Procedure: Determination of temperature e was by inserting the thermometer into water sample, thereafter the reading was taken.

3.5.4 Electrical conductivity

The samples' electrical conductivity was determined using a conductivity meter-bridge. The samples were poured into the electrolyte conductivity cell and the readings were taken.

3.5.5 Total dissolved solids (TDS)

Total dissolved solids in any water sample are the total solid materials in solution, ionized, dissolved gases and colloid. The total dissolved solids refer to solutes remaining in filtrate after filtration using membrane filter paper.

Apparatus used: membrane filter paper, crucible.

Procedure: The filter paper was evaporated to dry in an oven at 140° C and the crucible was allowed to cool in desiccators before it was weighed. The difference in weight between the initial and final weight of the crucible gives the total dissolved solid.

3.5.6 Turbidity

Turbidity decreases the clarity of water and regardless of source, that may be present in water and soil particles and other colloidal impurities. The degree of turbidity depends on fineness of the particles and their concentration.

Apparatus used: Turbidimeter.

Procedure: Turbidity was measured with a turbid meter by measuring the interference to the passage of light through a water sample.

3.6 Determination of Total Hardness

Total hardness is the sum of the calcium and magnesium concentrations expressed as calcium carbonate in mg/L. It may range from 0 to 100 mg/L in terms of calcium carbonate, depending on the source and treatment to which the water has been subjected.

3.6.1 Reagent used for determination of Total Hardness

A. Buffer solution: (i) Dissolved 16.9g ammonium chloride (NH_4CL). Add 1. 25g magnesium salt of EDTA and dilute to 250ml with distilled water.

(il). If the magnesium salt of EDTA is unavailable.

B. Dissolved 1017g disodium salt of ethylenediamine tetra-acetate acid dehydrate analytical reagent and 780mg magnesium sulphate ($MgSO_4$. 7H20) in 50ml distilled water. Add this solution to 16.9g NH_4CL and 143ml conc. NH_4OH with mixing and dilute to 250ml with distilled water. To attain the highest accuracy, adjust to exact equivalence through appropriate addition of a small amount of EDTA or $MgCL_2$

C. Erichrome black T Indicator Sodium salt of 1-(1-hydroxy-2-naphthylazo)-5-nitro-2-naphthol-4-sulfonic acid. Dissolve 0. 5g dye in tong 2.2.2-nitrilotriethanol or 2-methyoxymethanol. Add 2 drops per 50ml solution to be titrated.

Procedure: put 50ml of H_20 sample in a conical flask. Add 2ml buffer solution for hardness shake; add ½ spatula tip measures of E black T indicator. The contour will change from pink to blue.

3.6.2 Determination of calcium

Procedure: Calcium was determined by putting 5oml of water in a conical flask and 0.2ml of buffer solution for hardness of IM NaOH solution. It was shaken and 3g of murexide was added. Later, 3 drop of Erich Rome Black T as indicator and then titrated with 0.OIM EDTA standard against the sample until colour changes.

3.6.3 Determination of magnesium

Procedure: 50ml of water sample was poured into a conical flask and 2ml of Ammonia/ammonium chloride buffer was added. 0. 1-0. 2M indicator mixture was added using the head of a clean spatula. The solution was immediately titrated with standard EDTA until the last reddish tinge disappears. The end point was indicated by a clear blue color.

4. Result Discussions

The result of the physical analysis on water samples from streams, hand dug-wells and boreholes in the study area are presented in table 2 and table 3 These include appearance, taste, odour, temperature, turbidity and conductivity.

4.1.1 Appearance

As indicated in table 2 below, the appearance of water samples varied and they were all clear. It is important that water for drinking purposes should be clear in appearance. The appearance of water is a factor to be taken into consideration when examining water quality.

4.1.2 Turbidity

Turbidity is expressed in terms of reduced light transmission by the water. the penetration of light into water is caused by the presence of silt, clay, mica and other substance in the water. The W. H.O guideline for turbidity in drinking water is 5NTU. All the samples turbidity are below the WHO guideline (WHO, 2004).

4.1.3 Conductivity

The electrical conductivity of each sample were recorded, for the borehole's the electrical Conductivity ranges from 0.04 (mho/cm) to 0. 11 (mho/cm), for hand-dug wells the 0. 02 (mho/cm) to 0. 05 (mho/cm) and for stream's the conductivity ranges from 0.02 (mho/cm) to 0. 08 (mho/cm).

Table 2: The physical parameters from the samples

Sample	Appearance	Taste	Odour	Turbidity NTU	Temperature °c	Conductivity NU/CM
BH 1	Clear	tasteless	odourless	0.195	23	0.11
BH 2	Clear	tasteless	odourless	0.170	27	0.10
BH 3	Clear	tasteless	odourless	0.140	26	0.04
BH 4	Clear	tasteless	odourless	0.065	24	0.04
BH 5	Clear	tasteless	odourless	0.120	24	0.06
BH 6	Clear	tasteless	odourless	0.010	28	0.06
HDW 1	Clear	tasteless	odourless	0.200	27	0.50
HDW 2	Clear	tasteless	odourless	0.030	29	0.40
HDW 3	Clear	tasteless	odourless	0.115	28	0.20
STM 1	Clear	tasteless	odourless	0.225	22	0.03
STM 2	Clear	tasteless	odourless	0.090	26	0.02
STM 3	Clear	tasteless	odourless	0.050	23	0.08

Where:

HDW- hand-dug well

BH- borehole

STM- stream

Table 3: Results of chemicals analysis on collected water samples					
Sample	**Ph**	**Total dissolved solids (ppm)**	**Ca^{2+} (mg/l)**	**Mg^{2+} (mg/l)**	**Total Hardness**
BH 1	7.29	700	34.87	3.89	38.76
BH 2	6.68	700	7.21	10.45	17.66
BH 3	6.86	300	14.03	2.67	16.70
BH 4	6.15	300	36.47	41.31	77.78
BH 5	6.21	400	32.87	26.00	58.87
BH 6	5.97	400	31.26	20.41	51.67
HDW 1	6.31	100	15.23	16.52	31.75
HDW 2	6.26	300	40.08	2.43	42.51
HDW 3	5.40	300	28.06	38.39	66.45
STM 1	6.70	200	24.05	7.29	31.34
STM 2	6.84	100	30.46	12.15	42.61
STM 3	6.47	500	32.06	7.29	39.35

HDW= Hand-dug well

STM= Stream

BH = Borehole

4.2 The chemical parameters

The chemical parameters analyzed for the samples include pH, total dissolved solids, total Hardness, and concentration of ions. Table 3 and Figures 5-16 revealed the summary of the result on the chemical Parameters of the water samples. The table shows that the range of the pH vary between 5.40 -7.29, and since the W.H.O pH guidelines for water is between 6.5-9.0, therefore, the pH values of the samples are still within the permissible limit. The range of the pH of these samples shows that the water samples are slightly acidic and the borehole 1 is slightly basic. This shows that all the samples are good for domestic uses (Ofoma et al., 2005).

4.2.1 Total dissolved solids (TDS)

Total dissolved solids in the water samples is the total dissolved materials in solution, ionized, dissolved gases and colloid. The total dissolved solid is highest in borehole 1 with a value of 700ppm while stream 2 and hand dug well 3 has the lowest value of 100ppm respectively. The W.H.O TDS standard for water is 500ppm and the maximum permissible is 1500ppm. Therefore, all the water samples fall within the permissible limit prescribed by W.H.O.

4.2.2 Total hardness

The hardness of water is the measure of the capacity of the water for precipitating soap. Hardness can also be defined as the property of water which represents total concentration of calcium carbonate equivalent.

$$\text{Hardness} = \frac{Ca \times CaCO_3}{Ca} + \frac{Mg \times CaCO_3}{Mg}$$

i.e. total hardness-calcium hardness + Magnesium hardness

The hardness of water samples was determined gravimetrically ie By gravimetric analysis using 50ml of water samples which was added as a masking agent, 3 drops of indicator (Erich Rome Black T) was added and the solution was titrated against 0.01M EDTA standard until the colour changes from wine red to blue. The measured values are as indicated in the table 4.2. The Total Hardness is highest in borehole 4 with value of 77.78 and lowest in borehole 3 with value of 16.70.

4.2.3 Calcium Concentration

The value of the calcium concentration in the water samples range from 7.21mg/1 to 40.08mg/1. The W.H.O recommended minimum and highest desirable levels are 75mg/1 and 200mg/1 respectively. The values of the calcium hardness in the water samples falls within the minimum and maximum permissible limits of the World Health Organisation guidelines.

These results show that the water in the study area is good for domestic usage.

4.2.4 Magnesium hardness

The magnesium concentration of the samples ranges from 2.43mg/1-41.31mg/1. According to the World Health Organisation (Table 4) permissible limits for minimum and maximum values are given as (50m/1 and 150 mg/1), the water sample in the study area are good for domestic uses because the value of their magnesium hardness (Table 5) falls within the W.H.O recommendation. Magnesium is widely used in industries. Industrial waste tends to add an appreciable quality to underground and surface water. It is however important in the formation of muscles and blood cells.

Table 4: W.H.O guidelines (2004) for drinking water		
Parameters/conc. Level	**Highest desirable level**	**Maximum permissible**
Colour ⁰H	5	50
Turbidity NTU	5	25
PH	6.5-8.5	6.5-9.2
Total dissolved solids ppm	500	1500
Total hardness (Mg/l)	100	500
Conductivity (Mho/cm)	-	250
CL^- (mg/l)	200	500
SO_4^{2-} (mg/l)	200	500
NO_3^- (mg/l)	50	40-70
Fe^{2+} (mg/l)	0.03	0.03-0.10
Ca^{2+} (mg/l)	75	200
Mg^{2+} (mg/l)	50	150
Cu^{2+} (mg/l)	-	2.0
Zn^{2+} (mg/l)	-	3.0
Mn^{2+} (mg/l)	0.01	0.1-0.2
Na^+ (mg/l)	-	200
K^+ (mg/l)	-	50

Table 5: Hardness of water samples (after Sawyer and McCarty, 1976)			
Total hardness Ca+ Mg (mg/l)	**Water classification**	**Number of samples**	**Percentage (%)**
0-75	Soft	11	91.3
75-100	Moderately hard	1	8.3
150-300	Hard	-	-
>300	Very hard	-	-
Total		12	100

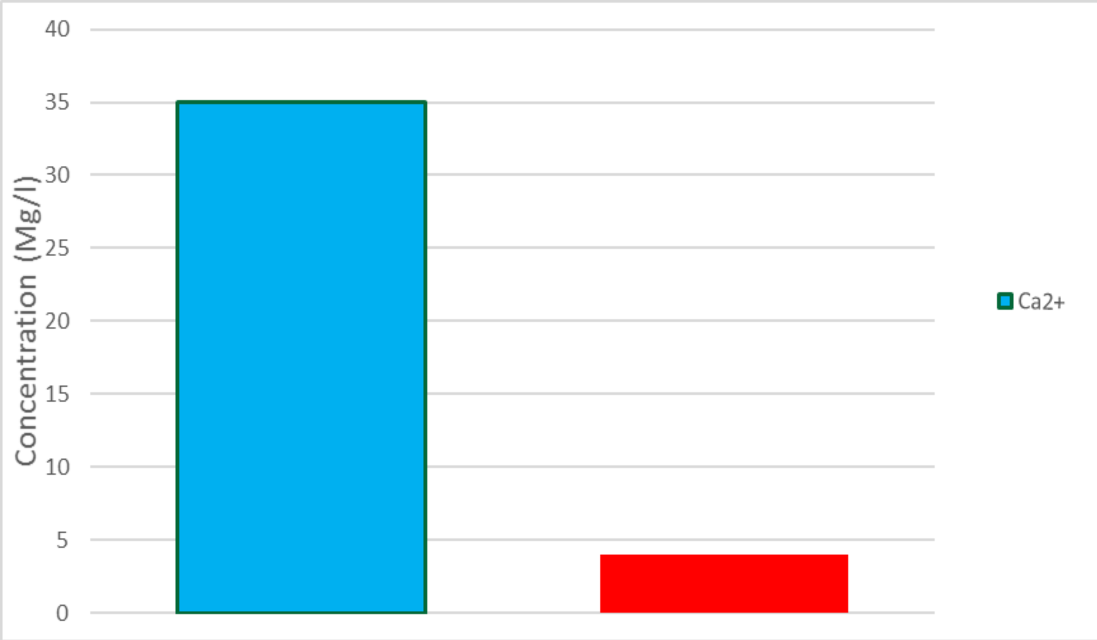

Figure 5: Anionic concentration of BH1 (Mg/l)

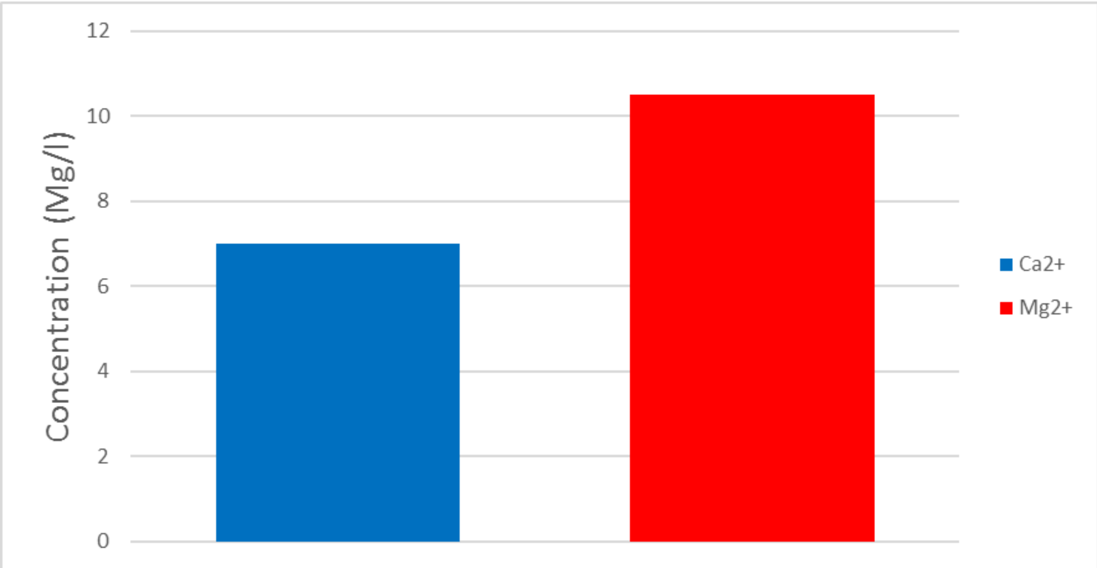

Figure 6: Anionic concentration of BH2 (Mg/l)

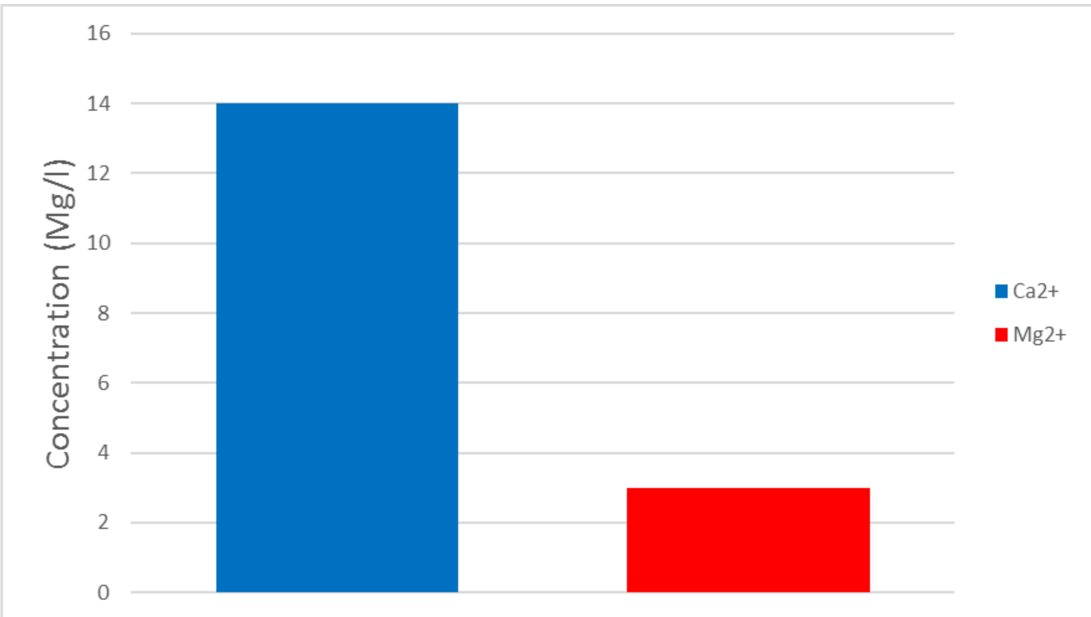

Figure 7: Anionic concentration of BH3 (Mg/l)

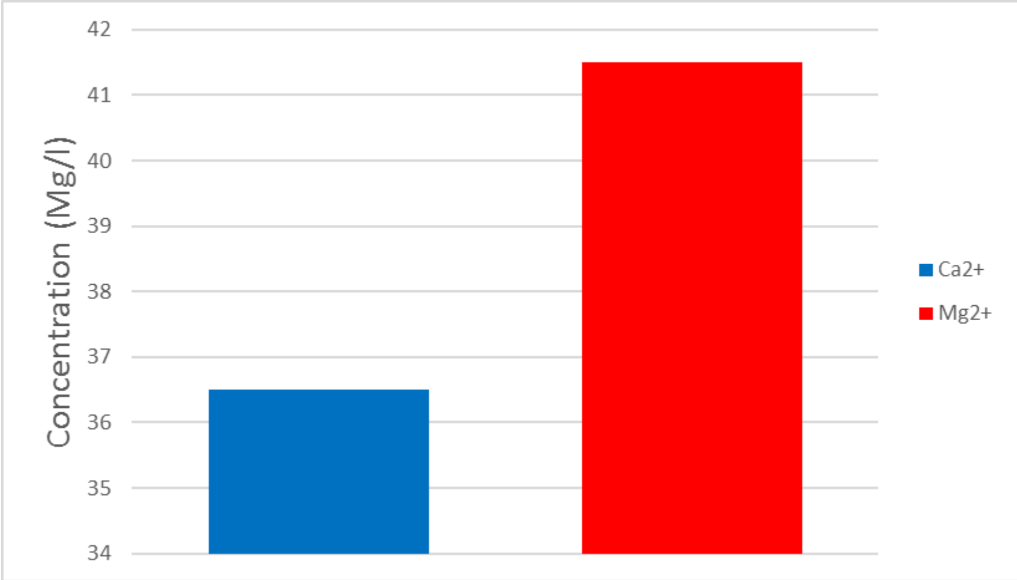

Figure 8: Anionic concentration of BH4 (Mg/l)

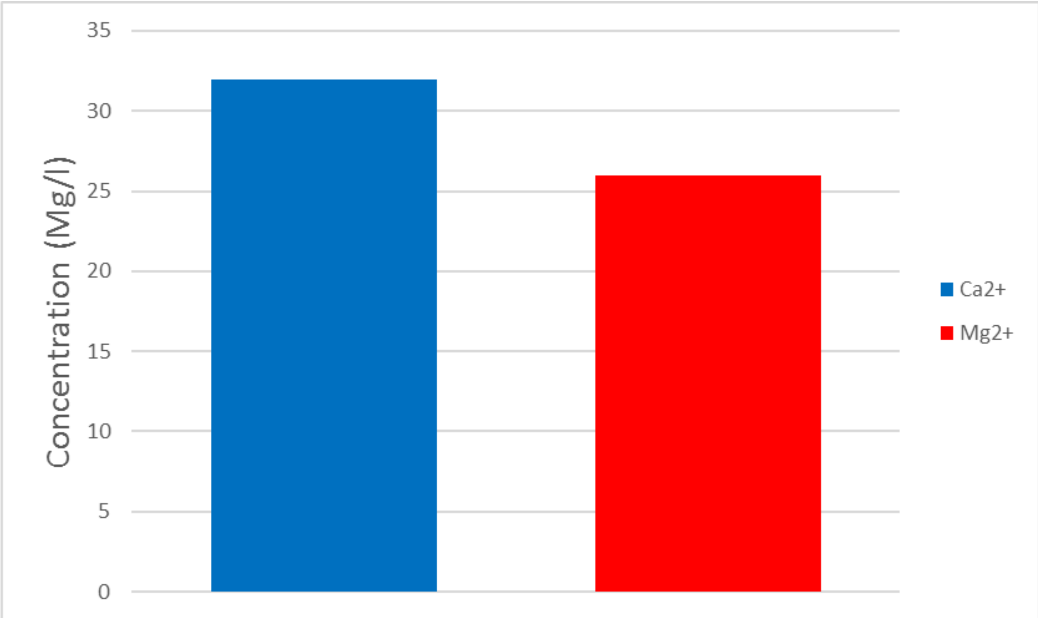

Figure 9: Anionic concentration of BH5 (Mg/l)

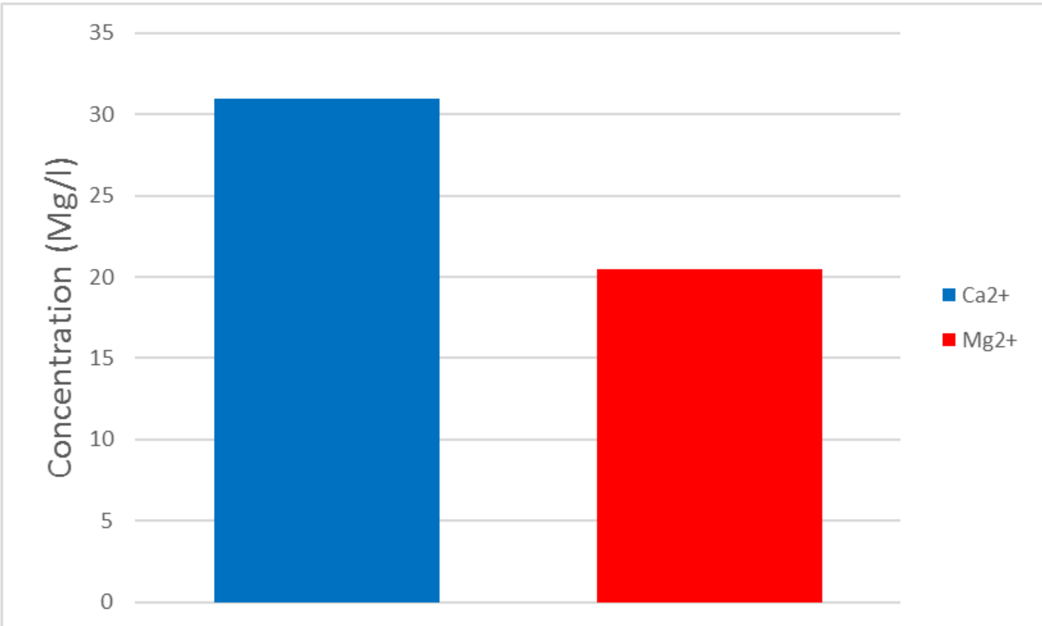

Figure 10: Anionic concentration of BH6 (Mg/l)

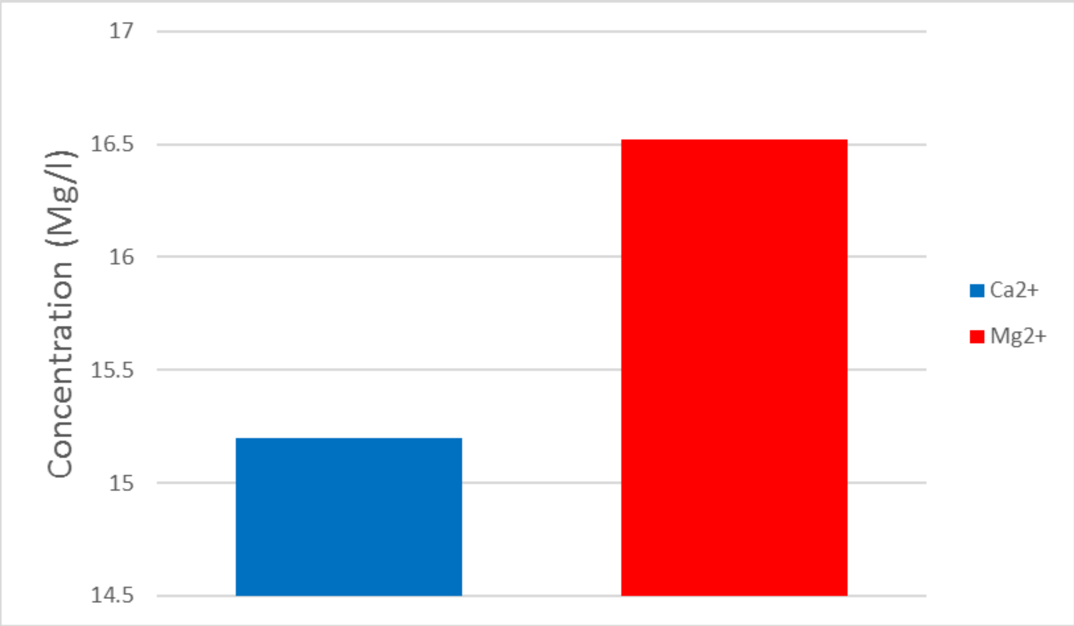

Figure 11: Anionic concentration of HWD1 (Mg/l)

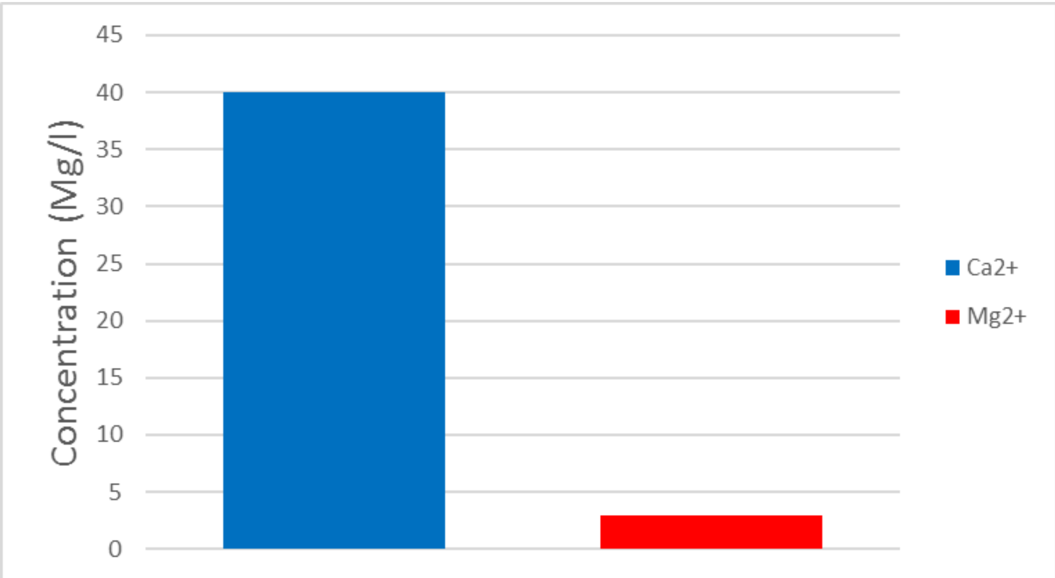

Figure 12: Anionic concentration of HWD2 (Mg/l)

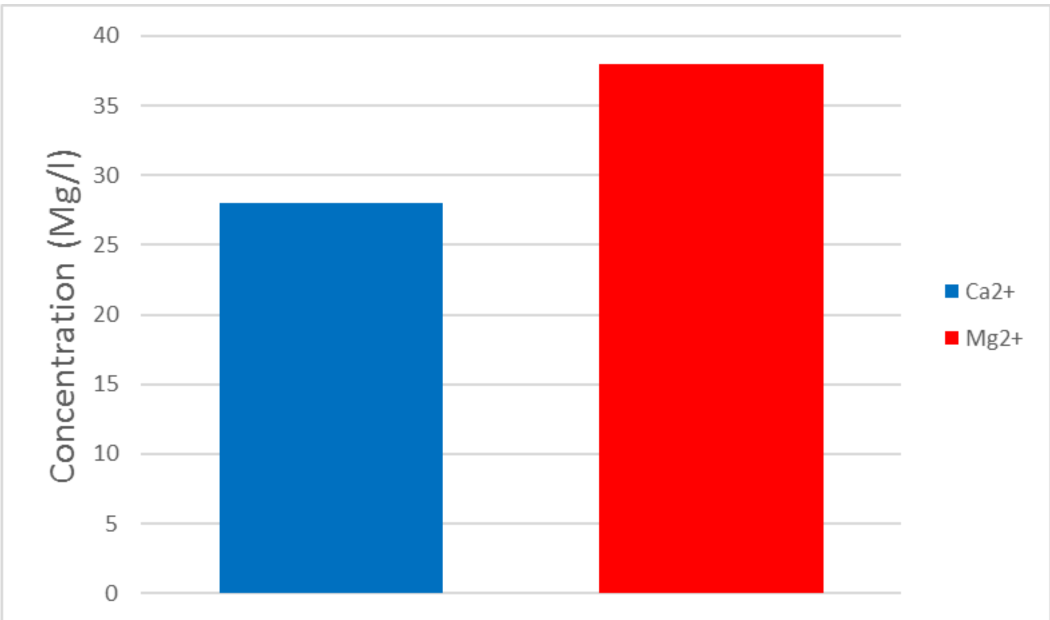

Figure 13: Anionic concentration of HWD3 (Mg/l)

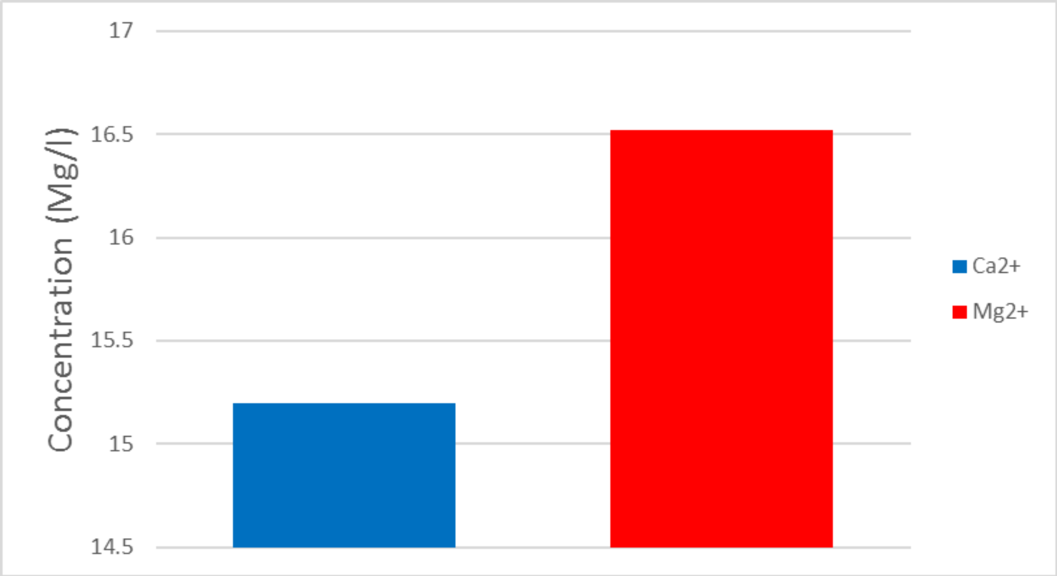

Figure 14: Anionic concentration of STM1 (Mg/l)

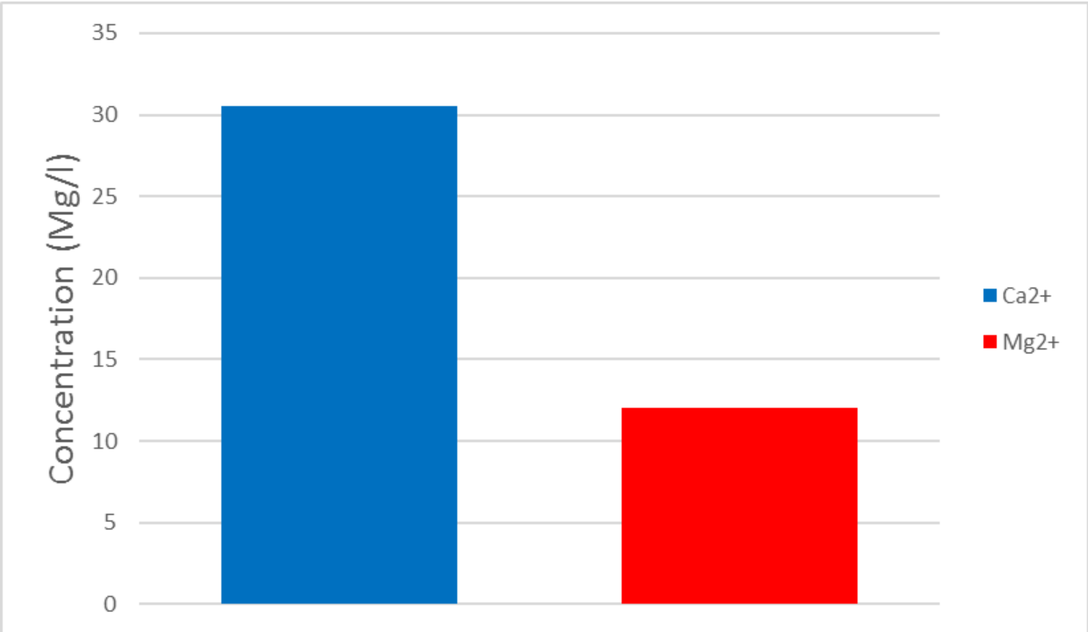

Figure 15: Anionic concentration of STM2 (Mg/l)

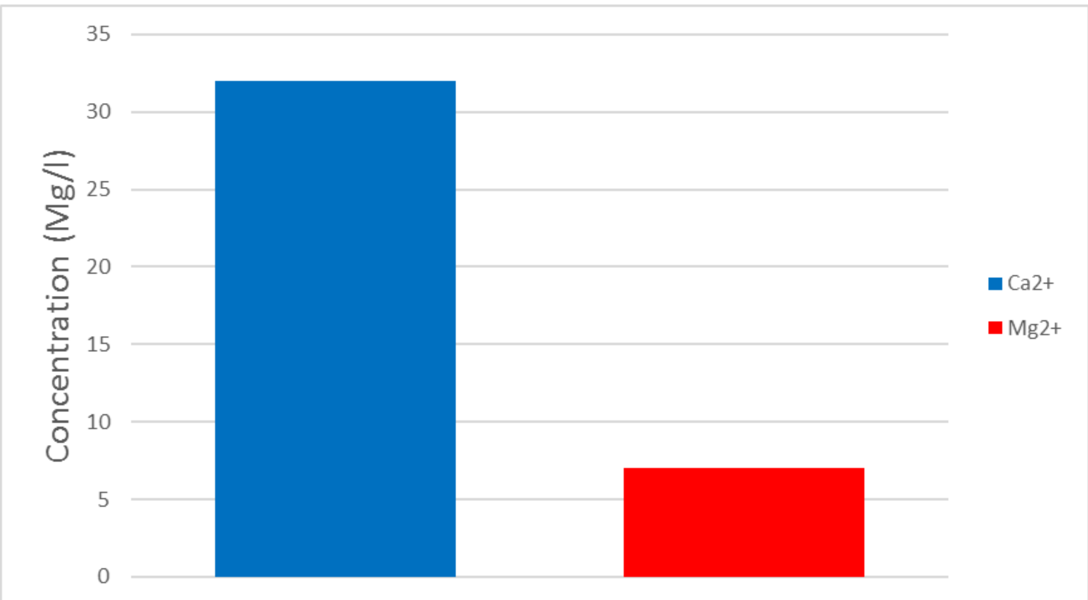

Figure 16: Anionic concentration of STM3 (Mg/l)

This section of the study discusses the result of the pH, total hardness, TDs and electrical conductivity of the water samples.

4.2.5 pH

The result of this analysis has shown clearly the measure of (n concentration in all the twelve water samples. From the results, it is shown that the water samples have a moderate measure of hydrogen ion (H') concentration in them and in terms of the pH value, the water is safe.

4.2.6 Total hardness

Water of good quality should not have excess hardness. water becomes unfit for drinking when it is hard, and this happens when the hardness of water exceeds 150mg/1. When its value falls within 0-75mg/1, the water is soft. The hardness in water is caused by calcium and magnesium. This is usually indicated by the precipitation of soap scum. This leads to a need for excess use of soap to achieve cleaning.

It is however noticed from the results that none of the samples are hard. Hard water has a value above 200m/1 and may cause scale deposition in treatment works, distribution system, pipe work and tanks with buildings. This hardness will also result in excessive soap consumption and subsequent "scum" formation. Soft water, with a hardness of less than 100m/1 may have a low buffering capacity and may be more corrosive for water pipes.

4.2.7 Total dissolved solids (TDS)

The dissolved solids in water are the sum of all solute in the solvent. The analysis shows that borehole have the highest amount of dissolved solids. The wells have total dissolved solids of 300ppm, and streams have total dissolved of 5ooppm (Kolawole, 2005). During the sampling of these wells and streams, I discovered that the wells are often left opened, though they posses metal covers. I also noticed that the environment in which the wells and the streams are located are unclean. In the study area, only 10 samples have total dissolved solids less than 500ppm which is the W. H. O highest desirable level. The TDS values range from 100-700ppm. The dissolved solids are colloids and sediments.

4.2.8 Electrical conductivity

The electrical conductivity of the samples in the mho/cm, from the results it is clear that borehole 1 have the highest electrical conductivity. The least conductive ability was noticed in stream 2 and hand-dug wel13 with a value of 0.02mho/cm (Nigerian Geological Survey, 2002). The electrical conductivity ranges from 0.2-0.5 mho/om in hand dug wells. For the stream's samples, the value ranges from 0.2-0.8 mho/cm. The borehole samples show a range of 0. 6-0. 11 mho

4.2.9 Magnesium

Magnesium content in the samples range from 2.43-4.31 mg/1. The Magnesium content in the hand-dug wells range from 2. 43-38. 39 mg/1, boreholes 2.67-41.31 mg/1 and streams samples 7.29-12.15rng/1. The magnesium concentration of 41.31 mg/J shows to be the highest in borehole 4. All the samples are still within the permissible limit for magnesium hardness in water. Hence, the water samples are good for domestic and industrial usage. Natural source of magnesium may be from amphiboles, pyroxene, dolomite, olivine, magnetite and clay minerals.

4.2.10 Calcium

The calcium content ranges from7.21-40.08 mg/1 in the samples analyzed. It is highest in HDW2 (hand-dug well) 40.08 mg/1, While calcium content is lowest in borehole 2 with 7.21 mg/I. The streams have a calcium hardness of 24.05-32.06 mg/1. The level of ca^{2+} in the water samples may be related to the mineralogical status of the area. The water samples are hence good for domestic usage.

5. Conclusion

The twelve samples were analyzed for chemical parameters. The result of the analysis compares favorably with the World Health Organization recommended highest desirable and maximum permissible limit for drinking water. The pH value also suggests that most of the water samples are slightly acidic but only a sample falls within the alkalinity range.

However, all the samples show pH values within the highest desirable and maximum permissible limit (i.e. 6.5-9.2). It is however, evident that groundwater chemistry is dependent on human activities, effluent discharge, the chemistry of the rock, leaking during infiltration and exchange of ions into the reservoir rocks. The analysis of twelve water samples collected from Adekunle Ajasin University Campus Akungba Akoko shows that all the samples on the basis of their appearance are fit for consumption.

The geochemical analysis of the trace elements concentrations in the drinking bottled water brands sold in Akoko region shows positive results, which are safe for human consumption. In this study, the geochemical assessments of the trace elements show no environmental impacts on the human life in Akoko area. The measured concentration levels of the trace element constituents in the bottled water brands falls within the standard limits set by WHO and APHA in guidelines for drinking water.

However, the present trace element concentrations in the tested bottled water samples are variable, which is most probably depends on many factors such as natural environment, source and composition of waters and the types of the treatment/purification techniques applied during the production. Additional changes in the water chemistry may also occur during storage and transportation, especially when bottles are exposed to direct sunlight. However, long term effects if there is not enough check maybe of major concern. Consequently, close monitoring of heavy metals must be carried out. This study recommends that regular needs for nationwide survey about the quality of waters including tap and river and ground waters.

As well as geochemical comparative studies. Additionally, the analysis and labelling of other parameters such as microbiological controls of water is needed to protect public health as well. Finally, the geology of an area influences groundwater chemistry while the activity of human influences the quality of groundwater. Water is a necessity for human. The health of a community depends largely on the provision of portable and good water supply. The quality of water in Adekunle Ajasin University Campus Akungba-Akoko South western Nigeria can be recommended for domestic use based on the physical and chemical characteristics of the water sampled in the area.

Since water is life, human cannot do without water. There should be a provision for quality water supply within the University Campus. Therefore, laws prohibiting indiscriminate disposal of refuse and sewage should be enacted. Workers within the University community should be educated on how to go about the use of chemicals in the laboratories. There should also be an orientation exercise to keep the people informed, since the study area is still a developing Campus.

Furthermore, the University authorities should also ensure that the relevant authorities concerned with issues related to health safety ensure that certain standard are met before water is said to be good for consumption. Such authorities include; the Ministry of Health, National Agency for Food and Drug Administration and Control (NAFDAC), environmental agencies and the World Health Organization (W. H. 0).

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