International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 03 – Issue 10 || October 2018 || PP. 05-12

Quality Assessment of Groundwater within Federal Polytechnic Campus, Ado-Ekiti, Ekiti state, Nigeria

Nenuwa O.B., Ajakaiye A. and Obisesan P.O.
Department of Mineral & Petroleum Resources Engineering,
Federal Polytechnic, P.M.B. 5351, Ado-Ekiti, Ekiti state, Nigeria

Abstract: An investigation of the physical, chemical and bacteriological properties of ground water from four different boreholes located within the campus of Federal Polytechnic, Ado-Ekiti was conducted. The result of the physical tests revealed that the water is colourless, odourless and tasteless. The temperature ranges from 26.4 – 26.9^{o}C, electrical conductivity ranges from 121.54 – 320.76µscm^{-1}, PH ranges from 7.1 – 8.6, total solids range from 103.12 – 141.60mg/l, total hardness ranges from 101.36 – 233.62mg/l and the total alkalinity ranges from 1.3 – 6.25mg/l. The chemical analysis showed that the water samples contained potassium (3.60 – 5.87mg/l), zinc (0.01 – 0.02mg/l), sodium (28.74 – 72.61mg/l), iron (16.38 – 20.05mg/l), calcium (5.30 – 20.80mg/l), copper (0.01mg/l), magnesium (5.63 – 14.47mg/l), manganese (0.23 – 0.36mg/l). The total microbial count in the water samples range from 21 – 575 count per ml. The physical quality of the ground water from the study area is good as it conforms to the World Health Organization (WHO) standards for potable water. Metals are concentrated in the groundwater to levels within acceptable limit except for iron which is higher. In order to ensure safe and potable supply of water, the iron content in the water must be reduced by appropriate treatment. The water should also be filtered, boiled or chlorinated before consumption or usage to eliminate the presence of micro-organisms.

Keywords: boreholes, groundwater, potable, quality, treatment

1. Introduction

Water is next to air in its importance to living things, there is no substitute for water in many of its uses. The chemical formula of water is H_2O. However, in as much as water is regarded as life, where and when it is available, it must be kept safe and free from contamination and pollution for the survival of mankind. Good water is not only necessary for man and plants, animals and all living organisms on the earth also need potable water for their survival and growth too. Getting water is one thing, ensuring the quality of such water for specific purpose is another. With increase in human population and attendant increase in demand for water for both domestic and industrial uses, it becomes absolutely pertinent to have a thorough appraisal of available sources of water globally (Balogun, 2010).

As of now, only earth is the planet having about 70% of water. But due to increased human population, industrialization, use of fertilizers in agriculture and man-made activities, water sources have been highly polluted with different harmful contaminants. Therefore it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases (Basavaraja *et al*, 2011).

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains different types of impurities which are introduced into aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials (Adeyeye, 1994).

Groundwater and surface water are important sources of water supply in the world which is needed for human survival and industrial development. The ground and surface water chemistry is controlled by the composition of its recharge components as well as geological and hydrological variations within the aquifers (Shahnawaz and Singh, 2009). Polluted groundwater and surface water sources are the cause for the spread of epidemic and chronic disease in human beings. Industrialization and increase in population are responsible for depletion of our groundwater sources (Khodapanah *et al*, 2009). Improved knowledge is required for understanding and evaluating the suitability of groundwater for different purposes. The knowledge of water-rock interaction as well as anthropogenic influence is necessary for eventual utilization and management (Todd, 1995; Kelly, 1940). Groundwater quality comprises physical, chemical and biological qualities of groundwater (Oluseyi *et al*, 2011). Temperature, turbidity, colour, taste and odour make up the list of physical water quality parameters. Since most groundwater are colourless, odourless and without specific taste, the concern is the chemical qualities. Naturally, groundwater contains mineral ions and these ions slowly dissolve from soil particles, sediments and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and the aquifer. Some dissolved solids may have originated in the precipitation water or river water that recharges the aquifer. However, human activities can alter the natural composition of groundwater through mining activities, disposal or dissemination of chemicals and microbial matter at the land surface and into soils or through injection of wastes directly into groundwater (Ayedun *et al*, 2012).

Everyday activities of people in an area can bring about possible pollution of groundwater, activities like changing of used engine oil which are left to be washed away by the next rain, others are herbicide, fertilizer, deliberate dumping of waste, leaks from underground tanks (mainly gasoline), septic tanks (Edet, 1993; Etu-Efeotor and Akpokodje, 1990).

Mineral enrichment from underlying rocks can change the chemistry of the groundwater, making it unsuitable for the consumption (Ako *et al*, 1990). In addition, water of poor physiochemical quality may have adverse health effects, causing avoidable economic and human losses. According to Hutchinson and Rigdeway (1995), the water cycle is an obvious mode of transmission of enteric diseases. Almost 385,000 Children die annually of various diseases due to polluted water. Polluted water is potentially dangerous to health because of possible outbreaks of typical dysentery or cholera, epidemics and other water-borne diseases. However, the chemistry of rocks and soils and the rock geological condition in any area has a great influence on the quality of water, which determines the concentration of introduced cations and anions in the water.

Groundwater, though mostly originates from rain or snowmelt infiltrates through soils into subsurface aquifers, is apparently purer than surface water because of the natural purification process which it undergoes while percolating through piles of soils. Uncontaminated groundwater is naturally clear, tasteless and odorless. All over the world there is an increasing demand of potable water in industries or in variety of other uses, surface water resources cannot adequately satisfy this astronomical increasing demand for potable water in both developing and industrialized world. Groundwater resources have a major role to play in the provision of potable water for the world populace and industries now and in the future. Consequently, healthy living is a function of accessible potable water supply. Most homes in the area depend on groundwater wells for their survival. However, since these wells sunk to tap the groundwater are situated in towns and villages where human beings dispose wastes, and animals like chicken, dogs and goats stray about and defecates arbitrarily, bacteria contents of the well water must also be investigated (Aturamu, 2012).

2. Geology of the Study Area

The area of study, Ado-Ekiti is a town in Ekiti State and it lies within the south western basement complex of Nigeria between latitudes $7^0\ 36^1$ and $7^0\ 49^1$ N of the Equator and longitudes $5^0\ 13^1$ and $5^0\ 16^1$ E. The study area is underlain by the Precambrian basement complex rocks of Southwestern Nigeria. The dominant lithologies include Migmatites gneisses, granite, Quartzite and charnockite. The granite rocks present are members of the older granites. These granites were emplaced during the Pan African Orogenic cycle which followed early sedimentation. The granitic rocks occupy about 25% of the total area of Ado-Ekiti. Three phases of older granite were recognized in the study area. They are - the fine grained granite and medium to coarse grained varieties. Charnockitic rocks in the study area were found in association with coarse grained porphyritic granites. They occur as low lying outcrops and are generally dark grey in colour containing quartz and feldspars. Other minerals present are plagioclase feldspars, antiperthite, biotite and hyperstene (Rahaman and Malomo, 1983).

The presence, extent and characteristic of aquifer are dependent on the depth and degree of weathering and fracturing of the underlying rocks within the area. Groundwater is primarily recharged by surface precipitation (rainfall) and secondarily by lateral flow from rivers and their tributaries. The prominent rivers in the study area are river Elemi and Ureje.

KEY: △ Ado-Ekiti (Study Area

Figure 1: Map of Ekiti state showing the location of the study area (Ado-Ekiti)

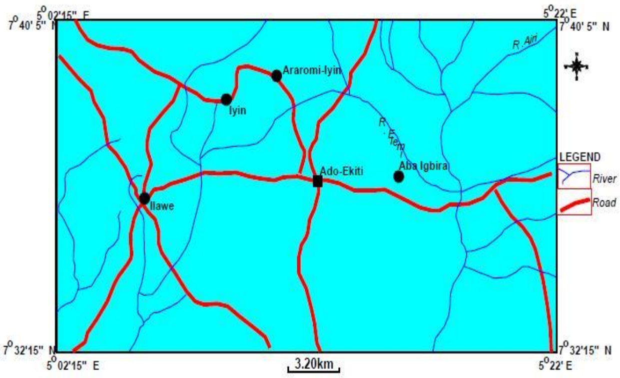

Fig. 2 : Drainage map of the study area.

3. Methodology

3.1 Sample Collection

Four groundwater samples were collected from four different boreholes in sterilized 2-litres plastic containers with tightly fitted covers wrapped in black polythene plastic bag and kept in a cooler to ensure constant temperature. The samples were immediately transported to the laboratory for analysis. Table 1 shows the detail of the location of the boreholes, co-ordinates and other information as collected with the aid of a hand-held Global Positioning System (GPS).

Table 1: GPS readings taken at the borehole sites

Points	Location of boreholes	Latitude	Longitude	Elevation (m)
MPE	MPRET Department	$07^{0}35^{1}25^{11}$N	$005^{0}17^{1}45^{11}$E	378
EED	Aquaculture farm	$07^{0}35^{1}26^{11}$N	$005^{0}17^{1}44^{11}$E	380
ABJ	Abuja hostel road	$07^{0}35^{1}22^{11}$N	$005^{0}18^{1}05^{11}$E	372
SQ	Staff Quarters	$07^{0}35^{1}58^{11}$N	$005^{0}17^{1}34^{11}$E	368

3.2 Materials and Equipment Used

Ground water samples, Global Positioning System (GPS), Four 2-litres plastic containers, black polythene bag, cooler, thermometer, PH meter, pipette, evaporating dish, petri dish, weighing balance, beaker, test tubes.

3.3 Laboratory Analyses of Water Samples

The analyses conducted were in three categories: physical tests, chemical tests and bacteriological analysis. All analyses were carried out at the laboratory using standard methods. PH, Total hardness, Alkalinity and the bacteriological analyses were carried out at the Analytical Chemistry Laboratory in the Department of Science Laboratory Technology, Federal Polytechnic, Ado-Ekiti, Ekiti State. The metals concentration of the groundwater samples were analyzed at Sustainable Agrotech Nigeria Limited Laboratory, near NNPC Mega Filling Station, Akure, Ondo State.

3.4 Physical Tests

The physical parameters tested are: colour, odour, taste, temperature, electrical conductivity, PH, total solids and total hardness.

i. Colour

100ml of the water sample was measured with the aid of measuring cylinder into a beaker and it was examined visually.

ii. Odour

100ml of the sample was measured and the odour was perceived with the nose.

iii. Taste

2 -3 drops of the water sample was tested with the tongue to examine the taste.

iv. Temperature

The temperature of the water samples was measured in-situ with the aid of a thermometer by placing the thermometer into the water and recording the value obtained in degree centigrade.

v. Electrical conductivity

It was measured by placing a conductivity probe in the water sample that was thoroughly stirred to ensure homogeneity and measuring the flow of electricity between the electrodes. The display of the electrical conductivity meter is allowed to stabilize before the reading is taken.

vi. PH

The electrode of the PH meter (Hanna PH) was removed from storage solution and rinsed gently with distilled water. The electrode was gently dried by blotting with a soft tissue, the meter was standardized with electrode immersed in buffer at PH 4, rinsed thoroughly and dried with soft tissue paper and was immersed in a second buffer at PH 10. The electrode was removed and rinsed in distilled water. 100ml of sample was then poured in the beaker and stirred for homogeneity and measurement was taken by dipping the electrode into the water sample. The PH meter reading was recorded at steady point for each sample.

vii. Total Solids

A clean evaporating dish was dried in the oven and cooled in the desiccator. The weight of the empty dish was taken to the nearest 0.001g using analytical balance. By using a measuring cylinder, well mixed water sample was measured into the re-weighed dish and evaporated to dryness on a hot plate. The dish was then dried in the oven at 105^0c and cooled in desiccator for 30minutes and weighed. The process of drying, cooling, desiccating and weighing was repeated until weight of residue was constant.

Calculation: $$\text{Total Solid Mg/l} = \frac{A-B \times 1000}{\text{Volume of sample (ml)}} \qquad (i)$$

Where: A = weight of dried residue +dish (mg)
B = weight of empty dish (mg)

viii. Total hardness

100ml of sample was measured into a conical flask and 5ml of ammonium acetate buffer solution was added. This was followed by addition of 1ml of masking agent and 2 drops of Eriochrome black T indicator. The whole mixture was titrated with 0.01M EDTA to a permanent blue end point. The total hardness is expressed as mg/l $CaCO_3$

Calculation: $$\text{Total hardness (mg/l } CaCO_3) = \frac{V \times M \times 100{,}000}{Volume\ \ of\ \ sample} \qquad (ii)$$

Where, $V =$ Volume of EDTA used for titration (ml)
$M =$ Molarity of EDTA

ix. Total Alkalinity

100ml of the water sample was measured with a pipette into a conical flask and 1drop of 0.05M $Na_2S_2O_3.5H_2O$ was added to remove any free residual chlorine. Then, two drops of phenolphthalein indicator was added, the solution was titrated against 0.01M H_2SO_4 to a permanent colourless end point. Then to obtain the alkalinity due to presence of hydroxyl carbonates ions, the titration was continued but the indicator replaced with methyl orange. At the end point the colour change was from yellow to orange.

Calculation: $$\text{Total alkalinity (mg/l } CaCO_3) = \frac{Vp + Vm \times M \times 100{,}000}{Volume\ \ of\ \ sample\ \ (ml)} \qquad (iii)$$

Where, $Vp =$ Volume of acid used at phenolphthalein end point (ml)
$Vm =$ Volume of acid used at methyl orange end point (ml)
$M =$ Molarity of acid

3.5 Determination of Metals in the Water Samples

By the means of standard volumetric flask, 100ml of sample acidified with 5ml of concentrated HNO_3 were measured into a 250ml conical flask, 5ml of concentrated HCl were added and heated on a hot plate to about 60^OC for 15minutes. The conical flask were removed from heating, cooled and then filtered. The filtrate from the flask were made up to 250ml in standard volumetric flask, and then analyzed for Na, K using Flame Photometer while Cr, Fe, Pb, Cu, Ca, Mg, Mn, Zn and As were analyzed using Atomic Absorption Spectrometer (AAS).

3.6 Total Microbial Count

The Breed method was used to determine the total microbial count. A diamond marker was used to make a square of $1cm^2$ on a microscope slide. And standard wire loop were used to transfer 0.01ml of sample into the square area marked on the slide. The slide was allowed to remain in a sterile inoculating loop for 10minutes to dry in air. Few drop of methylene blue solution were added to the slide and allowed to remain for 2-3minutes. Then excess of the stain was washed from the slide using sterile distilled water. The slide was allowed to drain dry in the cabinet. It was then examined under a microscope using oil immersion lens of 0.16mm field diameter. The number of organism in several field were counted in different parts to obtain the average count per field.

The number of bacteria per milliliter of water is given as: $\text{Count per ml} = \frac{N \times 4 \times 10^4}{\pi d^2}$ (iv)

Where, $N =$ Number of cells per field view objective lens
$d =$ Diameter of the field

4. Results and Discussion

4.1 Physical Properties

Table 2 presents the result of the physical analysis carried out on water samples collected from the four selected borehole. The table shows results of the PH values total hardness, total solids etc.

i. Colour, Odour and Taste

The colour, odour and taste of the water samples are acceptable as they are colourless, odourless and tasteless. This is consistent with the standard for potable water.

ii. Temperature

The temperature of the samples ranges from 26.4 - 26.9°C and it is below the World Health Organisation (WHO) standard of maximum value 28°C. From Table 2, sample ABJ has the highest value of 26.9°C while sample EED has the least temperature value of 26.4°C. The mean value is 26.7°C. Chemical reactions are enhanced by a rise in temperatures, enabling the water to dissolve more substances faster (Gideon *et al*, 2013).

iii. Electrical Conductivity

From Table 2, the electrical conductivity of the samples are less than that of World Health Organisation (WHO) standard and Standard Organisation of Nigeria (SON) which is 1400 μscm^{-1} and 1000 μscm^{-1} respectively. The value of the electrical conductivity of the water samples ranges from 121.54 – 320.76 μscm^{-1}. The mean value of the water samples is 205.89 μscm^{-1}. A higher conductivity results in high salinity of water which adds taste to the water. High conductivity increases corrosive nature of water.

iv. PH

The PH value of the water samples ranges from 7.1 – 8.6, this shows that the water is slightly alkaline except for sample SQ which can be said to be almost neutral. World Health Organisation (WHO) standard PH is 6.5 - 8.5, this shows that the value is within the acceptable range. Low PH value may increase corrosion and solubility of toxic metals in water while high PH adds taste to the water.

v. Total solids

The total solids (TS) are the combination of dissolved solids and suspended solid. From the results, sample EED has the highest value of 141.60mg/l and the least value is sample SQ of 103.12mg/l. The mean value of the total solid is 115.01mg/l. The concentration acceptable by World Health Organisation is 500 - 1500mg/l, the total solids in all the samples are lower than the minimum permissible level of 500mg/l. High total solids in water may impart salty taste to the water and such water becomes unsuitable for drinking and industrial purposes (O'Neill, 1995).

vi. Total hardness

World Health Organisation (WHO) standard for total hardness is 500mg/l. The highest value of total hardness is that of sample MPE with value 233.62mg/l while sample EED had the least value of 101.36mg/l. If the total hardness is high, the water will not form lather with soap easily and may also cause scale formation.

vii. Total alkalinity

The alkalinity of the borehole water samples tested ranges from 1.3 - 6.25mg/l with a mean value of 3.84, which is still below the maximum concentration acceptable by WHO which is 250mg/l.

Table 2: Physical properties of water in the study area

Parameters	MPE	ABJ	EED	SQ	Mean	WHO (2011)
Colour	CL	CL	CL	CL	-	-
Odour	OL	OL	OL	OL	-	-
Taste	TL	TL	TL	TL	-	-
Temp. (^oC)	26.5	26.9	26.4	26.8	26.7	28
EC (μscm^{-1})	121.54	200.49	320.76	180.76	205.89	1400
PH	8.6	7.5	8.5	7.1	7.9	6.5 – 8.5
TS (mg/l)	106.58	108.75	141.60	103.12	115.0	500 - 1500
TH (mg/l)	233.62	184.20	101.36	126.95	161.53	10 - 500
TA (mg/l)	3.62	4.20	1.30	6.25	3.84	250

Note: EC – Electrical Conductivity, TS – Total Solids, TH – Total Hardness, TA – Total Alkalinity
CL – colourless, OL – odourless, TL – tasteless,

The results above indicated that the groundwater in the study area is potable and are within WHO acceptable limit.

4.2 Chemical Properties

The results of the chemical analysis conducted on the four water samples are presented on Table 3.

i. Potassium (K): The potassium content of the water samples ranges from 3.60 - 5.87mg/l with the mean value of 4.89mg/l. According to World Health Organization, the maximum concentration acceptable is 200mg/l, all the borehole water samples examined in this study have their potassium value below the limit.

ii. Zinc (Zn): The acceptable concentrate of zinc in drinking water is 4.0mg/l according to the World Health Organization standard. However, the zinc concentrate of the water samples examined varies from 0.01 - 0.02mg/l with a mean value of 0.013mg/l, these values are still below the WHO limit which means the zinc content of the groundwater is acceptable.

iii. Sodium (Na): The sodium content of the borehole water samples varies from 28.74 - 72.61mg/l with a mean value of 45.84mg/l. These are below the WHO standard of drinking water which is 200mg/l.

iv. Lead (Pb): Lead was not detected in the borehole water samples tested, although World Health Organization maximum standard limit is 0.3mg/l. Water with lead concentration above this standard limit is dangerous to human health.

v. Iron (Fe): The highest desirable concentration of iron in water as required by WHO is 0.3mg/l. The concentration of iron for all the water samples analyzed is above the stipulated limit. The iron contents of the water samples ranges from 16.38 - 20.05mg/l with a mean value of 18.12mg/l. This is not acceptable because iron content should only be present in little concentration in drinking water. Iron may have been picked up from many underground formations and the water containing iron are corrosive, such water is termed 'ferruginous'. Excessive iron content in water makes it unpalatable, impart a bitter taste to the water and also cause brown stains on containers.

vi. Calcium (Ca): The concentration of calcium in the boreholes water samples analyzed ranges from 5.30 - 20.80mg/l with a mean value of 10.48mg/l, this indicated that all the water samples have calcium concentration below the World Health Organization desirable limit of 200mg/l. A high concentration of calcium in water leads to water hardness.

vii. Copper (Cu): The WHO maximum permissible level of copper in water is 2.0mg/l. Copper was not detected in sample EED representing the borehole located at EED aquaculture farm, while other samples have the same value of 0.01mg/l which is below the WHO accepted limit.

viii. Magnesium (Mg): The magnesium concentration of the borehole water samples in this study ranges from 5.63 - 14.47mg/l with a mean value of 9.95mg/l. The accepted value according to the World Health Organization standard is 150mg/l. It is noticed that the magnesium contents of the water samples are low. Magnesium causes hardness in water.

Table 3: Metal content in the water samples in mg/l

Elements	MPE	EED	ABJ	SQ	Mean Value	WHO limit
Potassium (K)	3.60	4.60	5.87	5.50	4.89	200
Zinc (Zn)	0.01	0.01	0.01	0.02	0.013	4.0
Sodium (Na)	48.63	72.61	33.40	28.74	45.84	200
Lead (Pb)	ND	ND	ND	ND	ND	0.05
Iron (Fe)	18.46	20.25	17.40	16.38	18.12	0.3
Calcium (Ca)	20.80	5.30	8.42	7.40	10.48	200
Copper (Cu)	0.01	ND	0.01	0.01	0.01	2.0
Magnesium (Mg)	14.47	13.15	6.55	5.63	9.95	150
Chromium (Cr)	ND	ND	ND	ND	ND	0.05
Manganese (Mn)	0.25	0.28	0.36	0.23	0.28	0.4
Arsenic (As)	ND	ND	ND	ND	ND	0.01

ND – Not detected

ix. Chromium (Cr) and Arsenic (As): Chromium and Arsenic were not detected in the selected borehole water samples in this study. Arsenic causes acute toxicity in water. The WHO acceptable limits for chromium and Arsenic are 0.05mg/l and 0.01mg/l respectively.

x. Manganese (Mn): The manganese content of the borehole water samples ranges from 0.23 - 0.36mg/l with a mean value of 0.28mg/l. The WHO international standard for water gives 0.4mg/l as the highest desirable level of manganese. All the water samples examined in this study have their value within WHO limit, however, manganese imparts brownish stain to laundry and affects taste of water.

4.3 Bacteriological Analysis

The result of the total microbial count obtained from the analysis is presented on the Table 4.

Table 4: Microbial count

Sample	Total count per ml
MPRET	80
EED	575
ABJ	24
SQ	21
Mean value	175

From the above results, the total microbial counts of the selected borehole water samples ranges from 21-575 count per ml with a mean value of 175. Sample SQ has the least number of 21 count per ml, while sample EED has the highest count of 575. Sample MPE has 80 as the total microbial count while Sample ABJ has 24 count per ml.

Base on this result, the groundwater from the selected boreholes contain microbiological organisms that can be very injurious to human health if consumed or used for domestic purposes without treatment. According to Akinyanju, (1987), Groundwater derived from deep wells are generally of good quality because vertical percolation of the water through the soil helps in the removal of much of the microbial and organic population, by contrast, waters from shallow wells are grossly polluted. However, the World Health Organization requires that portable water should be free from dangerous micro-organisms. The organisms can however be easily destroyed through chlorination and boiling.

5. Conclusions

Good quality water is very important for both domestic and industrial purposes. Base on the laboratory analysis result in this study, it was observed that the ground water samples were colourless, tasteless and odourless. The value of the temperature, PH, total solids, electrical conductivity, hardness and alkalinity of the water from the four boreholes are within WHO acceptable limit for potable water. All the metals detected have concentration that is within WHO acceptable limit except for iron (Fe). Water from the four sources in the study area however, contains micro-organisms.

The physical quality of the ground water from the study area is good, but there is need for further treatment to make it chemically and microbiologically suitable for use. In other to maintain good health, the water from the four locations should be properly treated to reduce the iron content. The water should also be boiled or chlorinated before consumption to eliminate the presence of micro-organisms. Boreholes should be located up gradient of pollution sources e.g. septic tank, dump site e.t.c. to prevent infiltration of contaminants into ground water. Water quality control unit should however, be established within the campus of the Federal Polytechnics, Ado-Ekiti in order to ensure the water distributed meet quality standard.

References

[1]. **Adeyeye, E.I. (1994):** Determination of heavy metals in *Illisha Africana*, associated Water, Soil Sediments from some fish ponds. *International Journal of Environmental Study*. 45: 231-240.

[2]. **Akinyanju, J. A. (1987):** Bacterialogical analyses of drinking water from three sources in Ilorin-an urban centre in Nigeria. *Jour. Pure and Applied Sci*. 2: 1-5.

[3]. **Ako, B.D, Adeniyi, F.I and Adepoju, J.F. (1990):** Statistical tests and chemical, quality of shallow groundwater from a metamorphic terrain Ile-Ife / Modakeke, S.W Nigeria. *Journal of African Earth Science*. 10 (3): 602-613.

[4]. **Aturamu, A.O. (2012):** Physical, Chemical and Bacterial Analyses of Groundwater in Ikere Township, Southwestern Nigeria. *International Journal of Science and Technology*. 2(5): 301 – 308.

[5]. **Ayedun, H., Oyede, R.T., Osinfade, B.G., Oguntade, B.K., Umar, B.F. and Abiaziem, C.V. (2012):** Groundwater quality around new cement factory, Ibese, Ogun state, Southwest Nigeria. *African Journal of Pure and Applied Chemistry*. 6(13): 219 – 223.

[6]. **Balogun, O. (2010):** Water and Life, Any Hope for Nigeria? *13th Obiakor Lecture Series, Federal Polytechnic, Ado-Ekiti, Nigeria*. pp. 1 - 64.

[7]. **Basavaraja, Simpi, S. M., Hiremath, K. N. S., Murthy, K. N., Chandrashekarappa, Anil N. Patel, E.T. Puttiah, (2011):** Analysis of Water Quality Using Physico-Chemical Parameters Hosahalli Tank in Shimoga District, Karnataka, India. *Global Journal of Science Frontier, Research*. 1(3): 31-34.

[8]. **Edet, A.E. (1993):** Groundwater Quality Assessment in Parts of Eastern Niger Delta Nigeria. Environmental Geology, Springer. 22:11 - 56.

[9]. **Etu-Efeotor, J.O. and Akpokodje, E.G., (1990):** The Preliminary Hydrogeochemical investigation of subsurface waters in parts of the Niger Delta. *Journal of Mining and Geology*. 18 (1). 103-105.

[10]. **Gideon, Y.B., Fatoye, F.B. and Omanda, J.I. (2013):** Quality Assessment of Physio-Chemical Characteristics of Okura River, Kogi state, Nigeria. *International Journal of Science and Technology*. 2(12):891 – 899.

[11]. **Hutchinson and Ridgeway (1995):** Microbial Agents of Drinking, Water Supply. "Aquatic microbiology shrew and strainer, *Society of Applied bacteriological Technical series*. 7: 41-50.

[12]. **Kelly, W.P. (1940):** Permissible composition and concentration of irrigation waters. Proceedings ASCE 66:607.

[13]. **Khodapanah, L., Sulaiman, W.N.A., Khodapanah, N. (2009):** Groundwater quality assessment for different purposes in Eshtehard district, Tehran, Iran. *Eur. J. Sci. Res*. 36(4): 543-553.

[14]. **Oluseyi, T., Olayinka, K., Adeleke, I. (2011):** Assessment of groundwater pollution in the in the residential areas of Ewekoro and Shagamu due to cement production. *Afr. J. Environ. Sci. Technol*. 5(10): 786-794.

[15]. **O'Neil, P. (1995):** Environmental Chemistry. *Unwin Hyman Limited. London*. pp. 83-87.

[16]. **Rahaman, M.A. and Malomo, S. (1983)**: Sedimentary and crystalline rocks of Nigeria in tropical soils of Nigeria in Engineering Practice (S.A Ola, ed), A.A Balkema, Rotterdam, pp.17-38.

[17]. **Shahnawaz, M.D., Singh, K.M. (2009):** Groundwater quality of Piro and Jagdishpur Blocks Bhorps district, a middle gangatic plain. *Intl. J. Pharma. Qual. Assur*. 1(1): 9-10.

[18]. **Todd, D.K. (1995):** Ground water Hydrology. *John Wiley and Sons Inc. New York*.

[19]. **World Health Organisation (2011):** Guidelines for Drinking Water Quality, 4th Edition. *WHO Press, Geneva, Switzerland*. Pp. 223 – 230.