Journal of Geology and Mining Research Vol. 3(6), pp. 147-152, June 2011
Available online http://www.academicjournals.org/jgmr
ISSN 2006 – 9766 ©2011 Academic Journals

Full Length Paper

Preliminary assessment of water quality in Ayede-Ekiti, Southwestern Nigeria

Ige O. O.[1]* and Olasehinde P. I.[2]

[1]Department of Geology and Mineral Sciences, University of Ilorin, P. M. B. 1515, Ilorin, Nigeria.
[2]Department of Geology, Federal University of Technology, P. M. B. 65, Minna, Nigeria.

Accepted 17 January, 2011

Problems of water borne diseases are expected where water quality to a community has been compromised. This was the case of Ayede Ekiti, southwestern Nigeria where cholera epidemic was reported recently. Hydrochemical investigation of twenty-seven groundwater and 3 surface water samples from the town were thus, carried out. This was aimed at evaluating major ions and their origin; establish hydro-chemical facies and determine their suitability for drinking and irrigation purposes. Electrical conductivity and pH were measured *in-situ,* while other hydrochemical analyses were carried out in the laboratory. The suitability of the waters for irrigation purposes was evaluated using Wilcox's diagram, Kelly's and Magnesium ratios. The source of ion in water was examined and classified using the Gibb's diagram. From the geochemical results, it was found that sodium and chloride are the most predominant ions of the total chemical budget. The pH ranges from 7.5 to 7.9, electrical conductivity range from 30 to 900 µs/cm. The hydrochemical characteristics of the water revealed that, the cationic concentrations is in the order of (Na+k)>Ca^{2+}>Mg^{2+} for both wells and surface waters, while the anionic concentrations is in the order of Cl^->HCO^-_3>SO_4^{-2}. The hydrochemical facies of both surface and groundwater were found to be three: CaNaCl>$CaHCO_3$>NaCl. Wilcox's, Kelly's ratio and magnesium ratios suggested that, majority of water samples are good for irrigation. Also, the source of the ions in the waters was examined and classified accordingly as rock weathering dominance. The results show that, the water resources are suitable for drinking and irrigation at the time of study. The source of cholera outbreak was concluded to be from anthropogenic sources. Further studies will be made in the next stage of research.

Key words: Water quality, Wilcox, groundwater, piper diagram, irrigation.

INTRODUCTION

The sources of water for any specific purpose are not as important as the suitability of the water for the desired purpose. With increasing human population, industrialization, urbanization and the consequent increase in demand for water for both domestic and industrial uses, the attendant increase in the implication of polluted water on man and the environment have been severally studied (Asiwaju-Bello and Akande, 2004; Ige et al., 2008*)*. Therefore, there is a need for thorough assessment of the quality of water available for human drinking, agricultural and industrial purposes. Recent outbreak of cholera in the study area motivated the present study which was carried out in the dry season.

The study area is Ayede metropolis which is one of the towns linking Ekiti and Kwara States, Nigeria and bounded by latitudes 7°53'N and 7°54'N and Longitudes 5°18'E and 5°22'E. It covers an area of about 52 km^2 with few settlements of Imojo, Itaji, Ilafon and Ishan Ekiti (Figure 1). The town lacks adequate supply of water as there are insufficient pipe-borne water supply systems. Hence, the people resort to rain water, surface and groundwater for domestic and agricultural uses.

The climate of the study area is tropical and the natural vegetation consists of rain forests. The drainage is generally dendritic with hummocky and undulating

*Corresponding author. E-mail: vickyige2002@yahoo.com. Tel: +4407579154299.

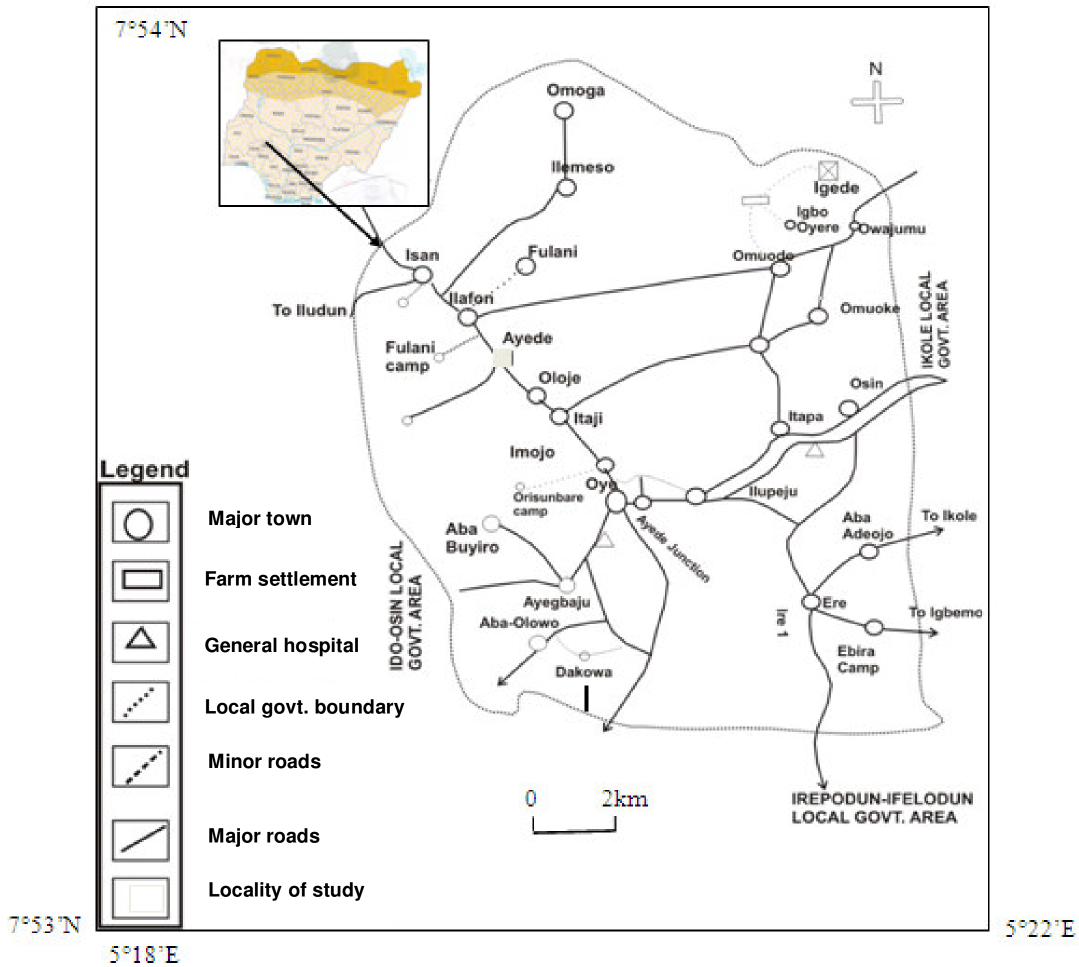

Figure 1. Map of Oye Local Government Area, Ekiti State, Nigeria, showing the studied area (Inset: Map of Nigeria showing Ekiti state).

topography. Annual rainfall is about 1300 mm and its distribution is bimodal within hydrologic year. The first peak occurs in June to July, while the second peak occurs in September to October rainy season. The two wet seasons are normally separated by a draught (August-break), while the dry season is defined by little or no rainfall between November and April (Ayoade, 1977).

MATERIALS AND METHODS

The water samples were collected between 17th and 19th of February 2010, representing dry season to evaluate the seasonal variations in chemical compositions (Wet season sampling was scheduled for September, 2010). The water samples were collected from wells (at depths ranging from 10 to 20 ft) and rivers. The samples were collected into new HDPE bottles dry-washed with dilute hydrochloric acid and rinsed three to four times with the water sample before filling it to capacity and then labeled accordingly. The samples were stored at a temperature below 4°C in the laboratory prior to analysis. For collection, preservation and analyses of the samples, the standard method (APHA, 1995) was followed. EC and pH of water samples were measured in the field (Table 1) immediately after the collection of the samples using portable field pH and electrical conductivity meters. Na^+ and K^+ were measured using a flame photometer (Model: Systronics flame photometer 128). Total dissolved solids (TDS) were measured by evaporation and calculation methods (Hem, 1991). Ca^{2+} and Mg^{2+} were determined titrimetrically using standard EDTA. Chloride was estimated by $AgNO_3$ titration. Sulphate was analysed using the turbidimetric method (Clesceri et al., 1998). Nitrate, phosphate, fluoride were analysed using UV-visible spectrophotometer (Rowell, 1994). All analyses were carried out at Petroc Nigeria Ltd, Ibadan, Nigeria.

RESULTS AND DISCUSSION

Chemistry of water

Table 1 presents the statistical summary of chemical analyses, while Figure 2 shows the variation of chemical parameters in the water of the study area. The pH values of water are slightly above neutral, ranging from 7.2 to

Table 1. The statistical summary of water chemistry.

Parameters	Minimum	Maximum	Mean	Standard deviation
pH	7.5	7.9	6.35	0.93
Conductivity(µs/cm)	30	900	408.67	254.8
Temparature (°C)	27.5	29.0	28.5	28.0
Color (Pt/co unit)	0	61	13.23	12.6
Turbidity(FTU)	0	12	2.36	2.92
TDS (mg/l)	70	500	222.3	123.3
Total hardness (mg/l)	13	188	81.2	20.4
Total alkalinity (mg/l)	14	1424	102.5	253.1
Chloride (mg/l)	0.1	90.64	39.08	28.2
Bicarbonate (mg/l)	18	180	58.30	42.6
Sulphate (mg/l)	0.85	56.1	12.70	14.5
Nitrate (mg/l)	0.14	11.27	1.0	1.9
Calcium (mg/l)	2.18	51.24	23.10	12.6
Magnesium (mg/l)	1.05	15.36	6.01	4.12
Sodium (mg/l)	0.78	46.80	23.30	12.6
Potassium (mg/l)	0.41	31.98	12.50	9.8
Iron (mg/l)	0	0.2	0.1	0.1
Kelly's ratio	0.1	1.5	0.8	0.02
Wilcox ratio	8.8	43.7	33.1	0.3
MR (%)	6.3	42.0	16.5	4.7
EB	0	0.4	0.2	0.1
ID	1.8	1.5	0.7	0.2

MR: Magnesium ratio; EB: electrical balance; ID: ionic difference.

7.7 with an average value of 7.45. The concentration of TDS ranges from 30 to 900 mg/1 with a mean of 254.8 mg/1. There is a considerable relative increase in the concentration of ions such as Na^+, Mg^{2+} and Cl^- in samples 5, 21, 22, 25 and 26. This may be due to direct application of "salt" to the wells as disinfectant by the owners. According to Fetters (1990), most of the groundwater samples collected during these periods belong to fresh water type (TDS<1,000 mg/1). The concentration of cations- Ca^{2+}, Mg^{2+}, Na^+, K^+ ions ranged from 2.18 to 51.24; 1.05 to 15.36; 0.78 to 46.80; 0.41 to 31.98 mg/1 with a mean of 32.10; 6.01; 23.30; 12.50 mg/1, respectively. The order of abundance is $Na^+ > K^+ > Ca^{2+} > Mg^{2+}$. Anions ($HCO_3^-$, SO^{2-}_4, Cl^-,NO^-_3) varied from 18.0 to 180.0, 0.85 to 56.10; 0.10 to 90.64 and 0.14 to 11. 27 mg/l with a mean of 58.3; 12.70; 39.1 and 1.0 mg/l, respectively. The order of abundance is $Cl^- > HCO^-_3 > SO^{2-}_4 > NO^-_3$.

Standard deviation results show that, the TDS values exhibit generally low level but slightly higher in values for samples 21, 22, 24, 25 and 26 indicating the influence of anthropogenic activities as a result of their shallow depths. The results showed an average value of 0.2 with the minimum and maximum values at 0 and 0.4, respectively. The ionic differences ranged from 0.1 to 1.5 indicating a fairly balanced ionic concentration and good water quality (Appelo and Postma, 2005).

Water quality

Piper's and Schoeller's diagrams

The evolution of hydrochemical parameters of groundwater can be understood by plotting the concentration of major cations and anions in the Piper's and Schoeller's diagrams. Figure 3 shows that 67% of the water samples analyzed fell in the field of mixed Ca-Mg-Cl, 23.3% fell in $Ca\text{-}HCO_3$, 23.0% fell in the field of Na-Cl. From the plots it is observed that, the alkaline earth (Ca^{2+} and Mg^{2+}) balances the alkalis (Na^+ and K^+) and $Na^+ + K^+ - Cl^-$ exceeds the other ions. The general water facie distributions indicated that, the examined water resources are suitable for drinking purpose.

Gibbs' diagram

The source of the dissolved ions in groundwaters can be understood by Gibbs diagram (Gibbs, 1970). It is a plot of $(Na^+ + K^+)/(Na^+ + K^+ + Ca^{2+})$ versus log TDS and $Cl^-/(Cl^- + HCO^-_3)$ versus log TDS. Figure 4 shows that, almost all the samples fall in the rock weathering dominance area. The Gibbs' diagrams suggest that, chemical weathering of the rock forming minerals is the main process which contributes the ions concentration in

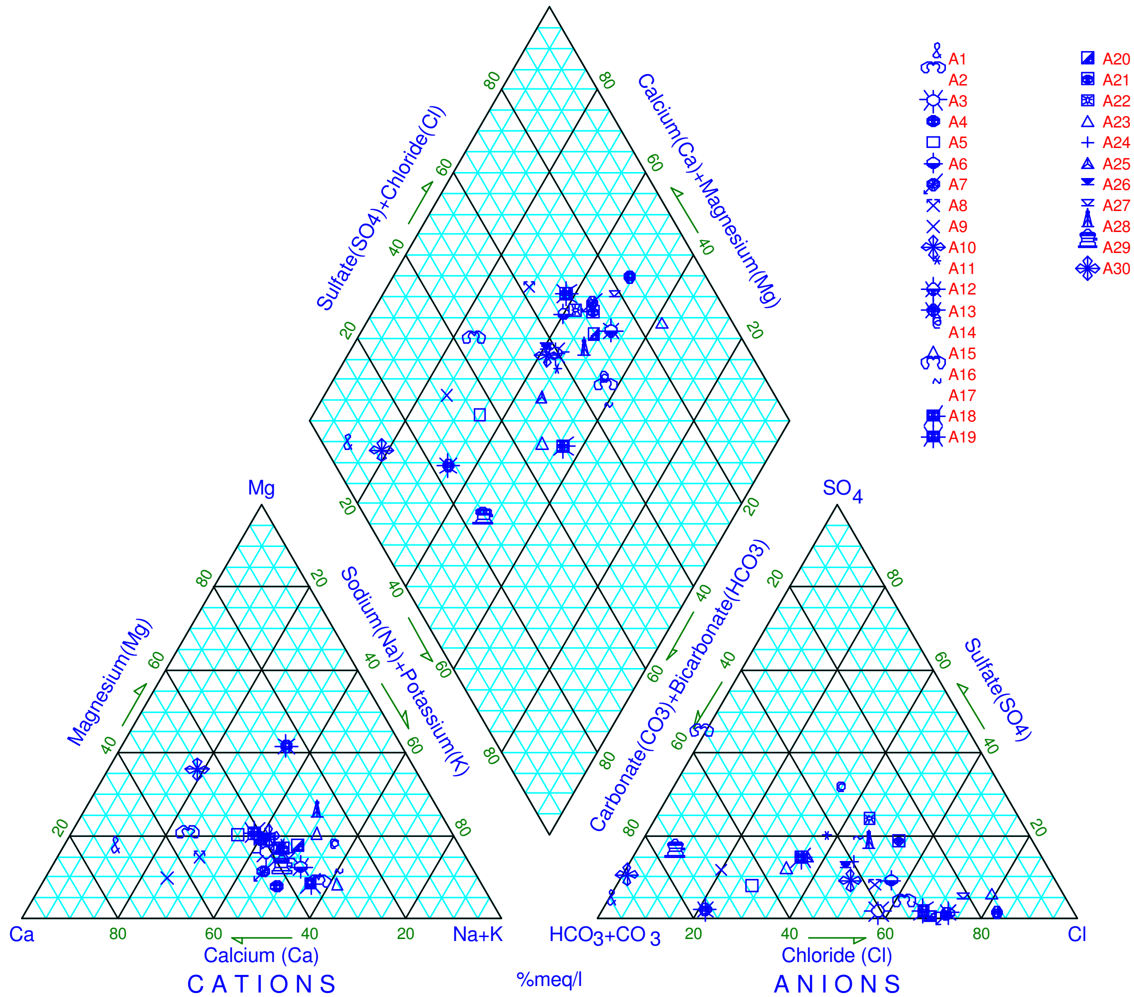

Figure 2. Piper's diagram showing the position of water samples.

the water.

Kelly's ratio

Kelly's ratio is used to find whether groundwater is suitable for irrigation or not. Sodium measured against calcium and magnesium was considered by Kelly (1951) for calculating Kelly's ratio. Groundwater having Kelly's ratio more than one (1) is generally considered as unfit for irrigation. Kelly's ratio for water samples varies from 0.12 to 1.58 with mean of 0.64 (Table 1). According to Kelly's ratio, 93.5% of the samples were found to be suitable for irrigation, whereas 6.5% were fairly suitable.

Magnesium ratio

Magnesium presence in soil and water would adversely affect their quality and render the soil unfit for cultivation (Chandu et al., 2008). Magnesium ratio of more than 50% in a body of water sample will make the water poisonous to plants (Rajmohan and Elango, 2005). Table 1 reveals that, 100% of samples showed magnesium ratio far less than 50% which confirms the suitability of the water samples for irrigation.

Wilcox diagram

Wilcox (1948) used percentage sodium and electrical conductance in evaluating the suitability of groundwater for irrigation. The results (Table 1) show that, 85% of the water samples clustered in the zone of very good to good, while 15% is plotted at the boundary of good to permissible (Figure 4).Therefore, the water samples are good for irrigation (Wilcox, 1948).

Conclusions

The preliminary evaluation of quality of water resources from Ayede-Ekiti, Nigeria provides the following

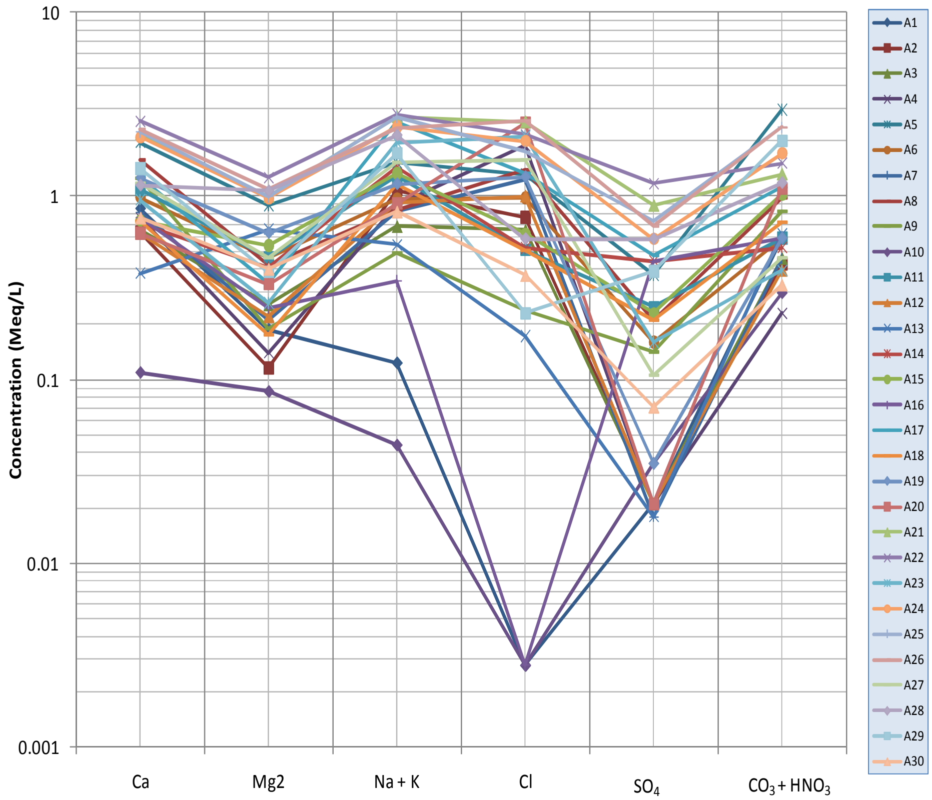

Figure 3. Position of the water samples on the Schoeller's plot.

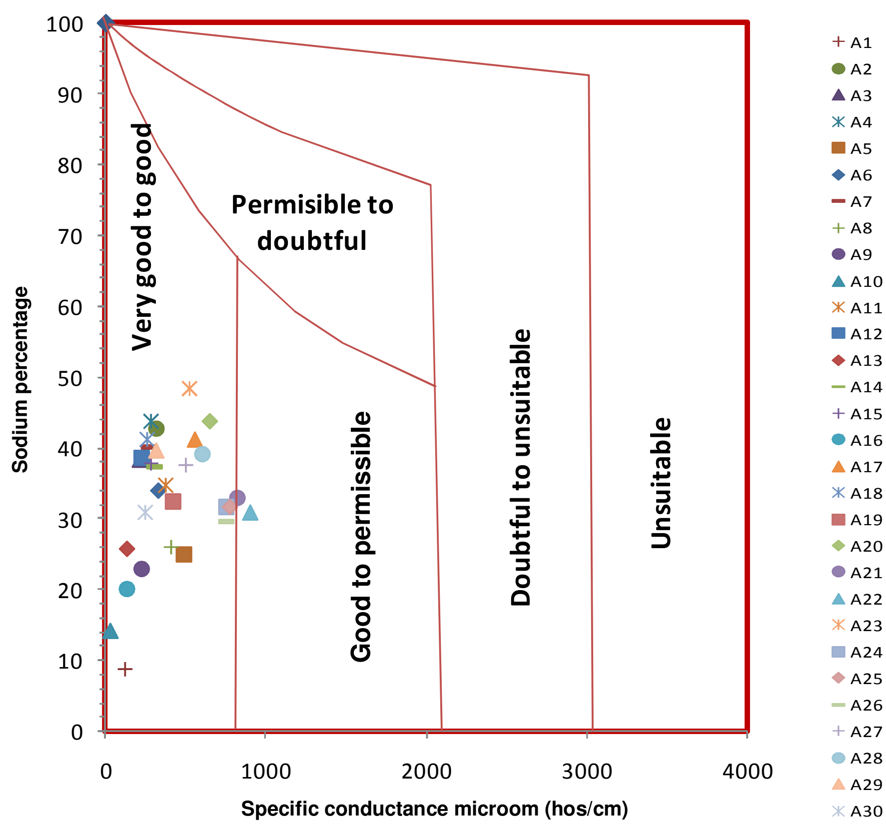

Figure 4. Position of the water samples on the Wilcox plots.

conclusion; the variations of the chemical parameters were evaluated and the order of abundance of the ions was determined to be (Na+k)>Ca^{2+}>Mg^{2+} and Cl^->HCO_3^->SO_4^{-2} for cations and anions, respectively. TDS values are generally lower than the permissible limit and the average concentration of the major ions is found to be within the WHO permissible limit, indicating passive leaching predominated by dilution effects on the water. However, bacteriological analyses were not conducted, as it was slated for the raining season.

The Gibbs' diagrams show that, the composition of water during sampling period is dominated by rock forming mineral. Piper diagram characterizes the water types in the study area. Hydro-chemical facies in the area are mixed CaNaCl > $CaHCO_3$ > NaCl in the order of dominance. Results from Kelly's ratio, Magnesium ratio and Wilcox diagram are within recommendations. These signify the usefulness of the water for irrigation purpose. Further works emphasizing biological studies will be done along with hydro-chemical studies during raining season.

REFERENCES

APHA (1995). Standard methods for the examination of water and wastewater. 19th edition. American Public Health Association, Washington DC. 1467.

Appelo CAJ, Postma D (2005). Geochemistry, Groundwater and Pollution. 2nd edtition, Balkema Publishers, Amsterland.

Asiwaju-Bello YA, Akande OO (2004). Urban groundwater pollution: Case study of a Disposal sites in Lagos metropolis. J. Water Res., 12: 22-26.

Ayoade JO (1977). Evaporation and evapotranspiration in Nigeria. J. Trop. Geol., 44: 9-19.

Chandu SN, Subbarao V, Raviprakash S (2008). Suitability of groundwater for domestic and irrigational purposes in some parts of Jhansi District, Indian. Bhu-jal News, 10: 12-18.

Clesceri LS, Greenberg AE, Eaton AD (1998). Standard methods for the examination of water and wastewater. 20th ed. Washington: Public Health department of American Water Works Association.

Fetters C (1990). Applied hydrogeology. CBS Publishers and Distributor, New Delhi, India, p. 234.

Gibbs RJ (1970). Mechanisms controlling world water chemistry. J. Sci., 17: 1088-1090.

Ige OO, Bale RB, Olasehinde PI (2008). Physio-chemical characteristics of water sources in Imeko, Southwestern, Nigeria. Water Res., 18: 32-36.

Kelly WP (1951). Alkali soils-Their formation properties and reclamation. 3rd edition. Reinhold Publication, New York, USA. p. 92.

Rajmohan N, Elango L (2005). Nutrient chemistry of groundwater in an intensively irrigated region of Southern India. Environ. Geol., 47: 820-830.

Rowell DJ (1994). Soil science: Methods and application. Longman Scientific and Technical books.

Wilcox LV (1948). The quality of water for irrigation use. US Department of Agriculture. Technical Bulletin of 1962, Washington, USA.