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Assessment of water quality Index for groundwater in Ado Ekiti, Nigeria

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ABSTRACT

This research focuses on the ground water quality index in Ado-Ekiti State, Nigeria. Groundwater sample wells were randomly collected and their spatial locations captured using a handheld GPS. Water samples were taken from 45 wells and their physio-chemical properties were analyzed in the laboratory. Spatial distribution maps of the water quality parameters were then developed. Herein, the Kriging method of interpolation from geospatial analyst wizard in Esri ArcGIS software was deployed in the generation of thematic maps of water quality parameters. A drinking water quality index was subsequently developed to describe the overall quality of groundwater in the study area. Laboratory analysis of 34 wells showed water of acceptable use as it conforms to WHO standard, while 11 wells were found to have unsuitable water for domestic use. The results further show spatial variation in the water quality. The south central depicts poor water quality, fair water quality in the south-east, while the North, north east, north-west down to the south west depicted the best water quality.

***Keywords*:** Groundwater, water quality index, mapping, well samples, Ado Ekiti, ArcGIS 10.3

1. INTRODUCTION

Nigerian urban cities face continuous threat coming from ground water pollution, increasing industrial and agricultural activities coupled with environmental pollution/ degradation and indiscriminate disposal of all kinds of wastes.

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An identification of potential areas for future environmental health problems, require consistent and continuous mapping of groundwater quality in major cities of the world. To this effect, the World Health Organization has to set safe standards for drinking water. This concern has attracted overwhelming studies on the quality status of groundwater abstracted from shallow wells (hand dug wells) and deep wells (boreholes) for human consumption in Nigeria urban areas. Pollution of ground water has been reported for a number of urban aquifers throughout the world because of its overwhelming environmental significance. A wide range of pollutants has been recognized including heavy metals, N-species, chlorinated hydrocarbons, phenols, cyanide, pesticides, major inorganic species and bacteria. An important tool to understand overall ground water quality of a region is ground water quality index (GWQI).

2. STUDY AREA

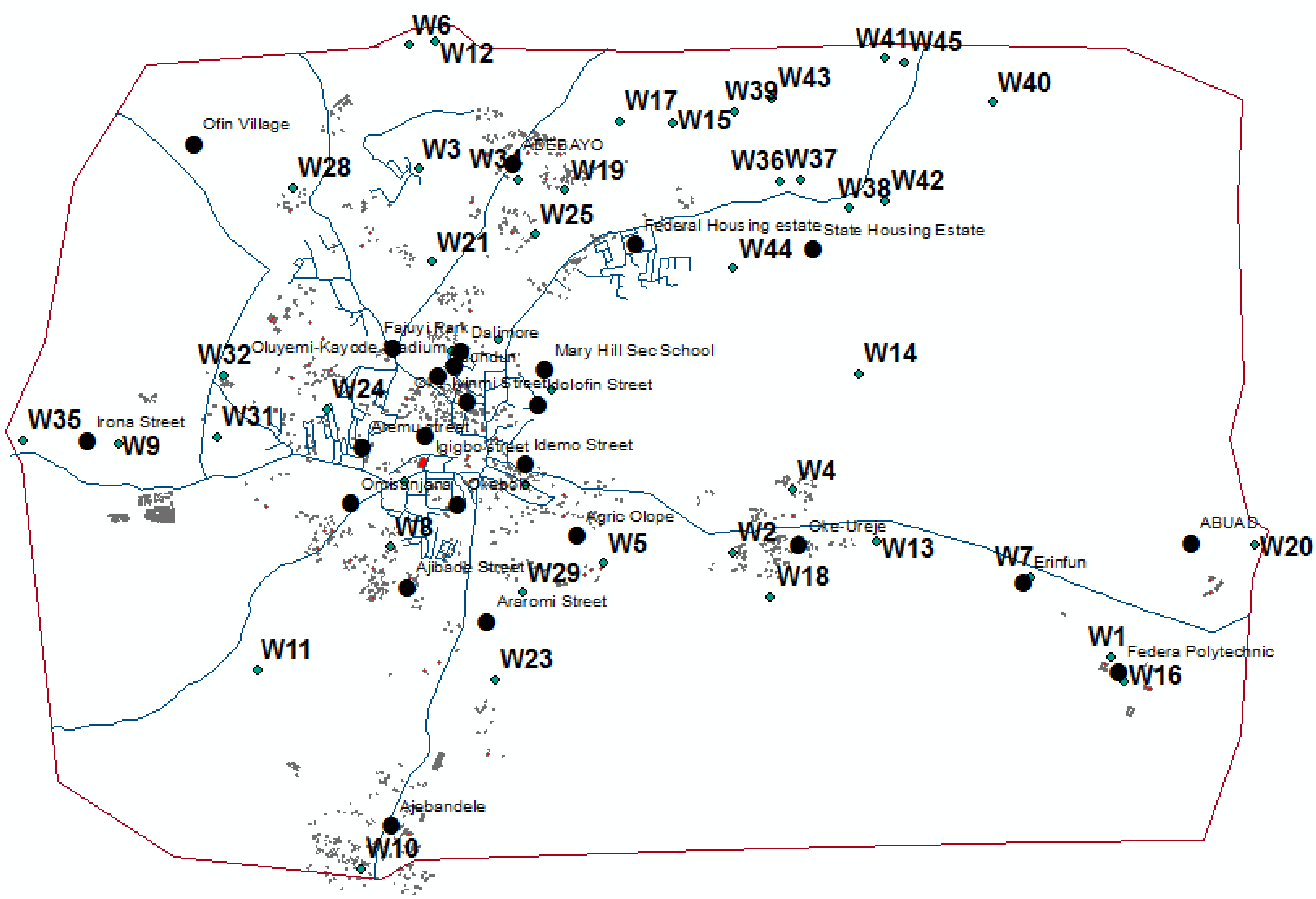

Figure 1. Map showing the locations of sampled wells

Ado-Ekiti is the capital city of Ekiti State in Southwest Nigeria. The city lies between Latitude 7º34' and 7º44' North of the Equator and Longitude 5º11' and 5º18' East of the

Greenwich Meridian. The city is the trade center for a farming region and is underlain by the Precambrian Basement Complex Rocks of Southwestern Nigeria with heavy dependence on rain water, surface water and groundwater for its water supplies. The sample wells used for this research covered about 45 percentage (%) of the whole local government which measures 345 km^2, while the study area have a coverage of 149 km^2.

3. MATERIAL AND METHODOLOGY

3. 1. Water Sampling and Analysis

A total of forty-five (45) wells were sampled for physiochemical analysis in February 2018 in Ado Ekiti metropolis. Ten (10) parameters (acidity (PH), electrical conductivity (EC), total dissolved solids (tds). hardness, calcium, magnesium, alkalinity, chloride, sulphate and nitrate) were analyzed. The simple random sampling technique was adopted because of ease of assemblage of the sample. The method adopted for the determination of the physico-chemical parameters was APHA, (APHA, 2005, *Standard methods for the examination of water and waste waters* Washington DC., American Public Health Association/American Water Works Association/ Water Environment Federation). The chemicals and reagent used for the analysis were of analar grade. The pH and conductivity were determined with a consort digital pH meter and consort digital conductometer respectively. JENWAY 6310 spectrophotometer was used to determine calcium and magnesium while JENWAY PFP-7 flame photometer was used for the determination of potassium and sodium.

3. 2. Calculation of WQI Index

Water quality index (WQI) is one of the most efficient and effective means of describing the quality of water to all stakeholders in the water sector. It is a good platform for the assessment and management of water resources It is a composite rating that reflects the impact of different water quality parameters on a given water resources (Sahu and Sikdar, 2008).

The kriging method of interpolation was adopted to determine the spread of the water quality parameters considered in the study. Spatial distribution maps of various water quality parameters were then produced in GA (geostatistical layer). Each GA layer was exported to raster using the export tool in ArcMap in order to allow for reclassification. Each water quality parameter was reclassified into 5 classes where 1 represent the least suitable and 5 the most suitable. The WHO standards for drinking water were considered during the reclassification process. Weights were calculated and assigned to each parameter in the formula below:

$$\mathbf{W} = \frac{K}{Sn}$$

$$\mathbf{K} = \frac{1}{\sum(\frac{1}{Sn})}$$

where:

W is weightage factor
Sn is the WHO standard
K is the proportionality constant of the formula to be applied.

The reclassified parameters and their assigned weights were used as inputs in the weighted overlay tool in ArcMap 10.3 software so as to generate a drinking water quality index for the study area. Table 1: shows the water quality parameters that were considered in the study using WHO standards as well as their calculated weight.

Table 1. Water Quality Parameters, WHO Standards and their Calculated Weights

	Standard (Sn)	$(\frac{1}{Sn})$	**K**	**Weight (w)**	**Weight in %**	**Arc map applied Weight %**
pH	8.5	0.117647	5.02	0.59	59	59
EC	300	0.003333	5.02	0.017	1.7	2
TDS	500	0.002	5.02	0.01	1	1
Hardness	300	0.0033	5.02	0.017	1.7	2
Calcium	75	0.0133	5.02	0.067	6.7	7
Magnesium	50	0.02	5.02	0.10	10	10
Alkalinity	120	0.008	5.02	0.042	4.2	4
Chloride	250	0.004	5.02	0.020	2	2
Sulphate	200	0.005	5.02	0.025	2.5	2
Nitrate	45	0.022	5.02	0.112	11.2	11

4. RESULTS AND DİSCUSSİONS

4. 1. Well Sample Location And Parameter Concentration

The table below shows the sampled wells that meet with the WHO standard (Table 2).

Table 2. Sampled well that met WHO Standard.

	Well that meet with WHO Standard	Well that failed to meet with WHO Standard
WELL ID	W3, W4, W8, W9, W10, W11, W12, W13, W14, W15, W16, W17, W18, W19, W20, W21, W24, W25, W26, W27, W28, W29, W30, W31, W32, W33. W36, W37, W38, W39, W40, W41, W43, W44.	W1, W2, W5, W6, W7, W22, W23, W34, W35, W42, W45.
TOTAL	34	11

Table 3. Laboratory Result of the Sampled Wells

Table

WELL

FID	Shape *	WELL_ID	W_LAT	W_LONG	W_PH	W_EC	W_TDS	W_HARDNESS	W_CALCIUM	W_MAGNESIU	W_ALKALINI	W_CHLORIDE	W_S
0	Point	W1	7.595969	5.295552	6.34	43.26	21.86	72	23.4	1.1	18.4	21.2	
1	Point	W2	7.607916	5.2526	6.23	50	27.2	64.2	28.2	1.86	17.8	18	
2	Point	W3	7.651297	5.217101	6.75	45.6	19.6	78.4	26.82	1.5	38	32.6	
3	Point	W4	7.614934	5.259508	7.32	52.4	27	88.2	24.2	1.62	33.2	23.6	
4	Point	W5	7.606796	5.237998	6.33	72.4	36.2	94.6	20.6	61	23.4	34.4	
5	Point	W6	7.665276	5.21606	6.12	53.5	25.6	77.1	23.1	2.86	26	39.6	
6	Point	W7	7.604999	5.286417	6.67	45.6	21.3	78	43.6	1.6	26.2	30.2	
7	Point	W8	7.608716	5.213652	6.34	44	23	76.6	18.23	0.78	44.6	21	
8	Point	W9	7.620554	5.182738	8.23	46.2	26.43	74.32	25.6	4.4	27	24.4	
9	Point	W10	7.572548	5.21013	6.45	47.5	23.45	82	23.3	1.82	34.6	38.1	
10	Point	W11	7.59501	5.198423	6.78	34.8	17.2	89.6	43.23	0.98	28	22.2	
11	Point	W12	7.665574	5.219034	6.44	38	20	81.2	25.3	1.42	20.4	24.4	
12	Point	W13	7.60912	5.269042	6.32	78.4	35.6	86.2	28.64	1.8	28.6	26.2	
13	Point	W14	7.628	5.267	6.23	64	33	77.3	26.42	1.82	23.6	23	
14	Point	W15	7.65626	5.246129	6.56	45.7	23.4	92.3	25.45	2.5	28.2	28.6	
15	Point	W16	7.593047	5.297013	6.19	48.6	23.7	88.25	23.2	1.18	34.62	31.1	
16	Point	W17	7.656562	5.240072	7.17	48	23.6	76.5	21.2	2.64	24.6	39.64	
17	Point	W18	7.602976	5.256918	6.76	66.2	31.2	72.34	81.1	30.2	30.2	21.2	
18	Point	W19	7.648805	5.23379	6.38	56.2	28.1	70.1	29.6	21	21	28.6	
19	Point	W20	7.608544	5.312026	6.56	84.6	39.2	68.2	25.5	2.2	32.2	26.42	
20	Point	W21	7.6408	5.2186	7	72	32	69	23.6	3.76	35	15.7	
21	Point	W22	7.6321	5.2261	7.07	75	33	86	15.7	0.84	30	97	
22	Point	W23	7.593772	5.225555	6.33	69	40	88	21.5	5.27	39	43.9	
23	Point	W24	7.624303	5.206529	6.68	65	43	76	21.1	2.9	31	40	
24	Point	W25	7.6439	5.2303	7.22	56	52	51	39.2	3.76	39	25	
25	Point	W26	7.6308	5.2208	7.2	86	51	82	43.3	0.83	51	26.9	

(0 out of 45 Selected)

WELL

PH: The following wells W1, W2, W5, W6, W23, were found to be acidic in nature
Calcium: Well W35 has calcium above the WHO standard
Magnesium: Well W5, W7, has magnesium a bit higher than the WHO standard
Alkalinity: W1,W22, W34, W42, has the alkalinity falling above WHO permissible standard
Nitrate: W21, W32, W45 has the nitrate value falling above WHO permissible standard

Figure 1 shows the location of the randomly sampled wells in Ado Ekiti. The laboratory analysis shown in Table 3 reveals that not all wells met with the WHO standard for drinking water.

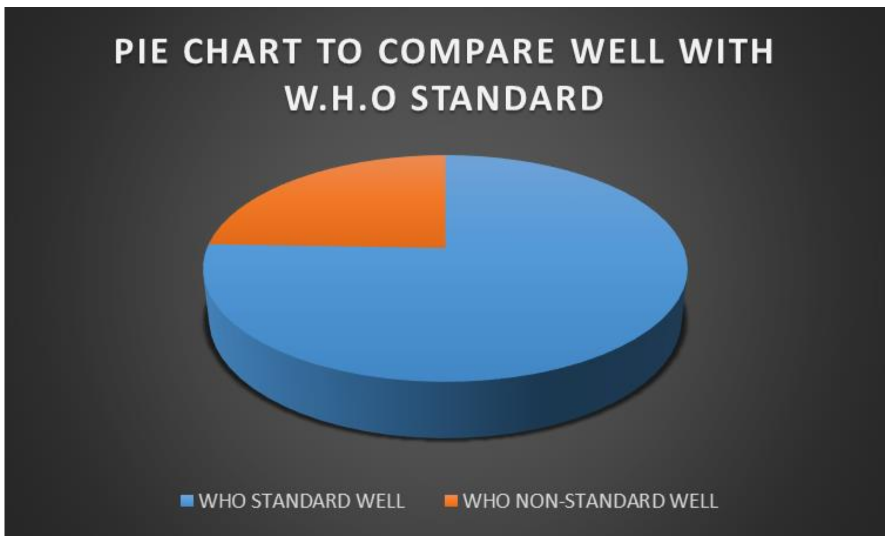

Figure 2. Standard and Non Standard Wells

4. 2. Spatial Distribution of Water Quality Parameters

The spatial distribution of each of the water quality parameter was generated by Kriging technique. These ten-spatial distribution layers were then used to generated the water quality index map through weighted overlay.

4. 3. Water Qualıty Index Map

Almost all the area in Ado Ekiti has good water quality good for drinking. Figure 3 shows the water quality index of the study area. However, in Ajebandele, the south central the water quality is poor this may be as a result of inappropriate management of fertilizers, pesticides, herbicides and insecticides because of the agricultural activities going on in that area. This has been inferred after a visual overlay of the land use map on the water quality index map. More also fair water quality in the south-east of Ado Ekiti may be due to poor solid and liquid waste management. The major solid waste disposal means is open dumping. Poor sewerage infrastructure may be another cause of ground water contamination. The residents of the area use open sewage to dispose their liquid wastes. The septic tanks are also poorly designed. The PH in the area is acidic in nature by recording a low pH., value in the area. High hardness is also note in the south east.

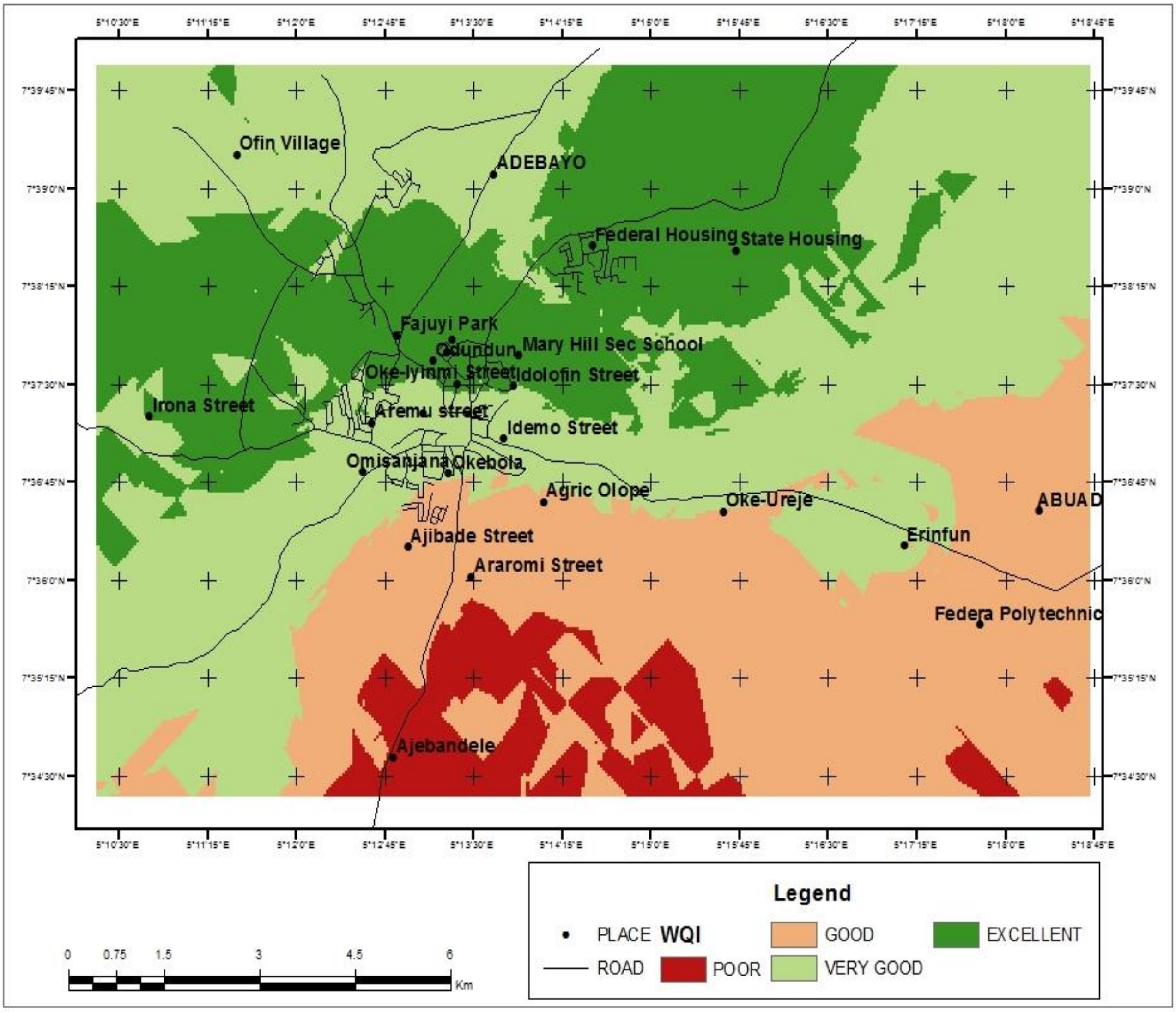

Figure 3. Water Quality Index Map

The Table 4 below shows the water quality statistics of all sampled well

Table 4. Water Quality Statistics

Water quality index (WQI)	Well identity	Percentage water quality index.
Poor	W10, W23	4.44
Fair	W1,W2, W5, W7, W13, W16, W18, W20, W29,	20

Very good	W3, W4, W6, W8, W11, W12, W14, W25, W28, W30, W32, W33, W34, W35, W40,	33.33
Excellent	W9, W15, W17, W19, W21, W22, W24, W26, W27, W31, W36,W37, W38, W39, W41, W42, W43, W44, W45	42.22

In Fajuyi Park, Odundu, Idolofin to federal and state hosing estate has the best water quality despite having a bit high concentration of the following: alkalinity at north central, calcium at south west. This result may due to the strict enforcement of various environmental compliance laws by the government to avoid environmental pollution. The rest of the study area shows that Ado Ekiti has good water quality fit for drinking.

5. CONCLUSIONS

The drinking water quality index that was generated for the study area shows that Fajuyi Park, Odundu, Idolofin to federal and state hosing estate in North, north east, north-west down to the south west has the best water quality index. It is also noted that Ajebandele in south central the water quality is poor. The rest of the location has good drinking water quality. The poor water quality in the mentioned areas may be attributed to mismanagement practices like poor waste management and poor farm management practices. Finally, the statistic of observed are as follows: two (2) well has poor water quality, nine (9) well has fair water quality, fifteen (15) well has very good water quality and nineteen well has an excellent water quality

References

[1] Brown, R. M., Mc Clelland, N., Deininger, R. A., & Tozer, R. G. (1970). A water quality index - do we dare? Water Sewage Works, Vol. 117, No. 10, pp. 339-343.

[2] Horton, R. K. (1965). An Index number for rating water quality. *Journal of Water Pollution Control Federation,* Vol. 37, No. 3, pp. 300-306.

[3] Oyedele, E. A. A. and Olayinka, A. I. (2012). Statistical Evaluation of Groundwater Potential of Ado-Ekiti, Southwest Nigeria. *Transnational Journal of Science and Technology*, 2, 110-127.

[4] Ramakrishaiah, C. R., Sadashivaiah, C. & Ranganna, G. (2008) Assessment of Water Quality Index for the Groundwater in Tumkur Taluk, Karnataka State, *E-Journal of Chemistry* Volume 6, Issue 2, Pages 523-530, http://dx.doi.org/10.1155/2009/757424

[5] Sahu, P. & Sikdar, P. K. (2008) Hydrochemical framework of the aquifer in and around East Kolkata wetlands, West Bengal, India. *Environmental Geolology,* pp. 55, 12.

[6] Swain, L., Webber, T., Ryan, A. L. A. & Yeow, A. (2005) Water sampling procedures, safety and quality assurance. In Branch, E. C. (Ed. British Columbia, Province of British Columbia.

[7] C. D. Abadom, H. O. Nwankwoala, Interpretation of Groundwater Quality Using Statistical Techniques in Federal University, Otuoke and Environs, Bayelsa State, Nigeria. *World Scientific News* 95 (2018) 124-148

[8] Godwin O. Emujakporue, Marcel I. Ngwueke, Spatial Variability Analysis of Some Groundwater Physico-Chemical Parameters in Parts of Akwa-Ibom State, Nigeria. *World Scientific News* 50 (2016) 20-32

[9] O. A. Olaoye, A. A. Onilude. Assessment of microbiological quality of sachet-packaged drinking water in Western Nigeria and its public health significance. *Public Health* Volume 123, Issue 11, November 2009, Pages 729-734

[10] Oguzie, F.A. (2003). Heavy metals in water and sediments of the lower Ikpoba River, Benin City, Nigeria. *Pakistan Journal of Science and Industrial Research* Vol. 46(3): 156-160.

[11] Enslin, J.F. 1943. Basins of decomposition in rocks. *Trans. geol. Soc. S. Africa,* 46: 1–12.

[12] Jacobson, R.R.J., Snelling, N.J. and Truswell, J.F. 1963. Age determinations in the geology of Nigeria. *Overseas Geol. Miner. Resources,* 9: 168–182.

[13] Jones, H.A. and Hockey, R.D. 1964. Geology of part of southwestern Nigeria. *Bull. Geol. Surv. Nigeria*, No. 31, 101.

[14] Fasae, K. P., Gross Alpha and Beta activity Concentrations and Committed Effective Dose due to Intake of Groundwater in Ado-Ekiti Metropolis; the Capital City of Ekiti State, Southwestern, Nigeria. *Journal of Natural Sciences Research,* Vol. 3, No.12, 2013