

ASSESSMENT OF ACTIVITY CONCENTRATIONS OF RADIONUCLIDE WITH DEPTH IN WASTELAND SOILS IN ABEOKUTA, SOUTHWEST NIGERIA

BY

BELLO RASAQ^{1*}. and FARINRE O. ZAINAB²

**¹DEPARTMENT OF PHYSICS,
UNIVERSITY OF PORT HARCOURT, PORT HARCOURT, NIGERIA.**

**²DEPARTMENT OF PHYSICS,
FEDERAL UNIVERSITY OF AGRICULTURE, ABEOKUTA, NIGERIA**

***TEL.: +234(O) 8036684498, E-MAIL: bellomo68@yahoo.com**

ABSTRACT

A survey of natural radionuclide level with depth in wasteland soils in some locations in Abeokuta was carried out in February 2013. Samples were collected at 10 cm depth interval from each of the locations visited. They were collected into containers with length 9 cm and width 7 cm and then sundried. The different soil samples picked from different locations were not mixed together in order to avoid cross contamination of the soil samples. Analysis was carried out on each of the soil samples and the specific activity concentration of the radionuclides K-40, U-238 and Th-234 was measured using the model 802 series thallium activated sodium iodide detector NaI (TI). The average specific activity values obtained for the 0 cm depth (surface) were 428.91 ± 15.05 Bq/Kg for K-40, 2.09 ± 0.84 Bq/Kg for U-238 and 54.60 ± 2.00 Bq/Kg for Th-234. The gamma absorbed dose rate and effective dose equivalent were also calculated and an average of 55.5 nGy/hr and 0.136 mSv/yr were obtained. These obtained values were found to be below the recommended standard values by UNSCEAR which are 55.9 nGy/hr and 0.7 mSv/yr. The results indicate that the radiation level within the dumpsites pose no significant health risk on the people living close to the dumpsite. Also, it was observed that as radionuclides are leached down, activity concentration reduces but may be altered again by factors such as the type of radionuclide, composition of subsurface materials, rate of ground water movement and the soil particles with which the radionuclides are connected.

Keywords: Radionuclides, Wasteland, activity concentration, Depth, Soil

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

1.0 INTRODUCTION

In physics, radiation is a process in which energetic particles or energetic waves travel through a vacuum or through matter-containing media that are not required for their propagation. Radiation can be classified as either ionizing/non-ionizing according to whether it ionizes or does not ionize ordinary chemical matter. Ionizing radiation is the radiation with sufficiently high energy which can ionize atoms. Because living cells and more importantly the orbit in those cells can be damaged by this ionization, it can result in an increased chance of cancer. In Non-ionizing radiation, the kinetic energy of particles is too small to produce charged ions when passing through matter. For non-ionizing electromagnetic radiation, the associated particles (photons) have only sufficient energy to change the rotational, vibrational or electronic valence configuration of molecules and atoms (Kwan-Hoong Ng, 2003).

In 1895, the German physicist Wilhelm Roentgen identified penetrating radiation, which produced fluorescence, and which he named X-rays. In 1896 two months later, Henri Becquerel discovered that penetrating radiation, later classified as α , β and γ rays, were given off in the radioactive decay of uranium and thus opened a new field of study of radioactive substances and radiations they emit (Katse, 2004).

Soils are naturally radioactive, primarily because of their mineral content. The main radionuclides are ²³⁸U, ²³²Th and their decay products, and ⁴⁰K. The radioactivity varies from one soil type to the other depending on the mineral makeup and composition. The objective in the measurement of the radioactivity in soil is to assess the radionuclide concentrations; and these concentrations may be used to characterise substances and relate the radiometric properties to physical properties of the material. This may be of use in mineral separation for example (Katse, 2004).

According to the work of Umar *et al* (2012) in measuring natural radioactivity in environmental samples (soil, vegetation and water) from the (Idu) industrial district of Federal Capital Territory (FCT) Abuja, Nigeria was measured by means of gamma-ray spectrometer with NaI (TI) detector to establish a baseline data for activity concentration of ⁴⁰K, ²²⁶Ra and ²³²Th. The highest activity concentration of ⁴⁰K, ²²⁶Ra and ²³²Th were found in soil collected from location S2 (943.1 Bq/kg), in vegetation VC (82.3 Bq/kg) and in soil collected from location S3 (107.3 Bq/kg), respectively, where only the activity from S2 is higher than the world average of 420 Bq/kg and the highest activity concentrations of both ²²⁶Ra and ²³²Th from VC (82.3 Bq/kg) is above the world average of 50 Bq/kg. Results from the twelve field samples analysed also indicated that the activity concentration due to ⁴⁰K in the soil samples ranked highest against the lowest value obtained for sediments in the water samples.

Jone *et al* (2008) carried out an assessment of the natural radiation dose to wildlife in England and Wales to determine the contribution it may make to the total radiation dose estimated during environmental
*Tel.: +234(0)8036684498
E-mail: bellomo68@yahoo.com

impact assessments. Significant use was made of systematic datasets for environmental media (stream sediments, stream waters and soils), in particular those produced by the Geochemical Baseline Survey of the Environment (G-BASE) project. This provided extensive, although variable, coverage for different elements and sample types after normalisation of data to account for changes in sampling and analysis over time. Almost complete coverage for K in stream sediments was achieved by merging G-BASE and Wolfson Atlas data. This required normalisation of the Wolfson data to the G-BASE results. Coverage was improved greatly for U and Th in sediments, and K, U and Th in soils, by using the strong relationship between soils and sediments and geology (both solid and superficial) to extrapolate the data. The total U, Th and K data were used to derive activity concentrations of ^{238}U and ^{232}Th series radionuclides and ^{40}K . External dose rates to wildlife were then estimated from derived media concentrations; internal dose rates were estimated from measured activities in biota or activities predicted using recommended concentration ratios.

Odusote *et al* (2014), in their study to measure the radionuclides in the t in mining soil mounds from the Jos Plateau, Nigeria and to evaluate the impact of radiation on the environment where the soils are used as building materials. Gamma spectrometry was employed via a NaI(Tl) detector to determine the activities of the radionuclides ^{40}K , ^{238}U and ^{232}Th in ten (10) samples from points within a distance of 20 km along the mining rail. The results of measurements of natural radionuclide (^{238}U , ^{232}Th and ^{40}K) in soil samples show that the concentrations of ^{238}U , ^{232}Th and ^{40}K ranged between 1.51 – 4.98, BDL - 8.64 and 10.3 – 35.2 Bq/kg with mean concentrations of 3.20 1.16, 1.31 2.75 and 25.60 8.89 Bq/kg, respectively. The external hazards ranged between 0.008 – 0.044 with mean value of 0.019 0.009 while the internal hazards ranged between 0.014 – 0.048 with mean value of 0.028 0.009. These hazard values are less than 1. The annual gonadal dose equivalent (AGDE) ranged between 10.28 – 55.87 Svy-1 with mean value of 24.22 12.16 Svy-1. The radium equivalent activities ranged from 3.07 – 16.23 Bq/kg with a mean value of 7.04 3.53 Bq/kg. The external absorbed dose rate ranged from 5.35– 18.76 Gyh-1 with a mean value of 12.95 4.26 Gyh-1. The internal absorbed dose rate ranged from 10.34 – 35.53 Gyh-1 with an average value of 24.87 8.13 nGyh-1.

Meindinyo and Agbalagba (2012), carried out the alpha and beta activity concentration and heavy metal assessment of soil and water in and around Imirigin oil field has been carried out. Study area was subdivided into five locations, Soil and water samples were collected from field undisturbed environment and oil spilled areas. Sample collection and preparation follows standard procedures. *In situ* measurement was conducted for pH and electrical conductivity, heavy metal analysis was carried out using Atomic absorption Spectrophotometer (AAS) and gross alpha and beta activity concentration was by using gas filled proportional counter. The results showed that the level of the various metals obtained differs from location to location. Values obtained in soil are within reported values in the Niger Delta region except Iron level. Heavy metals such as Ca, Fe and Cd exceed the WHO limits for drinking water.

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

The mean values for alpha and beta activity in soil are above reported values in similar environment while mean values obtained in water samples are above WHO recommended maximum permissible limit for drinking water. These values obtained shows that drinking water from sampled locations may pose some long term health hazards to the public users though soil from the area is still safe as construction material for buildings.

1.1 PROBLEM STATEMENT

Natural radionuclide that finds their way into the environment may cause harmful effects and pose threats and danger to the human health by radiation poisoning. Therefore a study of this nature will provide information on the activity concentrations of natural radionuclide in dump sites with depth beneath the earth surface.

1.2 OBJECTIVES

The general objective of this study is to determine the magnitude of the negative impact of natural radionuclide with respect to the exposure from dump sites in Abeokuta. Also the work aims to measure the activity concentrations of natural radionuclide in dump sites varying with the depths of 10cm, 20cm, 30cm and 40cm; to measure the outdoor annual effective dose equivalent; and to measure the gamma absorbed dose rate of the natural radionuclide.

1.3 MOTIVATION OF RESEARCH

Radiation emission characterization of waste dumpsites and measurement of radiation level in refuse dumps (Odunaike et.al, 2008) show the level and long term effects of these radiations if not properly monitored. The proper monitoring and evaluation of the radiation emanating from dumpsites in order to provide accurate data as a part of environmental monitoring research for proper assessment of radiation exposure rate of the Abeokuta metropolis and also the environmental pathways of radionuclide beneath the earth surface motivated this research.

2.0 LITERATURE REVIEW

Man is continuously exposed to ionizing radiation from naturally occurring radioactive materials (NORM). The origin of these materials is the earth crust, but they find their way into the soil, building materials, air water, food and the human body itself. In many parts of the world, building materials containing radioactive materials have been used for generations. The earth is naturally radioactive and about 90% of human radiation exposure arises from natural sources such as cosmic radiation, exposure to radon gas

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

and terrestrial radionuclides (Lee et al; 2004). However, it has been observed that the type and concentration vary considerably depending on the soil type. The effects of the radiation emitted by different radionuclides depend on the over lining soil material (thickness and type), its chelating agents and physio-chemical properties (Believermis et al., 2009).

Solid waste other than hazardous or radioactive material are often referred to as municipal solid waste (MSW). Municipal solid waste is useless unwanted material discharged as a result of human activity. Human activity creates wastes and it is the way this waste is handled, stored, collected and disposed of that constitute risk to the environment and public health. In the urban area especially the rapidly urbanizing cities of the developing world, problems and issues of solid waste management are of immediate importance. However, rapid population growth of most municipal authorities is to provide even the basic services when waste is collected. They are disposed of in uncontrolled dumpsites and/or burnt polluting water resources and air (Onibokun et.al, 2000). Municipal solid waste includes waste generated from residential, commercial, industrial institution, construction, demolition process and municipal services.

In most cases however, 'landfill' in developing countries is usually an unlined shallow hollow (often not deeper than 50cm). Zurbrugg (2002) referred to it as 'dumps' which receives solid wastes in a more or less uncontrolled manner, making a very uneconomical use of the available space and that which allows free access to waste pickers, animals and flies, and often produce unpleasant and hazardous smoke from slow-burning fires. Besides, instances have been revealed that even the lined(protected landfills have been inadequate in the prevention of ground water contamination (Lee and Lee, 2005).

In Nigeria, open dump is almost the very option for solid waste disposal, millions of tons of these wastes from a variety of sources; industrial, domestic, agricultural find their way into the soil. These wastes end up interacting with the soil system waste disposal, even in the capital cities. Sanitary landfill however is rare and unpopular except perhaps among few institutions and few affluent people. The soil is the primary recipient of solid waste (Nyle and Ray, 1999); millions of tons of these wastes from a variety of sources; industrial, domestic thereby changing the physical and chemical properties (Piccolo and Mbagwu, 1997). The accumulation of contaminants is aided by the capacity of soil to bind with clay minerals and organic substances. Their accumulation has multiple effects in the usability and functions of soil in the ecosystem. Wastes constitute an environmental and public health nuisance in major cities all over the world. Thus, governments consider waste management as an essential social service whose budgetary provision is made in line with population projections (Eja et.al, 2010). Hazards posed by such dumpsite are not only in term of odour and presence of disease causing micro-organism, but can arise from the radiation emanating from such dumpsite (Ojoawo et.al, 2011). It has also been established that vegetation and environmental fields in Nigeria contain traces of radionuclides (Akinloye and Olomo, 2005). All these are contained in the domestic waste which are indiscriminately dumped on open fields, farm soils, quarry sites, rivers, well and boreholes, industries and even on road sides and mechanic workshops. In addition, industrial wastes that are liable to contain traces of radionuclides are also dumped indiscriminately.

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

Consequently, the radionuclide content in the waste dumpsite, if not properly managed emits mixed radiation to the environment (Eja et.al, 2010). Solid is an asset when properly managed and Nigeria government has been and is being invested much on solid municipal waste management in cities one of which is Abeokuta, a case study, nevertheless the goal has not been met. Ideally wastes should remain immobile and unreactive but if water reaches the waste package, some radionuclides may dissolve or leach and move away from the disposal area. Radionuclides may be transported by water to the saturated zone and migrate with ground water flow depending on the type of radionuclide, the rate of ground water movement, the composition of subsurface materials, and time, a plum of contaminated wells and surface water. Depending on the type of radionuclide, the gas permeability and water content of the subsurface materials, volatile radionuclides can diffuse from the disposable area into the atmosphere such as radon. As radionuclides move away from the disposable area, their concentration may be lessened in severity by a number of physical and chemical processes.

3.0 METHODOLOGY

3.1 DESCRIPTION OF ABEOKUTA (THE STUDY AREA)

The study was carried out in February 2013 with samples collected in four different locations across Abeokuta as depicted in figure 2. Abeokuta is the capital of Ogun state in south-west Nigeria. It is situated on the Ogun River; 64 miles North of Lagos by railway or 81 miles by water. It was founded in 1825 and has coordinates $7^{\circ}39'39''\text{N}$ and $3^{\circ}20'54''\text{E}$ on the map. It has an elevation of 66m (217Ft). As of 2005, Abeokuta and the surrounding area had a population of 888,924 as at 2012.

Abeokuta is an ancient city; therefore many of the dumpsites are illegal and are situated very close to the residential areas which are liable to pose more threats than when they are a far off.

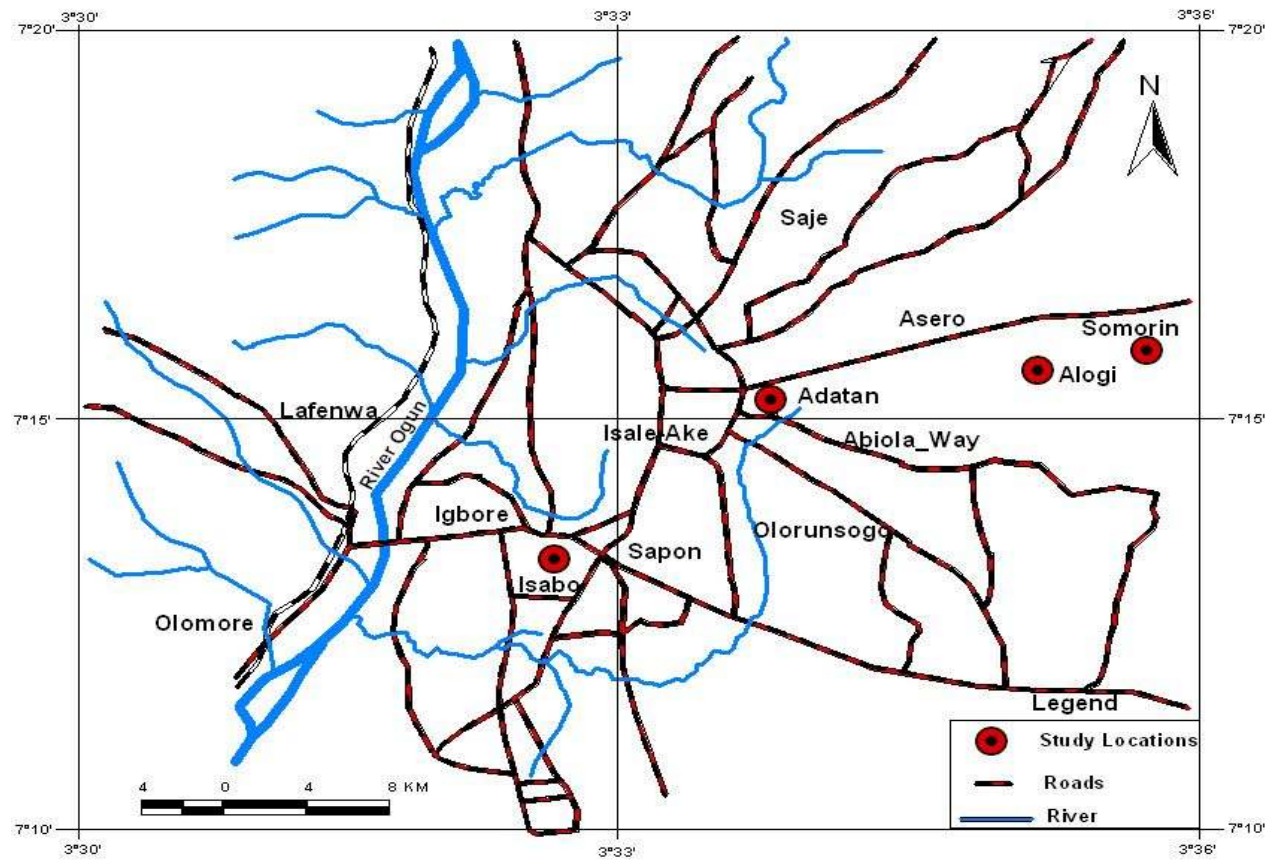


Fig 1: Map Showing Locations of Soil Sample

3.2 SAMPLE COLLECTION

Four densely populated areas were covered within Abeokuta metropolis. Table 1 shows the location of the dumpsites that were visited using the Global positioning system (GPS).

Table 1: Locations Covered with their Positions Using the Global Positioning System

Sites	Locations	Longitude (°E)	Latitude (°N)
1	Somorin	3.39997	7.17525
2	Alogi	3.39836	7.17635
3	Isabo	3.34736	7.14993
4	IsaleAbetu, adatan	3.36269	7.16719

The dumpsites visited have a very close proximity to the residential houses and have been in use for years. The soil samples were picked varying with depths of 0 cm, 10 cm, 20 cm, 30 cm and 40cm below the earth surface which implies that five soil samples were gotten from each location. The samples were collected into air tight containers of length 9 cm and width 7 cm and weighed 240 g each. A meter rule was used to measure the various depths from which the samples were picked. Each sample was crushed into finer particles and sundried. After collecting each of this soil samples from different dumpsites, the soil samples were not mixed together i.e. they were separately sundried in order to avoid cross contamination or pollution of the samples. In order to also enhance this, each of the containers was carefully labeled and left for 28days to ensure that the parent and daughter nuclide in the sample were at secular equilibrium.

3.0 MEASUREMENT AND ANALYSIS OF RESULTS

4.1 CONCENTRATION OF RADIONUCLIDE IN EACH SOIL SAMPLES VARYING WITH DEPTHS 10 CM, 20 CM, 30 CM, AND 40 CM.

This section shows the result of the analysis carried out by Sodium Iodide (thallium activated) scintillation detector Na(Tl)I, 802 series model. The Model 802 Series Scintillation Detector is a hermetically sealed assembly which includes a high resolution NaI(Tl) crystal, a photomultiplier tube, an internal magnetic/light shield, an aluminum housing, and a 14-pin connector. The 802 series of NaI(Tl) detectors provides high efficiency and uniform response on both the cylindrical and well configurations. These detectors have a proven record of long term reliability and stability. The analysis was done at The National Institute of Radiation Protection and research, University of Ibadan, Ibadan, South – West Nigeria. The section

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

comprises of tables, graphs and bar charts illustrating further how the various activity concentration of the radionuclides: U-238, K-40 and Th-238 vary with depths 0, 10, 20, 30 and 40 cm.

Table 2 shows the locations which were visited and where each of the soil samples was picked. Each of the locations Alogi, Adatan, Isabo and Somorin were represented with dumpsite 1, dumpsite 2, dumpsite 3 and dumpsite 4 respectively

Table 2: Locations at Which the Samples were Collected

DUMPSITES	LOCATION
Dumpsite 1	Alogi
Dumpsite 2	Adatan
Dumpsite 3	Isabo
Dumpsite 4	Somorin

Table 3 shows the concentrations of radionuclide K-40, U-238 and Th-234 with their various depths in dumpsite 1. From table 3, it was observed that K-40 is highest at depth 0 cm which is the surface, U-238 is highest at depth 20 cm and Th-234 is highest at 20 cm. This shows that the radionuclide after leaching down from the surface accumulated at the 20 cm depth.

Table 3: Concentration of Radionuclides in Dumpsite 1

Location	Depth	K-40	U-238 (Rn-226)	Th-234 (Ra-228)
No	(cm)	Bq/Kg	Bq/Kg	Bq/Kg
1	0	344.77±13.86	1.41±0.08	44.68±1.75
2	10	296.40±12.03	1.02±0.07	46.28±1.61
3	20	339.26±13.41	1.68±0.07	50.37±2.05
4	30	308.32±14.82	1.54±0.08	45.04±1.74
5	40	322.37±12.90	1.19±0.07	43.01±1.73

Table 4 showed the concentrations of radionuclide with depth in dumpsite 2 (Adatan). From the table, it was observed that the concentrations of the radionuclide: K-40, U-238 and Th-234 were highest at the 40 cm depth. This may be due to the fact that the radionuclide leached down from the surface and got accumulated at the 40 cm depth due to some physical and chemical processes which was further

explained under the discussion. This gave a high tendency of getting surface water and wells contaminated.

Table 4: Concentration of Radionuclides in Dumpsite 2

Location No	Depth (cm)	K-40 Bq/Kg	U-238 (Rn-226) Bq/Kg	Th-234 (Ra-228) Bq/Kg
1	0	391.82±14.04	3.00±0.20	60.28±2.19
2	10	423.79±15.63	2.56±0.08	65.40±2.14
3	20	399.20±14.04	3.26±0.09	60.52±2.18
4	30	460.10±15.28	3.28±0.09	78.70±2.21
5	40	618.57±17.76	4.59±0.12	103.21±2.87

Table 5 showed the concentrations of radionuclide with depth in dumpsite 3 (Isabo). The table showed that K-40 had highest at depth 20 cm, U-238 had highest at depth 40 cm and Th-234 had highest at depth 30 cm. This showed that the concentrations do not uniformly vary with depth and therefore no particular trend was followed.

Table 5: Concentration of Radionuclides in Dumpsite 3

Location No	Depth (cm)	K-40 Bq/Kg	U-238 (Rn-226) Bq/Kg	Th-234 (Ra-228) Bq/Kg
1	0	627.25±18.30	2.56±0.08	63.27±2.14
2	10	616.36±17.31	2.70±0.09	70.32±2.14
3	20	663.21±18.98	2.92±0.10	75.11±2.27
4	30	611.47±17.119	3.12±0.09	84.62±2.37
5	40	573.92±17.42	3.41±0.11	82.52±2.47

Table 6 showed the concentrations of radionuclide with depth in dumpsite 4 (Somorin). The table showed that generally, the concentrations of U-238, Th-234 and K-40 were low in dumpsite 4 compared to other locations visited, therefore the residents staying here are safe from the hazards posed by radionuclide from the dumpsites.

Table 6: Concentration of Radionuclides in Dumpsite 4

Location No	Depth (cm)	K-40 Bq/Kg	U-238 (Rn-226) Bq/Kg	Th-234 (Ra-228) Bq/Kg
1	0cm	351.79±14.00	1.40±0.08	50.18±1.93
2	10cm	307.70±13.32	0.88±0.07	44.11±1.66
3	20cm	294.68±12.35	0.78±0.07	41.74±1.61
4	30cm	320.86±12.68	1.00±0.06	42.69±1.58
5	40cm	317.55±14.96	0.74±0.06	37.32±1.59

The gamma absorbed dose rate D (nGy/hr) was calculated using the expression $0.043A_K + 0.427A_U + 0.662A_{Th}$ and annual effective dose equivalent A.E.D. (mSv/yr) was also calculated using the expression: Dose rate $\times 24\text{hrs} \times 365.25 \times 0.4 \times 0.7\text{SvGy}^{-1} \times 10^{-6}$ where the occupancy factor used (outdoor) is 0.4. The results were shown in tables 7 and 8.

Table 7: Gamma Absorbed Dose Rate D (Ngy/Hr) at 0cm Depth (Surface)

Location	Depth (cm)	K-40 Bq/Kg	0.043×A κ	U-2238 Bq/Kg	0.427×A u	Th-234 Bq/Kg	0.662×A Th	D (nGy/hr)
Alogi	0	344.77 ± 13.86	14.82 ± 0.60	1.41 ± 0.08	0.60 ± 0.03	44.68 ± 1.75	± 29.58	45.00 ± 1.78
		391.82 ± 14.04	16.85 ± 0.60	3.00 ± 0.20	± 1.28	60.28 ± 2.19	± 39.90	58.03 ± 2.09
		627.25 ± 18.30	26.97 ± 8.02	2.56 ± 0.08	1.09 ± 0.03	63.27 ± 2.14	± 41.89	69.95 ± 9.47
Isabo	0	351.80 ± 14.01	15.13 ± 0.60	1.40 ± 0.08	± 0.60	50.18 ± 1.94	± 33.20	48.93 ± 1.91
Somorin	0							

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

Table 8: Annual Effective Dose Equivalent at 0cm Depth (Surface)

Occupancy Factor (Outdoor) – 0.4

$$\text{A.E.D} = (D \times 24\text{hrs} \times 365.25 \times 0.4 \times 0.7\text{Sv/Gy} \times 10^{-6}) \text{ mSv/yr}$$

LOCATION	A.E.D. (mSv/yr)
Alogi	0.11 ± 0.01
Adatan	0.14 ± 0.01
Isabo	0.17 ± 0.02
Somorin	0.12 ± 0.01

*Annual Effective Dose Equivalent Average is 0.14 ± 0.01 mSv/yr

4.2 GRAPHS OF CONCENTRATION (Bq/Kg) OF K-40, U-238 AND Th-234 AGAINST DEPTH (CM) FOR ALOGI, ADATAN, ISABO AND SOMORIN

The graphs plotted in Figures 2 - 5 explained how the concentrations of U-238, Th-234 and K-40 varied with the depths 0 cm, 10 cm, 20 cm, 30 cm and 40 cm. The concentration (Bq/Kg) was plotted on the y-axis while the depth (cm) was plotted on the x-axis.

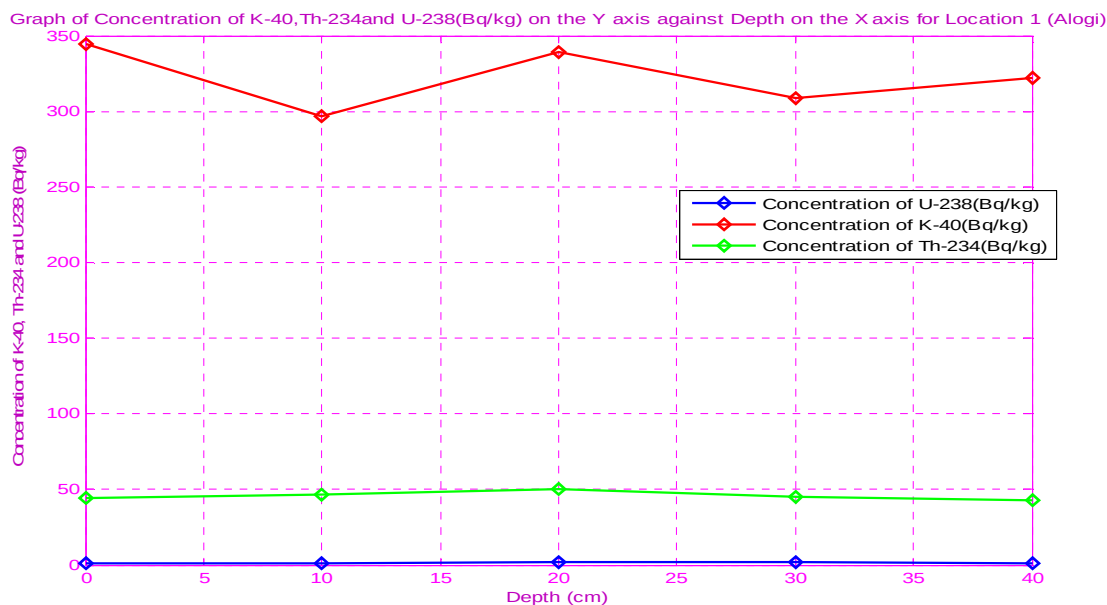


Fig. 2: Graph of Concentration of K-40 (Bq/Kg), K-40 (Bq/Kg), Th-234 (Bq/Kg) and U-238 (Bq/Kg) Against Depth (cm) at Alogi

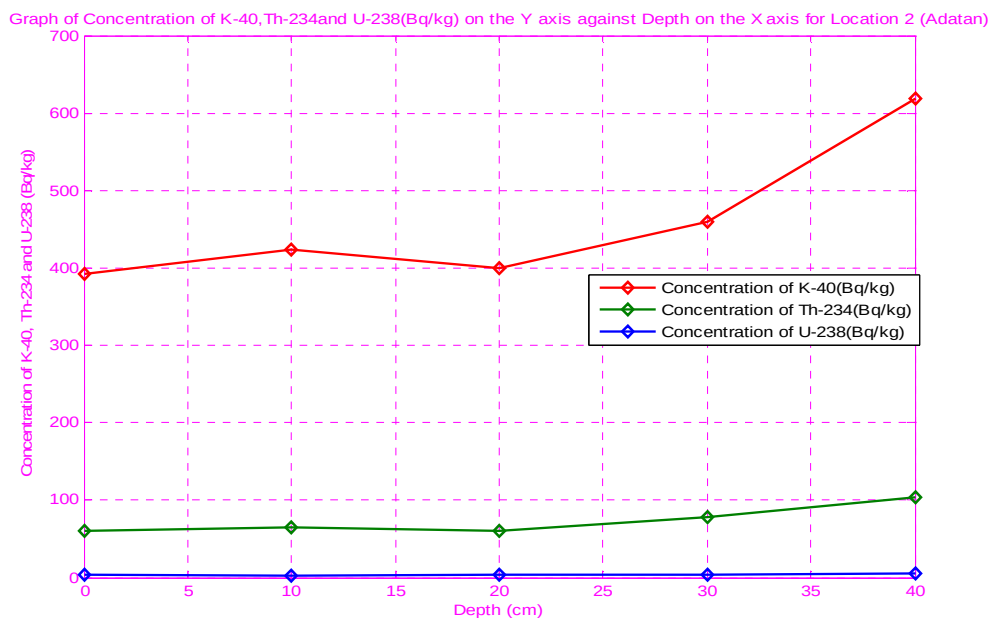


Fig. 3: Graph of Concentration of K-40 (Bq/Kg), K-40 (Bq/Kg), Th-234 (Bq/Kg) and U-238 (Bq/Kg) Against Depth (cm) at Adatan

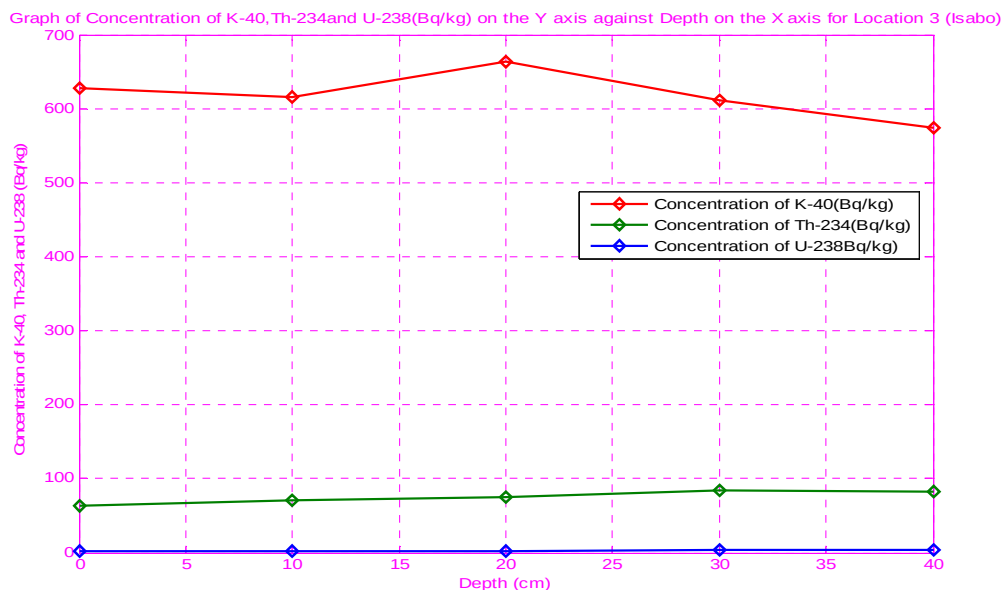


Fig. 4: Graph of Concentration of K-40 (Bq/Kg) Against Depth (cm) at Isabo

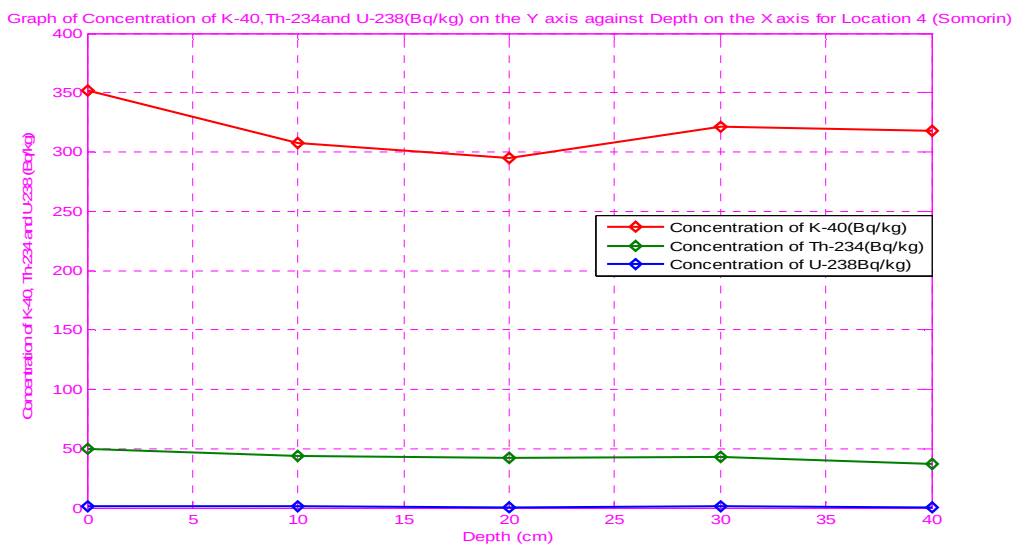


Fig. 5: Graph of Concentration of K-40 (Bq/Kg), Th-234 (Bq/Kg) and U-238 (Bq/Kg) Against Depth (cm) at Somorin

From Figures 2 to 5, it could be deduced that the surface soil (0 cm) had the highest concentration and this applies to all the locations, K-40 had the highest activity concentration due to the fact that potassium is abundant in air and the seventh most abundant element on earth making 2.4% of earth crust by weight.

4.3 BAR CHART SHOWING COMPARISON OF ACTIVITY CONCENTRATION AGAINST LOCATION AT EACH DEPTH

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

Bar charts were also plotted for each depth : 0 cm, 10 cm, 20 cm, 30 cm and 40 cm where their concentrations were plotted against the various locations : Alogi, Adatan, Isabo and Somorin. Each bar was represented by the radionuclide K-40, U-238 and Th-234. These were plotted and presented in Figures 6 to 10.

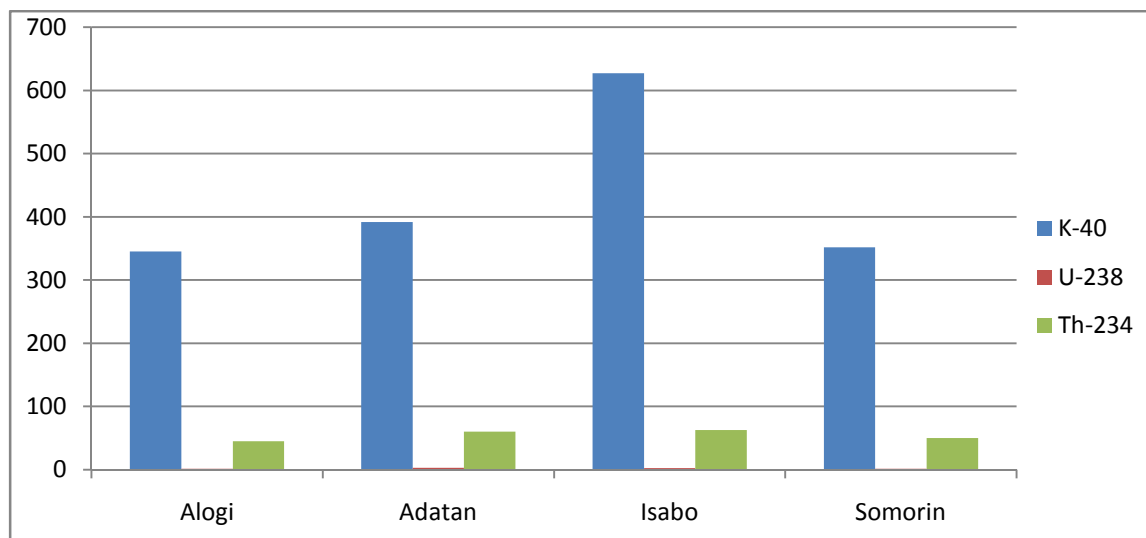


Fig 6: Activity Concentration against Location at 0 cm Depth (Surface)

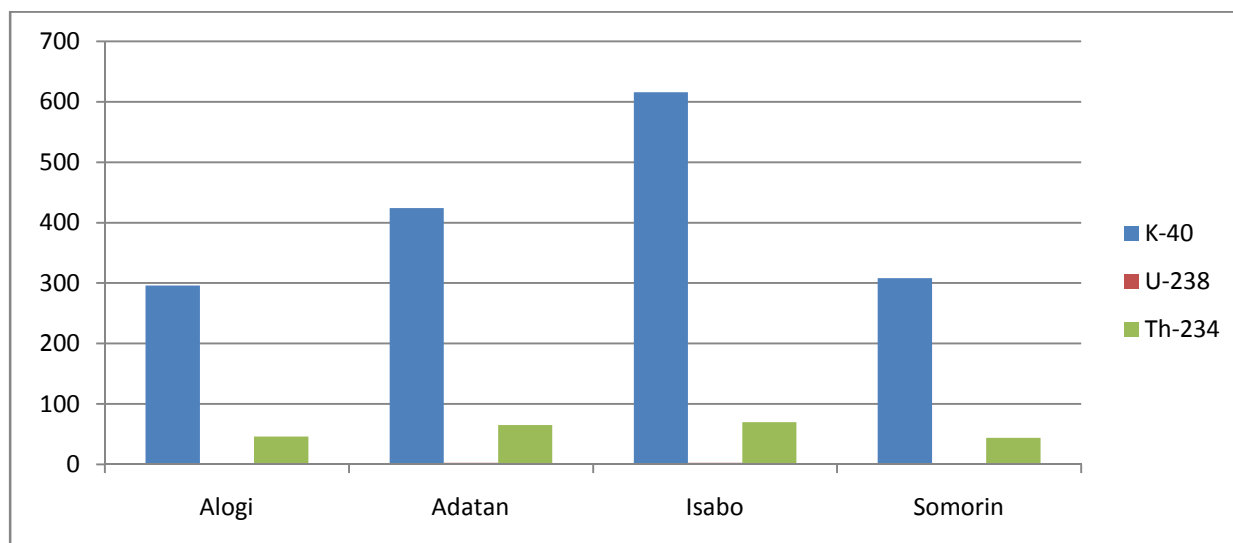


Fig 7: Activity Concentration against Location at 10 cm Depth

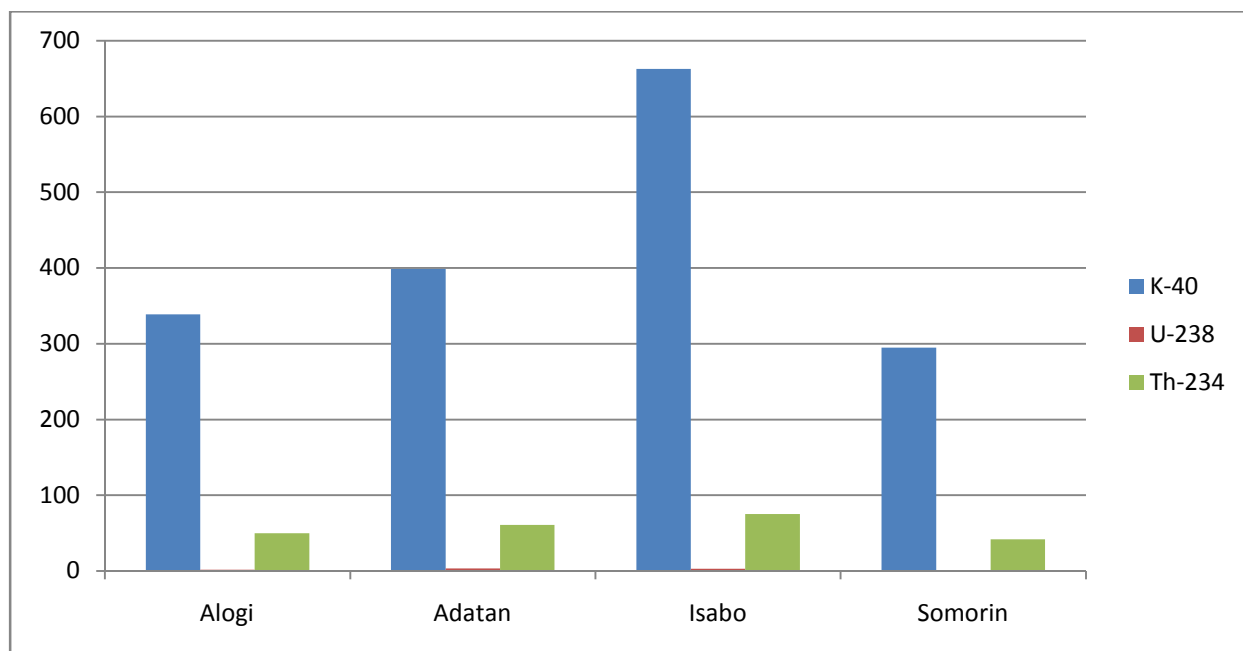


Fig 8: Activity Concentration against Location at 20 cm Depth

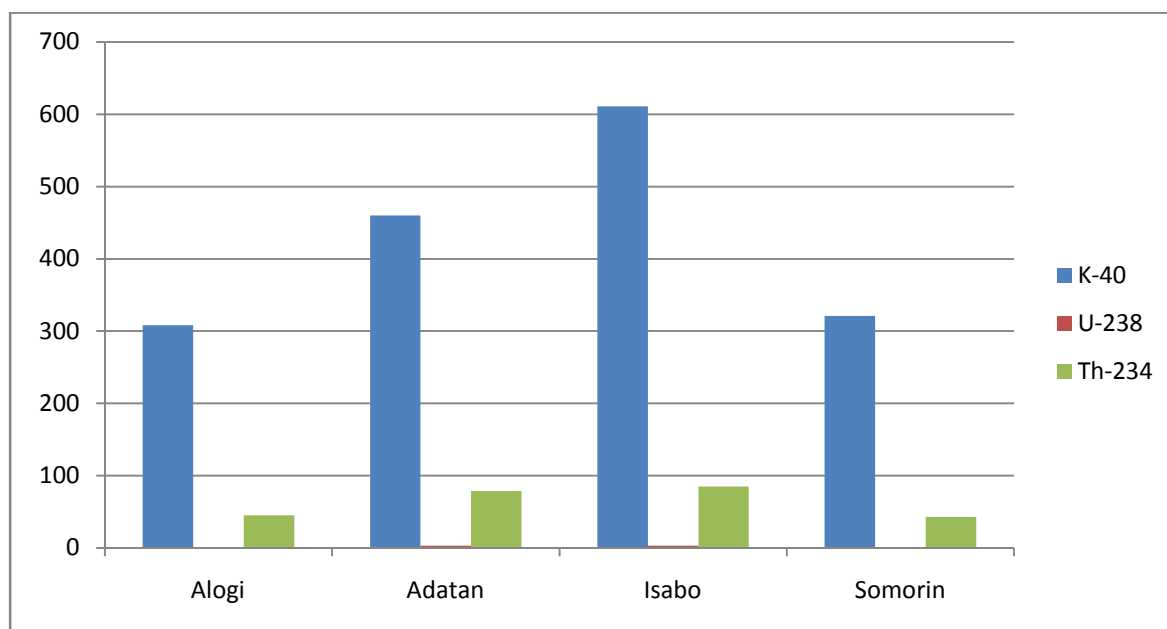


Fig 9: Activity Concentration against Location at 30 cm Depth

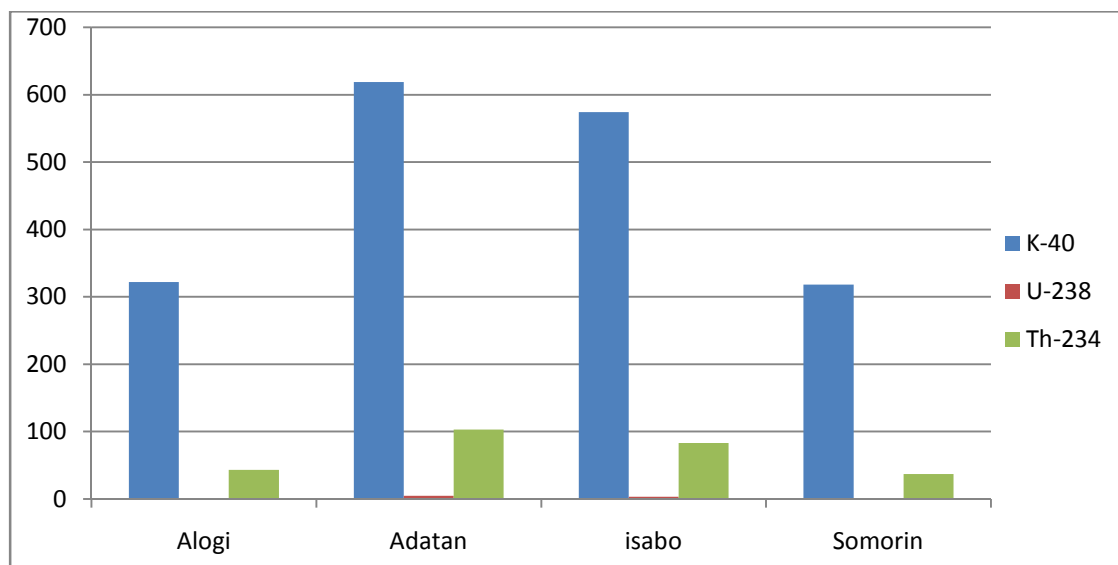


Fig 10: Activity Concentration against Location at 40 cm Depth

From figures 5 to 9, it could be observed that K-40 has the longest bar followed by Th-234. Uranium-238 was almost not detectable i.e. low concentration and this may be due to weathering and alteration caused by metamorphic process. It could also be observed that Adatan had the highest activity concentrations in all the depths as it had the longest bars in all the depths therefore we can conclude that the people staying at Adatan are at greater risk of being affected by the threats posed by natural radionuclide.

4.4 GENERAL DISCUSSION

From depths 0cm-40cm, the average activity concentration of radionuclide at Alogi ranges from 344 to 296 Bq/Kg for K-40, 1.0 to 1.6 Bq/Kg for U-238 and 43 to 50 Bq/Kg for Th-234, at Adatan the ranges were 391 to 618 Bq/Kg for K-40, 2.5 to 4.59 Bq/Kg for U-238 and 60 to 103 Bq/Kg for Th, at Isabo the ranges were 573 to 663 Bq/Kg for K-40, 2.56 to 3.4 Bq/Kg for U-238 and 63 to 84 Bq/Kg for Th-234 and the ranges for Somorin were 294 to 351 Bq/Kg for K-40, 0.74 to 1.4 Bq/Kg for U-238 and 37 to 50 Bq/Kg for Th. The mean value of U-238, Th-234 and K-40 concentrations determined for soil samples from the dumpsites at the 0 cm depth (surface) were 2.09 ± 0.09 , 54.60 ± 2.00 and 428.91 ± 15.05 respectively. The mean value of Th-234 and K-40 concentrations for soil samples at 0 cm depth in dumpsites were higher than permissible global values of 41.0 Bq/Kg and 230.0 Bq/Kg respectively by United Nations Scientific Committee on The Effect of Atomic Radiation (UNSCEAR, 2000) while the mean value of U-238 was far below the permissible global value of 52.2 Bq/Kg by UNSCEAR. The mean absorbed dose equivalent for soil sample at the surface from the dumpsite was 55.5 nGy/hr and the mean annual effective dose obtained was 0.136 mSv/yr. Both were found to be below the recommended standard by UNSCEAR (2000) which were 55.9 nGy/hr and 0.7 mSv/yr respectively.

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

4.0 CONCLUSION

From the analysis carried out, it was observed that all the samples analyzed at 0 cm depth (surface) from the dumpsites met the safety criteria by UNSCEAR and hence did not pose any threat or radiological hazard to the human health. This conclusion was made because the mean absorbed dose equivalent for soil obtained was 55.5 nGy/hr and the mean annual effective dose obtained was 0.136 mSv/yr and both were found to be below the recommended standard values by UNSCEAR (2000) which were 55.9 nGy/hr and 0.7 mSv/yr. It should also be mentioned that radionuclides are inclined to accumulate in the upper (0-20 cm) and lower soil layers as this was the area of homogenous lithology where a high correlation among natural radionuclide activity concentration is expected. Retention of uranium in the upper and lowest layers is connected with sorption of bivalent uranyl ions to the negative charged surfaces of clay minerals (Vandenhoveet al.2007). It has been noticed that radionuclide distribution is connected with particle size distribution which was related to the water infiltration in the 20-40 cm layer. Therefore it could be said that radionuclides were moving through the soil column along which the soil particles with which they were connected. This brings us to the final conclusion that radionuclides may be transported by water to the water table and migrates with ground water flow depending on the type of radionuclide, the composition of the subsurface materials and the rate of groundwater movement which may spread and contaminate wells and surface water. Ideally, as radionuclides leached down, activity concentrations reduces but may be altered again by factors mentioned earlier thereby causing accumulation in some fractions beneath the soil profile which tends to increase activity concentrations.

REFERENCES

- Akinloye, M.K and Olomo,J.B (2005).The Radioactivity in some grasses in the environment of nuclear research facilities located within the OAU, Ile Ife, Nigeria. Nig. J. Phys., 17S: 219-225.
- Beliverimis, M., Kilic, O., Coytuk, Y. and Topcough, S. (2009). The effects of physiochemical properties of gamma emitting naturalradionuclides level in the soil profile of Istanbul, Environmental monitoring and assessment. 163: 15-16.
- Eja, M.E, Alobi, N.O, Ikpeme, E.M, Ogri, O.R and Iyang, A.O (2010).Environmental and public health-related assessment of solid waste management in Uyo, Akwalbom State, Nigeria.World Journal of Applied Science and Technology.Vol.2. No. 1: 110-123.

IAEA BULLETIN, Detecting and measuring ionization radiation - a short history. Vol. 23 No. 4

*Tel.: +234(0)8036684498

E-mail: bellomo68@yahoo.com

Katse Piet Maphoto (2004), Determination of Natural Radioactivity Concentrations in Soil: a comparative study of Windows and Full Spectrum Analysis. A Thesis submitted in partial fulfillment of the requirements for the M.Sc. degree in Physics at the University of the Western Cape.

Jones D. G., Appleton J. D., Breward N., Mackenzie A. C., Scheib C., Beresford N. A., Barnett C. L., Wood M. D. and Copplestone D. (2008), Assessment of naturally occurring radionuclides around England and Wales: application of the G-BASE dataset to estimate doses to non-human species
Available at <http://www.nora.nerc.ac.uk/8032>

Kwan-Hoong Ng (2003). "Non-Ionizing Radiations – Sources, Biological Effects, Emissions and Exposures". Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN ICNIR 2003 Electromagnetic Fields and Our Health

Lee, E.M, Menezes, G., Flinch, E.C (2004). Natural radioactivity in building material in the Republic of Ireland. Health Physics. 86:378-388.

Lee, G.F, Lee, J.A (2005). Municipal solid waste landfills – water quality issues. Water Encyclopaedia: Water Quality and Resource Development. pp. 163-169.

Meindinyo R. K. and Agbalagba E. O. (2012), Radioactivity concentration and heavy metal assessment of soil and water, in and around Imirigin oil field, Bayelsa state, Nigeria.

Journal of Environmental Chemistry and Ecotoxicology Vol. 4(2), pp. 29-34, ISSN-2141-226X ©2012 Academic Journals
Available online <http://www.academicjournals.org/jece>

Odunaike, R.K, Alausa, S.K, Oyebanjo, O.A, Ijeoma, G.C and Alo, A.O (2008). Measurement of radiation level in refuse dumps across Lagos metropolis, Southwestern part of Nigeria. Environ. Res. J., 2:174-176.

Oduote O.O., Alausa S.K. and Gyang B. N. (2014), Radionuclide Concentrations and Impact Assessment of the Jos Tin Mining Soil Residues. The Nucleus: A Quarterly Scientific Journal of Pakistan Atomic Energy Commission NCLE AM, ISSN 0 02 9- 5 69 8. The Nucleus 51, No. 1

Ojoawo.S., Agbede, O. and Sangodoyin, A. (2011). On the Physical Composition of Solid Wastes in Selected Dumpsites of Ogbomosoland, South-Western Nigeria. Journal of Water Resource and Protection. Vol. 3: 661-666 doi:10.4236/jwarp.2011.39076.

*Tel.: +234(0)8036684498
E-mail: bellomo68@yahoo.com

Onibokun, A.G, Adedipe, N.O, Sridlier, M.K.C (2000). Affordable Technology and Statement in African Lesson and Experience. Center for African Settlement Studies and Development: Casad series no. 13, pp. 134.

Piccolo, A., Mbagulu, J.S.C (1997). Exogenous humic substances as conditions for the rehabilitation of degraded soil. Agro Foods Industry Hi-Tech.

“Radiation” – Wikipedia (2013), the free encyclopedia.

“Sodium Iodide Scintillation Detector” – Wikipedia (2013), the free encyclopedia

UNSCEAR (2000), Report to the General Assembly. Sources and Effects of Ionizing Radiation. ISBN 92-1-142238-8

Umar A. M., Onimisi M.Y. and Jonah S.A. (2012), Baseline Measurement of Natural Radioactivity in Soil, Vegetation and Water in the Industrial District of the Federal Capital Territory (FCT) Abuja, Nigeria. *British Journal of Applied Science & Technology* 2(3): 266-274, 2012 SCIENCE DOMAIN international
Available at <http://www.sciencedomain.org>

Zurbrugg Christian (2002), Urban Solid Waste Management in Low-Income Countries of Asia How to Cope with the Garbage Crisis. Presented for: Scientific committee on problems of the Environment (SCOPE), urban solid waste management review session, Durban, South Africa