

Original Research Article**ASSESSMENT OF ACTIVITY CONCENTRATIONS OF RADIONUCLIDE WITH
DEPTH IN WASTELAND SOILS IN ABEOKUTA, SOUTHWEST NIGERIA****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 10cm depth interval from each of the locations visited. They were collected into containers with length 9cm and width 7cm 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 0cm depth (surface) were $428.91 \pm 15.05 \text{ Bq/Kg}$ for K-40, $2.09 \pm 0.84 \text{ Bq/Kg}$ for U-238 and $54.60 \pm 2.00 \text{ Bq/Kg}$ 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

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 charge the rotational, vibrational or electronic valence configuration of molecules and atoms. (Kwan-Hoong Ng, 2003)

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 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.

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.

2.1 DETECTING AND MEASURING IONIZING RADIATION-A SHORT HISTORY

On the evening of 8 November 1895, while working in a carefully darkened room, Rontgen noticed that a piece of a cardboard coated with barium platinocyanide showed a faint, flickering, greenish light(fluorescence) when electrical discharges took place in a Hittorf-Crookes tube near the screen. The tube itself was carefully covered with a black shield impervious to any visible light. Rontgen subsequently performed many careful experiments on the radiation which he named X-RAYS.

On the 22 December 1895, Rontgen made the 1st medical x-ray photograph. It shows the hand of his wife and marks the birth of radiography. The fluorescent screen lost importance, although fluoroscopes or sciascopes were improved by W.F. Magic, E.P. Thomsson and T.A Edison. Rontgen also observed that air would conduct electricity when transverses by the rays. The effect was later used as the operating principle for several kinds of radiation detector. For his discovery, Rontgen was awarded the first noble prize in physics in 1901. The very early detection methods, namely the fluorescent screen, photographic plate, the gold leaf electroscope and the ionization chamber in combination with an electroscope or galvanometer had one common characteristic, they could only be used to respond to ‘bulk’ radiation but they were insensitive to single ray. Figure 1 shows the experimental set-up by which Rontgen discovered x-rays.(IAEA Bulletin. Detecting and measuring ionization radiation - A short history)

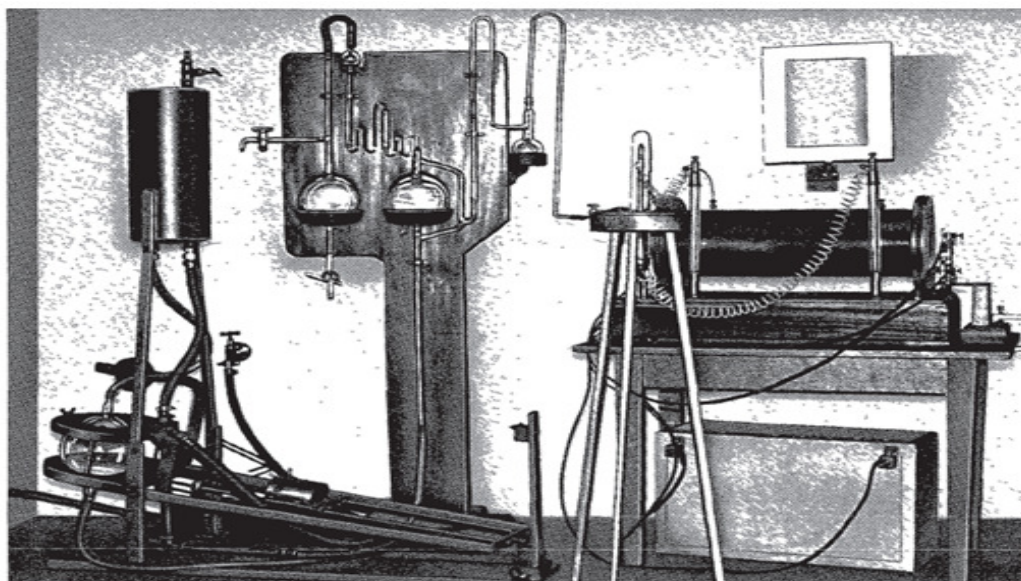


FIG. 1: RECONSTRUCTION OF THE EXPERIMENTAL SET UP BY WHICH RONTGEN
DISCOVERED X-RAYS

Source: IAEA Bulletin. Detecting and measuring ionization radiation - A short history

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.

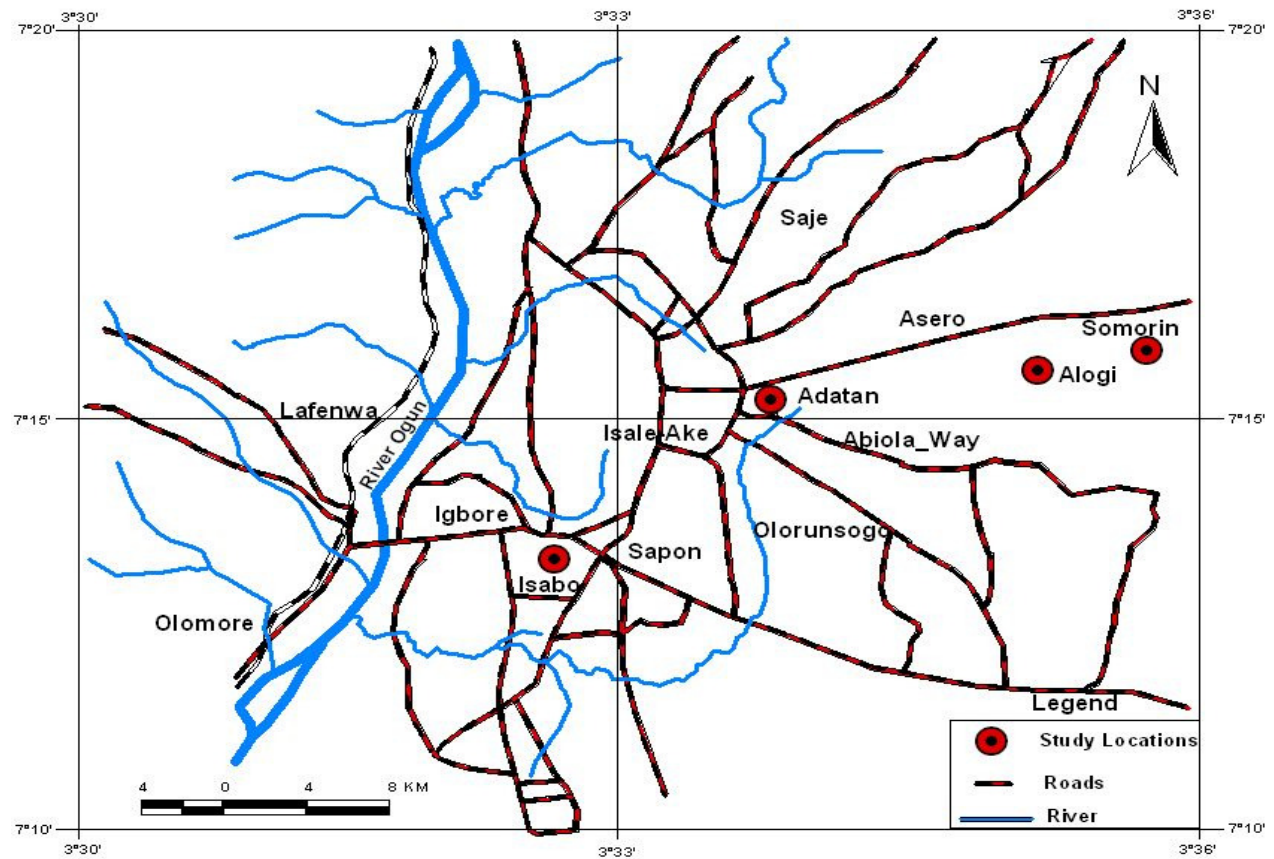


FIG 2: MAP SHOWING LOCATIONS OF SOIL SAMPLE

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 0cm, 10cm, 20cm, 30cm 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 9cm and width 7cm and weighed 240g 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.

4.0 MEASUREMENT AND ANALYSIS OF RESULTS

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

This section shows the result of the analysis carried out by the model 802 series scintillation detector. The section 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 40cm.

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 0cm which is the surface, U-238 is highest at depth 20cm and Th-234 is highest at 20cm. This shows that the radionuclide after leaching down from the surface accumulated at the 20cm depth.

TABLE 3: CONCENTRATION OF RADIONUCLIDES IN DUMPSITE 1

Location No	Depth (cm)	K-40 Bq/Kg	U-238 (Rn-226) Bq/Kg	Th-234 (Ra-228) Bq/Kg
1	0	344.766±13.8578	1.412±0.07512	44.6788±1.74466
2	10	296.4±12.0267	1.01972±0.067	46.2769±1.61297
3	20	339.254±13.4101	1.68383±0.07212	50.3667±2.04725
4	30	308.319±14.8217	1.53715±0.07843	45.0397±1.73626
5	40	322.374±12.8963	1.19197±0.06578	43.0119±1.72682

Table 4 shows the concentrations of radionuclide with depth in dumpsite 2 (Adatan). From the table, it can be observed that the concentrations of the radionuclide: K-40, U-238 and Th-234 is highest at the 40cm depth. This may be due to the fact that the radionuclide leached down from

the surface gets accumulated at the 40cm depth due to some physical and chemical processes which will be further explained under the discussion. This gives 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	391.824±14.0424	3.00062±0.09849	60.282±2.18538
2	10	423.792±15.6273	2.56494±0.08394	65.4029±2.14248
3	20	399.196±14.0442	3.26337±0.08751	60.5226±2.18202
4	30	460.102±15.2843	3.28322±0.08551	78.7034±2.20905
5	40	618.567±17.764	4.59059±0.11473	103.208±2.86596

Table 5 shows the concentrations of radionuclide with depth in dumsite 3 (Isabo). The table shows that K-40 is highest at depth 20cm, U-238 is highest at depth 40cm and Th-234 is highest at depth 30cm. this shows that the concentrations do not uniformly vary with depth and therefore no particular trend is 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	627.248±18.2977	2.5572±0.08095	63.272±2.14216
2	10	616.362±17.311	2.69918±0.09387	70.3175±2.14206
3	20	663.213±18.9861	2.92425±0.10312	75.1119±2.27312
4	30	611.471±17.1186	3.11971±0.09239	84.6148±2.36653
5	40	573.921±17.4227	3.41106±0.1103	82.5183±2.47255

Table 6 shows the concentrations of radionuclide with depth in dumsite 4 (Somorin). The table shows that generally, the concentrations of U-238, Th-234 and K-40 is low in dumsite 4

221 compared to other locations visited therefore the residents staying here are safe from the hazards
 222 posed by radionuclide from the dumpsites.

223

224 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	351.794±14.0062	1.40157±0.08096	50.1777±1.93934
2	10cm	307.706±13.3184	0.88313±0.0662	44.1117±1.65643
3	20cm	294.677±12.35090	0.78153±0.06886	41.7403±1.61324
4	30cm	320.858±12.683	0.99684±0.06005	42.6854±1.5773
5	40cm	317.551±14.9586	0.74385±0.06116	37.324±1.58794

225

226 The averages of the radionuclide K-40, U-238 and Th-234 were calculated and is shown below

227 **Averages of Radionuclide (K-40, U-238 And Th-234) in all the locations visited at 0cm**
 228 **(Surface)**

229 K-40 (Bq/Kg)- 428.91±15.05

230 U-238 (Bq/Kg)- 2.09±0.084

231 Th-234 (Bq/Kg)- 54.60±2.00

232 The averages calculated was based on the 0cm alone because the residents staying close to the
 233 dumpsites are directly exposed to the radiation emitted from the surface soils as activity
 234 concentrations of radionuclide tends to be higher on the surface (0cm depth). These values
 235 therefore would be compared to permissible global values of K-40, U-238 and Th-238 by
 236 UNSCEAR which are 230Bq/Kg, 52.2Bq/Kg and 41Bq/Kg respectively.

237 The gamma absorbed dose rate $D(nGy/hr)$ was calculated using $0.043A_K + 0.427A_U + 0.662A_{Th}$
 238 and annual effective dose equivalent A.E.D. (mSv/yr) was also calculated using the expression:
 239 $Dose\ rate \times 24hrs \times 365.25 \times 0.4 \times 0.7SvGy^{-1} \times 10^{-6}$ where the occupancy factor used (outdoor) is
 240 0.4. The results are shown in tables 7 and 8.

241 TABLE 7: GAMMA ABSORBED DOSE RATE D (nGy/hr) AT 0CM DEPTH (SURFACE)

Location	Depth (cm)	K-40 Bq/Kg	0.043× A _K	U-2238 Bq/Kg	0.427× A _U	Th-234 Bq/Kg	0.662× A _{Th}	D (nGy/hr)
Alogi	0	344.766	14.82	1.412	0.60	44.6788	29.58	45.00
		±	±	±	±	±	±	±
		13.8578	0.60	0.07512	0.03	1.74466	1.15	1.78
Adatan	0	391.824	16.85	3.00062	1.28	60.282	39.90	58.03
		±	±	±	±	±	±	±
		14.0424	0.60	0.09849	0.04	2.18538	1.45	2.09
Isabo	0	627.248	26.97	2.5572	1.09	63.272	41.89	69.95
		±	±	±	±	±	±	±
		18.2977	8.02	0.08095	0.03	2.14216	1.42	9.47
Somorin	0	351.794	15.13	1.40157	0.60	50.1777	33.2	48.93
		±	±	±	±	±	±	±
		14. 0062	0.60	0.08096	0.03	1.93934	1.28	1.91

242

243 TABLE 8: ANNUAL EFFECTIVE DOSE EQUIVALENT AT 0CM DEPTH (SURFACE)

244 Occupancy Factor (Outdoor) – 0.4

245 A.E.D = (D × 24hrs × 365.25 × 0.4 × 0.7Sv/Gy × 10⁻⁶) mSv/yr

246

LOCATION	A.E.D. (mSv/yr)
Alogi	0.110 ± 0.0044
Adatan	0.142 ± 0.0051
Isabo	0.172 ± 0.0232
Somorin	0.120 ± 0.0047

247

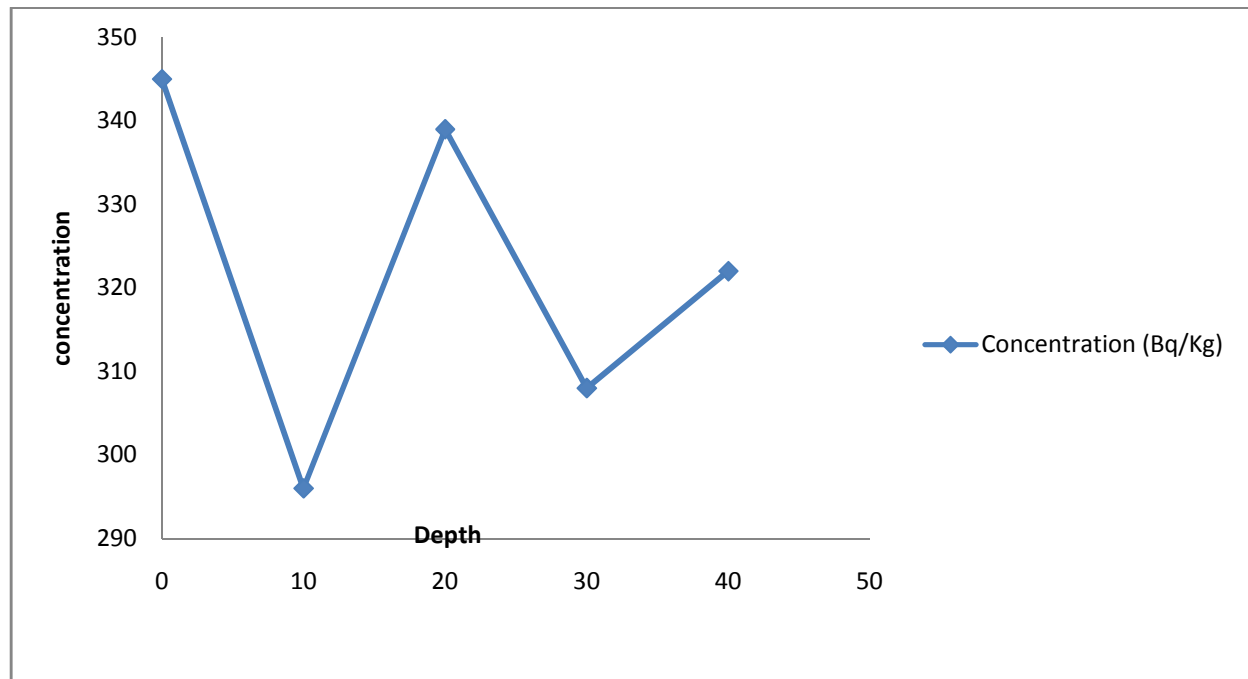
248 Annual Effective Dose Equivalent Average is 0.136 ± 0.00935 mSv/yr

249

250

251 **4.2 GRAPHS OF CONCENTRATION (Bq/Kg) OF K-40, U-238 AND Th-234 AGAINST**
 252 **DEPTH (CM) FOR ALOGI, ADATAN, ISABO AND SOMORIN**

253 The graphs plotted below (Figure 1 - 12) explain how the concentrations of U-238, Th-234 and
 254 K-40 vary with the depths 0cm, 10cm, 20cm, 30cm and 40cm. The concentration (Bq/Kg) was
 255 plotted on the y-axis while the depth (cm) was plotted on the x-axis.



256
 257 **FIG. 1: GRAPH OF CONCENTRATION OF K-40 (Bq/Kg) AGAINST DEPTH (cm) AT**
 258 **ALOGI**

259

260

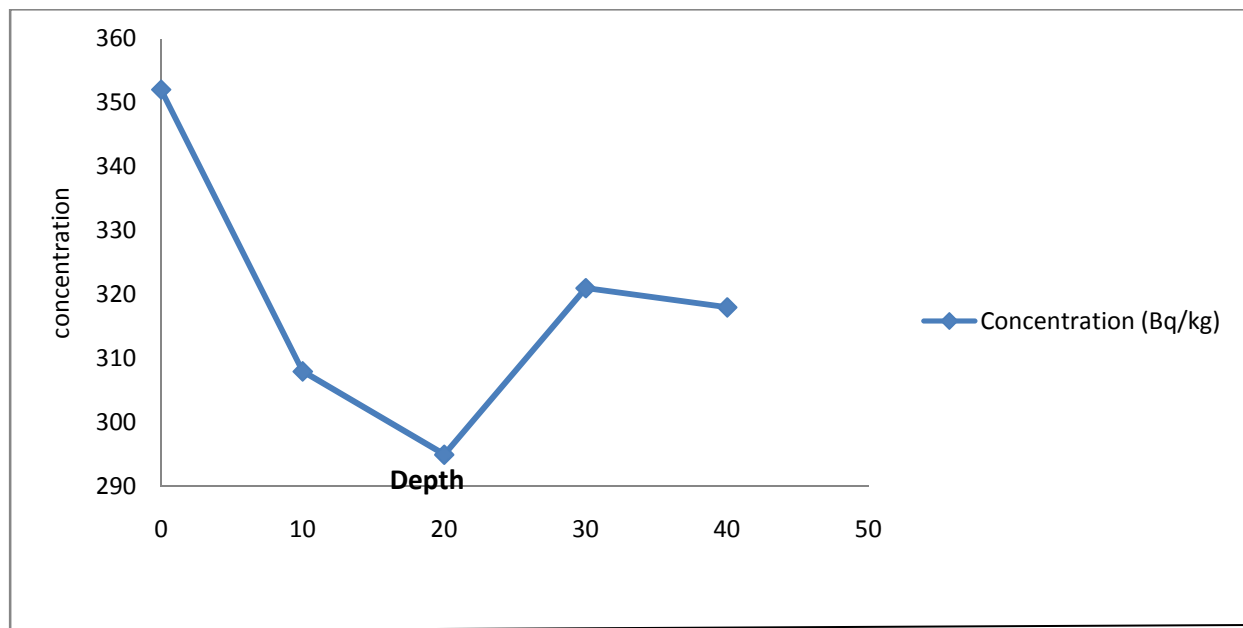


FIG. 2: GRAPH OF CONCENTRATION OF K-40 (Bq/Kg) AGAINST DEPTH (cm) AT ADATAN

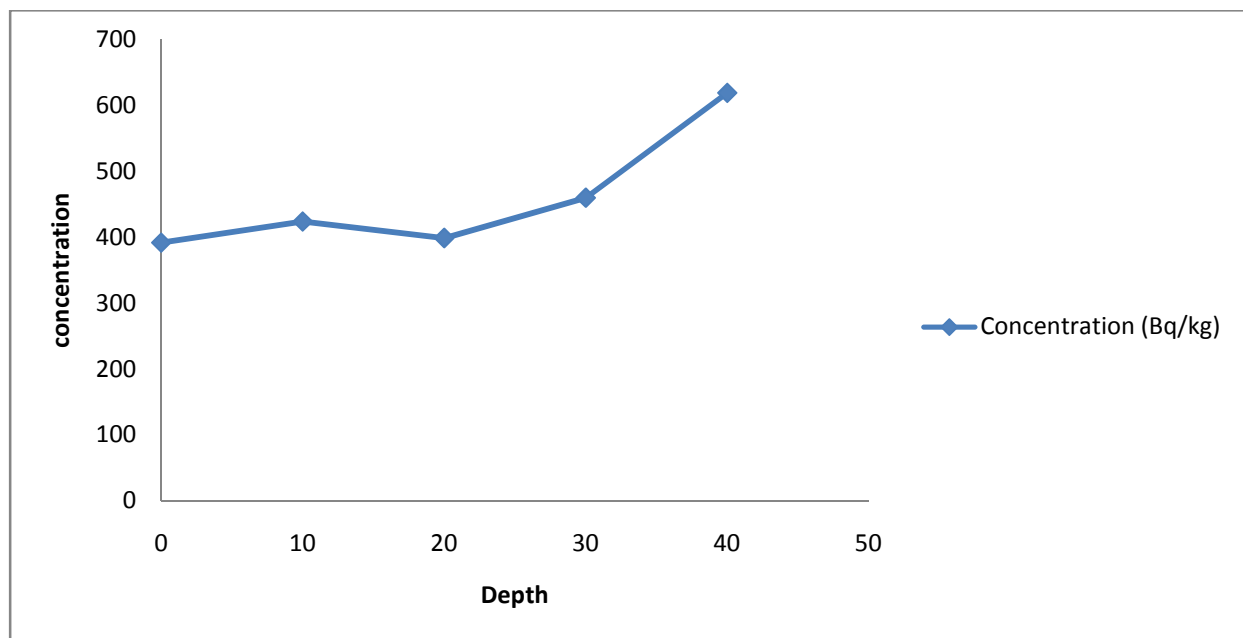


FIG. 3: GRAPH OF CONCENTRATION OF K-40 (Bq/Kg) AGAINST DEPTH (cm) AT ISABO

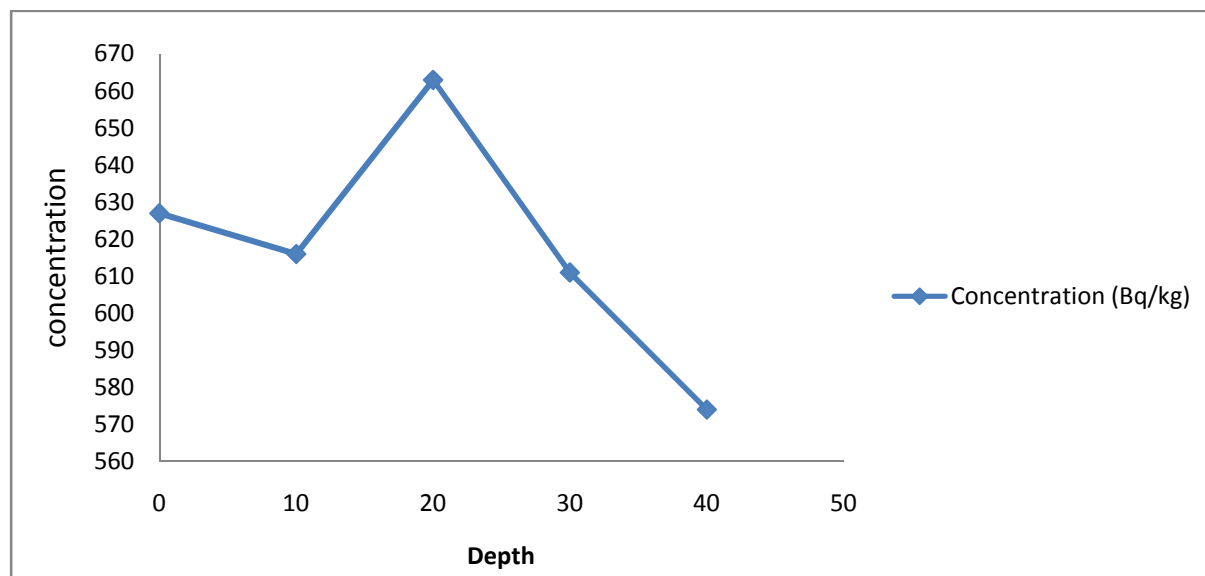


FIG. 4: GRAPH OF CONCENTRATION OF K-40 (Bq/Kg) AGAINST DEPTH (cm) AT SOMORIN

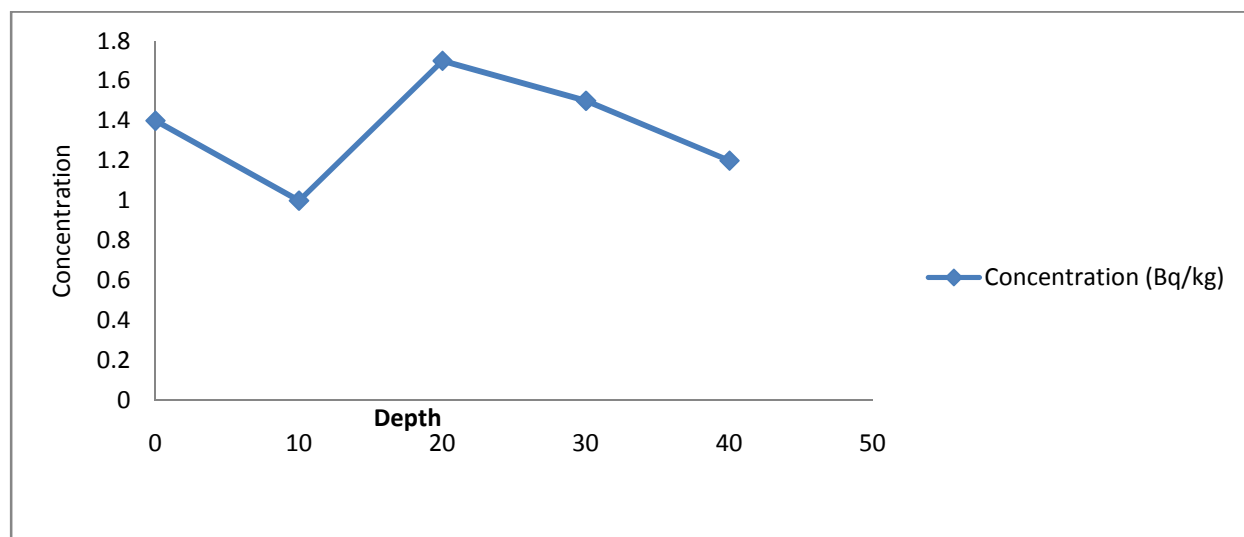
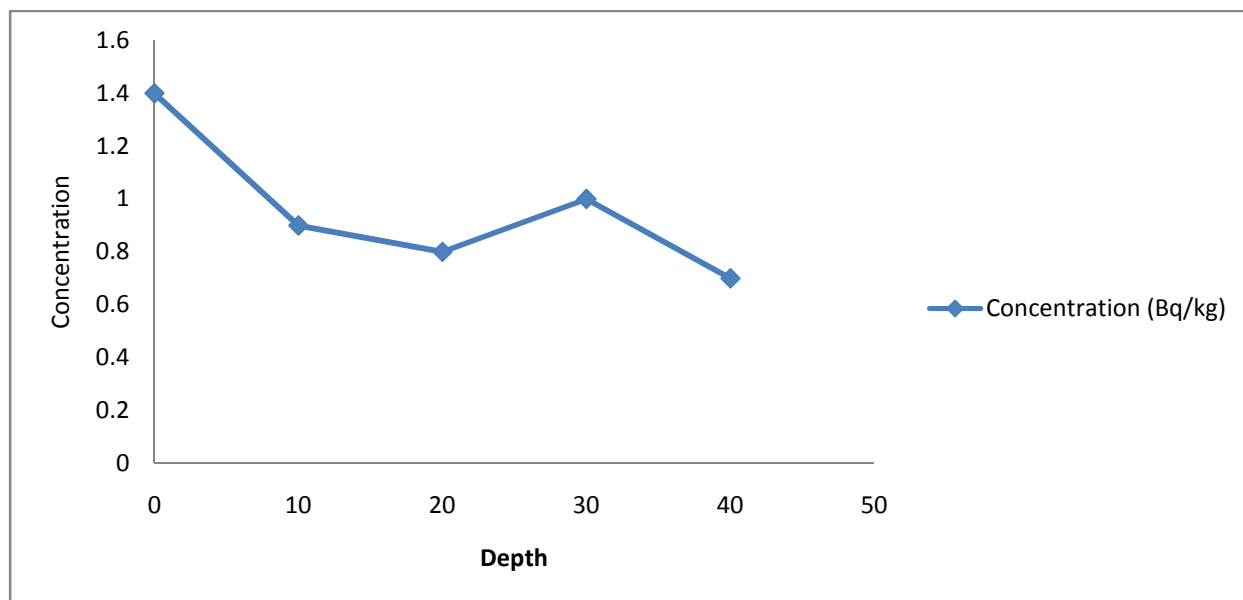


FIG. 5: GRAPH OF CONCENTRATION OF U-238 (Bq/Kg) AGAINST DEPTH (cm) AT ALOGI

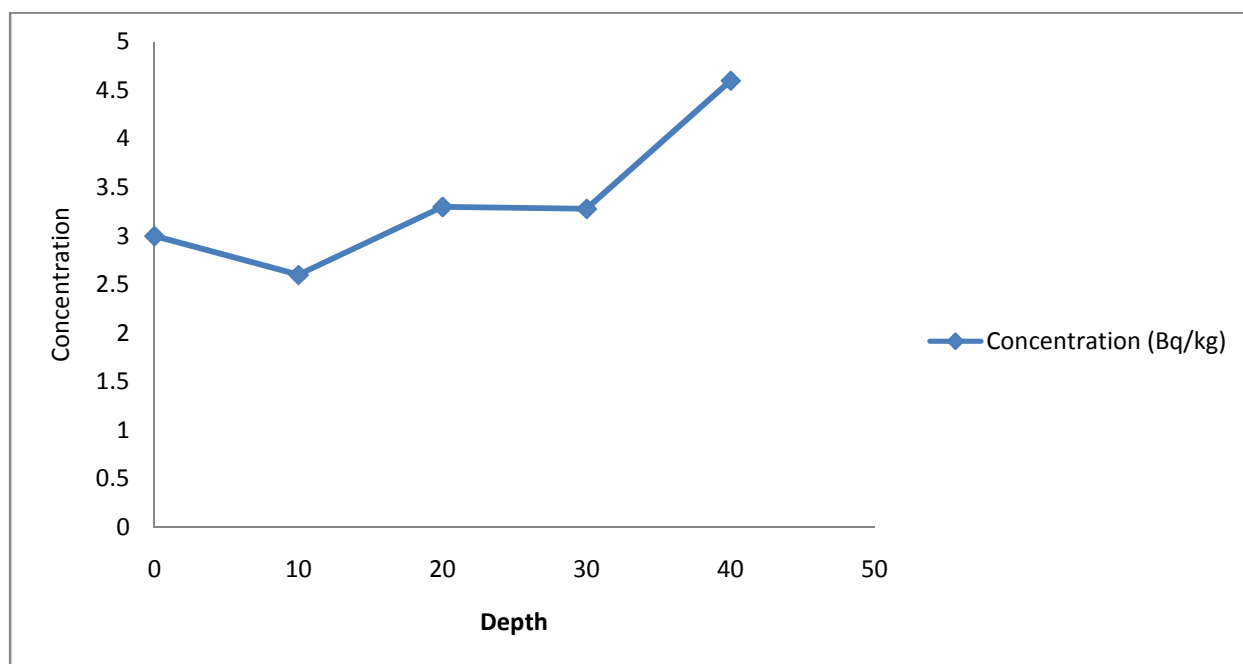
278



279

280 FIG. 6: GRAPH OF CONCENTRATION OF U-238 (Bq/Kg) AGAINST DEPTH (cm) AT
281 ADATAN

282

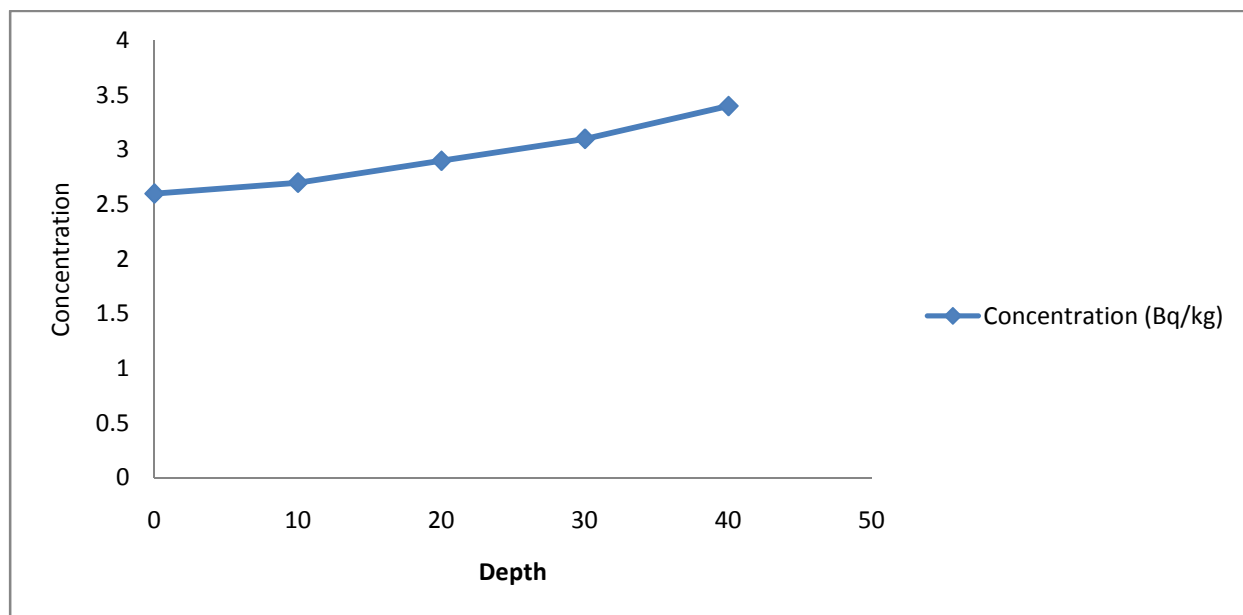


283

284 FIG. 7: GRAPH OF CONCENTRATION OF U-238 (Bq/Kg) AGAINST DEPTH (cm) AT
285 ISABO

286

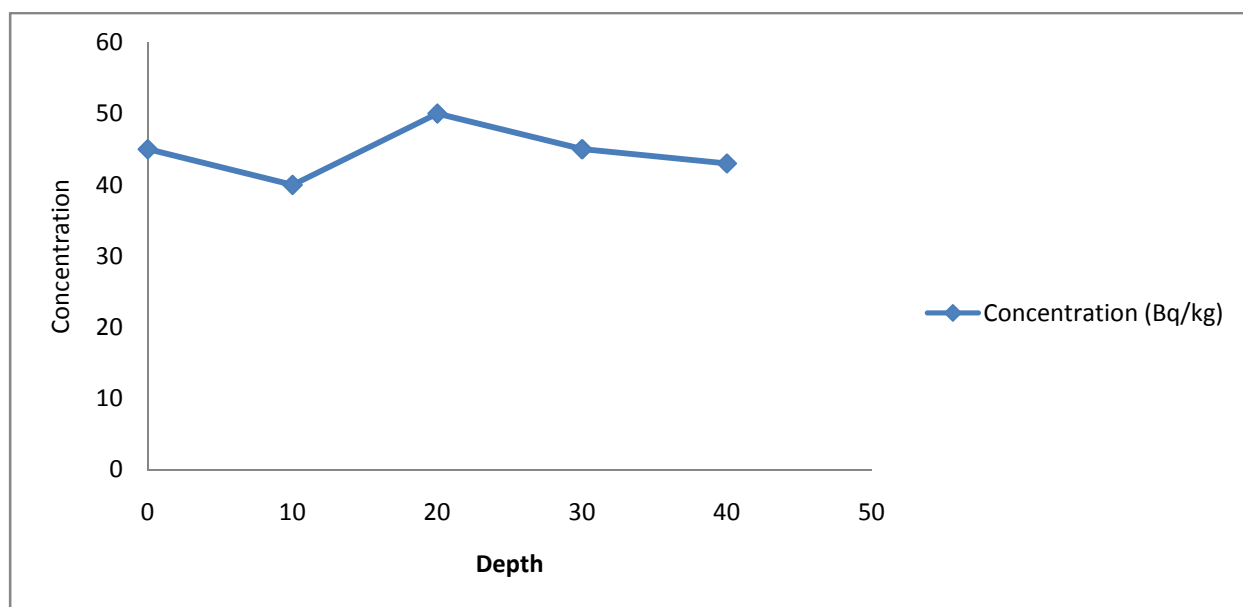
287



288

289 FIG. 8: GRAPH OF CONCENTRATION OF U-238 (Bq/Kg) AGAINST DEPTH (cm) AT
290 SOMORIN

291



292

293 FIG. 9: GRAPH OF CONCENTRATION OF Th-234 (Bq/Kg) AGAINST DEPTH (cm) AT
294 ALOGI

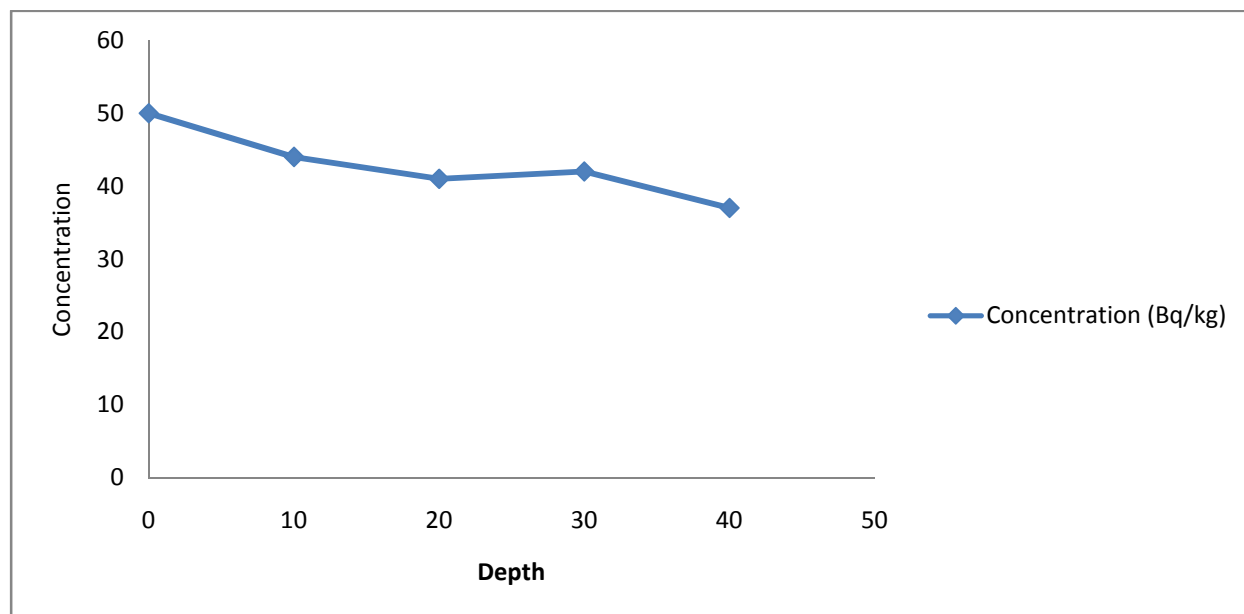


FIG. 10: GRAPH OF CONCENTRATION OF Th-234 (Bq/Kg) AGAINST DEPTH (cm) AT ADATAN

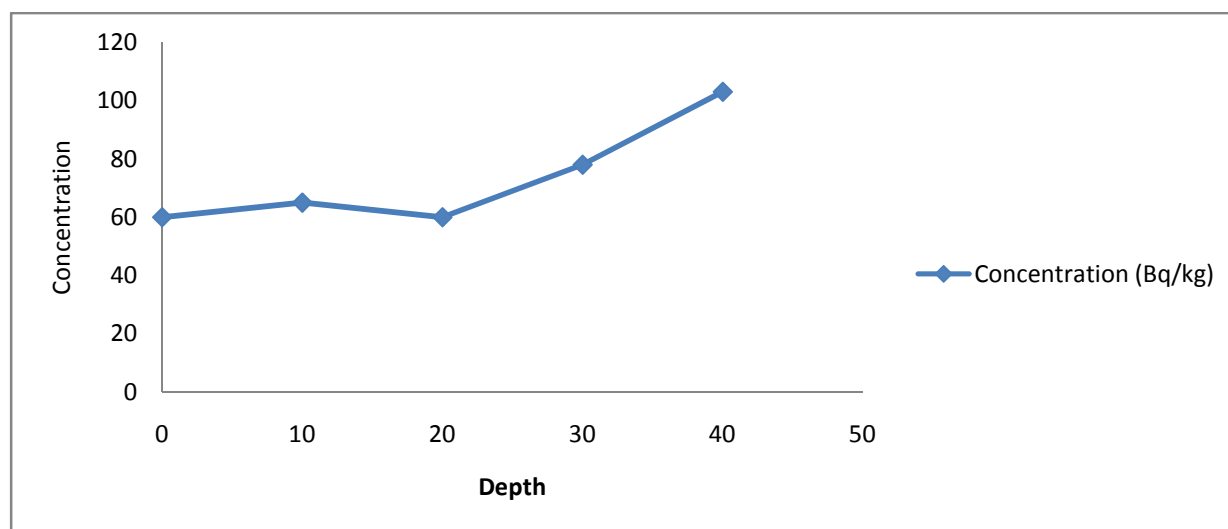
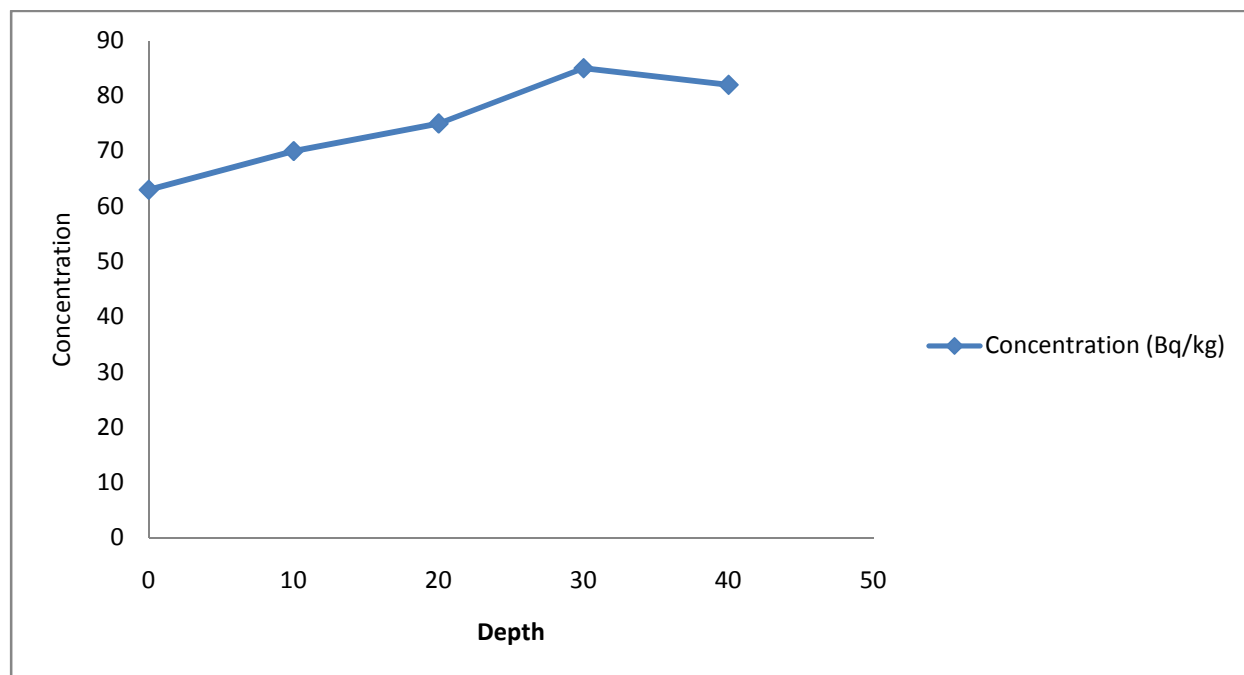


FIG. 11: GRAPH OF CONCENTRATION OF Th-234 (Bq/Kg) AGAINST DEPTH (cm) AT ISABO

304



305

306 FIG 12: GRAPH OF CONCENTRATION OF Th-234 (Bq/Kg) AGAINST DEPTH (cm) AT
307 SOMORIN

308 From Figures 1 - 12 above, it can be deduced that the surface soil (0cm) has the highest
309 concentration and this applies to all the locations, K-40 has the highest activity concentration due
310 to the fact that potassium is abundant in air and the seventh most abundant element on earth
311 making 2.4% of earth crust by weight.

312

313 4.3 BAR CHART SHOWING COMPARISON OF ACTIVITY CONCENTRATION 314 AGAINST LOCATION AT EACH DEPTH

315 Bar charts were also plotted for each depth : 0cm, 10cm, 20cm, 30cm and 40cm where their
316 concentrations were plotted against the various locations : Alogi, Adatan, Isabo and Somorin.
317 Each bar was represented by the radionuclide K-40, U-238 and Th-234. This is shown Fig. 13 to
318 17

319

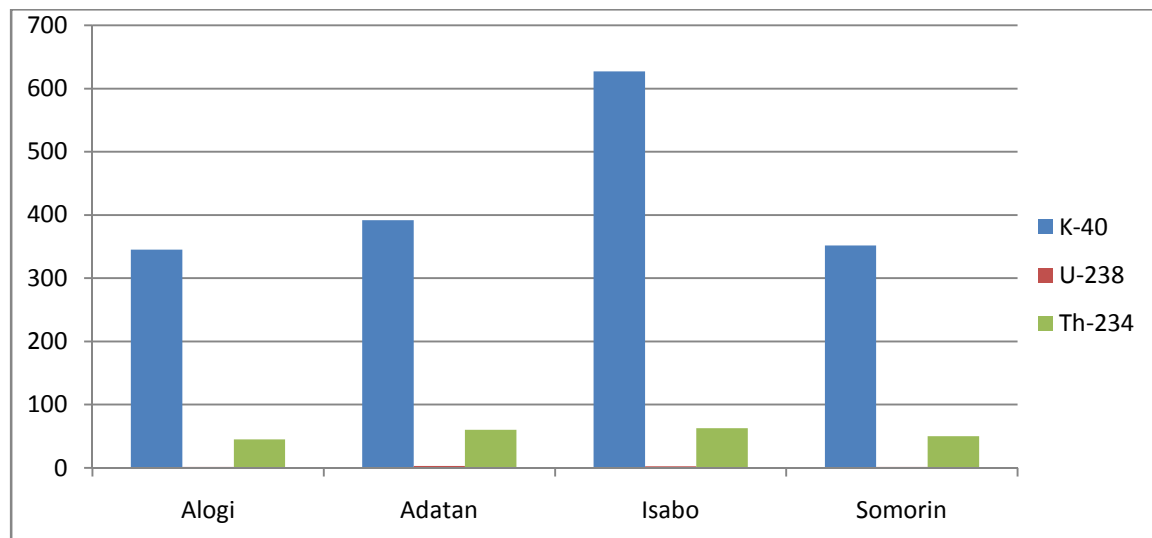


FIG 13: ACTIVITY CONCENTRATION AGAINST LOCATION AT 0CM DEPTH (SURFACE)

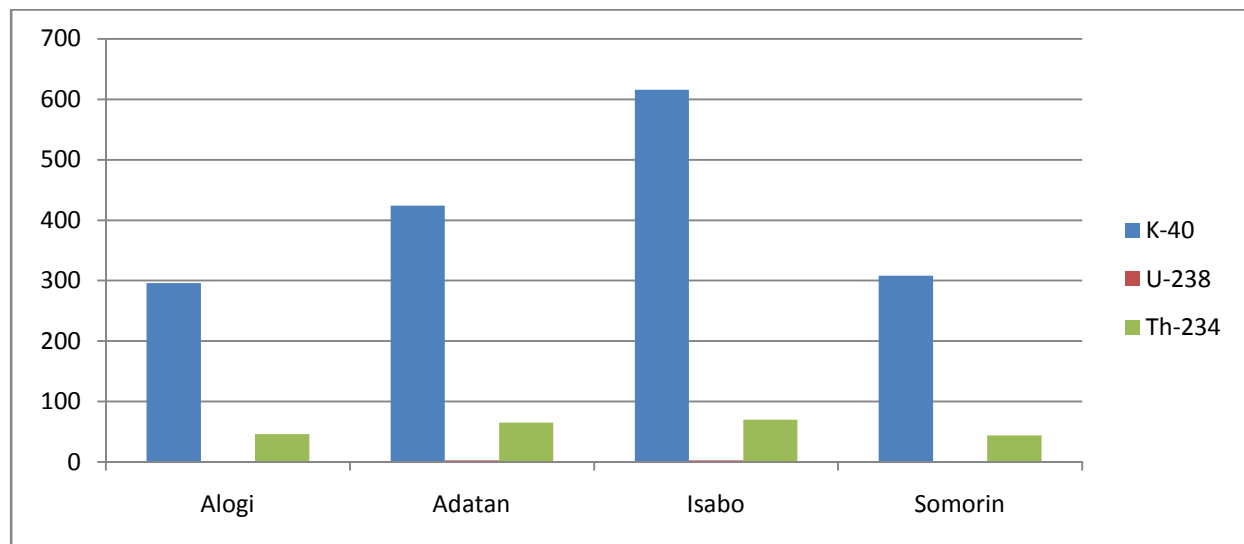


FIG 14: ACTIVITY CONCENTRATION AGAINST LOCATION AT 10CM DEPTH

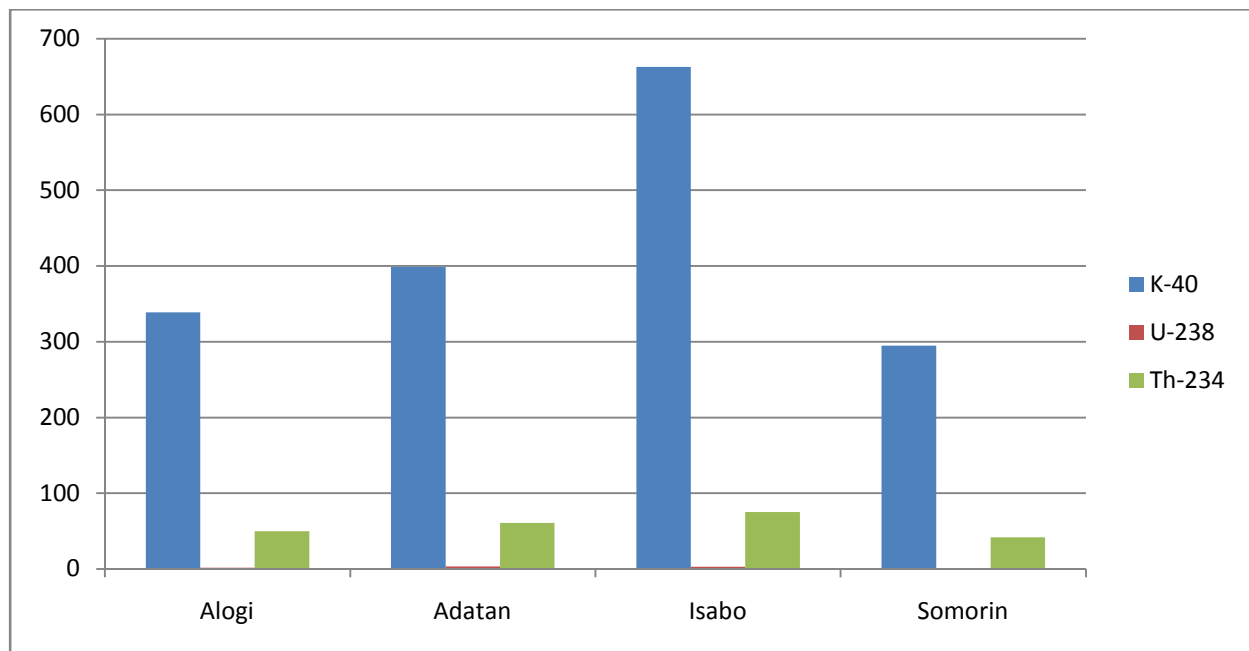


FIG 15: ACTIVITY CONCENTRATION AGAINST LOCATION AT 20CM DEPTH

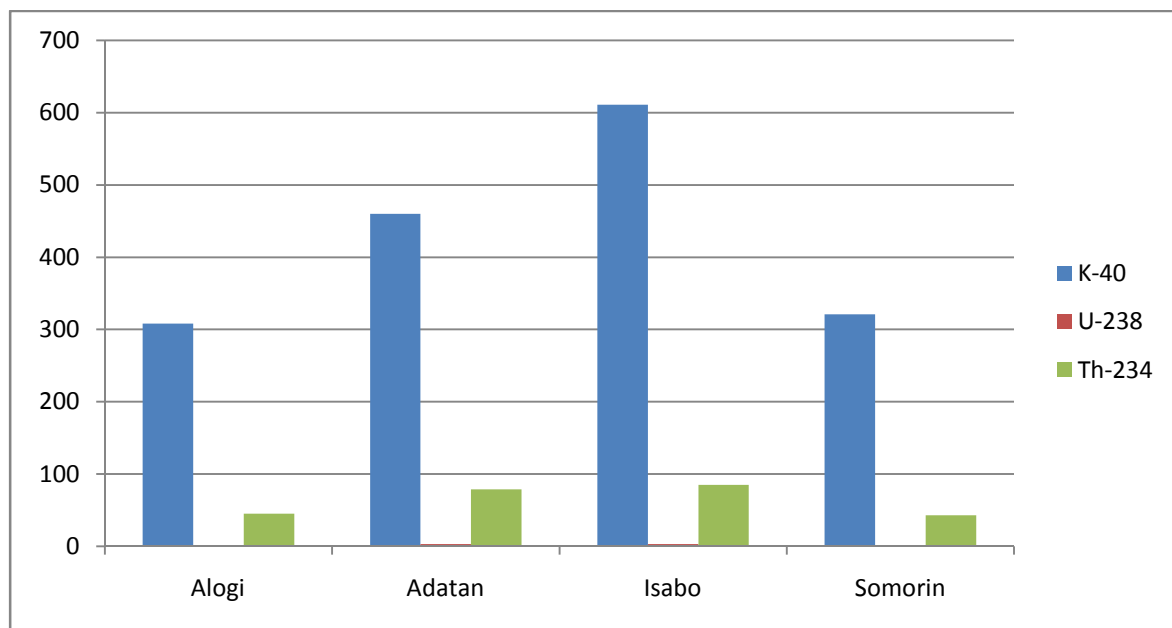


FIG 16: ACTIVITY CONCENTRATION AGAINST LOCATION AT 30CM DEPTH

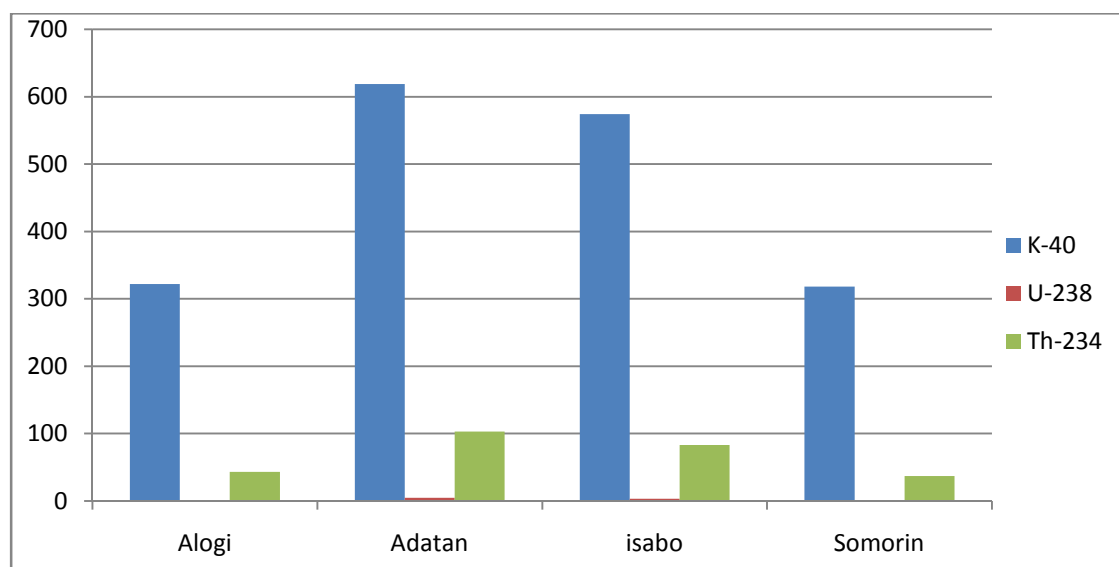


FIG 17: ACTIVITY CONCENTRATION AGAINST LOCATION AT 40CM DEPTH

From figure 13 - 17, it can be observed that K-40 has the longest bar followed by Th-234. Uranium-238 is almost not detectable i.e. low concentration and this may be due to weathering and alteration caused by metamorphic process. It can also be observed that Adatan has the highest activity concentrations in all the depths as it has 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 296Bq/Kg for K-40, 1.0 to 1.6Bq/Kg for U-238 and 43 to 50Bq/Kg for Th-234, at Adatan the ranges are 391 to 618Bq/Kg for K-40, 2.5 to 4.59Bq/Kg for U-238 and 60 to 103Bq/Kg for Th, at Isabo the ranges are 573 to 663Bq/Kg for K-40, 2.56 to 3.4Bq/Kg for U-238 and 63 to 84Bq/Kg for Th-234 and the ranges for Somorin are 294 to 351Bq/Kg for K-40, 0.74 to 1.4Bq/Kg for U-238 and 37 to 50Bq/Kg for Th. The mean value of U-238, Th-234 and K-40 concentrations determined for soil samples from the dumpsites at the 0cm depth (surface) were 2.09 ± 0.084 , 54.60 ± 2.00 and 428.91 ± 15.05 respectively. The mean value of Th-234 and K-40 concentrations for soil samples at 0cm depth in dumpsites were higher than permissible global

values of 41.0Bq/Kg and 230.0Bq/Kg respectively by United Nations Scientific Committee on The Effect of Atomic Radiation(UNSCEAR) while the mean value of U-238 is far below the permissible global value of 52.2Bq/Kg by UNSCEAR. The mean absorbed dose equivalent for soil sample at the surface from the dumpsite is 55.5nGy/hr and the mean annual effective dose obtained is 0.136mSv/yr. both were found to be below the recommended standard by UNSCEAR which are 55.9nGy/hr and 0.7mSv/yr respectively.

At Alogi, the graph shows that the activity concentration of uranium decreases with depth but gets accumulated at the 20cm depth therefore making the activity concentration high. This might be as a result of the nature of the soil which is able to hold nutrients and does not wash out easily and the soil fraction suspected here is the clay soil (Vandenhoeet al.2007). At 30cm, concentration reduces which may be due to leaching. From this result we can say that those at Alogi are safe from the contamination of wells and surface water as the activity concentration of these radionuclides decreases with depth.

At Adatan, the activity concentrations of K-40, U-238 and Th-234 increases with depth as their concentrations are highest at the 40cm depth. This may be due to the fact that the soil found here has large pore spaces due to surface cracking therefore as porosity increases, regularity of distribution of cracks increases and therefore we can say that the sand fraction is dominant at the depth 0-39cm as it enhances the mobility of radionuclides (Golmakani et al.2008) and accumulation of radionuclides in the lower layers such as the 40cm depth (Navas et al.2002). The soil suspected at the 40cm depth is the clay soil as it is more compacted and has smaller pores than other soils therefore able to hold more nutrients. We can therefore conclude here that the people living in the vicinity are at a higher risk of getting their surface water and wells contaminated.

At Isabo, uranium and thorium tends to increase with depth while potassium slightly increases with depth therefore we can say that there is an increase in the regularity of distribution of cracks as porosity increases as we go down the vertical profile of the soil which makes leaching easier and faster but gets accumulated at the 40cm depth due to the nature of the soil found there (clay) (Navas et al.2002). We can therefore also conclude that probability that radionuclides may wash down further into the ground water and contaminate wells and surface water is high.

Finally at Somorin, U-238, Th-234 and K-40 decreases with depth but gets accumulated at the 30cm depth which may be as a result of the nature of the soil found at that depth i.e. its ability to hold more nutrients than other types of soil and then washes down slightly little to the 40cm depth (clay) (Navas et al.2002). We can therefore conclude that the radionuclides here do not pose any hazardous threats to the surface water and wells.

5.0 CONCLUSION

From the analysis carried out, it was observed that all the samples analyzed at 0cm depth (surface) from the dumpsites met the safety criteria by UNSCEAR and hence do not pose any threat or radiological hazard to the human health. This conclusion was made because the mean absorbed dose equivalent for soil obtained is 55.5nGy/hr and the mean annual effective dose obtained is 0.136mSv/yr and both were found to be below the recommended standard values by UNSCEAR which are 55.9nGy/hr and 0.7mSv/yr. It should also be mentioned that radionuclides are inclined to accumulate in the upper (0-20cm) and lower soil layers as this is 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 (Vandenhoeve et al.2007). It has been noticed that radionuclide distribution is connected with particle size distribution which is related to the water infiltration in the 20-40cm layer. Therefore it could be said that radionuclides are moving through the soil column along which the soil particles with which they are 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 are 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.

414 **REFERENCES**

- 415 Akinloye, M.K and Olomo, J.B (2005). The Radioactivity in some grasses in the environment of
416 nuclear research facilities located within the OAU, Ile Ife, Nigeria. *Nig. J. Phys.*, 17S: 219-225.
- 417 Beliverimis, M., Kilic, O., Coytuk, Y. and Topcough, S. (2009). The effects of physiochemical
418 properties of gamma emitting natural radionuclides level in the soil profile of Istanbul,
419 Environmental monitoring and assessment. 163: 15-16.
- 420 Eja, M.E, Alobi, N.O, Ikpeme, E.M, Ogri, O.R and Iyang, A.O (2010). Environmental and public
421 health-related assessment of solid waste management in Uyo, Akwa Ibom State, Nigeria. *World*
422 *Journal of Applied Science and Technology*. Vol.2. No. 1: 110-123.
- 423 Golmakani, S., Moghaddam, M.V, Hosseini T. (2008). Factors Affecting the Transfer of
424 Radionuclides from the Environment to Plants. *Rad .Prot. Dos* 130: 368-375
- 425 IAEA BULLETIN. Detecting and measuring ionization radiation - a short history. Vol. 23 No. 4
- 426 Kwan-Hoong Ng (2003). "Non-Ionizing Radiations – Sources, Biological Effects, Emissions and
427 Exposures". Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN
428 ICNIR 2003 Electromagnetic Fields and Our Health
- 429 Lee, E.M, Menezes, G., Flinch, E.C (2004). Natural radioactivity in building material in the
430 Republic of Ireland. *Health Physics*. 86:378-388.
- 431 Lee, G.F, Lee, J.A (2005). Municipal solid waste landfills – water quality issues. *Water*
432 *Encyclopaedia: Water Quality and Resource Development*. pp. 163-169.
- 433 Navas, A., Soto, J., Machin, J. (2002b). ²³⁸U, ²²⁶Ra, ²¹⁰Pb, ²³²Th and ⁴⁰K Activities in Soil
434 Profiles of the Flysch Sector (Central Spanish Pyrenees). *App.Radiat.Isot.* 57: 579-589.
- 435 Nyle, C.B, Ray, R.N (1991). The Nature and Properties of soils. 12th Ed., United State of
436 America. 743-785
- 437 Odunaike, R.K, Alausa, S.K, Oyeбанjo, O.A, Ijeoma, G.C and Alo, A.O (2008). Measurement of
438 radiation level in refuse dumps across Lagos metropolis, Southwestern part of Nigeria. *Environ.*
439 *Res. J.*, 2:174-176.

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

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

446 Piccolo, A., Mbagulu, J.S.C (1997).Exogenuoshumic substances as conditions for the
447 rehabilitation of degraded soil.Agro FoodsIndustry Hi-Tech.

448 Principles of Radiation Detection.Nuclear Engg. Lab. Manual (1)

449 “Radiation” – Wikipedia, the free encyclopedia.

450 “Sodium Iodide Scintillation Detector” – Wikipedia, the free encyclopedia

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

453 Vandenhove, H., Van Hees, M., Wannijn, J., Wouters, K., Wang, L. (2007). Can we predict
454 Uranium Bioavailability based on Soil Parameters? Part 2: Soil solution uranium concentration is
455 nota good bioavailability index. Env. Poll 145: 577-586

456 Zurbrugg Christian (2002), Urban Solid Waste Management in Low-Income Countries of Asia
457 How to Cope with the Garbage Crisis. Presented for: Scientific committee on problems of the
458 Environment (SCOPE), urban solid waste management review session, Durban, South Africa
459

460

461

462

463

464