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Assessment of Extent of Radiological Exposures in Subsurface Dumpsite Sediments around the Residential Area of Oru-Ijebu South-West Nigeria

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ABSTRACT

Assessment of naturally occurring radionuclides was carried out from 20 sampling points in a dumpsite systematically collected from varying subsurface depth intervals of 0-0.2m, 0.2-0.4m, 0.4-0.6m, 0.6-0.8m and 0.8m-1.0m, while the control samples were taken from two sampling points located 200m away from the dumpsite. The samples were consequently analyzed in the laboratory for natural radioactive emission where each activity concentration measurements of the radionuclides were determined; the natural radionuclides identified were ^{226}Ra, ^{238}U, ^{232}Th, ^{40}K utilizing gamma ray spectrometry with NaI (IT) detector. The mean activity concentrations recorded in Bqkg^{-1} for ^{226}Ra, ^{238}U, ^{232}Th and ^{40}K in the subsurface soil samples were respectively 2.53±0.60, 31.50±2.01, 27.20±1.63 and 340.39±19.48 in depth 0m−0.2m; 1.96±0.37, 28.2455±2.50, 23.84±3.07 and 320.59±24.07 respectively in depth 0.2m-0.4m; 1.24±0.41, 24.197±3.66, 19.86±2.46 and 290.71±28.99 respectively in depth 0.4m−0.6m; 0.80±0.34 Bqkg^{-1}, 20.10±4.133, 16.10±1.54, and 259.04±34.22 in depth 0.6m−0.8m and 0.68±0.25, 18.509±2.08, 14.50±0.91 and 247±30.13 for 0.8-1.0m. The levels of radioactivity were then used to assess public dose rates and radioactive contamination thereby predicting changes in environmental radioactivity caused by poor waste management, industrial activities, and other human activities. In all the investigated sampling point ^{40}K exhibited the highest activity concentration in 0-0.2m depth with the value of 383.45±19.4883 while Pr exhibited the lowest activity concentration with the value of 0.08±0.4252 in depth 0.8-1.0m. The mean activity concentration of ^{238}U, ^{232}Th and ^{40}K**,** in the soil samples at the dumpsite were 20.80, 20.3 and 291.54 Bqkg^{-1}respectively for 0-0.2m depth. These results were lower than the world permissible standard stated by UNSCEAR. It was generally observed that the activity concentrations reduced with 0-0.2m having the highest concentration values for both the dumpsite and the control sites, while the mean activity concentrations of ^{238}U, ^{232}Th and^{40}K for the control sites were found to be 31.5045±2.0123, 13.145±1.4637 and 183.415±21.4465 respectively for 0-0.2m depth.

Keywords:
Natural radioactivity,
Radionuclides,
Dumpsite,
UNSCEAR.

INTRODUCTION

The significance of the radioactive nature of the earth both at the surface and subsurface cannot be overemphasized; about 90% of human radiation exposure arises from natural sources such as cosmic radiation, exposure to radon gas and terrestrial radionuclides (Lee and Lee, 2005). The most common terrestrial radionuclides that produce gamma-rays are member of the ^{238}U, ^{226}Ra, ^{232}Th, ^{40}K and their average concentrations vary considerably depending on soil type and local geology.

Daily human and environmental activities generates wastes at different times of varying level and the various means that these wastes are handled, stored, collected and dispersed can give rise to impacts on the environment and public health. Hazardous wastes can cause domestic and environmental pollution which can be virulent and debilitating to the general health and overall well being and might consequently result to untimely death. The varying environmental challenges posed by solid wastes has been very significant to the industry, public, medical institutions, and all the

stakeholders in environmental control and management in collaboration with the three tiers of government namely federal, state and local government authorities in Nigeria. Poor waste control and management have been known to pose series of challenges the well being of city dwellers due to the potential risks of the waste to polluting water, food sources, land, and vegetation (Porteous, 1985; Njoroge, 2007). Population explosion and industrial growth result in varying changes observed in the composition and quality of waste generated as can be seen in most cities in developing countries of the world which Nigeria cannot in anyway be exempted due to her huge daily waste generation (UNIDO, 2001).

At dumpsites very high chances are possible for radiation to be emitted due to the presence of radioactive waste in the landfills as well as naturally occurring radionuclides in the soil. The radioactive contamination of soil, water and air can be transferred to human through the soil via plants or through inhalation by biological population. These radionuclides even at low concentration can have potential clinical impacts on human health and overall environmental quality and may pose a long term risk. Due to varying exposure of humans to differential levels of existing radioactive sources, researchers investigate the environmental radiation present in soils to conduct background checks and monitor environmental radioactivity (Alzubaidi et al., 2016). Investigated levels of radioactivity can then be used to determine and address public dose rate, contamination, and prospect possible changes in these emissions caused by nuclear accidental discharge, industrial activities and other human activities (United Nations Scientific Committee on the Effects of Atomic Radiation [UNSCEAR], 2000). Acquired information about the distribution pattern of these radionuclides will help to locate and control sources of natural radiation where economical interest exists and that which legalisation can be applied (Ajayi and Ibikunle, 2012). Various studies have been investigated on radioactivity in dumpsites with results published (Okoronkwo et al., 2006; Odunaike et al., 2008; Ogundare and Alabi, 2008; Parth et al., 2011; Oladapo et al., 2012). Existence of traces of radionuclides in the staple foodstuffs consumed in Nigeria have been displayed by radioactivity measurements which revealed that staple foodstuffs consumed in Nigeria contain traces of radionuclides (Akinloye and Olomo, 2005; Jibril et al., 2007). Consequently, refuse dumpsites were identified as a liable and veritable recipient in containment and carrier of radioactive materials. The cultivation and planting of legumes, vegetables and so on by farmers around existing dumpsites enhances the possible transportation of heavy metals as well as radionuclides in the soil from the sites via root-uptake, transferred to human system through inhalation and ingestion. Therefore, it is necessary to assess the accurate extent of radionuclide composition in soil samples obtained from varying depth of investigation in a notable dumpsite, South-West, Nigeria. The primary aims of this study were to measure the natural radionuclides present in representative surface and subsurface soil samples from dumpsites using NaI (IT) detector to estimate the hazard indices from these dumpsites to the general public. This study was carried out in a notable dumpsite location around the residential environment of Oru-Ijebu, South-West Nigeria at different investigation depths namely 0-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8 m and 0.8-1.0 m with entire dimensions of 15 m by 70 m; has been in existence for the past 23 years. Wastes from this dumpsite was mostly generated from domestic wastes and partly industrial wastes from pharmaceuticals, beverages, iron and sheets, glass bottles, scrap metals, cloth rags, varieties of plastic wastes, nylon and toxic wastes are also alongside other materials.

Study area

Location and Accessibility of the Study Area

The study area lies within Oru-Ijebu. It is located within the latitude 6.935 to 6.965 and longitude 3.92 to 3.93. The area is accessible through major roads and minor roads, linking Oru-Ijebu with several towns and localities including Ago-Iwoye, Awa, Ilaporu, Imope and Ijebu Igbo and it lies within the basement complex of South western Nigeria and the transportation network consists of minor rods, major roads and footpaths. The relief is moderately low forming ridges in some places an undulated plain dotted with small isolated hills or hills rocks are noticed generally within Ago Iwoye. The general level of surface rises Northwards from about 0-500 ft above the coast northward to the area of the crystalline rocks. Drainage pattern is predominantly dendritic. The mapped area falls within the equatorial belt giving the area two major seasons namely, the wet and dry season. The climate is characterized by annual average minimum and maximum temperatures of 220 and 350 respectively, it experiences double maximal rainfall of which the peak being between June and September (Onakomaiya *et al.,* 1992). The month of December and January seasons are relatively dry in Oru community. Before the first rain in Late March or Early April, the weather is humid; the humidity is about 50 % all year round. The dry season is rather short with very hot days. In a year, maximum rain is recorded between June and October in this area. The vegetation of the mapped area shows that it lies within the tropical rainforest of Nigeria with many light forest, scattered cultivations and scrubs.

Geological Setting and Hydrogeology of the Study Area

The study area, Oru and its environs, lies within the Basement Complex of south western Nigeria. It forms

part of the Pan African mobile belt which lies to the east of West African Craton. Hence, several authors have worked on and classified the basement rocks based on their association and geochronology. Some of the classifications were carried out by Jones and Hockey (1964), Oyawoye (1972) and Oyinloye, 2007. Rahaman (1976) classified the basement complex rock units into 5 different groups viz: the migmatite – gneiss – quartzite complex, the newer metasediments, Chanockite, diorite and gabbro, older granite, Unmetamorphosed acid and basic intrusive and hyperbyssal rocks. The major rock types in the area of study include granite gneiss, granite, banded gneiss, pegmatite and undifferentiated migmatite and these have been intruded by quartz veins and pegmatite veins. (Fig.1). Granite gneiss is the major rock that dominated the study area. It belongs to the Gneiss group. There is a considerable variation in the amount of mafic and felsic minerals. They are typically medium grained in texture and the minerals present include quartz, biotite, plagioclase, orthoclase and other mineral accessories. Granite gneiss stretches from the eastern part to the north west of the area. Generally, it is grey in colour and texturally medium grained. Mineralogically, it consists of quartz, plagioclase, feldspar, biotite and hornblende. Granite is the second abundant rock type in the area covering the entire eastern and northwestern region. The colour is grey and texturally medium grained. Banded Gneiss are foliated and the rocks consist of alternating bands of light and dark minerals. The light band is composed of felsic mineral mainly quartz and feldspar while the dark band consists of mafic minerals. Mineralogically, banded gneiss contains both felsic and mafic minerals. Pegmatite is located at the western part of area of study. The entire Oru Township is underlain by pink pegmatite. Pegmatite is a very coarse grained minor igneous rock; they are formed from the residual magma that is rich in volatile and fugitive elements. They occur as massive intrusion in Oru. Texturally, it ranges from medium to coarse grained. Mineralogically, feldspar, mica (muscovite dominating over biotite) and quartz are the most abundant minerals while muscovite and tourmaline occurs as accessory mineral. Muscovite flakes from the weathered pegmatite liter the immediate (Figure 1). These types of aquifers are superimposed or isolated. In a crystalline medium, capacitive and conductive functions both exist within each aquifer. Potentialities of these aquifers depend into hydrological balance parameters and their configuration. Water bearing fissures and fractures; tectonics is the major factor governing the water flow in the study area. Figure 1 below shows the Geological Map of Study Area (Adekoya *et al.*, 2017); Figure 2 shows the Location and accessibility map of the study area while figure 3 shows the map of field set-up for the data acquisition in the study area.

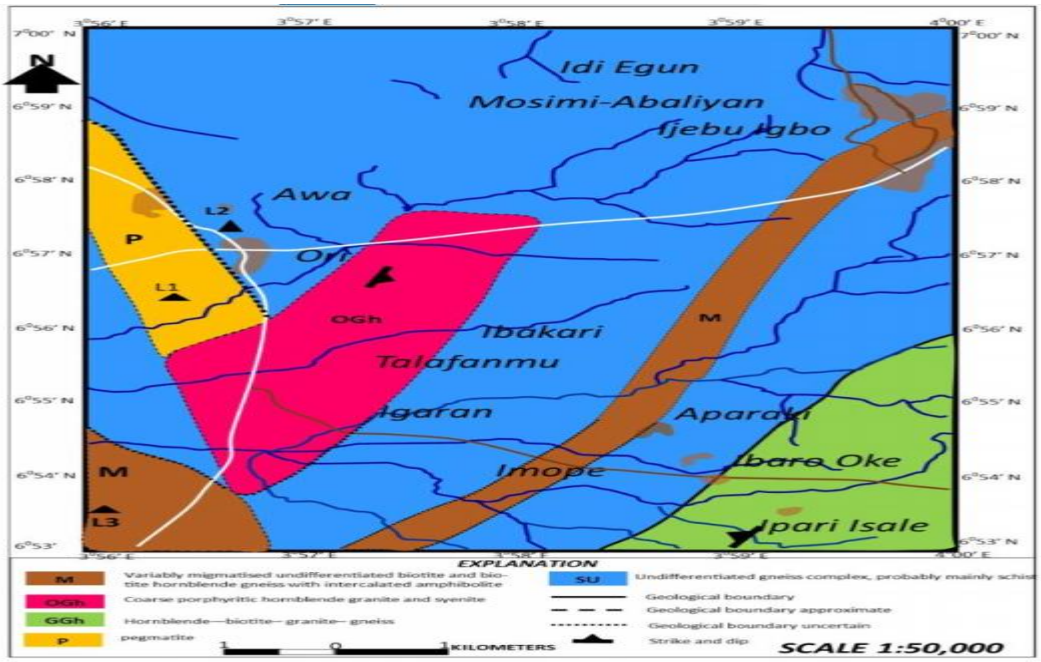


Figure 1: Geologic map showing rock description in study area (Modified after Nigeria Geological Survey Agency, Abuja 2004)

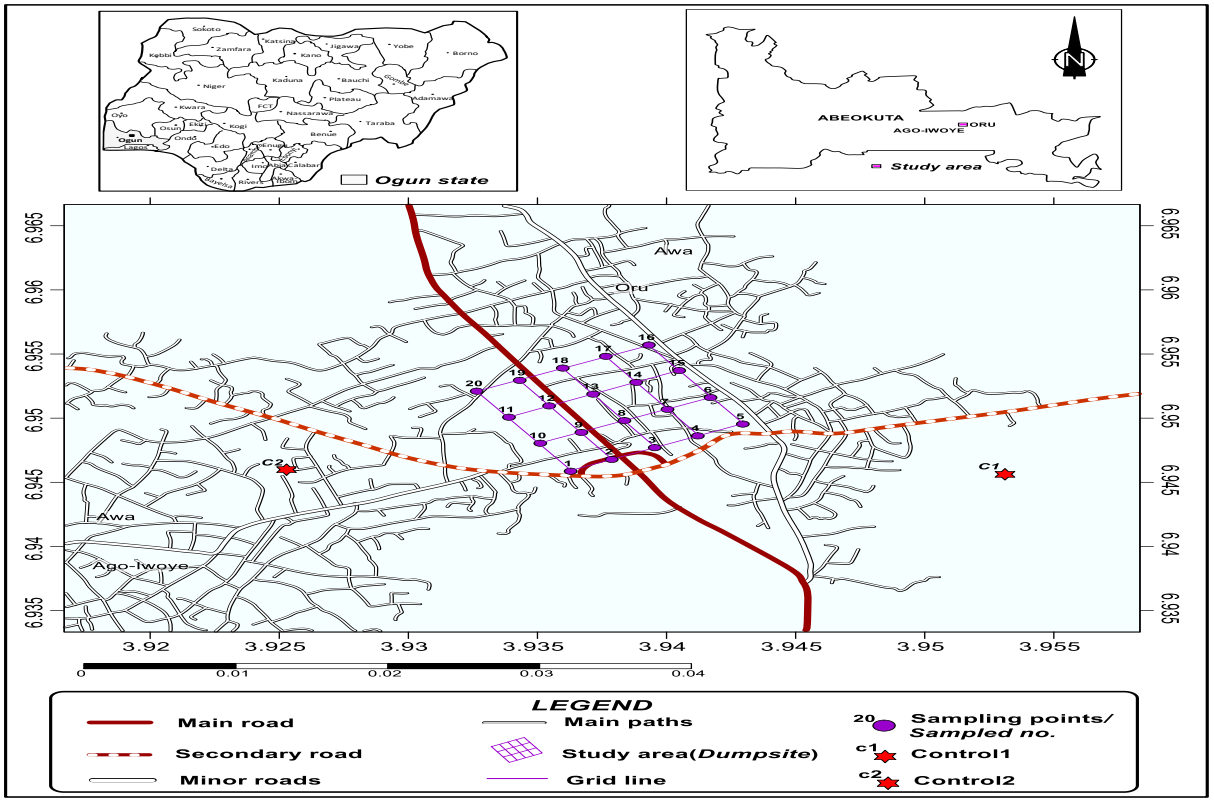


Figure 2: Location/Accessibility map

MATERIALS AND METHODS

Sample Collection and Processing

A hundred and ten (110) surface and sub-surface soil samples; 100 from the actual dumpsite and 10 (5 each) from two control sites of 200m away from the dumpsite were collected from an active dumpsites covering 20 sampling points (1-20) and a surface area dimension of 12m×40m with each sampling point maintaining a separating distance of 4m and 10m laterally and vertically from one another other (Fig. 3); the samples were systematically collected from varying depths of 0-0.2m, 0.2-0.4m, 0.4-0.6m, 0.6-0.8m and 0.8m-1.0m vertical depth along the soil profile from the dump-site; while the control samples were taken from two sampling points located 200m away from the dumpsite in opposite direction. Field samples were collected using earth auger, shovel, and polythene bags, sample bags, paper tape and marker; they were consequently subjected to laboratory analyses for natural radioactive emission where each activity concentration measurements of the radionuclides were determined; the specific parameters identified were ^{226}Ra, ^{238}U, ^{232}Th, ^{40}K utilizing gamma ray spectrometry with NaI (IT) detector. Consequently, the samples were processed following standard procedures (EMI, 1983). Soil samples were well mixed, weighed and then dried in an oven at 125 ^{0}C overnight and reweighed to find the water content. The samples were crushed and sieved through a 0.2mm sieve. Sieved samples were weighed and a mass of 200 g of each sample was placed in a non-radioactive plastic container. The plastic containers were hermatically sealed with adhesive tape (AERB, 2003) for over a month for secular equilibrium to develop (Olomo et al., 1994).

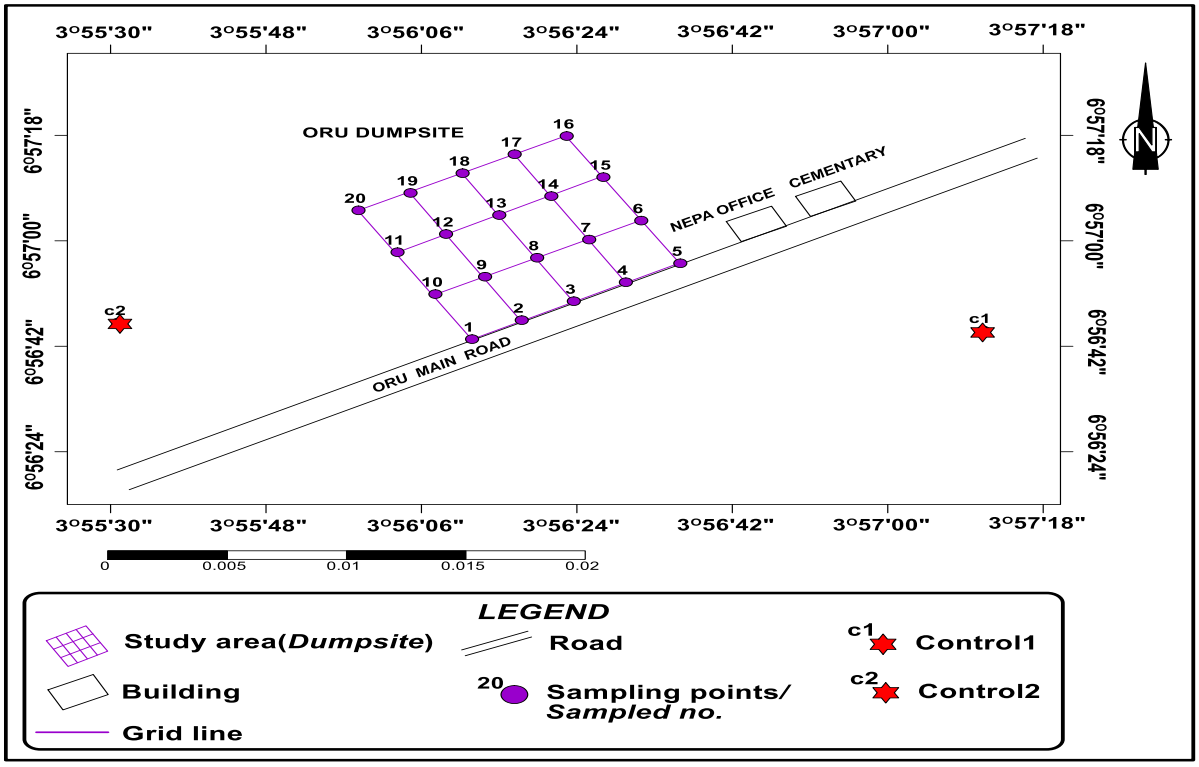


Figure 3: Field set-up/Data acquisition map

Experimental Methods

Analysis for radionuclide concentrations was performed by gamma-ray spectrometry using a sodium iodide detector. The counting assembly was a scintillation detector and a Canberra multi-channel analyzer. The detector was a 7.6× 7.6 cm^2 NaI(TI) manufactured by Bicron. A cylindrical lead shield of thickness 5cm with a fixed bottom and a movable cover shielded the detector from background radiation. The spectrometer was tested for its linearity and then calibrated for energy using gamma ray sources supplied by the International Atomic Energy, Vienna. This was achieved by collecting spectra data from standard sources with energies ranging from 0.511 to 2.62 MeV. The channel numbers of the photo peaks corresponding to the different gamma energies were recorded after 900s and the energy channel linear relationship was drawn. The detection efficiency calibration of the system was carried out using a reference standard gamma source prepared by Rocket-dyne laboratories, Canoga Park, CA, USA which is traceable to a mixed standard gamma source (INV94084-200g) by Analytic Inc, Atlanta Georgia, USA. The detector assembly has a resolution of −8% at 0.662 MeV of ^{137}Cs. The reference sources have activity concentration of 529.55 *Bqkg*$^{-1}$, 16.61 *Bqkg*$^{-1}$, and 452.22 *Bqkg*$^{-1}$, for ^{238}U, ^{232}Th, and ^{40}K respectively. The background count was determined by counting an empty container of the same dimensions as the one containing the samples and subtracting from the gross count. The counting time was set at 36, 000s (10 h) to obtain the gamma spectrum with good statistics. From the net area, the activity concentrations in the samples were obtained using equation 1.

$$A\ (Bq\ Kg^{-1}) - kC_n \quad (1)$$

where $k = \frac{1}{\varepsilon} P_\gamma M_s$

A = the activity concentration of the radionuclides in the sample given in $Bq\ kg^{-1}$

C_n = count rate under the corresponding peak

ε = detector efficiency of the specific γ−ray energy

P_γ= absolute transition probability of the specific γ−ray

M_s = mass of the sample in Kg.

The detection limit (DL) required for the estimation of the minimum detectable activity in a sample was obtained using equation 2 (Ademola et al., 2011).

$$LLD = 4.65\sqrt{\frac{C_b}{t_b}} \times f \quad (2)$$

where C_b = net background amount in the corresponding peak

t_b= background counting time in seconds

f = factor that converts counts per second (cps) to activity concentration($Bq\ Kg^{-1}$).

The detection limits obtained were 17.3($Bq\ kg^{-1}$), 19.25($Bq\ kg^{-1}$, 5.1($Bq\ kg^{-1}$) and 5.0($Bq\ kg^{-1}$) from ^{40}K, ^{238}U, ^{226}Ra, ^{232}Th respectively. The values below these numbers were taken as being below the detection limit. The concentration of ^{226}Ra determined on the basis of the 1.76 MeV gamma ray energy obtained from

^{214}Bi was evaluated. The gamma ray energy of 2.424 MeV from ^{208}TI was used to determine the activity concentration of ^{232}Th and the gamma ray of 1.450 MeV from ^{40}K was used to determine the concentration of ^{40}K in the sample.

Absorbed Dose Rate from the Oru-Dumpsite

The gamma dose rate D (nGyh^{-1}) in the dumpsites was calculated from equation given by UNSCEAR, 1993.

$$D = 0.446A_{Ra} + 0.662A_{Th} + 0.048A_k \quad (3)$$

where D is the dose rate (nGyh^{-1}) at 1.0 m above the ground due to ^{238}U, ^{232}Th, and ^{40}K in the soil samples; A_{Ra}, A_{Th} and A_k are the activity concentrations in $Bq\ kg^{-1}$ of ^{226}Ra, ^{232}Th, and ^{40}K respectively.

Radium Equivalent Dose

The radium equivalent equivalent activity (Raeq) which is a single index used to describe the gamma output from different mixtures of Radium, Thorium, and Pottassium in the material was calculated from equation described in equation 4 (Beretka and Mattew, 1985; UNSCEAR, 1982).

$$Raeq = A_{Ra} + 1.43A_{Th} + 0.077A_k \quad (4)$$

RESULTS AND DISCUSSION

The results of the gamma-ray analysis from 110 surface and sub-surface soil samples; 100 from the investigated dumpsite and 10 (5 each) from two control sites located 200m away from the investigated dumpsite with subsurface depth intervals of 0-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8 m and 0.8-1.0 m, are presented in Table 1. The data obtained from the study area were computed to determine the mean activity concentrations as shown in Table. 1; absorbed dose rates as shown in Table 2, and radium equivalent activity (Raeq) which gives a single index used to describe the gamma output from different mixtures of radium, thorium, and potassium in the material was calculated from equation 4 and presented in column 2 of table 2. The interpreted results were then compared alongside with the control results with the permissible limits of globally accepted standards as stated by United Nations Scientific Committee on the Effects of Atomic Radiation (2000). The radionuclides observed with reliable regularity belonged to the decay series chain headed by ^{238}U, ^{226}Ra, ^{232}Th.

Table 1: Mean activity concentrations of Radionuclides at different depth (0.0-1.0m)

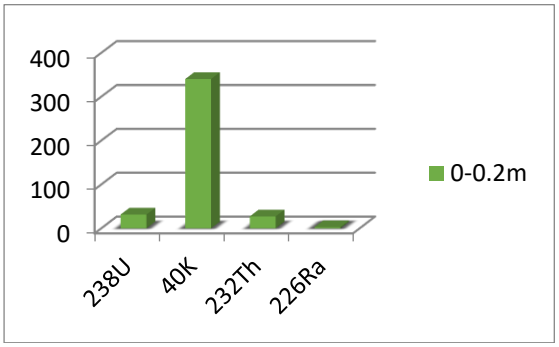
Oru Dumpsite	Depth (m)	^{238}U (Bqkg^{-1})	^{226}Ra (Bqkg^{-1})	^{232}Th (Bqkg^{-1})	^{40}K (Bqkg^{-1})
	0-0.2	31.50±2.01	2.53±0.60	27.20±1.63	340.39±19.48
	0.2-0.4	28.2455±2.50	1.96±0.37	23.84±3.07	320.59±24.07
	0.4-0.6	24.197±3.66	1.24±0.41	19.86±2.46	290.71±28.99
	0.6-0.8	20.10±4.133	0.80±0.34	16.10±1.54	259.04±34.22
	0.8-1.0	18.509±2.08	0.68±0.25	14.50±0.91	247.00±30.13
Control site					
	0-0.2	16.00±1.06	0.37±0.02	13.15±1.46	183.42±19.49
	0.2-0.4	12.97±0.35	0.36±0.04	10.87±1.01	165.15±24.08
	0.4-0.6	11.14±0.39	0.26±0.03	10.65±0.85	156.35±29.00
	0.6-0.8	10.3±0.13	0.20±0.01	13.62±0.06	147.59±34.22
	0.8-1.0	9.07±0.72	0.12±0.05	6.03±0.79	140.45±30.13

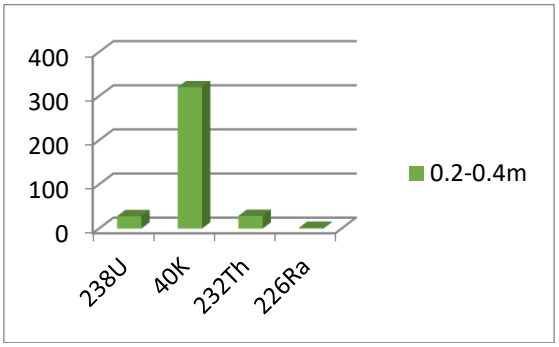
Table 2: Absorbed dose rate and Radium Equivalent Activity at different depth (0.0-1.0m)

Oru Dumpsite	Depth (m)	Absorbed Dose Rate (D)(nGyh^{-1})	Radium Equivalent Activity (Raeq) (Bqkg^{-1})
	0-0.2	35.47	78.93
	0.2-0.4	33.58	60.74
	0.4-0.6	27.65	52.03
	0.6-0.8	21.05	43.77
	0.8-1.0	21.76	40.43
	Mean	**27.90**	**55.18**
Control site			
	0-0.2	25.21	33.30
	0.2-0.4	15.12	30.03
	0.4-0.6	14.67	27.53
	0.6-0.8	16.19	31.04
	0.8-1.0	10.79	19.56
	Mean	**16.40**	**28.29**

The mean activity concentrations of radionuclide analyzed in the sampled dumpsite vary from one sampling point to the other and at various depth range (Fig. 4). The activity concentration of Uranium (^{238}U) in soil samples ranged from 31.50±2.01 Bqkg^{-1} from depth 0-0.2 m to 18.509±2.08 Bqkg^{-1} at depth 0.8-1 m, the activity concentration of Potassium (^{40}K) in soil samples ranged from 340.39±19.48 at depth 0-0.2 m to 247±30.13 at depth of 0.8-1.0 m, the activity concentration of Thorium (^{232}Th) in soil samples ranged from 27.2±1.63 at depth 0-0.2m to14.5±0.91 at depth 0.8-1 m, while the activity concentration of Radium (^{226}Ra) in the soil samples ranged from 2.53±0.6 at depth 0-0.2m to 0.68±0.25 at depth 0.8-1m (Table 1). The mean activity concentration of ^{40}K was found to be generally higher than the activity concentration of ^{238}U, ^{226}Ra and ^{232}Th in all sampling points and investigated sub-surface depths and the mean activity concentrations of ^{40}K were respectively found to be 340.39±19.48, 320.59±24.07, 290.71±28.99, 259.04±34.22 and 247±30.13 Bqkg^{-1} for **0**-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8 m and 0.8-1.0 m depths. Although, the mean activity concentrations of the radionuclides (^{238}U, ^{226}Ra and ^{232}Th) were lower than the world average of 35, 45 and 420 BqKg^{-1} respectively according to UNSCEAR, 2000. The investigated radionuclide parameters are observed to generally decrease with depth across the dumpsite. Across all samples, spike in activity concentration values were observed in ^{40}K, with an average dose rate of 340.393±19.4883 BqKg^{-1}. However, calculated average concentration for all the radionuclides is observed to be lower than the permissible limit as stated by United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR (2000).

Results also showed that the highest (35.47 nGyh^{-1}) average of the gamma absorbed dose rates was obtained in soil samples taken from the dumpsite and the lowest (21.05 nGyh^{-1}) were respectively obtained at subsurface depths of 0.0-0.2m and 0.6-0.8m (Table). The entire absorbed dose rate recorded values from Oru dumpsite appeared to be marginally lower than 60 nGyh^{-1} which serves as the world average (UNSCEAR, 2000). The investigated soil samples in Oru dumpsite exhibited a mean absorbed dose rate value of 27.90 nGyh^{-1} and corresponding Radium Equivalent Activity value of 55.18 Bqkg^{-1} while the control sites exhibited a mean absorbed dose rate value of 16.40 nGyh^{-1} and corresponding Radium Equivalent Activity value of 28.29 BqKg^{-1} with the highest dose rate (25.21 nGyh^{-1}) exhibited at 0.0-0.2m depth and the lowest dose rate (10.79 nGyh^{-1}) was exhibited at 0.8-01.0 m while in the control site, the highest dose rate (33.30 nGyh^{-1}) and the lowest dose rate (19.56 nGyh^{-1}) were respectively exhibited at the same depths with the investigated dumpsite. The comparisons of the exhibited variation for the mean activity variation for each of the radionuclides at different depths are displayed in Fig. 5. The values of Radium Equivalent Activity (R_{eq}) calculated for all the soil samples presented in Table 4 at various depth interval are 78.933 Bqkg^{-1}, 60.74 Bqkg^{-1}, 52.03 Bqkg^{-1}, 43.77 Bqkg^{-1} and 40.43 Bqkg^{-1} for depths 0-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8 m and 0.8-1.0 m respectively. These values are smaller than suggested maximal admissible value of 370 Bqkg^{-1}which is equivalent to an annual effective dose of 1.5 msv.





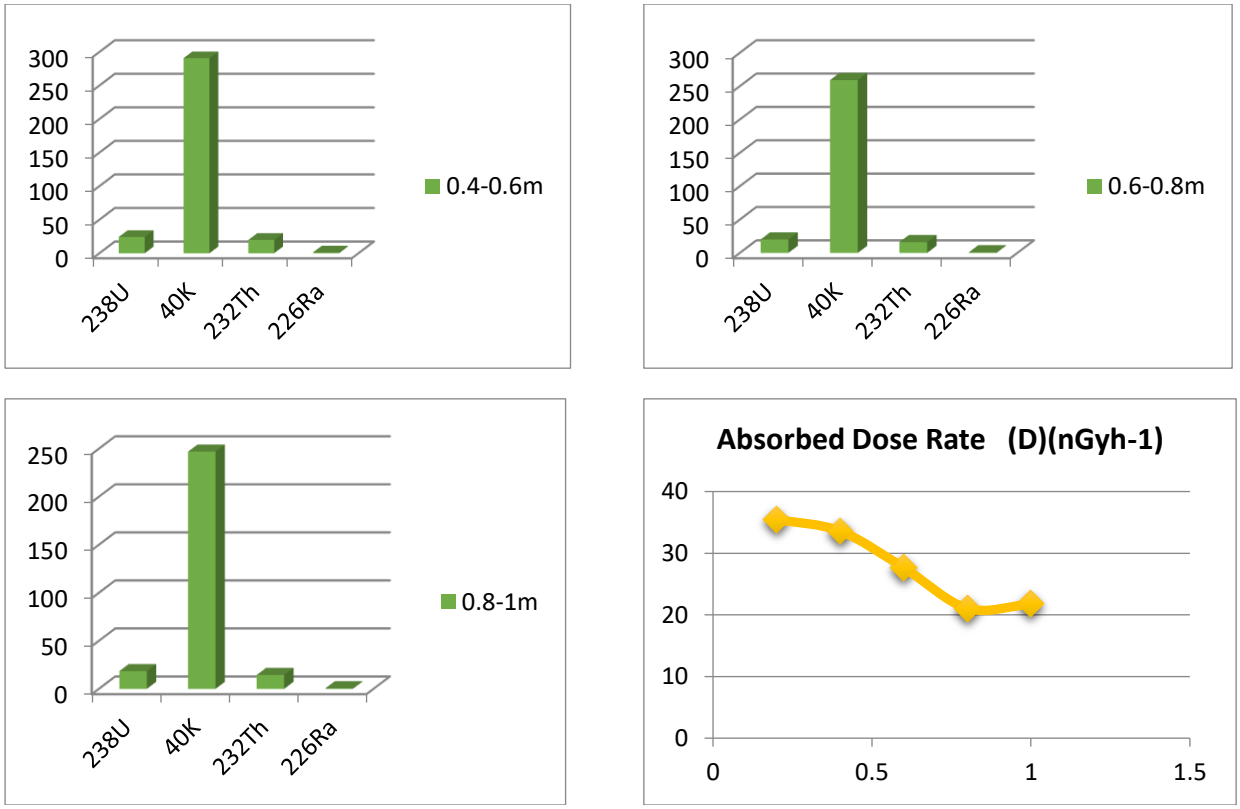
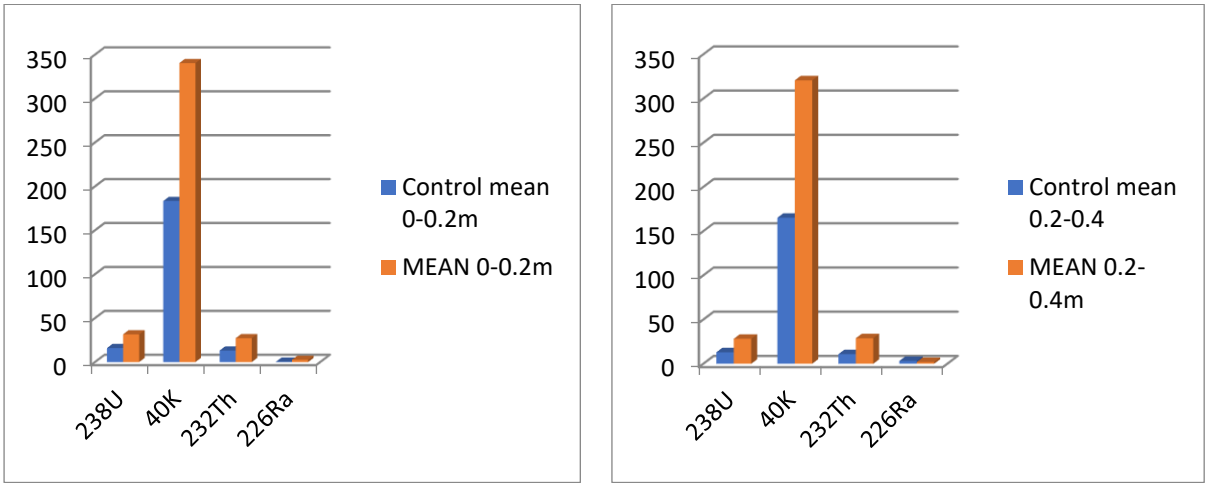


Figure 4: Mean activity concentration at different depth (0.0-1.0) and the absorbed dose rate



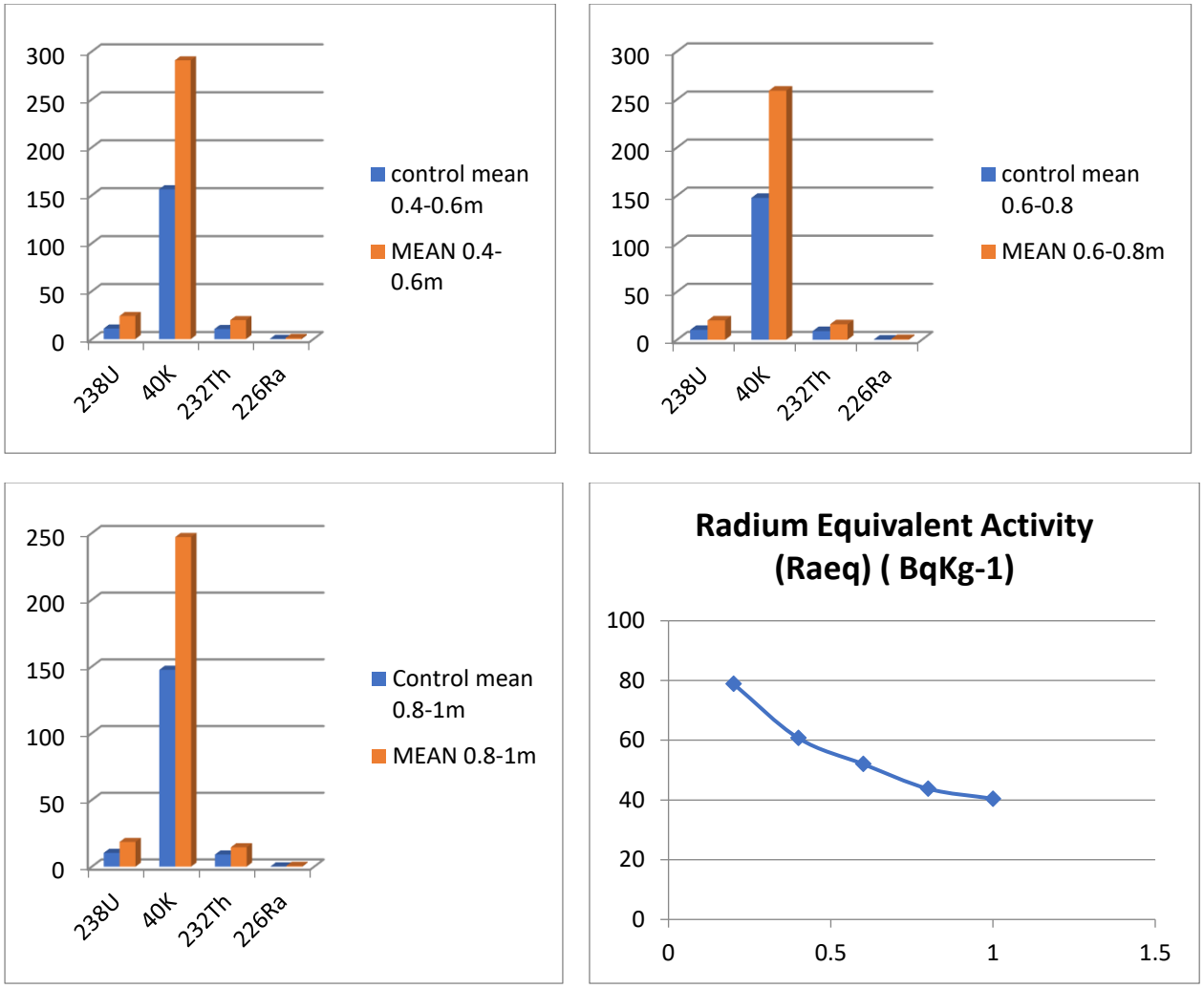


Figure 5: Mean activity concentration of dumpsite/control and Radium Equivalent activity Raeq at different depth (0.0-1.0m)

The mean activity values obtained in the study area were comparably well explanatory with investigated area in Boswana (Murty and Karunakara, 2008). The mean activities, absorbed dose rate and Radium Equivalent activities obtained from this study were lower than the values obtained from the investigated dumpsites in parts of Lagos and Ogun State (Ademola et al., 2015). The mean absorbed dose rates in this study was equally found to be comparably lower than the results obtained in Port-Harcourt (Avwiri et al., 2011) and Ekiti (Odeyemi et al., 2011). The mean activity concentration and the absorbed dose rates obtained in this study when compared with other studies under standard living conditions in Abeokuta (43 $Bqkg^{-1}$, 84 $Bqkg^{-1}$ and 329 $Bqkg^{-1}$ 88 $nGyh^{-1}$) and Ibadan (26 $Bqkg^{-1}$, 54 $Bqkg^{-1}$ and 619 $Bqkg^{-1}$, 60 $nGyh^{-1}$) Southwest Nigeria for ^{238}U, ^{232}Th and ^{40}K respectively; it was recorded to be lower alongside the mean absorbed dose rates.

CONCLUSION

Measurement of natural radionuclides from soil samples obtained from different sampling points in Oru-dumpsite at uniform subsurface depth intervals namely 0.0-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8m and 0.8-1.0m has been carried out using Sodium Iodide detector. The results show that natural radionuclides are not evenly distributed at various sampling points and no artificial radionuclides especially caesium are detected in any of the investigated soil samples. The mean activity concentration of Uranium (^{238}U) in soil samples ranged from 31.50±2.01 $Bqkg^{-1}$ from depth 0-0.2m to 18.509±2.08 $BqKg^{-1}$ at depth 0.8-1m, the activity concentration of Potassium (^{40}K) in soil samples ranged from 340.39±19.48 at depth 0-0.2m to 247±30.13 at depth of 0.8-1m, the activity concentration of Thorium (^{232}Th) in soil samples ranged from 27.2±1.63 at depth 0-0.2 m to14.5±0.91 at depth 0.8-1 m, while the activity concentration of Radium (^{226} Ra) in the soil samples

ranged from 2.53±0.6 at depth 0-0.2m to 0.68±0.25 at depth 0.8-1m (Table 1). The mean activity concentration of ^{40}K was found to be generally higher than the activity concentration of ^{238}U, ^{226}Ra and ^{232}Th in all sampling points and investigated sub-surface depths and the mean activity concentrations of ^{40}K were respectively found to be 340.39±19.48, 320.59±24.07, 290.71±28.99, 259.04±34.22 and 247±30.13 Bqkg^{-1} for 0-0.2 m, 0.2-0.4 m, 0.4-0.6 m, 0.6-0.8 m and 0.8-1.0 m depths. The radium equivalent activity (Raeq) in all the soil samples is lower than the suggested maximum admissible value of 370 Bqkg^{-1} which is equivalent to an annual effective dose of 1.5 mSv. The average activity concentrations of ^{226}Ra and ^{232}Th obtained in the samples from these dumpsites are lower when compared with the results obtained from the normal living condition in the same region. Though the activity concentrations in these dumpsites are low, it may still have significant effect on humans. Therefore, this radiation must be reduced by limiting the time spent in and around the dumpsite.

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