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Soil Radioactivity and Radiological Risks Exposure to Inhabitants near Coastal Region of Ado- Odo Ota, Ogun State, Nigeria

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ABSTRACT--*Background radiation assessment was carried out in and around near coastal areas of Ado-Odo Ota in Ogun State Nigeria to ascertain the soil potential health risks exposure to the inhabitants of the zone. Ninety eight stations with a spacing of 12 m were measured for the radioactivity levels from the naturally occurring radionuclide (^{238}U, ^{232}Th and ^{40}K) as well as the corresponding dose rates using highly sensitive portable gamma ray spectrometer (Super-Spec RS 125). The results showed that the measured value of ^{238}U varied from 44 to 79 Bq/kg. For ^{232}Th, it ranges between 37 and 121 Bq/kg respectively. The ^{40}K measured values ranged between 312 and 672 Bq/kg. Radiological parameters such as radium equivalent, internal hazard and external hazard assessments were estimated. The estimated values ranged from 143 to 351 Bq/kg, 0.76 to 0.95 and 0.51 to 0.84 for radium equivalent, internal hazard and external hazard respectively. The measured values of gamma dose-rates ranged between 76 and 181 $nGyh^{-1}$. The measured radionuclides and estimated radiological parameters were compared with international reference value and were found to be within the recommended values except those results from the stations adjacent to the production companies where over 60 % of the population densely occupied. The annual effective dose and cancer fatal risks exposure to inhabitants were found to be within the permissible level except 9 stations truncated towards the dumpsite area.These higher values of exposure risks that twice exceeded the permissible levels according to UNSCEAR, 2000 may be attributed to the industrial waste materials from the major Companies in the area. However, this study suggests that the authority should compel the companies to adequately channel both the wastes and drainage systems towards the unoccupied area of about 1000 m away from the zone as well as proper yearly Environmental impact assessment for the safety of the general public.*

Keywords--*Radionuclides, Gamma Spectrometer, Dose rate, Radium equivalent*

I. INTRODUCTION

The three basic radioactive elements: Potassium (K), Uranium (U), and Thorium (Th) and several other radioactive elements such as Rubidium (Rb), gamma rays etc which are generated when they decay or decayed to

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daughter isotopes that subsequently decay, are responsible for this ionization radiation. Their sources terrestrial and cosmic radiation (Sannappa et al., 2003) can cause external and internal exposure (Wang, 2002). The terrestrial radiation is composed of primordial radionuclides such as ^{40}K, ^{87}Rb, ^{238}U, ^{232}Th, ^{235}U present in air, soil and water and varies quantitatively depending on the geological and geographic characteristics of the region [1] (Bozkurt et al., 2007). The attention has been attracted towards human exposure to ionizing radiation because of the effects of undue exposure to man [1].Therefore, adequate knowledge of the dose received from both natural and man-made radioactivity is very significant. Studies have shown that the earth crust is a composition of various materials including naturally occurring radionuclides [2-3]. The importance of the earth materials especially as the home of various raw materials makes it nearly impossible for man to eliminate his interaction with these radioactive substances. Further research revealed that the average standard for indoor effective dose due to gamma rays from building materials is about 0.4 mSv per year [4-5]. The major contributors identified for natural radiation exposures include radioactive nuclides present in the earth's crust, natural radionuclides present in human body (taken in through diets) and cosmic ray particles incident on the earth [6-7]. People are more prone to radiation exposure by staying indoors as the radioactive materials are more concentrated indoor than outdoor [8-10].

Background radiation assessment was carried out in and around near coastal areas of Ado-Odo Ota in Ogun State Nigeria to ascertain the soil potential health risks exposure to the inhabitants of the zone

II. MATERIALS AND METHODS

Ninety eight (98) stations with a spacing of 12 m were measured for the radioactivity levels from the naturally occurring radionuclide (^{238}U, ^{232}Th and^{40}K) as well as the corresponding dose rates using highly sensitive portable gamma ray spectrometer (Super-Spec RS 125).

III. RESULTS AND DISCUSSION

3.1 Activity Concentrations of Radionuclides in the Study Area

It was observed that the higher values of Uranium-238 measured (77 and 78 Bq/kg) were found in stations 16, 17, 50, 70, 90 and 118. The highest value of 79Bq/kg was found to be at stations 16 and 17), 38 Bq/kg at station 50 while the value 48 Bq/kg was noted in stations 69 – 70. The Thorium-232 value ranged between 37 and 121Bq/kg respectively. The highest value of Thorium-232 was noted at stations 19, 22, 48, 85 and 83 respectively. The lowest values of Thorium-232 were noticed at stations 50. The measured value of Potassium-40 ranged between 312 and 672 Bq/kg, with lowest noted in station 44 while the highest value observed in station 60. Some stations have higher values above 200 Bq/kg. They are stations 20, 30, 35, 50, 60, 64, 75, 80, and 89 respectively. The lowest value of Potassium-40 was observed at station 44.

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3.2 Estimation Of Radiological Parameters

The radiological parameters indices were determined from the measured data. These radiological parameters used in this present study include radium equivalent, internal-radiation hazard index and external-radiation hazard index. These parameters have been established based on equations reported by [11-14] and have been used by various researchers [11-14] among others) which have proved the reliability of these equations.

3.3 Radium equivalent radiological factor

This refers to as the frequent denominator used for the comparison of radionuclides current in any substance, and this has been applied in this study to compare the radionuclides concentrations measured from the subsurface. Radium equivalent activities were evaluated base on the evaluation of Uranium-238, Thorium-232 and Potassium-40 at standard values of 370, 259 and 4810 $Bqkg^{-1}$ respectively. Equation (12) [13-17]was utilized in the estimation of the radium-equivalent activity.

$$R_{eq} = C_{Ur} + 1.43\ C_{Th} + 0.077\ C_K \quad (1)$$

The estimated values ranged from 60 Bq/kg to 140 Bq/kg with the lowest and highest value noted in stations 21 and 78. Their values are 143 Bq/kg and 351 Bq/kg respectively

3.3 External Hazard Assessment (H_{ex})

The evaluation of external risk assessment (H_{ex}) related with gamma dose rays generateds from subsurface was done by applying equation (14) as used by [18-21]

$$H_{ex} = C_{Ur}/370 + C_{Th}/259 + C_K/4810 \quad (2)$$

$C_{Ur,}$ C_{Th} and C_K are the concentrations of activities in B/kg.

The estimated value of this risk ranged from 0.51 to 0.84 in the study area.

The highest values above 0.8were noted at stations 81 and 86 while the lowest below 0.531 was noticed at stations 21and 49 respectively.

3.4 Gamma Dose Rate

The measured values ranged between 55 and 115 nGh^{-1}. The lowest is noted at station 22 and the highest value at station 116. However, high values of gamma dose rates above 80 nGh^{-1} were observed across the stations which are more than the suggested value of 80 as reported by [15]

IV. CONCLUSION

These higher values of exposure risks that twice exceeded the permissible levels according to [14-16] may be attributed to the industrial waste materials from the major Companies in the area. However, this study suggests that the authority should compel the companies to adequately channel both the wastes and drainage systems towards the unoccupied area of about 1000 m away from the zone as well as proper yearly Environmental impact assessment for the safety of the general public

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