iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** IX **Month of publication:** September 2015

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Volume 3 Issue IX, September 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Radioactivity Concentration within the Environment of Lautech Teaching Hospital Osogbo, Nigeria

G.A. Isola[1], D.A. Ajadi[2]
Department of Pure and Applied Physics, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

Abstract-This paper present the activity concentrations and environmental outdoor gamma dose rate within Lautech Teaching Hospital Osogbo, Nigeria. The outdoor gamma dose rates were determined in 170 sampling points and soil samples were taken from 85 locations. Gamma dose rates were determined by Alarm Dosimeter (LK3600) Geiger counter portable device for the measurements taken in air for two minutes at each sampling sport, 1m from the ground. Average outdoor gamma dose rate range from 40.98+0.36 to16.79+2.53 nGyh^{-1}. Soil samples collected from locations were analyzed by gamma spectroscopy. The average activities concentration of the detected radionuclides ^{226}Ra ^{232}Th and ^{40}K range 35.57±4.64 to 4.53± 1.80, 22.68± 4.13 to 4.54± 1.35 and 827.73±70.46 to 324.64±26.76 respectively. Outdoor gamma dose rate, radium equivalent and the external hazard index due to activity concentration were determined and found within acceptable limit. Though,^{60}Co and ^{152} Eu ,an artificial radionuclides due to activation and fallout were detected with very low activities.

I. INTRODUCTION

Natural radionuclides present in soil as well as certain artificial radionuclides released to the environment are the major contributions to the terrestrial exposure. Soil plays host to the reception of direct and by-products 0f these human perturbations of the environment, leading to hazards of different kinds and magnitude. Some sources of man-made radionuclides are used in medicine, in nuclear power plants for energy production, nuclear weapon production, nuclear bomb testing and nuclear power plants accidents. Radioisotopes that are present in soil significantly affect terrestrial gamma radiation levels. In the last decade, several studies were carried out to assess the average outdoor terrestrial gamma dose rate in air at 1m from the ground. These studies determined that the effective gamma radiation levels were generally in the range of 10 – 200nGyh^{-1} with the mean of 60nGyh^{-1} (UNSCEAR, 2000). Also, nationwide surveys have been carried out to determine the radium equivalent activity of soil samples in many countries including Nigeria (Al-Jundi et al, 2003: mireles et al 2003; Ibrahim, 1999 ; Sroor et al 2001 ; Ibrahim et al; 1993 ; Isola et al,2015 .) This study was motivated by the report of careless handling and disposal of sealed sources by waste management in our various hospitals. The sealed sources are used for variety of applications including teletherapy, brachytherapy and blood irradiation. It thus, becomes pertinent to study the natural radioactivity levels in such environment for patients and workers safety. Such investigations can be useful for both the assessment of public dose rates and the performance of epidemiological studies, as well as to keep reference data records, to ascertain possible changes in environmental radioactivity due to human activities.

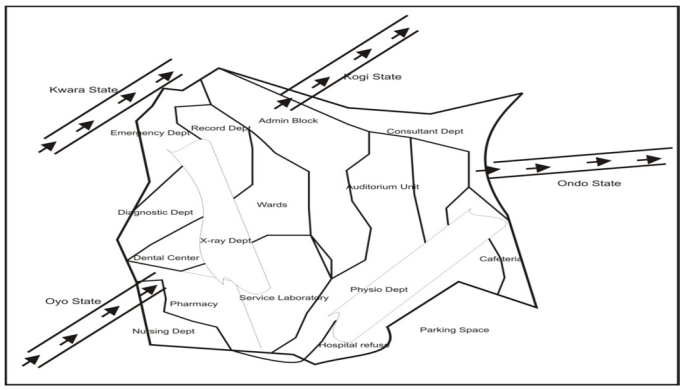


FIG 1: MAP SHOWING THE STUDY AREA WITH SAMPLING LOCATIONS

A. Determination Of Soil Radioactivity And Terrestrial Gamma Dose Rates

Measurements of the specific activity concentrations of the natural radionuclides in the samples were performed using direct gamma spectrometry. Seventeen major locations of the study were selected for sampling and soil samples were collected from 85 sports, 5 samples from each location and the mean were calculated as the activity concentration for that location. The first 10cm of topsoil was collected and kept in Marinelli type container for twenty-eight days before analysis at airtight condition to allow secular equilibrium between thorium and radium and their decay products. Prior to the analysis, energy and efficiency calibrations were performed in the energy range up to 2000keV to identify and quantify the radionuclides in the samples. The detector system was calibrated using standard mixtures of gamma emitting isotopes in Marinelli beaker traceable to Analytical Quality Control Services (AQCS, U.S.A). A counting time of 36,000s was used for each sample with correction for density and background. The activity concentration of the radionuclides in the samples were calculated after decay correction using the expression

$$A = \frac{Nsam}{fE.n(E).Tc.Msam} \quad (1)$$

Where, A is the activity concentration of the radionuclides in Bq/kg in the samples, M_{sam} is the mass of sample (kg), N_{sam} is the sample net counts in the peak range, f_E is the gamma emission probability, T_c is the counting time and n (E) is the photopeak efficiency. The activity concentration of ^{238}U was determined from the 63.3keV peak of ^{234}Th, ^{226}Ra was determined from the average activity concentrations of 295.3keV of ^{214}Pb and 1764.5keV of ^{214}Bi. The activity concentration of ^{232}Th was determined from the average activity concentrations of ^{212}Pb (238.6keV), ^{228}Ac (911.1 keV) and ^{208}Tl (2614.7 keV) and that of ^{40}K from 1460.0keV. The Minimum Detectable Activity (MDA) for each radionuclide ^{226}Ra, ^{232}Th and ^{40}K was calculated using the following equation:

$$MDA = \frac{1.645\sqrt{NB}}{fE.n(E).tc.M} \quad (2)$$

Where 1.645 is the statistical coverage factor at 95% confidence level, N_B is the background counts at the region of interest, t_c is the counting time, f_E is the gamma emission probability, n(E) is the photopeak efficiency and M is the mass of the sample. The MDA for each of the radionuclides were calculated as 0.30Bq/kg for ^{238}U, 0.12Bq/kg for ^{232}Th, 0.11 Bq/kg for ^{40}K respectively.

External terrestrial gamma dose rate was calculated from the concentrations of the radionuclides in soil. Based on the radioactivity levels of ^{226}Ra, ^{232}Th ^{40}K and ^{137}Cs.gamma absorbed dose rate in air (ADRA) in nGyh-1 at 1m above the ground level was calculated by using equation (3) (UNSCEAR,2000).

$$ADRA = 0.461A_{Ra} + 0.623A_{Th} + 0.0417A_k + 0.1243A_{Cs} \quad (3)$$

Where A_{Ra}, A_{Th}, A_K and A_{Cs} are activity concentration (BqKg-1) of ^{226}Ra, ^{232}Th, ^{40}K, and ^{137}Cs, respectively, in soil sample.

In addition, the absorbed dose rates from external exposure were measured with Alarm Dosimeter (LK 3600) Geiger counter portable device. Measurement were taken in air for two minutes at 1m above the ground at seventeen major locations of the study, for each sampling measurement were taken at ten different locations. The mean dose rates from of the ten measurement were collected and appointed as the outdoor gamma dose rate of the sampling of location and the gamma dose were recorded as µRh-1 and then converted to nGyh-1. The gamma absorbed dose in nGyh-1 were also converted to annual effective dose in mSvy-1 as proposed by UNSCEAR (UNSCEAR,2000).

The annual effective dose equivalent, H_E , from external exposure to gamma rays from the soil samples was calculated from the absorbed dose rate using the expression (UNSCEAR,2000):

$$H_E = D(nGy/h)*8760(h)*0.2*0.7(Sv/Gy) \quad (5)$$

Where 0.2 is the occupancy factor for outdoor, 8760 is the total time of the year in hours and 0.7 SvG/y is the conversion factor for external gamma irradiation.

Radium equivalent activity index for each sample was calculated using the relation (Sunta et al., 1982).

$$Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_k \quad (6)$$

Where A_{Ra}, A_{Th} and A_k are the activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in Bq/kg respectively. In this study, the Ra, Th and K contents were determined and the Ra_{eq} calculated. Similarly, the external hazard index (H_{ext}) represents the external radiation exposure associated with gamma irradiation from radionuclides of concern. The value of H_{ext} should not exceed the maximum acceptable value of one in order to keep the hazard insignificant. The external hazard index was calculated using the following equation (Sunta et al ,1982):

$$H_{ex} = \frac{Ara}{370} + \frac{Ath}{259}4810Bq/kg \text{ of } ^{40}K \text{ present in the same matrix.}$$

Volume 3 Issue IX, September 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

II. RESULTS

The results from this study highlight the presence and concentration of different radionuclide in the soil samples. The most significant are ^{40}k, ^{232}Th and ^{226}Ra.sThere is variation in the magnitude of the concentration of the radionuclides from different location. It is noticed that K-40 has higher concentration in all the samples followed by Ra-226, Th-232 and very low activity concentration of ^{152}Eu &^{60}Co .This results shows that the concentration of Ra-226 ranges from 35.57± 4.64 to 4.53 ± 1.80 Bq/Kg with a mean value of 15.73±6.57, Th-232 ranges from 22.68 ± 4.13 to 4.54 ±1.35 Bq/kg with a mean value of 14.28±2.84 and K-40 ranges from 827.73 ± 70.46 to 324.64 ± 26.76 Bq/Kg with an average value of 553.40 ±44.46 Bq/Kg as presented in table 1.Also presented in table 2 are the radium equivalent activity, external hazard index and the calculated absorbed dose rate due to activity concentration of the study. Three locations: hospital refuse dump site, X-ray unit and parking spaces have high radium equivalent, absorbed dose rate and external hazard index compare with other locations. This could be spill from sealed source use in the hospital. Also it was these locations ^{152}Eu and ^{60}Co were found but with very low activity.

Table 1: Mean Activity concentration of ^{40}K, ^{226}Ra and ^{232}Th in soil samples from the study area.

LOCATIONS	^{40}K	^{226}Ra	^{232}Th
Admin block	413.12±26.10	14.83±2.92	17.73±2.97
Service Lab	502.17±32.77	23.11±3.45	22.37±5.25
Consultant Dept	701.65±59.69	7.82±2.12	13.65±3.70
Wards	324.64±26.76	10.79±2.58	4.80±1.02
Nursing Unit	428.63±37.13	7.83±1.47	4.54±1.35
Dental center	650.58±55.04	15.81±3.05	14.38±3.45
Diagnostic Dept	827.73±70.46	12.06±4.83	15.76±2.51
Material Dept	576.07±41.08	4.53±1.80	10.32±2.57
Emergency Dept	635.14±46.06	21.76±4.18	12.66±2.84
Physio Dept	478.24±32.38	17.29±2.44	7.90±1.59
Cafeteria	452.22±40.38	8.78±2.28	16.33±3.64
Pharmacy	326.31±27.57	18.03±2.78	18.47±4.23
X-ray Unit	783.45±57.89	18.15±4.75	22.68±4.13
Hospital Refuse Dump Site	800.87±59.57	19.71±4.82	19.88±2.08
Record Dept.	408.37±36.88	11.68±2.85	8.45±2.08
Parking space	733.75±63.18	34.57±4.64	21.34±3.08
Auditorium Units	364.81±42.82	20.66±4.89	11.45±1.80
Mean Total	553.40±44.46	15.73±6.57	14.28±2.84

Table 2: Radium equivalent activities measured absorb dose rate, calculated dose rate and external hazard index due to soil samples in the study area.

LOCATIONS	Ra_{eq}	H_{ex}	Measured D(nGyh^{-1})	Calculated D(nGy^{-1})
Admin Block	69.10	0.19	18.69±2.02	34.99±0.6
Service Lab.	90.25	0.25	40.99±1.36	45.38±0.2
Consultant Dept	76.46	0.22	30.66±1.80	41.15±0.1
Wards	40.38	0.12	26.23±1.02	21.40±0.7
Nursing Unit	44.33	0.13	25.01±1.73	24.18±0.2
Dental Center	81.91	0.23	25.01±1.73	43.18±0.3
Diagnostic Dept	92.54	0.27	24.74±1.40	49.65±0.4

Volume 3 Issue IX, September 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Material Dept	59.61	0.17	21.23±1.68	32.37±0.1
Emergency Dept	84.32	0.24	25.17±1.90	44.21±0.9
Physio Dept	62.06	0.18	34.55±2.68	32.69±0.8
Cafeteria	63.79	0.18	25.18±1.78	32.94±0.1
Pharmacy	67.28	0.19	16.78±1.53	33.33±0.5
X-ray Dept.	105.42	0.30	24.40±1.23	54.93±0.1
Hospital Refuse Dump Site	104.20	0.30	20.48±1.33	54.63±0.2
Record Dept.	52.35	0.15	20.33±1.87	27.56±0.3
Parking space	116.45	0.33	20.19±1.20	59.61±0.4
Auditorium unit.	62.57	0.18	21.55±0.90	31.76±0.1

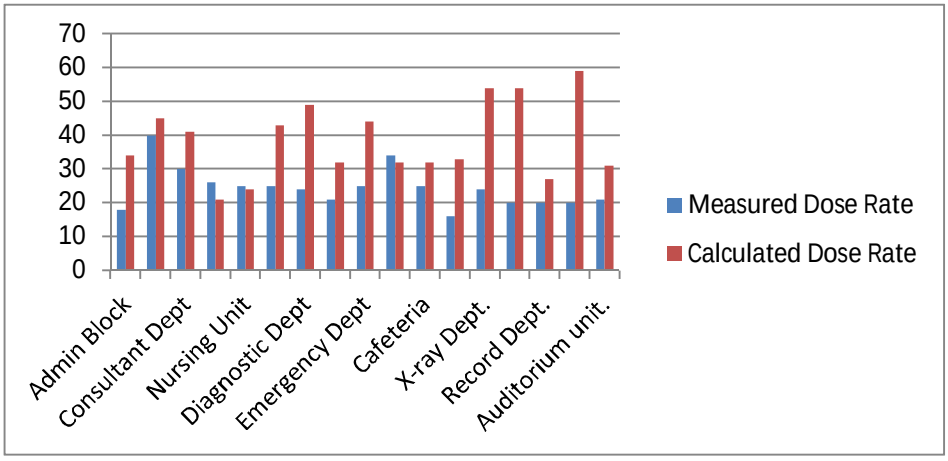


Fig. 1: Comparison of measured and calculated absorbed dose rate for the study.

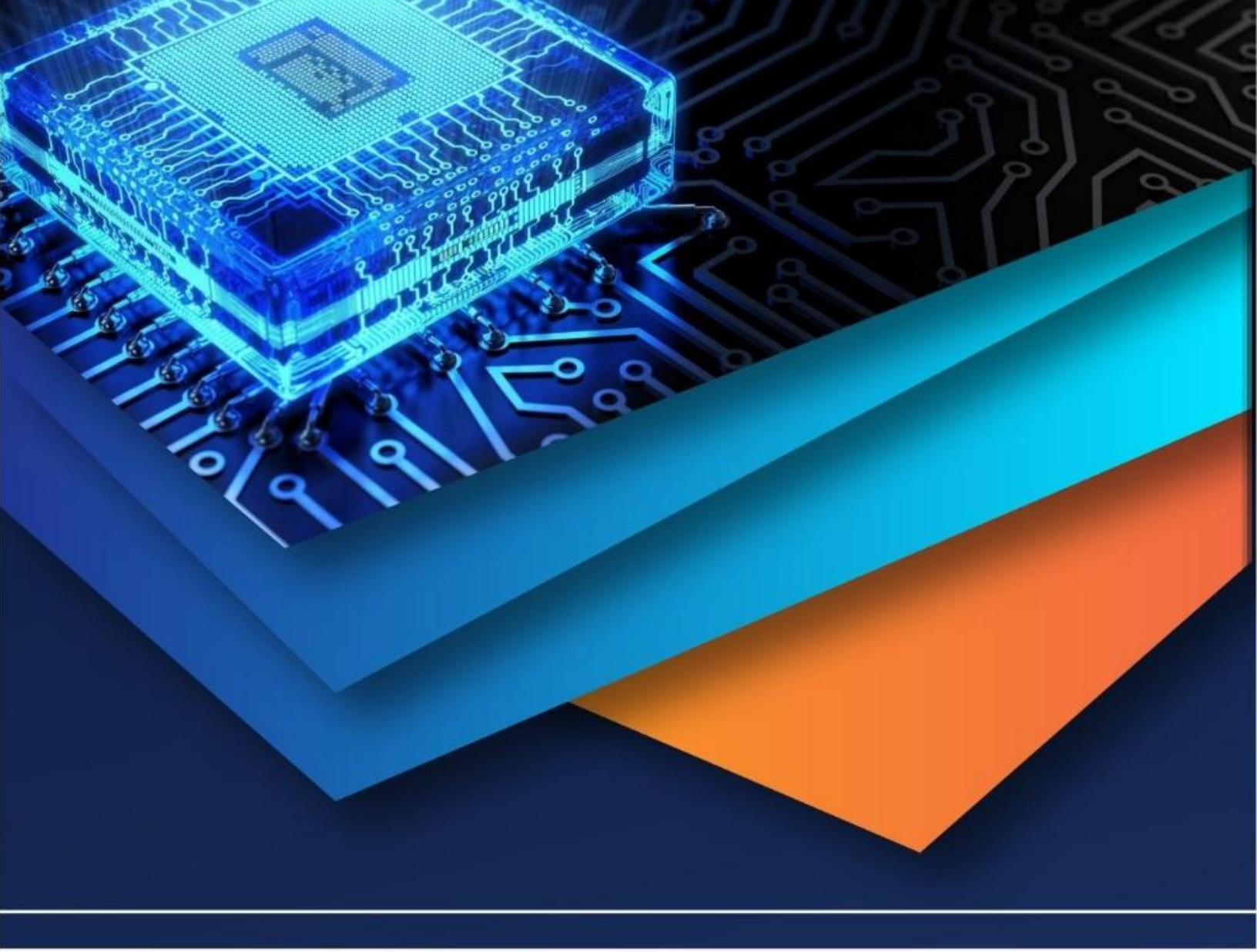
III. CONCLUSION

The assessment of the environmental radionuclides and the effects of the exposure to radiation within the premises of LAUTECH Teaching Hospital, Osogbo Nigeria had been carried out. The results from the studies indicated primordial radionuclides headed by ^{40}K, ^{226}Ra and ^{232}Th very prominent. ^{152}Eu and ^{60}Co were detected in three places with very low activity of about 6.8± 1.5 and 6.3 ±0.5 respectively. This could be due to the presence of artificial radionuclide from the material use for treatment. The radium equivalent and external hazard due to these primordial activity concentration were found below the UNSCEAR recommended values. The above results show that the condition of exposure to radiation within the premises of the hospital possesses no serious health hazards or adverse effects on the staffs and patients of the hospital.

REFERENCES

[1] Al-Jundi, J, B.A Al-Bataina, Y. Abu-Rukan and H.H. Shehadeh, 2003. Natural Radioactivity concentrations in soil samples along the Amman Aqaba Highway, Jordan. Radiation Measurements, 36: 555-560.
[2] Isola G.A and Ajadi D.A 2015. Estimation of Natural Radioactivity levels in Beach sands from Lagos, South-Western Nigeria.
[3] Isola G.A, Oni O.M and Olasunkanmi S.K 2015. Radionuclide concentrations in soils around waste dumpsites and its excess lifetime cancer risk due to gamma radioactivity in ogbomoso metropolis, South-Western Nigeria.
[4] Mireles, F., J.I. Davilla, L.L. Quirino, J.F. Lugo, J.L. Pinedo and C. Rios, 2003. Natural soil gamma radioactivity levels and resultant population dose in the cities of Zacatecas and Guadalupe, Zacatecas, Mexico. Health Physics, 84: 368-372.
[5] Sroor, A, S.M. El-Bahi, F. Ahmed and A.S. Abdel-Haleem, 2001. Natural radioactivity and radon exhalation rate of soil in southern in Egypt. Applied Radiation and Isotopes, 55: 873-879.
[6] Sunta, C.M., M.David and M.C. Abani, 1982. Analysis of Dosimetry Data of High Natural Radioactivity Areas of SW Coast of India. In: Vohra, K.G., U.C.

Mishra and K.C. Pillai (Eds.), Natural Radiation Environment Wiley Eastern Limited, New Delhi, pp: 35-42.
[7] UNSCEAR 2000; Annex A: United Nations Scientific Committee on the Effects of Atomic Radiation, REPORT 2000, Assessment Methodologies.
[8] UNSCEAR, 2000. Sources and effects of Ionizing Radiation, United Nations Scientific Committee on the effects of Atomic Radiation, United Nations, New York.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY