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ASSESSMENT OF EXCESS LIFETIME CANCER THREAT POSSIBILITY USING THE SURFACE DOSE RADIATION INFORMATION FROM TOWN CAMPUS, UNIVERSITY OF UYO, NIGERIA

BY

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Abstract

Excess lifetime cancer threat possibility is investigated to know more about the health satus of University of Uyo campus. A radiation survey meter (Diligert 200) was the major device used to obtain the primary data. Global positioning system was also used to note the locations and elevations. The locations with the highest Excess Lifetime Cancer Risk (ELCR) are latitudes and longitudes $05^{0}02.314^{1}$ and $007^{0}55.569^{1}$, $05^{0}02.298^{1}$ and $007^{0}55.540^{1}$, $05^{0}02.316^{1}$ and $007^{0}55.483^{1}$

respectively; whose values are above 0.0009 $Bqkg^{-1}$ but not up to 1.0 $x10^{-3}$ $BqKg^{-1}$. The lowest values of 0.000307 $Bqkg^{-1}$ and 0.000368 $Bqkg^{-1}$ are noted on latitudes and longitudes $05^{0}02.338^{1}$ and $007^{0}55.569^{1}$, 05^{0} 02.300^{1} and $007^{0}55.482^{1}$ correspondingly. This value is lower than the recommended world average of $1.0x10^{-3}$ $BqKg^{-1}$. Activities encouraging rise in radiological hazard should be discouraged in the University of Uyo Town campus as the highest values obtained, though are not up to maximum standard but really approaching this value.

Keywords: *Cancer threats, Radiation, Dose rate, Radiological hazard*

INTRODUCTION

Excess lifetime cancer risk predicts the risk of death of cancer in excess of the natural background threat, mostly from exposure to pollutants. This may also be seen as a valuation of the danger to a person dying from cancer as a result of radionuclide consumption in food (Ejoh *et al.*, 2023). The exposure generally involves more than one carcinogen and the risk of cancer death may be greatly reduced by therapy (Freni, 1987). The research on surface dose rate is significant in the field of radiation projection and safety. The excess lifetime cancer risk information depends on the surface dose rate and other parameters. Surface dose rate refers to the amount of radiation dose received per unit of time on the surface of an object or a person. It is a crucial parameter used to assess the potential risks associated with radiation exposure for individuals or equipment in various scenarios, such as nuclear power plants, medical faculties, boundaries, or areas contaminated by radioactive materials. The greatest problem the world is facing today is radioactive waste or environmental pollution. Radioactive waste can remain hazardous for a long period due to the radioactive decay process. Hazards from buildings and dumpsites can come from the radiation originating from these places. This consists of unstable isotopes that undergo decay and emit ionizing radiation, which is very harmful to surroundings, wildlife, nuclear research, and nuclear weapons reprocessing.

Many researchers have engaged in research on excess lifetime cancer risk. This study is important due to how it affects humans in our environment. Some of them include Abdullahi *et al.* (2019) (they obtained results which were below the recommended maximum values and concluded that the radiological hazards attributed to building materials under study are negligible). Ibikunle et al. (2018) outcomes were higher than the world average described by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). They concluded that the ELCR due to natural radiation sources is a function of environmental geology. Ezekiel (2017) had been read; the values he obtained for ELCR indicate that the chance of contracting cancer for residents in the area under investigation is low; the effective dose is insignificant. Olowookere *et al.* (2022) recorded higher mean ELCR which is greater than the world average standard. Eyibio *et al.* (2023) also conducted related research and noted no radiological risk of ingestion.

The goal of this research is to assess the possibility of Excess Lifetime Cancer Risk (ELCR) on workers or students in the

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Town campus of University of Uyo, Nigeria. Exposure to radiation may relate with some forms of leukemia and cancer as well. Lung, breast, and thyroid could be affected (UNSCEAR 2000). The radiation-induced cancer takes time before the harm is manifested and by then the organs may be damaged (Davou and Mangset, 2015). Long-term health effects like cancer and cardiovascular disease are possible. If the outcome of this study is accurate and appreciable, the information could be adequate for the advances in better strategies to reduce or control dose rate in the campus and the environment of University of Uyo.

Theoretical Background

The level of ionizing radiation in the environment at a particular location which is not due to deliberate introduction of radiation sources is termed background Radiation. The majority of background radiation occurs naturally from minerals and a small fraction comes from man-made elements. Background radiation sources could be either or both natural and artificial. The human body may contain some of these naturally occurring radioactive minerals. Background radiation is typically measured in units of radiation dose (sieverts (Sv) or millisieverts (mSv)). Its average level varies depending on geographic location, altitude, and other factors. When it exceeds the permissible level, the environment becomes unsafe.

From radioactivity, an important term which is significant in this research is the activity [measure of the number of radioactive decays per time]. It is usually stated in becquerel. One becquerel equals one decay per second (Rutherford, 1906). The activity of a radioactive substance can be obtained using Equation 1.

$$A = \lambda N \qquad (1)$$

Where *A* is the activity

N is the number of radioactive nuclei present and expressed mathematically in Equation 2. λ is the decay constant. Equation 3 defines its relationship with half-life ($t_{1/2}$) [which is the time it takes for half of the initial radioactive nuclei to decay] (Ayto, 1989; Rosch, 2014; Ekpo *et al*., 2020).

$$N = N_o e^{-\lambda t} \qquad (2)$$

$$t_{1/2} = \frac{0.693}{\lambda} \qquad (3)$$

In order to determine the excess lifetime cancer threats, measurement of absorbed dose, evaluation of effective dose, and determination of annual effective dose equivalent are necessary. Absorbed Dose (AD) is to the amount of energy deposited in a material per unit mass by ionizing radiation. It is typically measured in gray (Gy), where 1 Gy is equal to the absorption of 1 Joule of energy per kilogram of the material. It is used to examine the potential health effects on exposure to radiation. Equivalent Dose (ED) is used to account for the biological effect of ionizing radiation on the human body. Since AD is measured in mR/hr, ED was obtained in mSv/hr by multiplying AD with 0.01 converting it from mR/hr to mSv/hr while considering the sum of weighting factors for all the tissues in the body as 1. This yields AED (Average Equivalent Dose) expressed in Equation 4.

$$AED = \sum DR \times W \qquad (4)$$

AED is the Average Equivalent Dose, DR is the dose rate and W is the weighting factor.

W is a weighing factor of x-ray or gamma-ray but since one is adequate for all the factors, Equation 4 is in order.

Annual Effective Dose Equivalent is another important parameter for the determination of ELCR. It may be achieved using Equation 5.

$$AEDE = AED \times T \times OF \times 10^{-3} \qquad (5)$$

AED is the Average Equivalent Dose, T is the time in hours per year (8760 was used), OF is occupancy factor (0.2 and 0.8 for outdoor and indoor respectively (UNSCEAR, 2008; Ekpo *et al*., 2020; Eke *et al*., 2022).

$$ELCR = AEDE \times DL \times RF \qquad (6)$$

$ELCR$ is the lifetime cancer risk, $AEDE$ is Annual Effective Dose Equivalent, DL is the duration of life (taken as 70 years), RF (in Sv^{-1}) is the risk factor equals 0.05 (Ugbede *et al*., 2017).

Location Description and Geology

University of Uyo is a higher institution in the capital city of Akwa Ibom State, Nigeria. The county is in the southern part of Nigeria and experiences two distinct seasons: wet and dry (Atat *et al*., 2020a; Atat and Umoren, 2016) just like other city (Ilorin) in the western part of the country do (Oladipo *et al*., 2018); even in the coastal area of Akwa Ibom State like Ikot Abasi, wet and dry seasons are also observed (George *et al*., 2024). The major agricultural practices include vegetables, fruits, and cassava. In the environment are abundance of Agricultural produce like cassava, yam, vegetables, and plantain. Availability of deposits of crude oil is in abundance (Atat *et al*., 2023). The city has a hilly or undulating nature and semi equatorial type of climate. The area is considered as coastal plain sands (Benin Formation). It is also observed that the area of study is in the Niger Delta (this region is within latitudes 3°N and 6°N; longitudes 5°E and 8°E) and Atat *et al*. (2022), Reijers *et al*. (1996), Klett *et al*. (1997), Akpabio *et al*. (2023) and Umoren *et al*. (2019) have confirmed this information in their publications. As noted by Atat and Umoren (2016), the Niger Delta is the youngest Sedimentary basin in the Benue Trough system. Groundwater is tapped from the top of the stratigraphic sequence (George *et al*., 2017). Atat *et al*. (2020b; 2020c), Umoren *et al*. (2020), and Hospers (1965) in their articles agreed that the volume of sediment in the region is approximately 5 x 10^5 km^3.

MATERIALS AND METHOD

Material

Surface radiation dose measurements were made using Diligert 200 survey meter and the Global Positioning System (GPS) was used for the definition of the different locations (latitudes and longitudes) in the University of Uyo Town Campus.

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Method

Inspection and calibration of the equipment were done before the survey commences; the battery level was noted to be at maximum. Measurements were made twice (approximately three minutes interval) about one metre above the ground and the mean obtained for the Absorbed Dose Rates (ADR). The meter recorded dose rate in milliroentgen per hour (mR/hr) which one mR/hr is equivalent to 0.01 mSv.hr^{-1} (microSievert per hour). The values were used to compute the Annual Effective Dose Equivalent (AEDE) in µSv/yr in which staff and students are the target. With the result of AEDE, ELCR was achieved.

RESULT AND DISCUSSIONS

Result

The research outcomes are presented in this subsection. Table 1 presents the results noted from measured parameters. Figure 1 is the Combo Representation of Results of calculated parameters (AEDE and ELCR).

Table 1: Measured Parameters Information

Sample Points	Coordinates		Elevation (m)	Surface dose rate (mR/hr)			
	Latitude ^{o}N	Longitude ^{o}E		1	2	3	Average
B_1	05^{o} 02.314^{1}	007^{o}55.569^{1}	59	0.025	0.015	0.009	0.016
B_2	05^{o} 02.323^{1}	007^{o}55.575^{1}	31	0.014	0.013	0.011	0.013
B_3	05^{o} 02.33	007^{o}55.577^{1}	31	0.006	0.011	0.020	0.012
B_4	05^{o} 02.338^{1}	007^{o}55.569^{1}	30	0.004	0.007	0.005	0.005
B_5	05^{o} 02.345^{1}	007^{o}55.535^{1}	22	0.016	0.006	0.013	0.012
B_6	05^{o} 02.344^{1}	007^{o}55.504^{1}	16	0.009	0.017	0.014	0.013
B_7	05^{o} 02.315^{1}	007^{o}55.520^{1}	34	0.009	0.011	0.013	0.011
B_8	05^{o} 02.300^{1}	007^{o}55.533^{1}	43	0.016	0.009	0.007	0.011
B_9	05^{o} 02.298^{1}	007^{o}55.540^{1}	49	0.014	0.017	0.018	0.016
B_{10}	05^{o} 02.336^{1}	007^{o}55.543^{1}	16	0.004	0.014	0.011	0.009
B_{11}	05^{o} 02.348^{1}	007^{o}55.552^{1}	15	0.007	0.009	0.005	0.007
B_{12}	05^{o} 02.365^{1}	007^{o}55.559^{1}	17	0.014	0.011	0.003	0.009
B_{13}	05^{o} 02.378^{1}	007^{o}55.546^{1}	18	0.004	0.020	0.007	0.010
B_{14}	05^{o} 02.367^{1}	007^{o}55.533^{1}	11	0.009	0.008	0.011	0.009
B_{15}	05^{o} 02.350^{1}	007^{o}55.524^{1}	11	0.019	0.013	0.009	0.014
B_{16}	05^{o} 02.359^{1}	007^{o}55.491^{1}	12	0.011	0.014	0.005	0.010
B_{17}	05^{o} 02.316^{1}	007^{o}55.483^{1}	14	0.014	0.015	0.016	0.015
B_{18}	05^{o} 02.300^{1}	007^{o}55.482^{1}	15	0.004	0.008	0.007	0.006
B_{19}	05^{o} 02.303^{1}	007^{o}55.474^{1}	12	0.019	0.009	0.007	0.012
B_{20}	05^{o} 02.280^{1}	007^{o}55.461^{1}	14	0.014	0.006	0.005	0.008

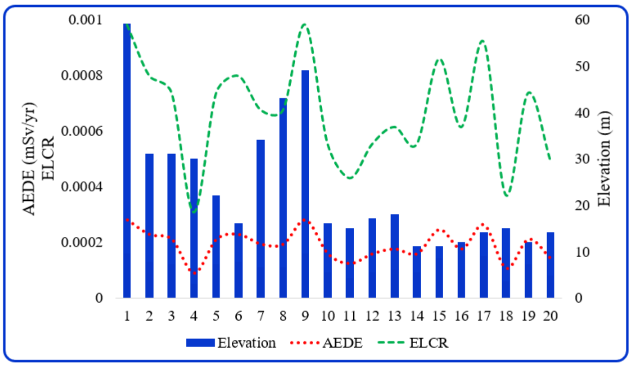

Figure 1: Combo Representation of Results of Elevation (blue), AEDE (red) and ELCR (green).

Discussion

Part of the result in Table 1 was achieved directly from the radiation survey meter for AD; others (latitude, longitude, and elevation) were measured using GPS. AD results yielded ED in mSv/hr. Equation 4 was adequate in computing AED. Annual Effective Dose Equivalent was realized by the use of Equation 5. The time used was 8760 in hours per year and the choice of the occupancy factor was 0.2 to account for outdoor investigation. $ELCR$ which is the lifetime cancer risk was calculated by means of Equation 6. The duration of life and

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the risk factor considered in the determination were 70 years and 0.05 Sv^{-1} respectively. All these outcomes are seen in Figure 1.

From Figure 1, ELCR increases with an increase in AEDE and becomes small when AEDE reduces. The elevation outcome does not affect the results of neither AEDE nor ELCR. The locations with the highest ELCR are 1, 9 and 17 whose values are above 0.0009 $Bqkg^{-1}$ but not up to 1.0 $x10^{-3}$ $BqKg^{-1}$. The lowest values of 0.000307 $Bqkg^{-1}$ and 0.000368 $Bqkg^{-1}$ are noted at locations 4 and 18 respectively. This value is lower than the recommended world average of $1.0x10^{-3}$ $BqKg^{-1}$ (Ejoh *et al*., 2023). Activities encouraging rise in radiological hazard should be discouraged in the University of Uyo Town campus as the highest values obtained, though not up to maximum standard but it is very close to this value.

Conclusion

An investigation to examine the possibility of radiological risk in the University of Uyo Town campus had been conducted. The outcomes from the excess lifetime cancer risk indicate that there is no location on campus that is harmful or could pose a threat to the health of the staff or the students in University of Uyo, Nigeria in future. The management of University of Uyo should consider or adopt approaches of handling hazardous waste within the University community to ensure rapid reduction in the value of excess lifetime cancer threat.

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