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Assessment of Radiation Exposure Levels within Ikot Akpaden Campus of Akwa Ibom State University, Nigeria

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Abstract: *In-situ measurements of the equivalent dose in* $\mu Svhr^{-1}$ *at twenty two locations within Ikot Akpaden Campus of Akwa Ibom State University, Nigeria, using Portable Inspector Alert Nuclear Radiation Monitor, have been conducted. Hundred measurements per study location were taken for averaging. The average values with standard error were for each location converted to annual dose rate in* $mSvyr^{-1}$ *and presented. The result of the computed mean equivalent dose rate for the University Community was* $0.2442 \pm 0.0240 mSvyr^{-1}$. *Comparing the result with the stipulated regulatory maximum permissible level, even at location within the Campus with maximum measured value, it is far below the maximum permissible level, indicating that there is no threat of radiological hazard within the University Campus which has operated for more than five years now. However, routine and periodic radiation level assessment within the University Campus and its vicinity is recommended as accumulated effect which is a function of time may raise the level and pose threat to health and the environment in future.*
Keywords*: Equivalent dose, annual dose rate, background radioactivity, equivalent dose, permissible dose, health hazard*

I. Introduction

The materials, with which the earth is made up of, contain many radioactive isotopes. Some of these materials have short and long half-lives. Rocks, soil, air, food and drinking water and the total environment contain natural radioactive materials. This means that the natural environment is the major contributor of radiation. Radiation from natural sources that we are all exposed to at all times is referred to as background radioactivity (Solomon, 1986).

Cosmic sources and earth crust, together with artificial sources of radiation resulting from medical applications, nuclear industry and nuclear bomb explosion, contribute to an average of about 2.5 mSv radiation dose per year for each inhabitant of the earth (UNSCEAR, 1988).

The effects of radiation may be acute somatic effect, developmental effect, genetic effect and late somatic effect (Noz and Maguire, 1979; UNSCEAR, 1972, 1977, 1982, 1988, 2000, 2009).

Radionuclides in natural environment may enter into the body unintentionally through inhalation, ingestion or absorption and get deposited at various sites in the body. Unfortunately, human body has no means of directly sensing exposure to radiation, except it is invariably at lethal level. Hence, it is difficult therefore, for the body to provide defense against radiations. This poses a severe problem to mankind. Therefore on this basis, it is imperative that acceptable (safe) levels of radiation exposure and maximum permissible doses (MPD) be set by various bodies based on research findings in the field of radiation. Such bodies, which are regarded as regulatory bodies include International Commission on Radiological Protection (ICRP), The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), World Health Organization (WHO), Nigerian Nuclear Regulatory Authority (NNRA) to mention but a few.

Maximum permissible dose (MPD) for none occupationally exposed individual is put at $1 mSvyr^{-1}$ while that of nuclear energy workers is put at $20 mSvyr^{-1}$ (Lewis et al., 1999). Ionizing radiation becomes dangerous at high doses; therefore, knowledge of the level of radiation within our living and working environment becomes necessary, considering the health implications. It is therefore based on the above that this research is predicated.

The justification for choosing Akwa Ibom State University as the study area is primarily due to the population of the students and staff that the Campus harbours while some of industrial and scientific activities that emit radiations taking place. Chemicals are stored and used in the laboratories; drugs are used in the medical centre, and different rock samples and solid minerals brought into the school premises are crushed, processed and used for study in the Geosciences units. It therefore becomes very necessary to carry out radiation measurements to know the radioactivity level and, of course, assess the equivalent dose that the occupants are exposed to in comparison with the internationally accepted maximum permissible level. In doing this, it will be possible know whether radiations pose danger or health threat to the occupants for the purpose of regulation and control.

Measurements of natural background radiation have been carried out in several parts of the world using various techniques. Such techniques include appropriate chambers as well as portable and airborne scintillation counters among others. Laboratory analyses of the radioactive elements in soil, air, rock and water have equally been employed for estimation of average radiation exposure in different environments (Mishroi and Sadosioan 1970; Arena, 1971; Molla and Alan, 1975; Abe et al., 1980; AcAnlay and Colgan, 1980; Babalola, 1984; Chang et al., 1985; Umor, 1985; Umar, 1995; Solomon, 1986; Ekpo and Inyang, (1998); Eisenbud and Paschoa, 1989; Azu, 1993; Baeza et al., 1994; Hayumb and Maleya, 1995; Bou-Rabee and Bem, 1996 Ajayi and Ajayi, 1999; Johnson et al., 1999; Parisi et al.,1999; Romanyukha et al., 1999; Adiukwu-Brown and Ogezi, 2001; Ajayi, 2002;Solomon et al., 2002; Chad-Umoren and Margaret, 2007; Odunaike, 2009;

This paper intends to study comprehensively, radioactivity level at Ikot Akpaden Main Campus of Akwa Ibom State University, Nigeria, using Portable Alert Nuclear Radiation Monitor.

II. Study location

The study sites are located within latitudes $04^0 37'$ 18.6" – $04^0 37'$ 29.9", north of the Equator and Longitudes $07^0 46'$ 02.8"- $07^0 45'$ 44.1", east of the Prime Meridian. The area which is surrounded by swamps has estimated terrain elevation above sea level ranging from 18-30m. The area is characterized by ionization and radiations from powered plants, discarded/expired chemicals and heaps of rocks of various types from geosciences units. Other sources of radiations include discarded biochemical fluids from the University health centre, stench associated radiations from the argillaceous formation of the surrounding swamps, vehicular radiations within and outside the University and radiations from oil spills and gas flaring activities brought in by the operating oil companies flanking the university.

Statements of problem and purpose of the study

The survey locations are within a public institution where students, staff and the general public are found. The institution stores some chemicals, reagent, equipment, rock and mineral elements in addition to drug, granite and other building materials that may contribute to background radiation. There is need for survey to know the level of radiation with reference to the maximum permissible level in order to find out whether it calls for the attention of regulatory control agencies to make recommendations based on findings.

III. Material and methods

In situ measurement of radioactivity and assessment of total radiation intensity was carried out using a Portable Inspector Alert Nuclear Radiation Monitor (Serial number 33333, made in USA by International Medcom) at twenty two (22) selected sites within the Main Campus of Akwa Ibom State University, Ikot Akpaden in Mkpat Enin Local Government Area, Akwa Ibom State, Nigeria.

One hundred (100) in-situ measurements were taken per study site and the mean calculated with standard error. That was done for the 22 selected study sites. The measurements were taken in micro sievert per hour ($\mu Svhr^{-1}$). The equivalent dose rate in $\mu Svhr^{-1}$ from the survey meter was converted to annual dose rate in $mSvyr^{-1}$ using the mathematical relationships given by Marilyn and Maguine (1995), thus:

$$HT_c = \frac{\delta \times \mu \times 24 \times 365}{1000} \quad (1)$$

$$\delta = \frac{HT}{Q} \quad (2)$$

HT being equivalent dose in $\mu Svhr^{-1}$, HT_c is equivalent dose in $mSvyr^{-1}; \delta$ being the absorbed dose in $Gyhr^{-1}$; μ is the outdoor occupancy factor; Q is the quality factor = 1

The standard error SE was equally calculated for each of the locations using

$$SE = \frac{HT_{CH} - HT_{CL}}{F} \quad (3)$$

HT_{CL} is the lowest value of equivalent dose ($mSvyr^{-1}$) for the study site calculated,

F is the frequency or total number of measurements taken for the estimated site.

HT_{CH} is the highest value of equivalent dose in $mSvyr^{-1}$ for the study site calculated.

Recommended indoor and outdoor occupancy factors of 0.8 and 0.2 respectively given by UNSCEAR (1988) are the proportion of the total time which an individual is exposed to radiation field.

IV. Results and discussion

The results of the measurements obtained are presented in Table 1. The table shows the mean dose equivalent with standard error in $mSvyr^{-1}$ for the twenty two study locations within the University Campus. The mean location dose equivalent ranges between $(0.1269 \pm 0.0078)\, mSvyr^{-1}$ in location RAD 12, Female Word (medical centre) to $(0.7247 \pm 0.0980)\, mSvyr^{-1}$ in location RAD 7, Chemistry Store for chemicals and reagents.

Table 1: The Mean Dose Equivalent with Standard Error for Locations in Akwa Ibom State University Ikot Akpaden Main Campus

Location code	Locations	Average equivalent dose ($\mu Svhr^{-1}$)	Average equivalent dose ($mSvyr^{-1}$)
RAD 1	Behind main chemistry Lab.	0.2061 ± 0.0090	0.3606 ± 0.0158
RAD 2	Physics Laboratory 2	0.1123 ± 0.0201	0.1965 ± 0.0350
RAD 3	Physics laboratory 1	0.1165 ± 0.0110	0.2039 ± 0.0193
RAD 4	Physics lecture room	0.0918 ± 0.0118	0.1606 ± 0.0206
RAD 5	University field	0.0525 ± 0.0075	0.1506 ± 0.0131
RAD 6	Chemistry Laboratory 2	0.11750 ± 0.006	0.2057 ± 0.0105
RAD 7	Chemistry store	0.4141 ± 0.0560	0.7247 ± 0.0980
RAD 8	Science lecture theatre	0.2901 ± 0.0060	0.5077 ± 0.0105
RAD 9	Administrative block	0.0770 ± 0.0060	0.1348 ± 0.0105
RAD 10	Faculty of Education	0.1145 ± 0.0086	0.2004 ± 0.0150
RAD 11	Medical centre	0.1170 ± 0.0080	0.2048 ± 0.0140
RAD 12	Female ward (medical centre)	0.0725 ± 0.0420	0.1269 ± 0.0735
RAD 13	Workshop and Maintenance	0.1550 ± 0.0090	0.2713 ± 0.0157
RAD 14	Power house	0.1185 ± 0.0015	0.2074 ± 0.0026
RAD 15	University dump site	0.0741 ± 0.0045	0.1296 ± 0.0078
RAD 16	Café tens kitchen	0.1325 ± 0.0105	0.2319 ± 0.0184
RAD 17	Botany laboratory	0.0835 ± 0.0060	0.1462 ± 0.0105
RAD 18	Behind Geosciences laboratory	0.1415 ± 0.0030	0.2477 ± 0.0053
RAD 19	Main road entrance	0.2405 ± 0.0090	0.4209 ± 0.0158
RAD 20	Biotechnology laboratory	0.1050 ± 0.0120	0.1838 ± 0.0210
RAD 21	Male ward (medical centre)	0.1145 ± 0.0300	0.2004 ± 0.0525
RAD 22	Medical laboratory	0.0895 ± 0.0240	0.1567 ± 0.0420

This is plausibly due to the chemical contents in the location that may contribute to the high dose. The results obtained did not indicate health threat on the occupants of the campus. In all, it is far below the dose equivalent recorded by Chad-Umoren et al., (2010) for Upland College Campus Environment in Rivers State, Nigeria, which recorded between $0.704 \pm 0.106\ mSvyr^{-1}$ and $0.805 \pm 0.070\ mSvyr^{-1}$. This is plausibly due to the chemical contents in the location that may contribute to the high dose. The results obtained did not indicate health threat on the occupants of the campus. In all, it is far below the dose equivalent recorded by Chad-Umoren et al., (2010) for Upland College Campus Environment in Rivers State, Nigeria, which recorded between $0.704 \pm 0.106\ mSvyr^{-1}$ and $0.805 \pm 0.070\ mSvyr^{-1}$

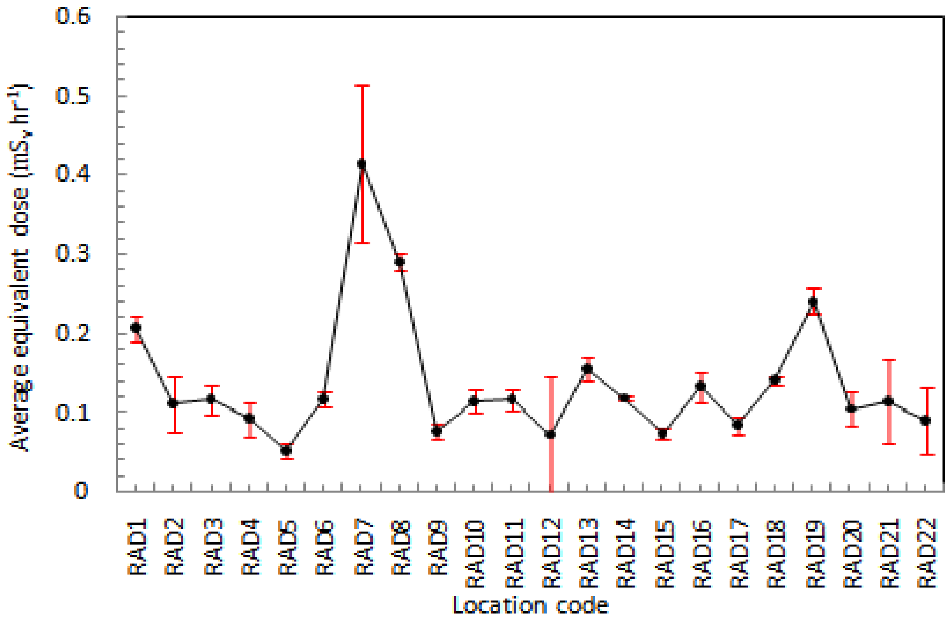

Figure 1 (a) A graph showing variations of average equivalent dose ($\mu S_v hr^{-1}$) and the error bars against the location code in Akwa Ibom State Universit

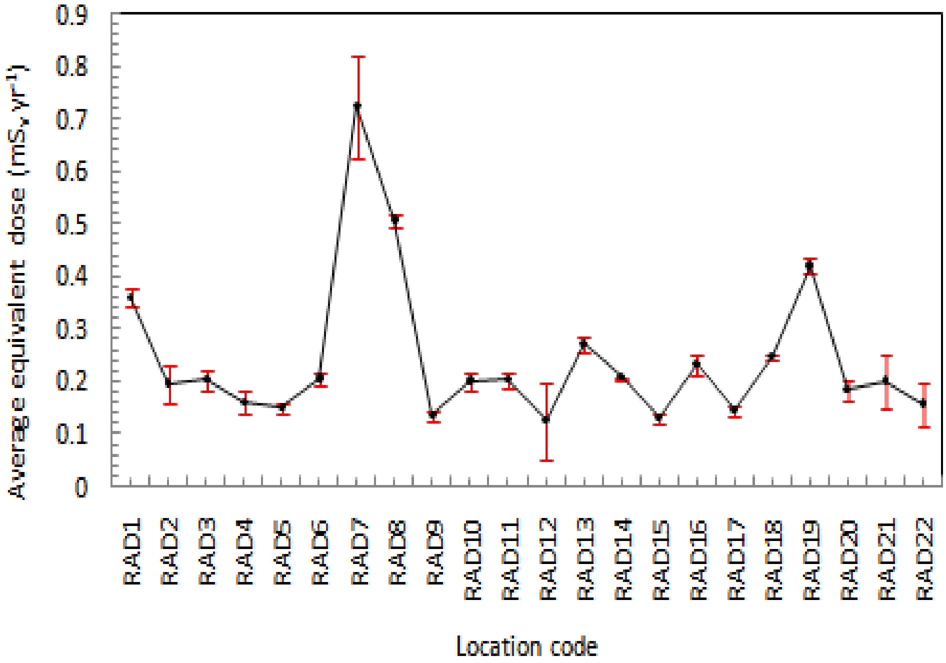

Fig 1 (b): A graph showing variation of average annual equivalent dose ($mS_v yr^{-1}$) and the error bar against the location code in Akwa Ibom State University

The values in our report are less than the values reported for locations in some Nigerian towns such as Enugu, Port-Harcourt, Owerri, Benin City, Awka, Ijebu Ode, Ibadan and Lagos by Obioha and Okonkwu (2001). In general, our measured values are far below the maximum permissible dose (MPD) of $1\,mSvyr^{-1}$ and $20\,mSvyr^{-1}$ as seen in Lewis et al. (1999), despite the fact the location of study is within the oil - rich Niger Delta region, where oil exploration and solid mineral mining is in the increase.

V. Conclusion

The result of the computed mean equivalent dose rate for the University Community is $0.2442 \pm 0.0240 mSvyr^{-1}$. Comparing the result with the stipulated regulatory maximum permissible level, even at location within the campus with maximum measured value, it is far below the maximum permissible level, indicating that there is no threat of radiological hazard within the University Campus which has operated for five years now. However, routine and periodic radiation level assessment within the University campus and its vicinity is recommended as accumulated effect which is a function of time may raise the level of radiations and pose threat to health in future. The findings of this survey within the investigated University campus show that radiations are far below the stipulated permissible level given by Regulatory and Controlled Agencies hence, does not pose a threat of radiological health hazard on the occupants within the University. However, the above notwithstanding, routine or periodical investigation or survey to monitor radiation level and, of course, equivalent dose within the University campus which has only being in operation for five years and its vicinity is recommended.

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