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BACKGROUND RADIATION LEVEL MEASUREMENT IN DELTA STATE UNIVERSITY, CAMPUS III, ABRAKA, NIGERIA

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Abstract
An in-situ measurement of the background radiation level was carried out at the Delta State University Campus III, Abraka. A portable Radiation levels monitor FS2011+ and ETREX Germin GPS was used for the measurement. A total of 22 points (11 outdoor and 11 indoor) was surveyed across the campus for background environmental radiation. The outdoor dose rate varies from 0.13µSv/hr to 0.25µSv/hr. For the indoor measurement, the minimum dose rate 0.12µSv/hr the maximum dose rate 0.23µSv/hr. It was noticed that the outdoor dose level was higher than the indoor dose level. The results show that the average outdoor and indoor point studied is 0.19µSv/hr and 0.12µSv/hr and this radiation level did not exceed the recommended limit of 1mSv/annum by International Commission on Radiation Protection which is still less than the ICRP limit value for non-occupational population exposure.
Keywords: Radiation, emission, indoor, outdoor, dose rate, study, exposure

INTRODUCTION

Natural sources of external radiation exposure consist of cosmic and terrestrial radiation. There has been an increasing interest in the identification of low-level radiation sources as a part of the defense strategy against dirty bomb scenarios (Kathren, 1991). The ability to identify the signatures of such sources enables us to detect them before they are set-off, in particular while they are being transported or stored. In another scenario, such capability enables us to detect radiation traces and estimate their extent in seemingly conventional explosions so that first responders can be forewarned and suitably protected against such low-level yet very hazardous radiation (Ademola, 2008). Typically, in both these scenarios the radiation levels could be low enough to appear as normal variations of the background radiation. This problem is particularly acute since the radiation measurements follow the Poisson process whose variance is of the same order as the radiation level itself. While long-term averages of low-level sources do result in elevated levels and eventually be detected, our focus is on identifying them quickly to ensure fast response. In general, the area of detecting various radiation sources using individual sensors has been well established both in terms of devices and detection methods, most of which are dedicated to single or co-located sensor systems. Recent advent of sensor network technologies, however, opened up the potential for improved detection, and also for the estimation of source parameters by utilizing measurements from multiple, geographically dispersed sensors, as reflected in several works(Kathren, 1991).

Exposure to natural radiation can come through inhalation, ingestion or otherwise enters the blood stream through wounds and also from irradiation from external sources such as linear accelerators. Radiation damage to tissues or organs of the body depends on the dose of radiation received or the absorbed dose which is expressed in a unit called gray (Gy). The potential damage from an absorbed dose depends on the type of radiation and sensitivity of different tissues and organs. The effective dose is used to measure ionizing radiation in terms of the potential for causing harm. Sievert, the unit of effective dose takes into account the type of radiation and sensitivity of tissues and organs (WHO, 2008).

Compared to the identification of high intensity radiation sources, detection and localization of low-level sources is difficult, particularly when the intensity levels are only marginally above background radiation levels. There are two major considerations:

Varied Background Radiation: The background radiation depends both on local natural and manmade sources and global sources such as cosmic rays, and hence may vary significantly from one deployment region to the other. If not carefully interpreted, such measurements may lead one to conclude ghost sources that potentially cause unnecessary response and panic and

Probabilistic Radiation Measurements: The radiation sources give rise to inherently probabilistic measurements. Typically the gamma radiation from point sources follows the Poisson distribution to a first order of approximation. The probabilistic nature combined with varied background radiation makes it hard to derive a priori thresholds needed by typical detection methods. Furthermore, the estimation of source location parameters is more complex compared to the usual triangulation methods developed for deterministic measurements. Nevertheless, the estimation can be made more effective when a network of sensors is employed, although many estimation problems still remain to be solved (Abison 2001).

There would be no life on earth without lots of sunlight, but we have increasingly recognized that too much of it on our persons is not a good thing. In fact it may be dangerous, so we control our exposure to it. Background radiation dose consists of the radiation doses receive from natural and man-made background. Radiation sources are classified into natural radiation source and man-made radiation source (Abison 2001).

Natural background radiation contributes about 81% of the annual dose to the population and man-made background radiation contributes the remaining 19%. Natural and m man-made radiations do not differ in kind or effect. Man-made radiation is generated in range of medical, commercial and industrial activities. The most familiar and, in national terms, the largest of these sources of exposure is medical X-rays (Hunt, 1987).

The objective of this project is measure the background radiation level and the absorbed dose rate to the students, staffers and member of the general public within Delta State University, Abraka, Campus III campus of the tertiary institution. The values obtained for background radiation from this work will form part of the baseline data for environmental radiation in study area.

The use of radiation detection instrument has been successfully used for the past three decade the measured and monitored radiation level. A typical system consists of a gamma source, detector and microprocessor (Gyang, and Ashano, 2005). The gamma source is normally mounted external to the vessel, and emits energy through the vessel walls collimated in a direction towards the detector, mounted on the opposite side of the vessel. The gamma energy reaches the detector when the vessel is empty. As the process level rises in the vessel, the gamma energy reaching the detector will decrease in an inversely proportional relationship to the level. A computer processes the detector signal and outputs the process variables in 4-20mA. Gamma technologies are an attractive option to users because they are mounted external to the tank or vessel, allowing for installation and maintenance to take place without expensive modifications or interruption to the process.

Nyango (2006) measured the background radiation within University of Jos campus environment and reported a mean equivalent dose of 2.059mSv/yr. (Agba and Tyovenda, (2007) measured the background radiation in Akwanga, Nigeria, using an Inspector alert nuclear radiation meter and reported that the indoor readings ranged from 1.04 to 1.75mSv/yr while the outdoor readings ranged from 0.24 to 0.44mSv/yr. The Annual mean equivalent doses for indoor and outdoor backgrounds were 1.29±0.13 to 0.31±0.14mSv/yr respectively. Jwanbot et al (2012) measured the indoor background ionizing radiation in some Science laboratories in University of Jos-Nigeria and obtained a range of 2.081mSv/yr to 2.733mSv/yr.

Agbalagba and Meindinyo (2010), measured the radiation impact associated with oil spillage in Ughelli region of Delta State using a diligent nuclear radiation monitor meter and a geographical positioning system (GPS). In their study, they measured the average radiation ranged between 0.010 mRh^{-1} (0.532mSv/y) to 0.019 mRh^{-1}(1.010mSv/y). They show that the annual exposure rate ranged between 0.013±0.006mRh^{-1}(0.692±0.080mSv/y) to 0.016±0.005mRh^{-1} (0.851±0.100mSv/y) in the oil spillage area.

Kuroda (1991) reported that this background radiation levels are from a combination of terrestrial (^{40}K, ^{232}Th, ^{226}Ra etc) and cosmic radiation (muons, photons etc.). He also reported that the level of radiation is fairly constant over the world, being 0.008- 0.015mRh^{-1}. Avwiri and Ebeniro (1998) studied the external environmental radiation in an industrial area of Rivers state. They reported an average value of 0.14 mRh-1 of background ionizing level. The results indicated a slight elevation from the normal background radiation of 0.013 mRh^{-1}.

Akinloye et al. (2004) studied the indoor radiation exposure rates in some building in Ogbomoso, Nigeria and reported a value range of 1.57-1.89μRh^{-1}. They concluded that the values obtained are within the limits of 2.0-3.0μRh^{-1} for areas of normal background radiation.

Halim, et al., (2009), studied natural background radiation of a base station in Yalvaç county using a Geiger-Mueller LND712 detector, Radiation Alert Monitor 4, calibrated by Cesium 137 (137Cs) every month during one year in order to detect natural background radiation rate exposed by man around base station in Yalvaç. In their study, they show that the annual arithmetic mean radiation dose varies from 1.92 to 2.27mSv/year and it was compared with radiation dose limits of a body.

Abou-Bakr, et al., (2012). Forecasts gamma radiation levels using digital image processing. In their work, they introduce a new way for data visualization. Its name was " Digital 'application name' Image". They created normal digital image by digital camera or digital scanner but digital application name image is created by measurements of monitoring data. They used data which was measured by some radiation monitoring stations and classifies it using fuzzy logic rules to create some digital radiation images.

Olarinoye et al., (2010) measured the background gamma radiation levels at two tertiary institutions in Minna, Nigeria. They carried out their work three campuses of two major tertiary institutions in Minna using portable Geiger-Mueller tube-based environmental radiation dosimeter for the measurement. They show that in their survey, the mean dose rate was 0.154μSv/hr with a standard deviation of 0.017μSv/hr. They reported that the average annual effective dose obtained from this study is 0.189mSv/annum which is still less than the recommended limit of 1mSv/annum by International Commission on Radiation Protection for non-occupational population exposure.

MATERIALS AND METHODS

Study Area

Delta State University, Abraka, Campus III, is located in Ethiope East Local Government Area of DELSU. The population of these areas has increased tremendously over recent years due to many factors. These may factors include, relative peace, increase in business activities in the town due to the increasing numbers of students being admitted each year. Although the town does not boast of any manufacturing company which utilizes radioactive materials, the geology of the state suggests that environmental radiation level in the state could be significant. The study area is dominated by moderate vegetation cover and slight flat topography. The area is covered by three major formations; the Benin, Akata and Abada formations. The sedimentary rocks to the south are characterized by sandstones and alluvial deposits. This subarea also contains the extensive flood plains of the River Niger and this has made the state to be one of the largest and most fertile agricultural lands in the country. Fig 1 show the map of Delta State showing the study area.

Figure 1: Map of Delta State showing study area.
Study Area

METHODS

Abraka is the host community of Delta State University, with three campuses in the community. Abraka was chosen because of the increasing population of the area. The study was carried out in campus III, the sample sites was randomly selected for even distribution of the study to be carried out. They include areas which record high population flux throughout the day. These include: Pre-degree Auditorium (PDA), Business Center (BC), Pre-degree Hall (PDH), Faculty of Social Science (FSS), Anglican Chapel Church (ACC), Institute of Science Laboratory Lecture Hall (ISLTH), Pharmacy Lecture Room (PLR), Senate Chamber (SC), Lecture Theatre (LT), Medical Lecture Hall (MLH), Medical Student Hostel

(MSH). Radiation levels monitor FS2011+ was used to measure the radiation and ETREX Germin Global Position System (GPS) was used to determine the coordinates of the sample area. The instrument is capable of measuring gamma dose rates in the range 0-20mR/hr. This is because of its high sensitivity. The monitor was suspended in air via a retort stand at one meter above the ground level at open and undisturbed level. At each point, the total count for 30 minute was recorded. Five successive readings were taken for each point. The measurement was taken for outdoor and indoor.

DATA PRESENTATION, INTERPRETATION AND DISCUSSION

Results

Table 1 and 2 Shows the Radiation Field Data. Table 1 shows the outdoor radiation level while table 2 shows the indoor radiation level.

Date: 06/07/2017.

Observer: Osiga-Aibangbee, Site Location: DELSU Campus III, Instrument: Radiation levels monitor FS2011+ and ETREX Germin GPS

Table 1: Outdoor Radiation Level.

S/N	Geographical Location	Sample Location	Dose Rate $mSvh^{-1}$
1	N05⁰47.273' E006⁰07.059'	PDA	0.13
2	N05⁰47.301' E006⁰06912	BC	0.25
3	N05⁰47.280' E006⁰06.971'	PDH	0.14
4	N05⁰47.412' E006⁰07.400'	FSS	0.17
5	N05⁰47.376' E006⁰07.154'	ACC	0.17
6	N05⁰47.504' E00607.225'	ISLTH	0.25
7	N05⁰47.642' E006⁰07.412'	PLR	0.23
8	N05⁰47.912' E006⁰07.591'	SC	0.24

9	N05⁰47.948' E006⁰07.530'	LT	0.16
10	N05⁰47.277' E006⁰07.231'	MLH	0.18
11	N05⁰47.297' E006⁰07.185'	MSH	0.21
Mean			0.19

Table 1: Indoor Radiation Level.

S/N	Geographical Location	Sample Location	Dose Rate mSvh^{-1}
1	N05⁰47.273' E006⁰07.059'	PDA	0.12
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4	N05⁰47.412' E006⁰07.400'	FSS	0.12
5	N05⁰47.376' E006⁰07.154'	ACC	0.09
6	N05⁰47.504' E00607.225'	ISLTH	0.12
7	N05⁰47.642' E006⁰07.412'	PLR	0.12
8	N05⁰47.912' E006⁰07.591'	SC	0.10
9	N05⁰47.948' E006⁰07.530'	LT	0.12
10	N05⁰47.277' E006⁰07.231'	MLH	0.11
11	N05⁰47.297' E006⁰07.185'	MSH	0.12
Mean			0.12

DISCUSSION

A total of 22 points was surveyed, 11 outdoor and 11 indoor across the campus for background environmental radiation. The dose rate obtained at each point is presented in table 1 and 2. For the indoor measurement, the minimum dose rate 0.12µSv/hr the maximum dose rate 0.23µSv/hr at as shown in figure 2 and 6. The

outdoor dose rate varies from 0.13µSv/hr to 0.25µSv/hr at as shown in figure 3 and 7.
Generally, the outdoor dose rate and the indoor dose rate are compared to one another (Figure 4 and 5) and could simply be attributed to natural sources as there are no radiation generators around the campus. The outdoor and the indoor mean dose rate of the surveyed areas are found to be 0.19µSv/hr and 0.12µSv/hr respectively. This may be due to the fact that they have similar geology. The results of the exposure rate in the study area show that the radiation level did not exceed the normal background level which is still lower than the recommended limit of 1mSv/annum by International Commission on Radiation Protection (ICRP, 2006). The average effective dose for the outdoor and indoor point studied is 0.19µSv/hr and 0.12µSv/hr which is still less than the ICRP limit value for non-occupational population exposure.

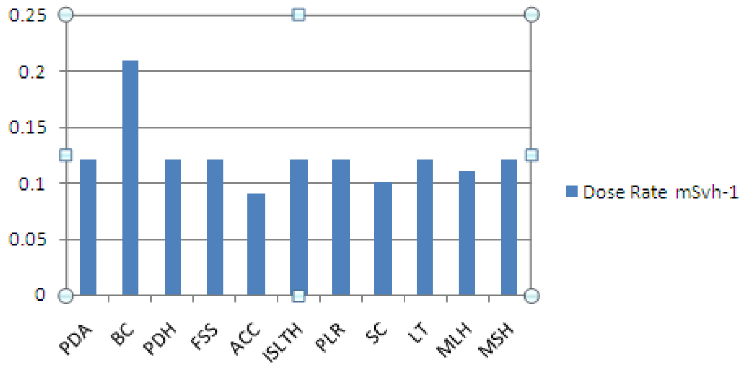

Figure 2: Indoor Dose rate for locations at Campus III

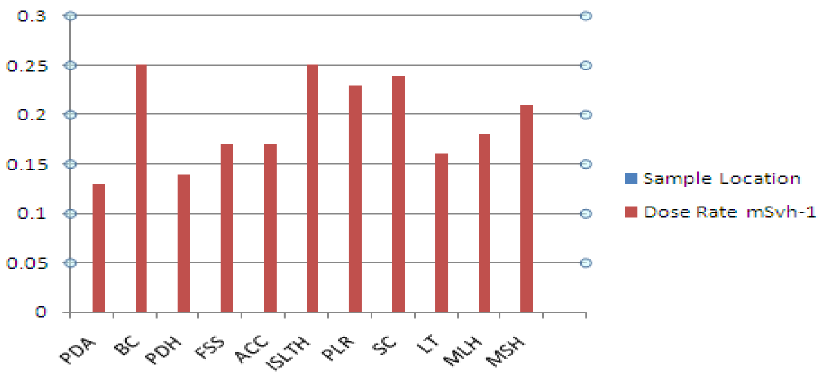

Figure 3: Outdoor Dose rate for locations at Campus III

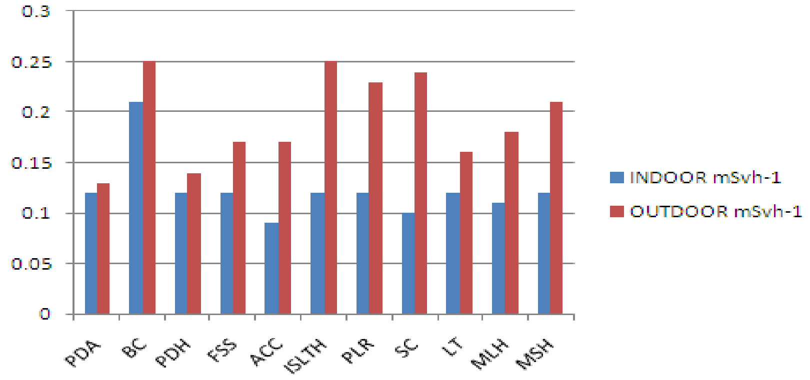

Figure 4: Comparison of outdoor and indoor Dose rate for locations at Campus III

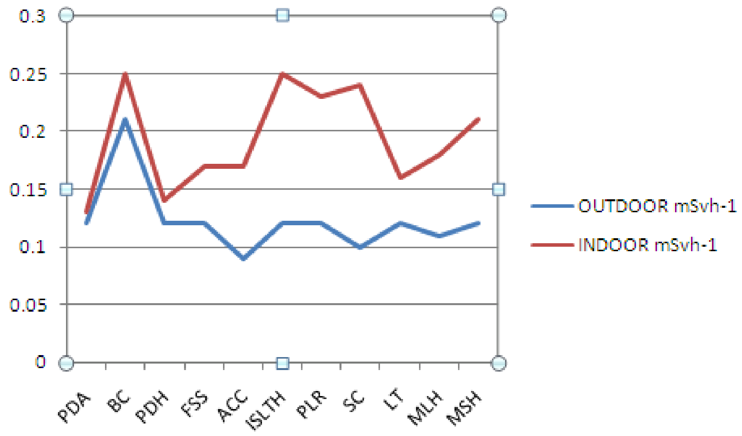

Figure 5: Comparison on outdoor an indoor Dose rate for locations at Campus III

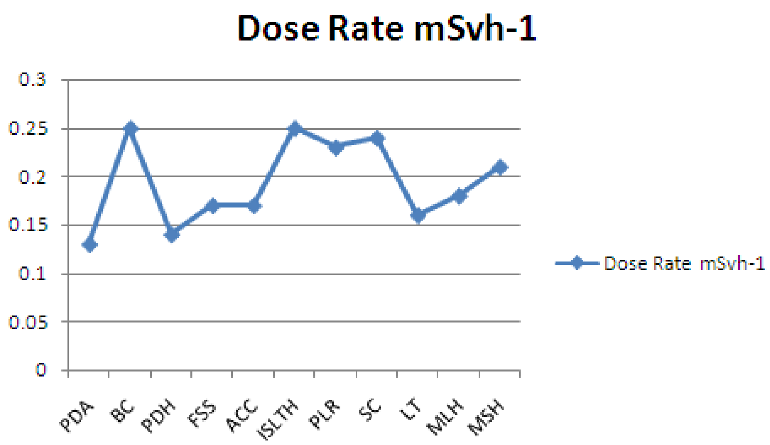

Figure 6: Indoor Dose rate for locations at Campus III using line graph

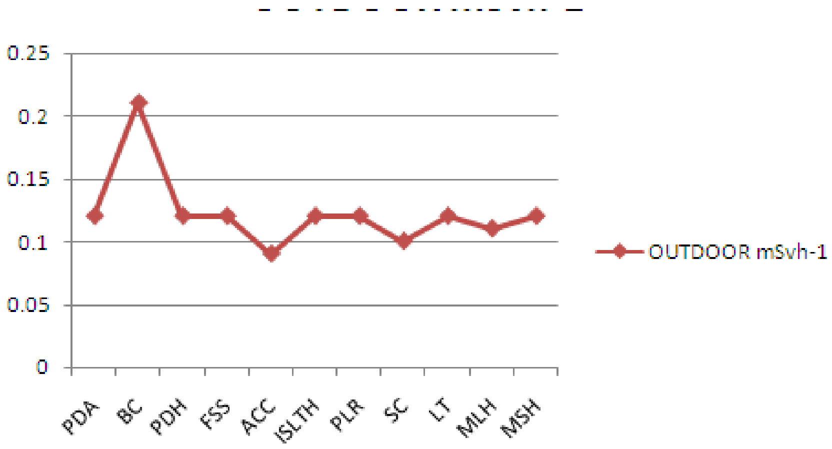

Figure 7: Outdoor Dose rate for locations at Campus III using line graph

CONCLUSION

Radiation level measurement has been conducted in Delta State University Campus III, Abraka. Outdoor and indoor survey was conducted. The result obtained shows the background radiation in the study area. A total of 11 outdoor and 11 indoor points was surveyed. The background radiation observed at the surveyed area could be attributed only to natural sources (cosmic and terrestrial). The geology of the area suggests that the soil in the town also contributes radiation level measured in the area. The results show that there is no trace of deposit of radioactive mineral around the survey areas. The dose rate values obtained are lower when compared to values from indoor and outdoor to the global average; their effective annual dose is still lesser than the dose limit recommended by the ICRP.

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