

## **Estimation of Outdoor Background Radiation Doses in Three Science Laboratories in the Niger Delta University, Bayelsa State**

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### **ABSTRACT**

*This work estimates the outdoor background radiation of three (Chemistry, Physics and Biology) laboratories in the Niger Delta University (NDU), Bayelsa State, Nigeria. A typical Radiation Monitoring Device - Radalert x 100 was used. The outdoor of the three laboratories were sectioned into seven different locations. The Background Ionizing Radiation (BIR) mean value of 0.009mSv/y was recorded in Physics laboratory, which has the lowest and 0.013mSv/y was recorded at Biology laboratory, which is the highest while Chemistry laboratory recorded 0.010mSv/y. The mean Absorbed dose rate (AbD) of 0.077nGy/h was recorded in the outdoor of the Physics laboratory, which is the lowest and mean value of Absorbed dose rate (AbD) of 0.112nGy/h was recorded in Biology laboratory, which is the highest while chemistry laboratory recorded AbD mean value of 0.087nGy/h. A mean value of Annual Effective dose Equivalent (AEDE) rate of 0.118mSv/y was recorded in Physics laboratory, which is the lowest while a mean value of Annual Effective dose Equivalent (AEDE) of 0.171mSv/y was recorded in Biology laboratory and Chemistry laboratory with an AEDE mean value of 0.128mSv/y. On the Excess Life Cancer Risk (ELCR) mean values of the three laboratories, Physics recorded the lowest mean value of 0.326; Biology documented the highest mean value of 0.473 and Chemistry with a mean value of 0.352. The values obtained were then compared to the World Permissible Limit as given by UNSCEAR 2000. Continuous background Ionization radiation was recommended to checkmate the BIR level in the laboratories.*

**Keywords:** *Radiation, Background Ionizing radiation, Dose rate, Dose Distribution, measurement*

## INTRODUCTION

Radiation is defined as energy that passes through matter or space as a wave or particle. We are surrounded by many forms of radiation (WHO, 2020). Although there are many other types of radiation, most people associate it with radioactivity, nuclear power, and atomic energy. Familiar forms of radiation include sound, visible light, radio and television transmissions (NRC, 2022). Natural background radiation is the term used to describe the ionizing radiation that comes from natural sources to which we are all exposed. Man-made radiation is produced by commercial, industrial, and medical operations (EPA, 2022). There is unavoidably background radiation from nature in our surroundings. Higher radiation levels are connected with volcanic rocks, such granite, while lower levels are associated with sedimentary rocks (World Nuclear Association, 2022). The quantity of radiation is correlated with the kind of soil that the soils come from (Abubakar *et al*, 2017). Radon is a gas that permeates the earth's crust and is found in the air we breathe, and it is mostly to blame for our natural exposure. According to Osiga (2014), the primary sources of natural radiation are soil, gas, cosmic radiation, terrestrial radiation, and naturally occurring radioactivity inside the body. The global annual equivalent dose rate of ionizing radiation was established by the International Commission on Radiological Protection (ICRP, 1990) at 2.4mSv/yr as the upper limit for human protection. Because radiation has an adverse effect on human health, it is imperative that we understand the amount of radiation present in our surroundings.

The following are some of the goals of this research project:

- to estimate the radiation dosage in the science laboratories in the Niger Delta University.
- to determine the outdoor background ionization radiation of the three science laboratories
- to determine the effective absorbed dose rate (AbD)
- determination of the annual effective dose equivalent rate (AEDE)

The Niger Delta University in Amassoma, Bayelsa state, was the site of this study. The Bayelsa State Government founded the institution in 2000. It now has four campuses: Gloryland Campus, New Site Campus, College of Health Sciences (CHS Campus), and Faculty Law Campus, as a part of its initiatives to support human capital development and meet the educational requirements of the people living in the Niger Delta. With the establishment of three faculties in 2001, academic activities have expanded to provide a broad spectrum of courses in several fields.

With GPS coordinates of latitude 40 58'13 N and longitude 60 32.94" E, the university is situated in Amassoma.

## MATERIALS AND METHOD

The materials used for this research include a handheld Radiation monitoring device. A computer software- Micro Soft Excel was used for statistical analysis. The outdoor background radiation of the three science laboratories, Chemistry laboratory, Physics laboratory, and Biology laboratory in Niger Delta University was measured at Seven (7) different locations randomly using a typical handheld radiation meter. In order to assess the average exposure level (height) of the human body, the radiation meter was held one meter above the ground. It was also angled vertically upward throughout the measurement process to expose the device's window to incoming radiation. Seven readings were obtained for every laboratory, in addition to measures collected outside at places like walks, walkways, and roads. The radiation meter's display screen was used to get the effective dose measurements, which were measured in milliradiation units per hour (mR/hr). According to UNSCEAR (2000), the occupancy factors for outdoor spaces are 0.8 and 0.2, respectively.



**Fig 1:** Back and Front view of the Radiation Monitoring Device- Radalert x100.

## RESULTS AND DISCUSSION

**Table 1:** The Outdoor Background Ionization Exposure rate in Chemistry laboratory and other calculated parameters

Location	BIR (mSv/hr)	AbD Dose (nGy/h)	Eqv Dose (mSv/y)	AEDE (mSv/y)	ELCR x 10 <sup>-3</sup>
Point 1	0.017	0.148	1.489	0.227	0.626
Point 2	0.006	0.052	0.526	0.080	0.221
Point 3	0.009	0.078	0.788	0.120	0.331
Point 4	0.011	0.096	0.964	0.147	0.405
Point 5	0.013	0.113	1.139	0.173	0.479
Point 6	0.005	0.044	0.438	0.067	0.184
Point 7	0.006	0.052	0.526	0.080	0.221
<b>Mean</b>	<b>0.010</b>	<b>0.083</b>	<b>0.838</b>	<b>0.128</b>	<b>0.352</b>

Table 1 shows the Outdoor Background Ionizing Radiation (BIR) exposure rate measurements for 7 different locations at the Chemistry laboratory and other calculated radiological parameters.

**Table 2:** The Outdoor Background Ionization Exposure rate in Physics laboratory and other calculated parameters

Location	BIR (mSv/hr)	AbD Dose (nGy/h)	Eqv Dose (mSv/y)	AEDE (mSv/y)	ELCR x 10 <sup>-3</sup>
Point 1	0.007	0.061	0.613	0.093	0.258
Point 2	0.008	0.070	0.701	0.107	0.294
Point 3	0.008	0.070	0.701	0.107	0.294
Point 4	0.007	0.061	0.613	0.093	0.258
Point 5	0.006	0.052	0.526	0.080	0.221
Point 6	0.009	0.078	0.788	0.120	0.331
Point 7	0.017	0.148	1.489	0.227	0.626
<b>Mean</b>	<b>0.009</b>	<b>0.077</b>	<b>0.776</b>	<b>0.118</b>	<b>0.326</b>

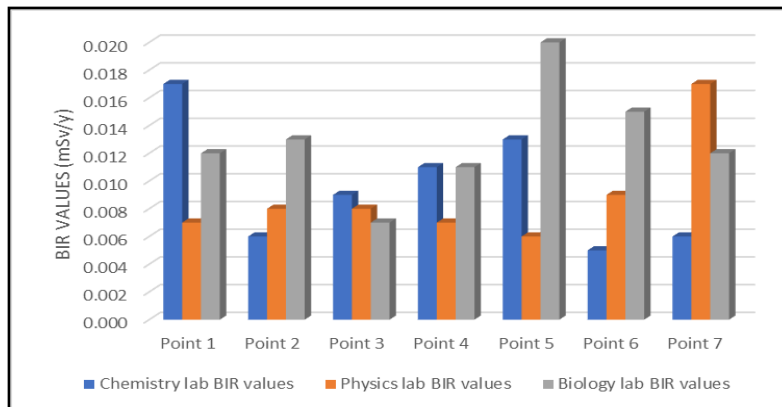
Table 2 shows the outdoor Background Ionizing Radiation (BIR) exposure rate measurements for 7 different locations at the Physics laboratory and other calculated radiological parameters.



**Table 3:** The Outdoor Background Ionization Exposure rate in Biology laboratory and other calculated parameters

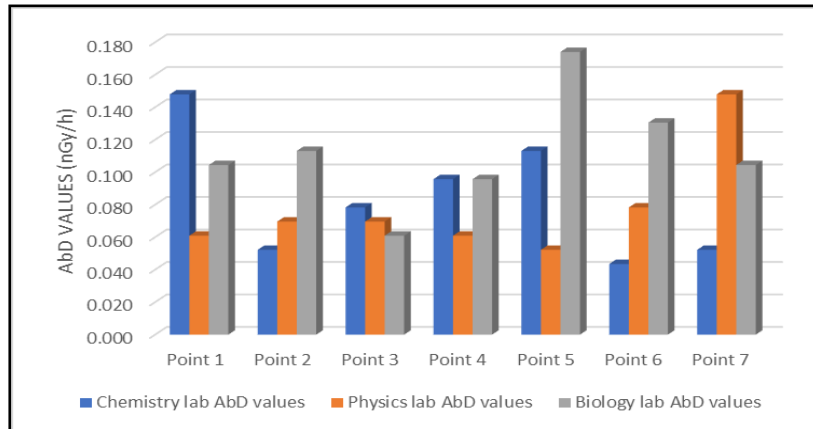
Location	BIR (mSv/hr)	AbD Dose (nGy/h)	Eqv Dose (mSv/y)	AEDE (mSv/y)	ELCR x 10 <sup>-3</sup>
Point 1	0.012	0.104	1.052	0.160	0.442
Point 2	0.013	0.113	1.140	0.173	0.479
Point 3	0.007	0.061	0.614	0.093	0.258
Point 4	0.011	0.096	0.965	0.147	0.405
Point 5	0.020	0.174	1.754	0.267	0.736
Point 6	0.015	0.131	1.316	0.200	0.552
Point 7	0.012	0.104	1.052	0.160	0.442
<b>Mean</b>	<b>0.013</b>	<b>0.112</b>	<b>1.128</b>	<b>0.171</b>	<b>0.473</b>

Table 3 shows the BIR measurements for 7 different locations at the Biology laboratory and other calculated radiological parameters.



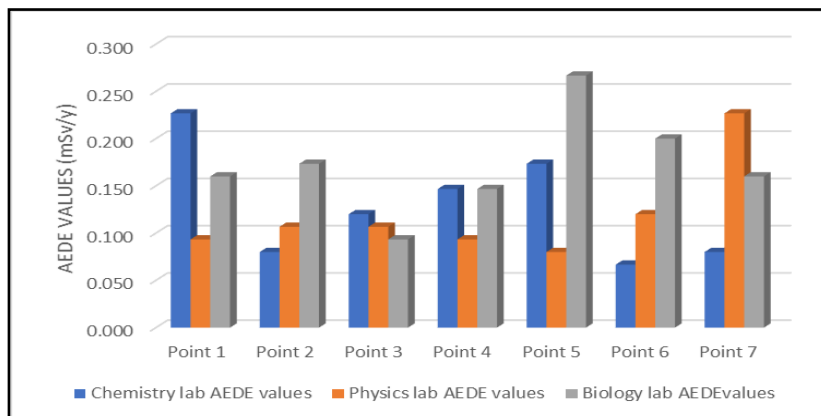
**Fig 1:** BIR exposure rate in different locations at Chemistry, Physics, and Biology laboratories

Figure 1 shows the Bar charts of BIR exposure rate values for various points at Chemistry laboratory, Physics laboratory and Biology laboratory. Biology laboratory has the highest BIR value at point 5 with a corresponding value of 0.020mSv/y and Chemistry laboratory with the lowest at point 6 with a value of 0.005mSv/y.



**Fig 2:** AbD exposure rate in different locations at Chemistry, Physics, and Biology laboratories

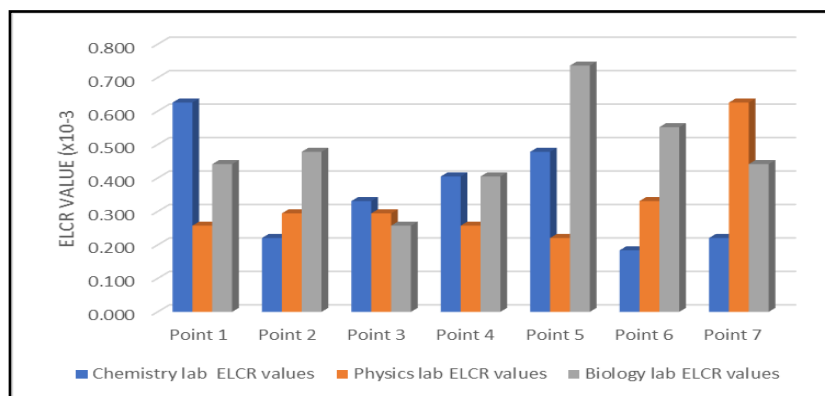
Figure 2 indicates the Bar charts of AbD exposure rate values for the three locations-Chemistry, Physics, and Biology laboratories, where Biology laboratories has the highest value of 0.144nGy/h and Chemistry laboratory with the lowest value with 0.113nGy/h.



**Fig 3:** AEDE exposure rate in different locations at Chemistry, Physics, and Biology laboratories

Figure 3 is a Bar chart of AEDE exposure rate values for the three locations-Chemistry, Physics, and Biology laboratories, where Biology laboratory has the highest

value of 0.267mSv/y and Chemistry laboratory with the lowest value with 0.173mSv/y. The results revealed that the occupational radiation dose is within the recommended limits within the world average value 0.013mSv/y as stipulated by UNSCEAR 2000.



**Fig 4:** ELCR exposure rate in different locations at Chemistry, Physics and Biology laboratories

Figure 4 is a bar chart of ELCR exposure rate values for the three locations- Chemistry, Physics and Biology laboratories, where Biology laboratories has the highest value of 0.736, Physics laboratory has the lowest value with 0.479, which is comparison with the world permissible limit,  $0.29 \times 10^{-3}$  provided by UNSCEAR 2000

The Background Ionizing Radiation (BIR) mean value of 0.009mSv/y was recorded in Physics laboratory, which has the lowest and 0.013mSv/y was recorded at Biology laboratory, which is the highest while Chemistry laboratory recorded 0.010mSv/y. The mean Absorbed dose rate (AbD) of 0.077nGy/h was recorded in the outdoor of the Physics laboratory, which is the lowest and mean value of Absorbed dose rate (AbD) of 0.112nGy/h was recorded in Biology laboratory, which is the highest while chemistry laboratory recorded AbD mean value of 0.087nGy/h. A mean value of Annual Effective dose Equivalent (AEDE) rate of 0.118mSv/y was recorded in Physics laboratory, which is the lowest while a mean value of Annual Effective dose Equivalent (AEDE) of 0.171mSv/y was recorded in Biology laboratory and Chemistry laboratory with an AEDE mean value of 0.128mSv/y. On the Excess Life Cancer Risk (ELCR) mean values of the three laboratories, Physics recorded the lowest mean value of 0.326; Biology documented the highest mean value of 0.473 and Chemistry with a mean value of 0.352. The values obtained were then compared to the World Permissible Limit as given by UNSCEAR 2000.

## CONCLUSION AND RECOMMENDATION

The research work shows the Outdoor Background Ionizing Radiation of Chemistry, Physics and Biology laboratories in Faculty of Science, Niger Delta University (NDU), Bayelsa State, Nigeria. A total of 7 Outdoor Background Ionizing Radiation was measured at 7 different points randomly outside the laboratories and other radiological parameters were also calculated. The Background Ionizing Radiation mean values of 0.010mSv/y, 0.013mSv/y in Chemistry and Physics laboratories respectively are below the world standard as recommended by UNSCEAR 2000 while the BIR value of 0.013mSv/y recorded in Biology laboratory is exactly the same with the permissible limits - 0.013mSv/y. Other radiological parameters values like the Absorbed Dose Rate (AbD), Annual Effective Dose Equivalent (AEDE) and Excess Life Cancer Risk are also below their individual world permissible limits as provided by UNSCEAR 2000. Hence, continuous background Ionization radiation should be carried out in the future to checkmate the BIR level in the laboratories.

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