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IJPRA ISSN 2766-2748 INTERNATIONAL JOURNAL OF PHYSICS RESEARCH AND APPLICATIONS

Research Article

Measurement of background ionizing radiation in the federal university of technology owerri, Nigeria using calibrated digital geiger counter

Eke BC[1]* and Emelue HU[2]

[1]Federal University of Technology Owerri, Nigeria
[2]Alvan Ikoku Federal College of Education Owerri, Nigeria

Abstract

The measurement of the natural ionizing radiation in the Federal University of Technology Owerri, Nigeria was carried out using a well calibrated Digital Geiger Muller counter models GCA – 04w. Measurements were taken randomly in thirty (30) different locations outside the building and thirty (30) locations inside different buildings in the University. Results obtained for outdoor Dose rate ranges from 0.07 μSv/hr to 0.23 μSv/hr with a mean value of 0.144 μSv/hr. While the result for the indoor dose rate ranges from 0.08 μSv/hr to 0.21 μSv/hr with a mean of 0.14 μSv/hr. The highest value recorded for the outdoor radiation is from the university front gate which is .023μSv/hr. While the highest value recorded inside the buildings is from the School of Agriculture and Agricultural Technology (SAAT) which is 0.21 μSv/hr. All these values are lower than the world safely limits of 0.247 μSv/hr. This shows that the risk of ionizing radiation on the staff and students of the Federal University of Technology is minimal.

More Information

***Address for Correspondence:** Emelue Henry Uzoma, Department of Physics, Faculty of Science, Alvan Ikoku Federal College of Education, Owerri, Nigeria, Tel: +2347031243228; Email: henrolala@hotmail.com; hemelue1@yahoo.com

Submitted: 06 May 2020
Approved: 22 May 2020
Published: 25 May 2020

How to cite this article: Eke BC, Emelue HU. Measurement of background ionizing radiation in the federal university of technology owerri, Nigeria using calibrated digital geiger counter. Int J Phys Res Appl. 2020; 3: 070-074.

DOI: 10.29328/journal.ijpra.1001025

Keywords: Ionizing radiation; Geiger muller counter; Dose rate; Outdoors; Indoors

Introduction

Natural radiation sources are classified into two groups. The first group is due to highly penetrating cosmic radiation mainly of glacial origin, while the second group is the terrestrial radiation from the primordial radionuclides, which have survived since the formation of the earth. The primordial radionuclides include the decay series of the radionuclides of Uranium–238 (^{238}U) and Thorium–232 (^{232}Th) and the single member chain of Potassium–40 (^{40}K) [1]. The primordial radionuclides which are widespread in the atmosphere constitute about 85% of the natural background radiation received by man. Then the remaining 15% is from the cosmic radiations [2]. Long term exposure to ionizing radiation has severe health implications such as acute leukemia, lung cancer, pancreas, hepatic, skin, kidney cancers, cataracts, sterility and atrophy of the kidney [3]. In Nigeria, environmental radiation measurements started in October 1959 following the nuclear weapons testing carried out by France in Reganne in the Sahara region of Africa. This monitoring effort was motivated by the fear of likely fallout in densely populated countries in the tropical Africa [4]. The results of this exercise, which spanned for three years, showed that the highest dose to the gonads was about 20% of the average annual dose of 0.1 rem (1 mSv) to individuals from natural causes. Since then, some specific or localized studies on radioactivity assessment in the environment have been done.

The Federal University of Technology Owerri (FUTO) was one of the institutions that were established in 1981. It moved into its permanent site (which is the location of this study) in 1993 with a land mass of about 4580 hectares. It is one of the most populous universities in the South East with a population of about forty five thousand (45,000) people (both staff and students) [5]. The map of the study area is shown below as figure 1. Eke and Emelue has previously studied the radiation emission and health hazard implications of refuse dump site in FUTO using the sodium iodide scintillation counter [5]. This present study focused not only on the refuse dump site, but on the entire school both outdoors and indoors. Exposure to ionizing radiation over extended period is known to result in non – leather mutation, which could increase the risk of

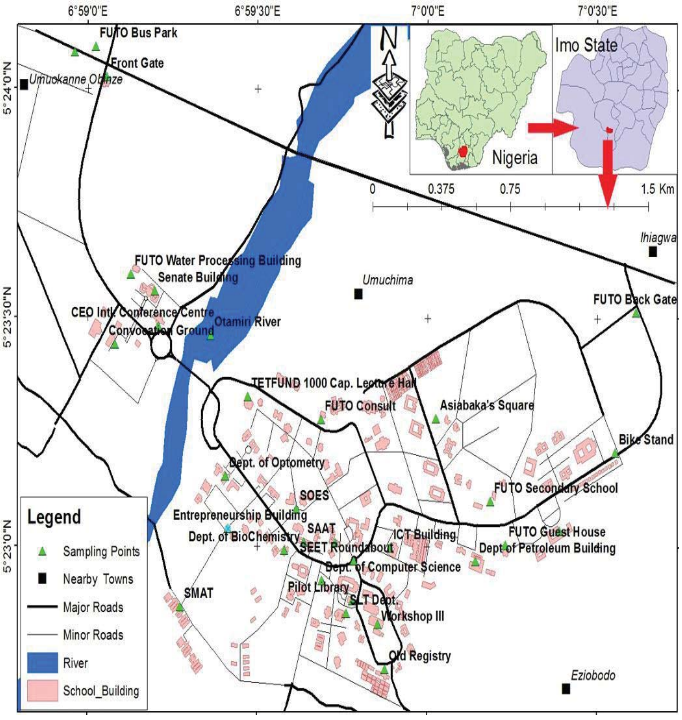

Figure 1: The map of the study area.

cancer [6]. There is a linear, no – threshold (LNT) relationship between radiation dose and the occurrence of cancer [7]. This dose-response hypothesis suggests that any increase in radiation dose, no matter how small, could results in an increase in cancer risk [8]. Hence the purpose of this study is to

1. Measure the natural background radiation present in both outdoors and inside the buildings in the Federal University of Technology (FUTO).

2. To compare the values obtained with international safety limits.

3. To obtain a baseline data for future reference and more research in the area.

Material and methods

The natural radiation levels were assessed using the digital Geiger – Muller Counter GCA – 04 and GCA – 04W. This instrument is capable of measuring the Natural Background Radiation (NBR) rates in one count per minutes (CPM). The digital Geiger counter is a particle detector that could detect Alpha, Beta and gamma radiations (although it detects gamma ray with lower sensitivity compared to other detectors). The main elements of a digital Geiger – Muller counter is a tube which is a chamber filled with a noble gas. This tube contains two electrodes (anode and cathode) which are coated with graphite. The anode is represented by a wire in the centre of the chamber, while the cathode forms the lateral area. One end of the cylinder through which the radiation enters the chamber, is sealed by a mica window. These features make it an ideal choice for the measurement of the natural background radiation rates. Ionizing radiation coming from the surrounding medium passes through the mica window and enters the Geiger – Muller tube [9]. It ionizes the gas inside the gas chamber and transforms it into positively and negatively charged ions. The negatively charged ions migrate towards the anode, while positively charged ions accelerate to the cathode end of the detector chamber. The positively charged ions in the anode will collide with the noble gas to produce more ions through an avalanche effect. This will produce electrical impulse between the two electrodes that could be measured as radiation measurement.

The location sites for the radiation measurements were randomly selected for even distribution of the study. The Geiger–Muller counter was held at about one meter above the ground level at open and undisturbed space. At each point, the total count was recorded for 60 seconds. Two successive readings were taken at each point so that the mean could be obtained. Each count was converted to micro – sievert per hour (μSv/hr) using equation 1. [10].

$$1 \text{ CPM} = 0.01\ \mu\text{Sv/hr} \quad (1)$$

Results and discussions

The results are presented in the tables and figures. The results for the outdoor radiation Dose rate ranges from 0.07 μSv/h to 0.23 μSv/hr as shown in table 1. The lowest measurement is 0.07 μSv/hr was recorded from the old Registry, while the highest value of 0.23 μSv/hr is from the From Gate. The mean value for the outdoor radiation measurements

Table 1: Outdoor radiation Dose rates.

S/N	Locations	CPM	Dose Rate (µSv/hr)	$\lvert X_i - \bar{X} \rvert$	$\lvert X_i - \bar{X} \rvert^2$
1	FUTO consult	14	14 X 0.01 =0.14	0.00	0.0000
2	Department of optometry	13	13 X 0.01 =0.13	0.01	0.0001
3	SAAT	11	11 X 0.01 =0.11	0.03	0.0009
4	Entrepreneurship building	11	11 X 0.01 =0.11	0.03	0.0009
5	SMAT	9	9 X 0.01 = 0.09	0.05	0.0025
6	SOET	19	19 X 0.01 = 0.19	0.05	0.0025
7	Department of Biochemistry	14	14 X 0.01 = 0.14	0.00	0.0000
8	Department of computer Sci	20	20 X 0.01 = 0.20	0.06	0.0036
9	Main Gate	23	23 X 0.01 = 0.23	0.09	0.0081
10	Convocation Ground	14	14 X 0.01 = 0.14	0.00	0.0000
11	Otamiri River	20	20 X 0.01 = 0.20	0.06	0.0036
12	SEET round about	12	12 X 0.01= 0.12	0.02	0.0004
13	Workshop 3	14	14 X 0.01 = 0.14	0.00	0.0000
14	Old Registry	7	7 X 0.01 = 0.07	0.07	0.0049
15	SOSC New lecture hall	12	12 X 0.01 = 0.12	0.02	0.0004
16	FUTO entrance express road	14	14 X 0.01 = 0.14	0.00	0.0000
17	FUTO water processing building	15	15 X 0.01 = 0.15	0.01	0.0001
18	C O International conference centre	13	13 X 0.01 = 0.13	0.01	0.0001
19	TETFund 1000 capacity lecture Hall	19	19 X 0.01 = 0.19	0.05	0.0025
20	FUTO bus park	16	16 X 0.01 = 0.16	0.02	0.0004
21	FUTO primary school	14	14 X 0.01 = 0.14	0.00	0.0000
22	Asiabaka's square	13	13 X 0.01 =0.13	0.01	0.0001
23	Bike stand	15	15 X 0.01 =0.15	0.01	0.0001
24	Petroleum building	8	8 X 0.01 = 0.08	0.06	0.0036
25	ICT building	12	12 X 0.01 = 0.12	0.02	0.0004
26	FUTO secondary sch	18	18 X 0.01 = 0.18	0.04	0.0016
27	FUTO back gate	19	19 X 0.01 = 0.19	0.05	0.0025
28	SLT	17	17 X 0.01 = 0.17	0.03	0.0009
29	FUTO guest house	16	16 X 0.01 = 0.16	0.02	0.0004
30	Pilot Library	11	11 X 0.01 = 0.11	0.03	0.0009

$\bar{X}$ (Outdoor mean) 0.144 µSv/hr; Standard deviation = 0.037 µSv/hr: World standard recommended value 0.274 µSv/hr

Table 2: Indoor radiation Dose rates.

S/N	Locations	CPM	Dose Rate (µSv/hr)	$\lvert X_i - \bar{X} \rvert$	$\lvert X_i - \bar{X} \rvert^2$
1	Physics lab. Room 229	14	14 X 0.01 = 0.14	0.00	0.0000
2	Ground Floor SoSe extension	10	10 X 0.01 = 0.10	0.04	0.0016
3	Drawing Studio SEET Head	13	13 X 0.01 =0.13	0.01	0.0001
4	Department of Fisheries & Aquaculture	19	19 X 0.01 =0.19	0.05	0.0025
5	Department of IMT	12	12 X 0.01 =0.12	0.02	0.0004
6	Hall of Mercy	11	11 X 0.01 =0.11	0.03	0.0009
7	750 capacity lecture theatre	14	14 X 0.01 = 0.14	0.00	0.0000
8	FUTO Medicals	18	18 X 0.01 =0.18		
9	Library	17	17 X 0.01 =0.17	0.03	0.0009
10	STACC	16	16 X 0.01 =0.16	0.02	0.0004
11	School of Health	17	17 X 0.01 =0.17	0.03	0.0009
12	Department of MMT	13	13 X 0.01 =0.13	0.01	0.0001
13	SOET	8	8 X 0.01 =0.08	0.06	0.0036
14	ETF SAAT	11	11 X 0.01 =0.11	0.03	0.0009
15	Senate Building	17	17 X 0.01 =0.17	0.03	0.0009
16	PRT Lecture hall	10	10 X 0.01 =0.10	0.04	0.0016
17	Biochemistry Lab.	14	14 X 0.01 =0.14	0.00	0.0000
18	SAAT Audit	21	21 X 0.01 =0.21	0.07	0.0049
19	Workshop 2	16	16 X 0.01 =0.16	0.02	0.0004
20	SEET Lecture hall 2	9	9 X 0.01 =0.09	0.05	0.0025
21	Department of Dental technology	14	14 X 0.01 =0.14	0.00	0.0000
22	Access Bank	15	15 X 0.01 =0.15	0.01	0.0001
23	Hostel C	14	14 X 0.01 =0.14	0.00	0.0000
24	SEET complex	18	18 X 0.01 =0.18	0.04	0.0016
25	Chemical Building	11	11 X 0.01 =0.11	0.03	0.0009
26	NDDC Hostel	10	10 X 0.01 =0.10	0.04	0.0016
27	Hostel A	20	20 X 0.01 =0.20	0.06	0.0036
28	Post Graduate Building	9	9 X 0.01 =0.09	0.05	0.0025
29	Frihub	13	13 X 0.01 =0.13	0.01	0.0001
30	Department of Physics	16	16 X 0.01 =0.16	0.02	0.0004

$\bar{X}$ (Indoor mean) = 0.140 µSv/hr; Standard Deviation = 0.034 µSv/hr; World standard recommended value 0.274 µSv/hr`

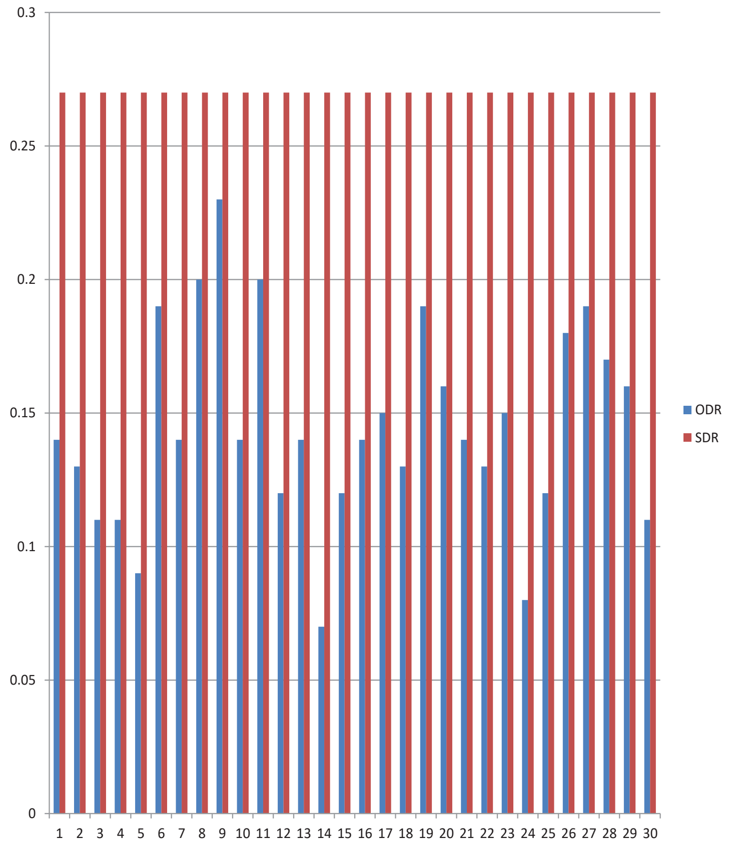

Figure 2: The outdoor Dose Rate compared to the Standard Dose Rate.
ODR: Outdoor Dose Rate; SDR: Standard Dose Rate

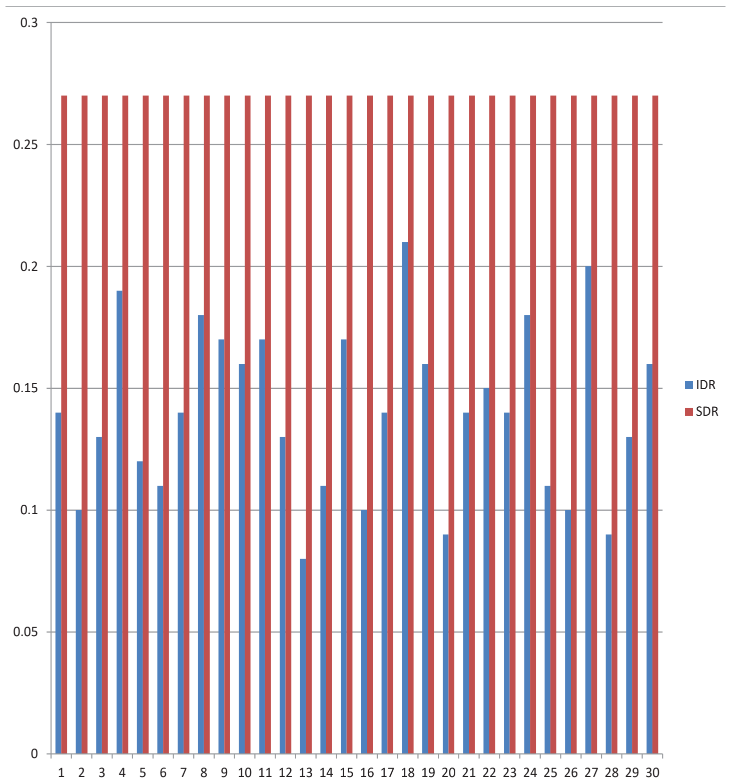

Figure 3: The indoor Dose Rate compared to Standard Dose Rate.
IDR: Indoor Dose Rate; SDR: Standard Dose Rate

is 0.144 μSv/hr, and the standard deviation is 0.037 μSv/hr. The distribution of the Dose Rate values compared to the world standard values is shown in figure 2. Then the results for the indoor radiation Dose rates ranges from 0.08 μSv/hr to 0.21 μSv/hr. The lowest value of 0.08 μSv/hr from the indoor radiation measurement is from the School of Environmental Technology (SOET), while the highest value of 0.21 μSv/hr is from the School of Agriculture and Agricultural Technology SAAT. The mean value of the indoor Dose Rate is 0.140 μSv/hr while the standard deviation is 0.034 μSv/hr. The distribution of the indoor Dose rate compared to the world standard values is shown in figure 2. The values obtained for both outdoor and indoor radiation Dose rates are lower than the world standard recommended value 0.274 μSv/ [12].

Conclusion

The in situ measurement of the natural background ionizing radiation in the Federal University of Technology Owerri, Nigeria was carried out using a well calibrated Digital Geiger Muller counter models GCA – 04w. The result of the study showed that the natural radiation levels are within the permissible levels. This is in agreement with a similar research done by [12]. However, some departments have relatively high indoor radiation levels. They should be constantly monitored, to ensure that they do not exceed the recommended permissible levels. This study could serve as bases for future reference and further research in the Federal University of Technology Owerri.

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