Assessment of Indoor and Outdoor Background Radiation in Science Laboratories of Adamawa State University, Mubi.

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Abstract— Assessment of an indoor and outdoor background radiation in Science Laboratories of Adamawa State University, Mubi, was carried out using a well calibrated Geiger Muller counter; An in-situ approach of background radiation measurement was adopted and preferred to enable samples maintain their original environmental characteristics. The dose equivalent results obtained from the fifteen (15) laboratories ranges from 0.028μSv/hr to 0.046μSv/hr with an average annual equivalent dose of 0.263mSv/yr for an indoor measurement while the outdoor values ranges from 0.620μsv/hr to 0.771μsv/hr with an average annual equivalent dose of 0.672mSv/yr. The study also revealed that General Chemistry laboratory has the highest indoor annual equivalent dose of 0.322mSv/yr while general Physics laboratory has the lowest indoor annual equivalent dose of 0.196mSv/yr more so, Computer Lab(e-library) has the highest outdoor annual equivalent dose of 0.771mSv/yr with Biology lab 4 having the lowest outdoor annual equivalent dose of 0.543msv/yr. These results revealed that the dose levels in all the laboratories (indoor and outdoor) were below the 1 mSv/y maximum permissible dose limit for the public set by International Commission on Radiological Protection (ICRP). There-fore, the science laboratories(L1-L15) of the Adamawa State university, Mubi were radiologically safe for both the students, staff and the general public.

Index Terms— Absorbed dose, Background radiation, Equivalent dose, Effective dose, Radiation monitor.

1 INTRODUCTION

Background radiation is the measure of the level of ionizing radiation present in the environment at a particular location, it consists of three primary types: primordial, cosmogenic and anthropogenic. Primordial radionuclides are present in the earth's crust and found throughout the environment. Cosmogenic radionuclides are produced when cosmic radiation interacts with elements present in the atmosphere and are deposited through both wet and dry deposition. Anthropogenic sources of radiation result from human activities, but are considered background because their presence is ubiquitous [1]. Human beings are ex-posed to background radiation that stems both from natural and man- made sources. In general, approximately 85% of the annual total radiation dose of any person comes from natural radionuclides of both terrestrial and cosmogenic origin [2], [3]. Exposure to ionizing radiation can cause inju-ries and clinical symptoms; which may include a chromosomal transformation, cancer induction, free radical formation, bone necrosis and radiation catractogenesis [4]. The injuries and clinical symptoms could be caused by both chronic and acute dose exposure. Because of the lethal effects of ionizing radiation, the practice has been to monitor and assess the levels of exposure and keep one's exposure to ionizing adiation As Low As Reasonably Achievable (ALARA).

Many authors have worked on the assessment of indoor and outdoor radiation levels at various places. These works include; studies carried out by [5] which shows an annual efecive dose of 0.72mSv/yr for background radiation in Lorestan province of Iran. [6] showed that the background ionising radiation of Skane Radiodiagnostic Centre, Jos, Plateau state was 2.063 msv/yr and 1.848 msv/y for indoor and outdoor measurement respectively while for Plateau State Specialist Hospital, the indoor and outdoor results were 2.444 msv/y and 2.002 msv/y respectively. [7] measured the background ionising radiation level at Braithwaite Memorial Specialist Hospital Port Harcourt, Rivers State. Results obtained range from 0.16 ± 0.01 μsv/h to 0.14 ± 0.02 μsv/h with an average of 0.146 ± 0.02 μsv/h for indoor measurement within x-ray department, 0.17 ± 0.02μsv/h to 0.1 ± 0.01 μsv/h with an average of 0.1413 ± 0.02 μsv/h for measurements in departments and locations within the hospital, 0.19 μsv/h to 0.12 ± 0.01 μsv/h with an average of 0.136 ± 0.02 μsv/h for indoor measurements in wards within the hospital.

[8] measured the indoor and outdoor background ionizing radiation level of Kwali, general hospital Abuja, the dose equivalent results obtained range from 0.100±0.001 μSv/h to 0.124±0.007 μSv/h with an average of 0.107±0.003 μSv/h for in-door measurement while it ranges from 0.100±0.001 μSv/h to 0.122±0.003 μSv/h with an average of 0.108±0.003 μSv/h for outdoor measurement respectively and concluded that the Kwali general hospital is radiologically safe according to [9] standard.

The study area in this work comprises of the following Laboratories coded as L1 to L15 in Adamawa State University, Mubi where practical and research work are usually conducted; General Physics laboratory, Physics laboratory(dark room), Physics research la-boratory, Physics lab 3, Physics lab 4, Biology lab 4, Microbiology lab 1, Botany lab, Chemistry lab 2, General Chemistry lab, Chemistry research lab, Computer lab (e-library), Computer lab 2, Soil Science Laboratory, and Crop Production /Protection laboratory respectively.

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2 MATERIALS AND METHOD

The materials used in this research work were radiation detector (Geiger Muller counter), stopwatch and a measurement tape. An in-situ approach of background radiation measurement was adopted and preferred to enable samples maintain their original environmental characteristics. A solid state Geiger Muller counter (radiation alert smart 4) with its unit of measurement in microsivert per hour (μS/hr.) was turned on and suspended in the air at a distance of five millimeter (5mm) above the ground surface; these was done to avoid any form of contamination and interference from the ground surface. Five (5) different readings of both the indoor and outdoor emitted radiation were taken at different point within and outside the laboratories. The readings per minute count were tabulated and the average absorbed equivalent dose and the annual absorbed equivalent dose rate in each of the laboratories were calculated.

[3] recommended indoor and outdoor occupancy factor (OF) of 0.8 and 0.2 respectively. This occupancy factor (OF) is the proportion of the total time during which an individual is exposed to a radiation field. Eight thousand seven hundred and sixty hours per year (8760hr/yr) was used. To convert the equivalent dose rate in μSv/hr into annual equivalent dose rate in mSv/yr, equations (1) and (2) by [3] were used for annual indoor and outdoor equivalent dose.

For annual indoor equivalent dose;

$$E = \bar{x} \times 8760(hr/yr) \times 0.8 \times 0.001 \quad (1)$$

While for the annual outdoor equivalent dose;

$$E = \bar{x} \times 8760(hr/yr) \times 0.2 \times 0.001 \quad (2)$$

Where E is the annual indoor and outdoor Equivalent Dose Rate (mSv/yr), is the mean indoor equivalent Dose Rate (μSv/hr).

RESULTS AND DISCUSSION

The mean dose equivalent readings and the annual dose equivalent readings were obtained using equations (1) and (2) of both indoor and outdoor measurements. Results of the indoor and outdoor mean equivalents dose and the annual effective dose rate of back-ground radiation levels of all the Laboratories are presented on Table 1 and 2 respectively. The equivalent doses of both the indoor and outdoor background radiation for all the laboratories under study were plotted and compared with the standard value in fig. 1.

Table 1. Indoor values of background radiation in Science laboratories, Adamawa State University, Mubi.

Lab Code	Emitted radiation x(μsv/hr)					Mean($\bar{x}$)
	1st	2nd	3rd	4th	5th	(mSv/yr)
L1	0.026	0.029	0.031	0.028	0.026	0.196
L2	0.033	0.036	0.041	0.038	0.035	0.259
L3	0.028	0.029	0.031	0.031	0.028	0.203
L4	0.038	0.038	0.036	0.034	0.036	0.252
L5	0.033	0.035	0.033	0.036	0.033	0.238
L6	0.033	0.033	0.035	0.033	0.029	0.231
L7	0.046	0.043	0.043	0.033	0.045	0.294
L8	0.046	0.039	0.033	0.033	0.038	0.267
L9	0.033	0.035	0.035	0.036	0.033	0.238
L10	0.048	0.046	0.045	0.046	0.046	0.322
L11	0.046	0.043	0.043	0.043	0.045	0.308
L12	0.041	0.043	0.043	0.045	0.046	0.308
L13	0.036	0.036	0.036	0.035	0.035	0.252
L14	0.038	0.043	0.046	0.039	0.043	0.294
L15	0.038	0.043	0.039	0.043	0.041	0.287
	Average					0.263

Table 2. Outdoor values of background radiation in science laboratories, Adamawa State University, Mubi.

Lab Code	Emitted radiation x(μsv/hr)					Mean($\bar{x}$)
	1st	2nd	3rd	4th	5th	(mSv/yr)
L1	0.036	0.036	0.035	0.035	0.035	0.62
L2	0.036	0.038	0.036	0.035	0.035	0.631
L3	0.035	0.036	0.038	0.035	0.039	0.641
L4	0.043	0.041	0.039	0.041	0.039	0.718
L5	0.038	0.038	0.036	0.039	0.038	0.666
L6	0.029	0.031	0.033	0.031	0.029	0.543
L7	0.031	0.035	0.036	0.035	0.038	0.613
L8	0.039	0.043	0.041	0.039	0.039	0.7
L9	0.036	0.035	0.035	0.036	0.038	0.63
L10	0.043	0.045	0.043	0.045	0.038	0.753
L11	0.038	0.038	0.039	0.038	0.039	0.666
L12	0.046	0.045	0.043	0.045	0.041	0.771
L13	0.038	0.035	0.038	0.035	0.039	0.648
L14	0.038	0.043	0.045	0.043	0.043	0.736
L15	0.043	0.043	0.045	0.043	0.043	0.753
	Average					0.672

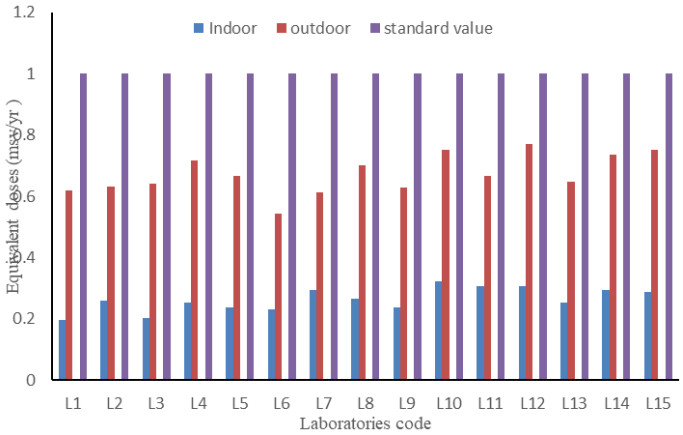

Fig. 1. variation in indoor and outdoor annual equivalent dose of an emitted radiation in Science laboratories with accepted standard values.

From the result on table (1) and (2), the mean dose equivalent ranges from 0.028μSv/hr to 0.046μSv/hr with an annual equivalent dose of 0.196 mSv/yr to 0.322msv/yr for an indoor measurement, while the outdoor mean equivalent dose ranges from 0.031μSv/hr to 0.046μSv/hr with an annual equivalent dose of 0.543 mSv/yr to 0.771msv/yr respectively. The study also revealed that the average annual equivalent dose rate for the fifteen (15) laboratories were 0.263mSv/y and 0.672 mSv/yr for indoor and outdoor measure-ments respectively. The result presented in fig. 1 further revealed that General Chemistry laboratory (L10) has the highest indoor annual equivalent dose of 0.322mSv/yr while General Physics laboratory (L1) has the lowest indoor annual equivalent dose of 0.196mSv/yr, more so, Computer lab (e-library) (L12) has the highest outdoor annual equivalent dose of 0.771mSv/yr with Biology lab 4 (L6) having the lowest outdoor annual equivalent dose of 0.543msv/yr.

4 Conclusion

The assessment of indoor and outdoor background radiation of Adamawa State University, Mubi, Nigeria was carried out using a well calibrated radiation monitor (Geiger Muller counter). An in-situ measurement approach was adopted. The easurements were car-ried out in fifteen (15) different Science laboratories within Adamawa State University, Mubi. The study showed that the mean equiva-lent dose rate and the annual equivalent dose levels are within the standard permissible limits of 1msv/yr set by the International Commission on Radiological Protection (ICRP). Hence the Science laboratories within Adamawa State University, Mubi is radiologically safe. The dose limit stated for public exposure by IAEA are equivalent dose rate of 1 mSv/year. Therefore, the level of radiation from the fifteen laboratories (L1-L15) of Adamawa State University, Mubi as measured with an average annual equivalent dose of 0.263msv/yr for an indoor background radiation and 0.672msv/yr for an outdoor background radiation are low enough to be consid-ered safe.

References

[1] C Okeyode and A.M Oluseye "Studies of the Terrestrial Outdoor Gamma Dose Rate Levels in Ogun-Osun River Basins Development Authority Headquarters, Abeokuta, Nigeria". Physics International vol 1 no. 1, pp. 1-8, 2010.

[2] M Belivermis, N. Kilic, Y. Cotuk, S. Topcuoglu, "The effects of physicochemical properties on gamma emitting natural radionuclide levels in the soil profile of Istanbul". Environ Monit Assess. Vol.163, no. (1-4): pp 15–26, 2010.

[3] UNSCEAR "United Nations Scientific of Committee on the Effect of atomic Radiation, Effects and risks of ionizing radiation". United Nations, New York, 2000.

[4] A Norman. and A.R Kagan "Point counterpoint: Radiation Therapy are not safe". Med. Phys. Vol. 24 no.11, pp1710-1713, 1997.

[5] M Gholami and A Jomehzadeh "Studies of gamma background radiation, Lorestan Province of Iran" Int J. Radiat Res. Vol. 9 no.2 pp89-93, 2011.

[6] D. I Jwanbot, M.M Izam, G.G Nyam, I.S Agada "Evaluation of Indoor background ionising radiation profile in some hospitals in Jos Plateau state Nigeria.". Journal of Natural Sciences Research vol.2 no.7, pp35-40, 2012.

[7] G.O Avwiri and P.C Okoye "Evaluation of background ionising radiation levels of Braithwaite memorial specialist Hospital Port Harcourt, River State." Am. J.Sci.Ind. Res. Vol. 4 no. 4 pp359-365, 2013.

[8] I.U James, I.F Moses, J.N Vandi, U.E Ikoh. "Measurement of indoor and outdoor background ionizing radiation level of Kwali, general hospital Abuja." J. Applied science and environmental management. vol. 19 no.1 pp 89-93, 2015.

[9] ICRP ICRP publication 60 radiation protection Retrieved: 1990 recommendation of the International Commission on Radiological Protection, Oxford: Pentagon press.