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ASSESSMENT OF INDOOR AND OUTDOOR BACKGROUND RADIATION LEVELS IN OLUSEGUN AGAGU UNIVERSITY OF SCIENCE AND TECHNOLOGY, OKITIPUPA ONDO STATE, NIGERIA.

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Abstract

In this study, the indoor and outdoor background ionizing radiation exposure levels in two of the Campuses of Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria, were assessed using a GQ GMC-500 digital Geiger Muller Counter. The indoor and outdoor background ionizing radiation exposure levels were used to determine indoor annual effective dose rate (IAEDR) and outdoor annual effective dose rate (OAEDR), which were the radiological health impact on the studied area's residents' environment. The results of this study's mean indoor and outdoor annual effective dose rates were lower than the worldwide average dose of 2.4 $mSvyr^{-1}$. The results showed that the study areas are radiologically safe due to the insignificant health risk of background ionizing radiation in the study areas.

Keywords: Background ionizing radiation; indoor annual effective dose rate; outdoor annual effective dose rate; radiological health impact.

Introduction

Any form of energy transmitted as rays, waves or a stream of particles that could be ionizing or non-ionizing is known as radiation. The radiation that produces ionization when irradiated matters are known as ionizing radiation and are therefore more dangerous than non-ionizing radiation. Ionizing radiation is a form of radiation that produces ions that can impair biological processes. On the other hand, Non-ionizing radiation cannot produce ions when irradiated matter but can harm human health. Every day, we are exposed to specific amounts of ambient radiation, which can come either from natural (e.g., radon gas, soil, granite rocks) or artificial (e.g., x-ray machines, building materials, radioactive wastes from reactors, etc.) sources in the environment, and the level of radiation varies from one location to the other (Farai and Vincent, 2006). The introduction of industrialization, along with inadequate environmental management systems, has resulted in the release of hazardous, corrosive, and radioactive wastes and pollutants into the environment (Ugbede and Benson, 2018). In recent years, the detrimental health effects of industrial activity on the environment have been highlighted (Ugbede and Benson, 2018). Contamination and degradation of the environment are global concerns due to their harmful health effects. Ionizing radiation in the background might be termed environmental pollution if it's above the recommended acceptable public and occupational limits (Agbalagba *et al.*, 2016). Over the years, human activities (research, industrial, agricultural and medical) in the environment have increased background ionizing radiation which was initially due to cosmic rays and radionuclides from natural sources (Ademola and Olatunji, 2013). This is because raw materials used in such environments contain naturally occurring radioactive materials (NORMs) which later discharge themselves as by-products into human environment after undergoing some processes (Ademola and Olatunji, 2013). As a result, the general public is exposed to significant radiation doses and risks that harm human health. Ionizing radiation is a type of high-energy particle with strong penetrating power. When such radiations irradiate biological cells or tissues, they generate excitation and ionization, causing the cells' structure changes. Humans are exposed to high doses of gamma radiation, which produces severe health impacts like chromosome aberration, genetic mutations, cancers of different kinds and various disorders (Taskin *et al.*, 2009). The ALARA concept maintained that human irradiation level is maintained as low as reasonably practicable in the practice of radiation protection (ICRP, 1973).

Many studies on the assessment of indoor and outdoor background ionizing radiation exposure rate have been conducted in various higher institutions of learning in Nigeria (Tikya *et al.,* 2017). Still, work on assessing indoor and outdoor background ionizing radiation levels in the Olusegun Agagu University of Science and Technology, Okitipupa campuses, has yet to be published. As a result, this study aims to measure the indoor and outdoor radiation levels of the study area to assess its radiation safety status.

Materials and Method.

Study Area.

This study was conducted in Mini and Mega Campuses of Olusegun Agagu University of Science and Technology. Olusegun Agagu University of Science and Technology (OAUSTECH) is a state-owned University situated in Okitipupa in the Southern Senatorial District of Ondo State, Nigeria. OAUSTECH; a multi-campus institution founded on September 27, 2010, and began academic activities in January 2011, with three Campuses: Main, Mini, and Mega Campuses. The Mega Campus is the second largest of the University Campuses hosting the University's School of Engineering and Engineering Technology and partly the School of Agriculture, Food and Natural Resources. The Mini Campus is the smallest of the University Campuses hosting the University's School of Post Graduate Studies, Center for Continuing Education and Human Resources Development, and partly the School of Agriculture, Food and Natural Resources.

Assessment of the Background Radiation Levels and Radiological Health Hazard indices.

The indoor and outdoor background ionizing radiation exposure levels survey was conducted in selected locations of the study area using a GQ GMC-500 digital Geiger Muller Counter. The radiation level in each location was measured by placing the Geiger Muller Counter at a height of 1.0 m and noting the amount of ionization produced. Measurements were repeated four times at each site and the mean characteristic dose distribution was obtained. Right from the display screen of the Geiger Muller Counter, the measured indoor and outdoor radiation levels were recorded in $Svhr^{-1}$. The coordinates of the geographical locations of the measurement points were taken using a GPS device.

The radiological health effects in the immediate surroundings were calculated using the measured indoor and outdoor radiation levels. The study's estimated radiological health hazard indices utilized to evaluate the environment's radiation safety status were indoor annual effective dose rate (IAEDR) and outdoor annual effective dose rate (OAEDR). The

dose rates in $\mu Svhr^{-1}$ were converted to effective dose rates in $mSvyr^{-1}$ using equations (i) and (ii).

$$\text{IAEDR } (mSvyr^{-1}) = Y\ (\mu Svhr^{-1}) \times 8760\ (hryr^{-1}) \times 0.8 \times 10^{-3} \quad \text{(I)}$$

$$\text{OAEDR } (mSvyr^{-1}) = Z\ (\mu Svhr^{-1}) \times 8760\ (hryr^{-1}) \times 0.2 \times 10^{-3} \quad \text{(ii)}$$

where;

Y and Z are the mean indoor and outdoor background ionizing radiation exposure levels, IAEDR and OAEDR are the indoor and outdoor annual effective dose rates. 0.2 (5/24) and 0.8 (19/24) are the indoor and outdoor occupancy factors recommended by UNSCEAR, 1988. These occupancy factors represent the percentage of a person's overall exposure time to a radiation field.

In radiation assessment and protection, the overall absorbed dose rate per year is determined by the annual effective dose rate (Darwish *et al.*, 2015). It's used to assess the likelihood of long-term consequences in the future.

The AEDR indoor take place inside a building and assesses the radiation risks posed by building components or materials. AEDR outdoor, on the other hand, takes into account the absorbed dose emitted by radionuclides in the environment.

Results and Discussion.

The mean indoor and outdoor background ionizing radiation exposure levels in ($\mu Svhr^{-1}$), OAEDR ($mSvyr^{-1}$), and IAEDR ($mSvyr^{-1}$) for the studied area are presented in Tables I to IV. Figures I to IV are the bar charts that represent the mean indoor and outdoor background ionizing radiation exposure levels in ($\mu Svhr^{-1}$), OAEDR ($mSvyr^{-1}$),IAEDR ($mSvyr^{-1}$) and their recommended safety limits respectively. From the charts, it can be seen that the indoor and outdoor background ionizing radiation exposure levels measured in the University's Mega Campus ranged from 0.09 to 0.22 $\mu Svhr^{-1}$ with a mean value of 0.14 $\mu Svhr^{-1}$ and 0.09 to 0.13 $\mu Svhr^{-1}$ with a mean value of 0.11 $\mu Svhr^{-1}$ respectively. The measured indoor and outdoor background ionizing radiation exposure levels in the University Mini Campus ranged from 0.01 to 0.14 $\mu Svhr^{-1}$ with a mean value of 0.11 $\mu Svhr^{-1}$ and 0.01 to 0.14 $\mu Svhr^{-1}$ with a mean value of 0.11 $\mu Svhr^{-1}$ respectively. The estimated indoor and outdoor annual effective dose rate in the University Mega Campus ranged from 0.63 to 1.54 $mSvyr^{-1}$ with a mean value of 0.98 $mSvyr^{-1}$ and 0.16 to 0.23 $mSvyr^{-1}$ with a mean value of 0.19 $mSvyr^{-1}$ while that of the University Mini Campus ranged from 0.07 to 0.98 $mSvyr^{-1}$ with a mean value of 0.75 $mSvyr^{-1}$ and 0.02 to 0.25 $mSvyr^{-1}$ with a mean value of 0.19 $mSvyr^{-1}$ respectively. These results shows that the mean indoor annual effective dose rate (IAEDR) in the two University understudied Campuses are higher than the mean outdoor annual effective dose rate (OAEDR), possibly due to the presence of radon gas in the air as a result of radiation emission from building (earth) materials used in the University's construction and other activities taking place within the studied area buildings. The values reported for the mean indoor and outdoor annual effective dose rates recorded in this study are less than the global average dose of 2.4 $mSvyr^{-1}$ (ICRP, 2007). Thus, the University's staff, students, and immediate neighborhoods at the campuses of the University are exposed to an insignificant ionizing radiation health risk and are radiologically safe.

Table 1: Indoor Mean Background ionizing radiation exposure levels and IAEDR for Mega Campus

School Code	Location	Geographical Location	Y($\mu Svhr^{-1}$)	IAEDR ($mSvyr^{-1}$)
SC 1	NUESA Secretariat	6°29'30"N 4°47'20"E	0.12	0.84
SC 2	Auditorium	6°29'30"N 4°47'20"E	0.11	0.77
SC 3	Lobby	6°29'30"N 4°47'20"E	0.19	1.33
SC 4	HOD Civil Engr	6°29'40"N 4°47'12"E	0.09	0.63
SC 5	Admin Building	6°29'45"N 4°47'21"E	0.13	0.91
SC 6	Lobby	6°29'45"N 4°47'21"E	0.11	0.77
SC 7	Room 1	6°29'45"N 4°47'21"E	0.15	1.05
SC 8	Computer Lobby	6°29'25"N 4°47'25"E	0.22	1.54
SC 9	Physics Lab	6°29'40"N 4°47'12"E	0.11	0.77
SC 10	General Place	6°29'40"N 4°47'12"E	0.16	1.12
SC 11	Dept. of EEE	6°29'40"N 4°47'12"E	0.16	1.12
SC 12	Studio	6°29'45"N 4°47'12"E	0.12	0.84
Mean			0.14	0.98

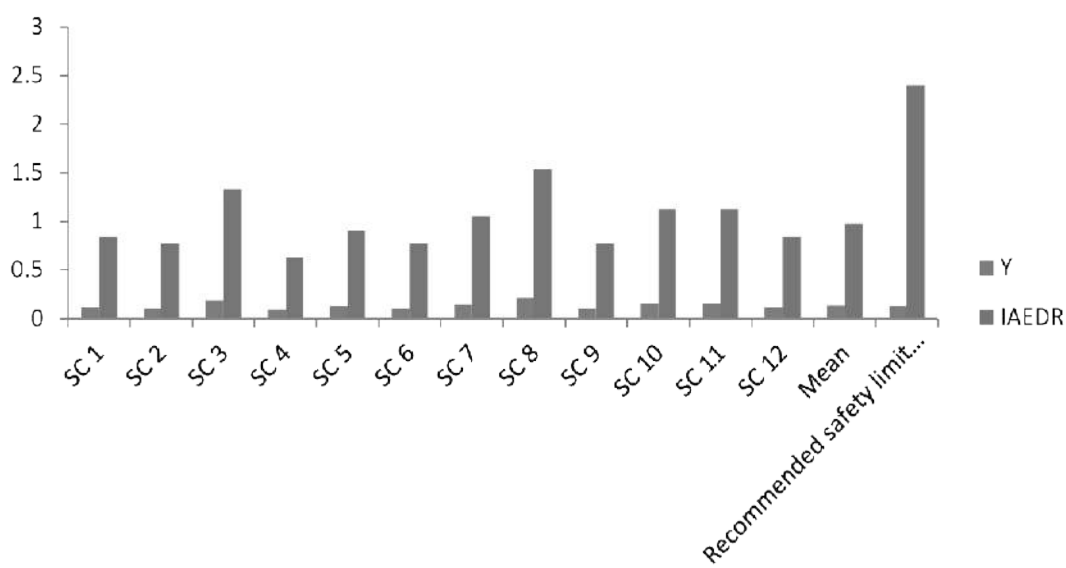

Figure 1: Indoor Mean Background ionizing radiation exposure levels (Y) and IAEDR for Mega Campus.

Table 2: Indoor Mean Background ionizing radiation exposure levels and IAEDR for Mini Campus.

School Code	Location	Geographical Location	Y(μSvhr⁻¹)	IAEDR(mSvyr⁻¹)
SC 1	Lecture Room 1	6°30'44"N 4°46'52"E	0.13	0.91
SC 2	Lecture Room 2	6°30'44"N 4°46'51"E	0.11	0.77
SC 3	Laboratory 1	6°30'25"N 4°46'43"E	0.12	0.84
SC 4	Laboratory 2	6°30'25"N 4°46'43"E	0.12	0.84
SC 5	Lobby	6°30'23"N 4°47'10"E	0.08	0.56
SC 6	Crop Soil & Pest Mgt	6°30'23"N 4°47'10"E	0.12	0.84
SC 7	Fst Hall 1	6°30'23"N 4°47'10"E	0.01	0.07
SC 8	Fst Hall 2	6°30'23"N 4°47'10"E	0.14	0.98
SC 9	General room	6°30'23"N 4°47'11"E	0.13	0.91
Mean			0.11	0.75

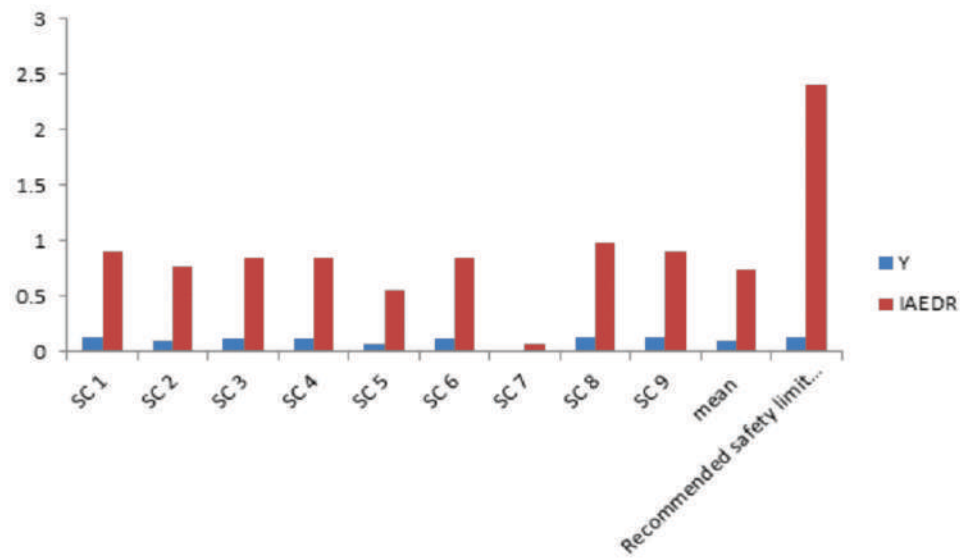

Figure 2: Indoor Mean Background ionizing radiation exposure levels (Y) and IAEDR for Mini Campus.

Table 3: Outdoor Mean Background ionizing radiation exposure levels and OAEDR for Mega Campus

School Code	Location	Geographical Location	Z(μSvhr⁻¹)	OAEDR(mSvyr⁻¹)
SC 1	Auditorium (Back Outside)	6°29'40"N 4°47'12"E	0.12	0.21
SC 2	Small Gate	6°29'30"N 4°47'20"E	0.11	0.19
SC 3	Football pitch	6°29'30"N 4°47'20"E	0.09	0.16
SC 4	Main Gate	6°29'40"N 4°47'12"E	0.10	0.18
SC 5	Admin Building	6°29'40"N 4°47'12"E	0.11	0.19
SC 6	Auditorium (Front Outside)	6°29'45"N 4°47'21"E	0.13	0.23
SC 7	Physics lab hallway	6°29'45"N 4°47'21"E	0.08	0.14
Mean			0.11	0.19

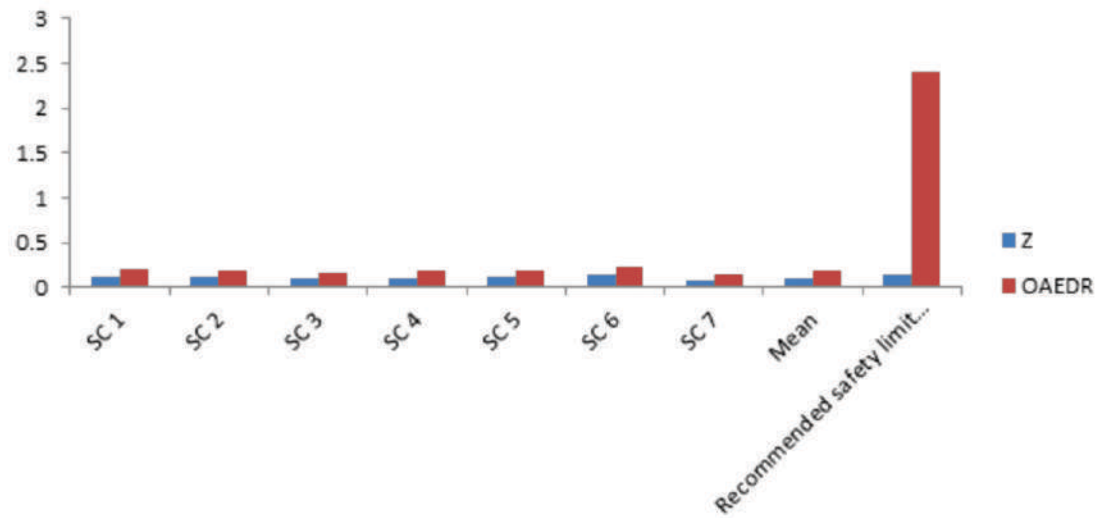

Figure 3: Outdoor Mean Background ionizing radiation exposure levels (Z) and OAEDR for Mega Campus.

Table 4: Outdoor Mean Background ionizing radiation exposure levels and OAEDR for Mini Campus.

School Code	Location	Geographical Location	Z($\mu Svhr^{-1}$)	OAEDR($mSvyr^{-1}$)
SC 1	Lecture Room 1	6°30'45"N 4°46'43"E	0.14	0.25
SC 2	Laboratory 1	6°30'25"N 4°46'43"E	0.11	0.19
SC 3	Security Post	6°30'25"N 4°46'43"E	0.14	0.25
SC 4	Hallway 1	6°30'26"N 4°46'43"E	0.13	0.23
SC 5	Flower Garden	6°30'23"N 4°47'11"E	0.11	0.19
SC 6	Hallway 2	6°30'23"N 4°47'11"E	0.01	0.02
Mean			0.11	0.19

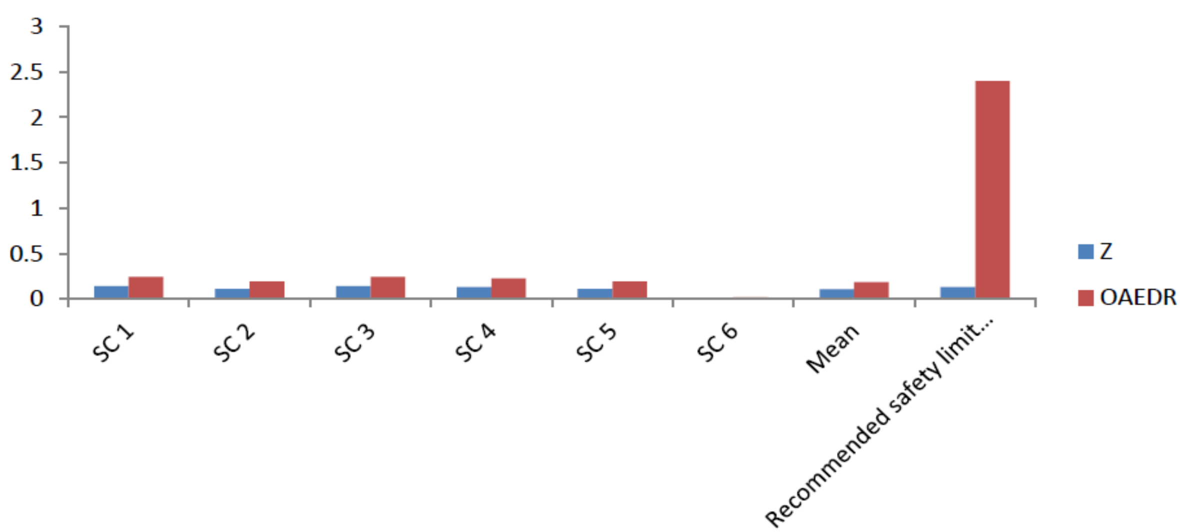

Figure 4: Outdoor Mean Background ionizing radiation exposure levels and OAEDR for Mini Campus.

Conclusion and Recommendation.

Since the assessment of ionizing radiation exposure levels and doses in human surroundings is an essential aspect of radiation safety, this study assessed the indoor and outdoor ionizing radiation exposure rates in two of the Campuses of Olusegun Agagu University of Science and Technology and its environs to determine the radiological health hazards on the University's staffs, residents and environment. Due to background ionizing exposure levels, the determined radiological health hazard indices indicate that the studied area does not pose any radiation hazards to staff, students and the public. As a result, we suggest that the natural radionuclide concentrations and background ionizing exposure rates of the studied area should be constantly and adequately monitored to keep the radiation level as low as reasonably achievable.

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