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Assessment of Radiation Dose in Some Selected Buildings within the Main Campus of the Federal University of Agriculture, Abeokuta, Nigeria

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ABSTRACT

The natural environmental radiation exposure that humans encounter typically surpasses that from human-made sources. This radiation can have hereditary and somatic effects on individuals. Thus, an evaluation of radiation levels in selected buildings across the Federal University of Agriculture, Abeokuta main campus was conducted using a Geiger-Muller (GM) survey meter as the measuring device. Utilizing GPS, twenty-five evenly distributed sampling locations were identified in the initial phase of the university's main campus, and radiation exposure rates for staff and students were measured using a detector. The resulting analysis showed minimum and maximum mean absorbed doses of 0.026 and 0.04 mR/hr, respectively. The mean annual dose equivalent was calculated to be 0.82 mSv/yr. This value stands as the baseline dose equivalent, which is below the maximum permissible dose equivalent for members of the public, set at 1.0 mSv/yr by the International Commission for Radiological Protection (ICRP, 2009). Consequently, it can be concluded that the main campus of the Federal University of Agriculture Abeokuta is free from radiological contamination. The area is deemed safe for community members and all forms of human activities.

Keywords: Radiation dose, Dose rate, Dose equivalent, Survey meter

INTRODUCTION

Natural radioactivity arises mainly from the primordial radionuclide such as ^{40}K, and the radionuclide from ^{238}U and ^{232}Th series and their decay products; which are present at trace level in all ground formation (Iqbal et al., 2000). Radioactivity monitoring all over the world has revealed a lot of useful information about radiation level in natural and polluted environment because the information obtained has provided a wealth of knowledge on a human (Ajayi et al., 1995). Gamma radiation emitted from naturally occurring radioisotope; also called terrestrial background radiation, represents the main external source of irradiation of the human body. Naturally environmental radioactivity and the associated external exposure due to gamma radiation depends primarily on the geographical condition; and appear at different levels in the soil of each region in the world (Anagnostakis et al., 1996; Shender, 1997; Tzortzis & Tsertos, 2004).

The reason for current interest is due to the fact that external radiation exposure from naturally occurring radionuclide contributes half of the average annual dose to the human body from all radiation sources (Iqbal et al., 2000). In any environment, accurate knowledge of the natural background radiation is essential for correct assessment of radiation pollution and a number of investigators have done this using different equipment. The objective of this study is focused on the estimate of the effective dose rate received by students and staff compared with the ICRP recommended dose limit. The measure of the absorb dose rate within the university campus will predict the health effect, if any, and determine whether or not students and staff are occupationally exposed to radiation and the possible risk involved.

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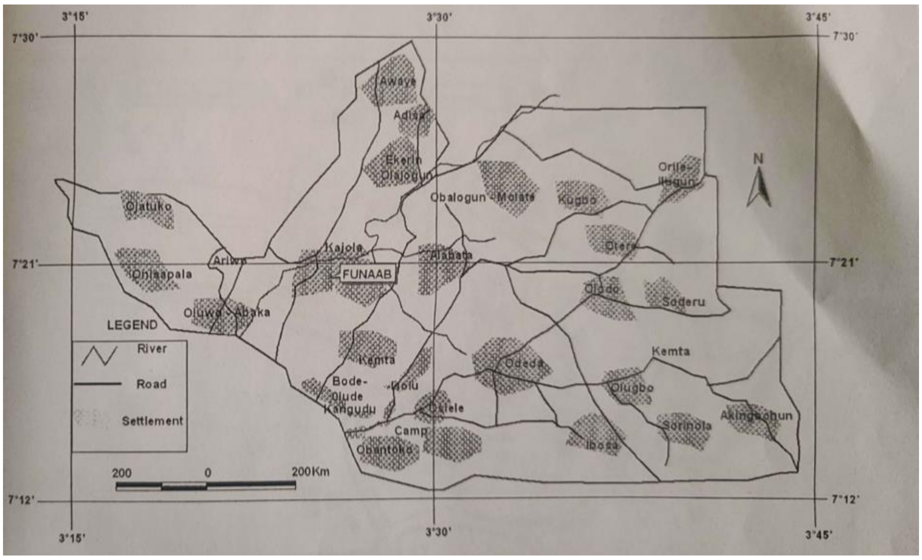

Figure 1: Map of Odeda Local Government Area

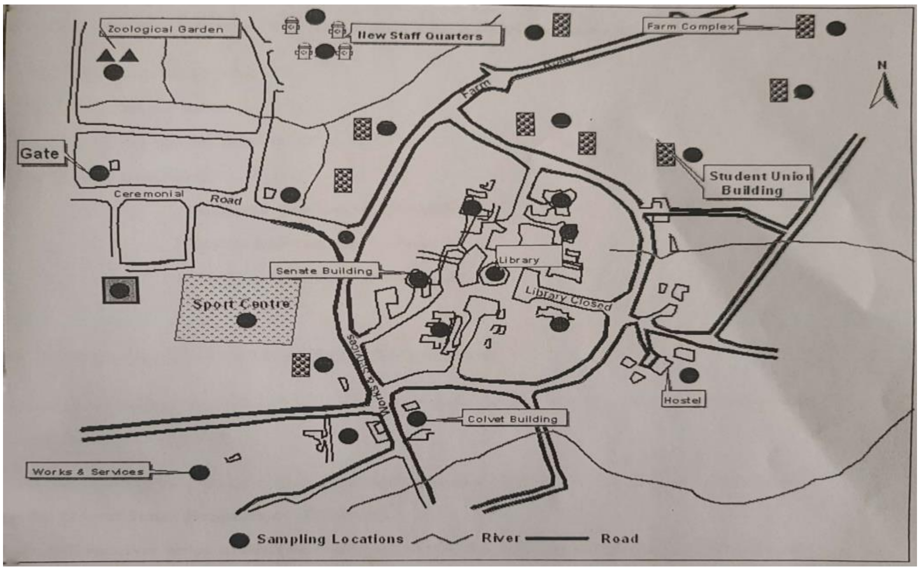

Figure 2: Map of the Study Area (Federal university of Agriculture, Abeokuta)

MATERIALS AND METHODS

Geology of the Study Area

Federal University of Agriculture, Abeokuta, Ogun State, Nigeria, was established in January, 1988. The permanent site is located next to the Ogun Osun River Basin Development Authority (OORBDA) along Alabata road, in Odeda Local Government Area, Abeokuta. Abeokuta is the capital of Ogun State and situated in the tropical rain-forest zone of Nigeria, on the latitude 7° 30’ N and longitude 3° 54’ S, found on the east bank of Ogun River, Ogun State, Nigeria.

Radiation Detection Instruments

Human senses cannot perceive radiation, yet its presence is more prevalent in certain industries than commonly perceived. Detecting radiation in any situation where it is utilized or exists is crucial. Various instruments are available for the detection and measurement of radiation, including pocket dosimeters, film badges, thermoluminescent dosimeters, and survey meters.

This study employed a survey meter, an instrument specifically designed to detect and measure the presence and intensity of radiation. The detector within the survey meter operates based on the voltage applied between the anode and the cathode, functioning as an ion chamber, a proportional counter, or a Geiger-Müller (GM) detector.

The survey meter utilized in this research is a portable dose rate monitor featuring a graduated screen with a moving coil counter. It is powered by a 6-volt battery and operates as a GM survey meter, calibrated to measure absorbed dose rate in units of milliroentgen per hour (mR/hr) and counts per minute (CPM). It has a typical accuracy of ±10% with an operating temperature of 0℃ to 50℃ and a full scale for caesium 137.

Its range switching shows;

X1 meter reads up to 0.5 mR/hr

X10 meter reads up to 5 mR/hr

X100 meter reads up to 50 mR/hr

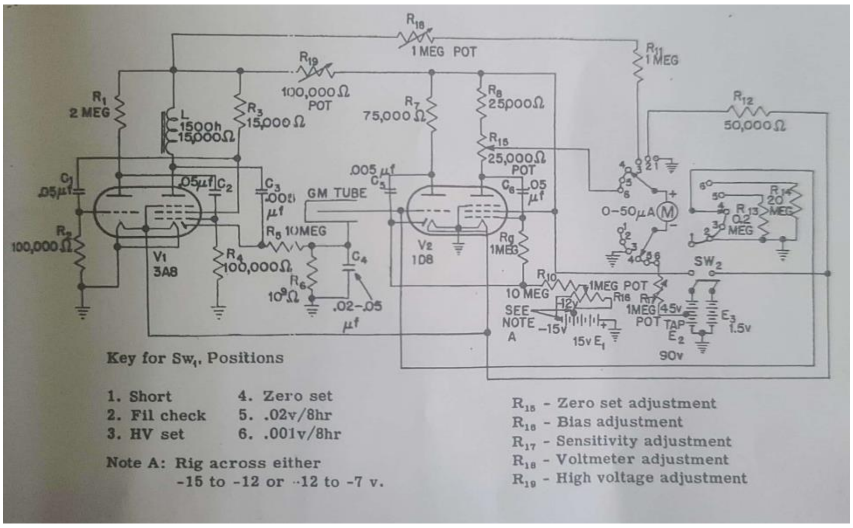

Figure 3: Schematic Diagram of a Survey Meter

Figure 4: Survey Meter

The Global Positioning System (GPS)

The Global Positioning System (GPS) aids in pinpointing the precise location where readings are obtained. Officially named the Navstar Global Positioning System, it is overseen and managed by the United States Department of Defense. A GPS receiver facilitates the determination of a location on Earth's surface by gathering signals from a minimum of three satellites using a method called triangulation. This process enables accurate location identification.

When coupled with a topographic map, a GPS receiver offers valuable insights into the characteristics of the nearby landscape. It can assist in devising efficient routes from one point to another by leveraging this detailed geographical information.

Methodology

The radiation exposure rate was assessed using a survey meter device, commonly employed for such measurements. Twenty-five evenly distributed sampling locations were identified across the first phase of the university's main campus with the aid of a GPS. The detector of the survey meter was employed to gauge the radiation exposure rate among both staff and students. Positioned at a distance of 100 centimeters from the surface under scrutiny, the survey meter was activated to capture radiation for a brief duration. The highest stable deflection point was recorded. Five readings were acquired at each location, and the average absorbed dose was computed to determine the annual dose equivalent. These values were converted into milli Sievert per year (mSv/yr) utilizing the formula recommended by the International Commission on Radiological Protection (ICRP).

$$\text{mSv/yr} = \text{mSv/hr} \times 365 \text{ days} \times 24\text{hrs}$$

Table 1. Average dose recorded from the survey meter for each location

Nature of Floor	Sample Location	Cpm	Mr/Hr
Tiles	Pg. School	36.0 ± 5.8	0.036 ± 0.0058
	Colmas Buiding	38.0 ± 6.8	0.038 ± 0.0068
	Unity House	30.0 ± 3.2	0.030 ± 0.0032
	Sport House	28.0 ± 4.0	0.028 ± 0.0040
	Health Center	32.0 ± 5.1	0.032 ± 0.0051
	Gate House	30.0 ± 10.5	0.030 ± 0.0105
	Zoological Gargen	26.0 ± 3.7	0.026 ± 0.0037
	Colvet	28.0 ± 2.4	0.028 ± 0.0024
	Farm Center Complex	32.0 ± 7.5	0.032 ± 0.0075
Concrete	Multipurpose Building	32.0 ± 9.3	0.032 ± 0.0093
	2000 Seater Hall	40.0 ± 9.5	0.040 ± 0.0095
	Sub	35.0 ± 4.5	0.035 ± 0.0045
	Food Tech. Consult	40.0 ± 5.8	0.040 ± 0.0058
	Colnas	35.0 ± 8.9	0.035 ± 0.0089
	Colplant	34.0 ± 7.3	0.034 ± 0.0073
	Hostel	30.0 ± 4.5	0.030 ± 0.0045
	Colerm	28.0 ± 2.4	0.028 ± 0.0024
	Coleng	35.0 ± 7.1	0.035 ± 0.0071
	Library	32.0 ± 6.8	0.032 ± 0.0068
	Senate	35.0 ± 6.3	0.035 ± 0.0063
	Filling Station	40.0 ± 10.6	0.040 ± 0.0106
	Staff Quarters 1	28.0 ± 4.0	0.028 ± 0.0040
	Staff Quarters 2	26.0 ± 5.8	0.026 ± 0.0058

	Works and Service	38.0 ± 5.1	0.038 ± 0.0051
	2500 Seater Hall	40.0 ± 4.5	0.040 ± 0.0045

Table 2. Dose equivalent in mSv/hr and mSv/yr

Nature of Floor	Sample Point	Mr/Hr	Dose Equivalent (Msv/Hr)	Dose Equivalent (Msv/Yr)
Tiles	Pg. School	0.036 ± 0.0058	3.6×10^{-4}	3.154
	Colmas Buiding	0.038 ± 0.0068	3.8×10^{-4}	3.328
	Unity House	0.030 ± 0.0032	3.0×10^{-4}	2.628
	Sport House	0.028 ± 0.0040	2.8×10^{-4}	2.453
	Health Center	0.032 ± 0.0051	3.2×10^{-4}	2.803
	Gate House	0.030 ± 0.0105	3.0×10^{-4}	2.628
	Zoological Gargen	0.026 ± 0.0037	2.6×10^{-4}	2.278
	Colvet	0.028 ± 0.0024	2.8×10^{-4}	2.453
	Farm Center Complex	0.032 ± 0.0075	3.2×10^{-4}	2.803
Concrete	Multipurpose Building	0.032 ± 0.0093	3.2×10^{-4}	2.803
	2000 Seater Hall	0.040 ± 0.0095	4.0×10^{-4}	3.504
	Sub	0.035 ± 0.0045	3.5×10^{-4}	3.066
	Food Tech. Consult	0.040 ± 0.0058	4.0×10^{-4}	3.504
	Colnas	0.035 ± 0.0089	3.5×10^{-4}	3.066
	Colplant	0.034 ± 0.0073	3.4×10^{-4}	2.978
	Hostel	0.030 ± 0.0045	3.0×10^{-4}	2.628
	Colerm	0.028 ± 0.0024	2.8×10^{-4}	2.453
	Coleng	0.035 ± 0.0071	3.5×10^{-4}	3.066
	Library	0.032 ± 0.0068	3.2×10^{-4}	2.803
	Senate	0.035 ± 0.0063	3.5×10^{-4}	3.066
	Filling Station	0.040 ± 0.0106	4.0×10^{-4}	3.504
	Staff Quarters 1	0.028 ± 0.0040	2.8×10^{-4}	2.453
	Staff Quarters 2	0.026 ± 0.0058	2.6×10^{-4}	2.278
	Works and Service	0.038 ± 0.0051	3.8×10^{-4}	3.329
	2500 Seater Hall	0.040 ± 0.0045	4.0×10^{-4}	2.453

RESULTS AND DISCUSSION

The observed mean absorbed dose rate in air for a height of 1m above the ground surface and their corresponding dose equivalent in (mSv/yr) are as shown in Table 2. The minimum and maximum mean absorbed was found to be 0.026 and 0.040 mR/hr, respectively and their corresponding dose equivalent is 2.278 and 3.504 mSv/yr respectively. The mean annual dose equivalent is 0.82 mSv/yr. This value constitutes the baseline dose equivalent which is below the 1.0 mSv/yr recommended by International Commission for Radiological Protection (ICPR, 2009) as the maximum permissible dose equivalent for members of the public. By present knowledge, 1.0 mSv/yr carries a negligible probability of severe somatic or genetic health problems.

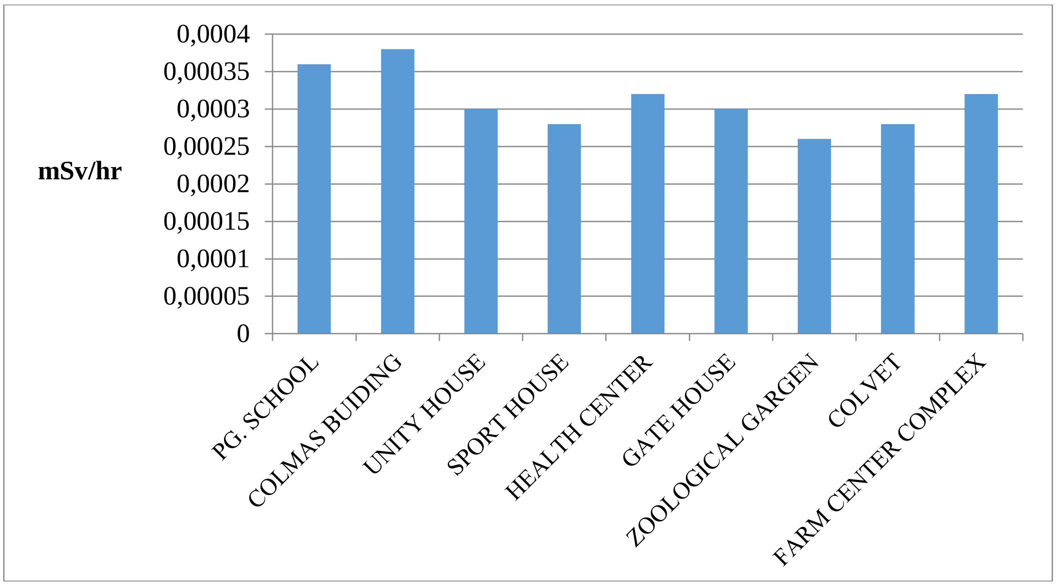

Figure 5: **Graph showing mSv/hr against tiled floor location**

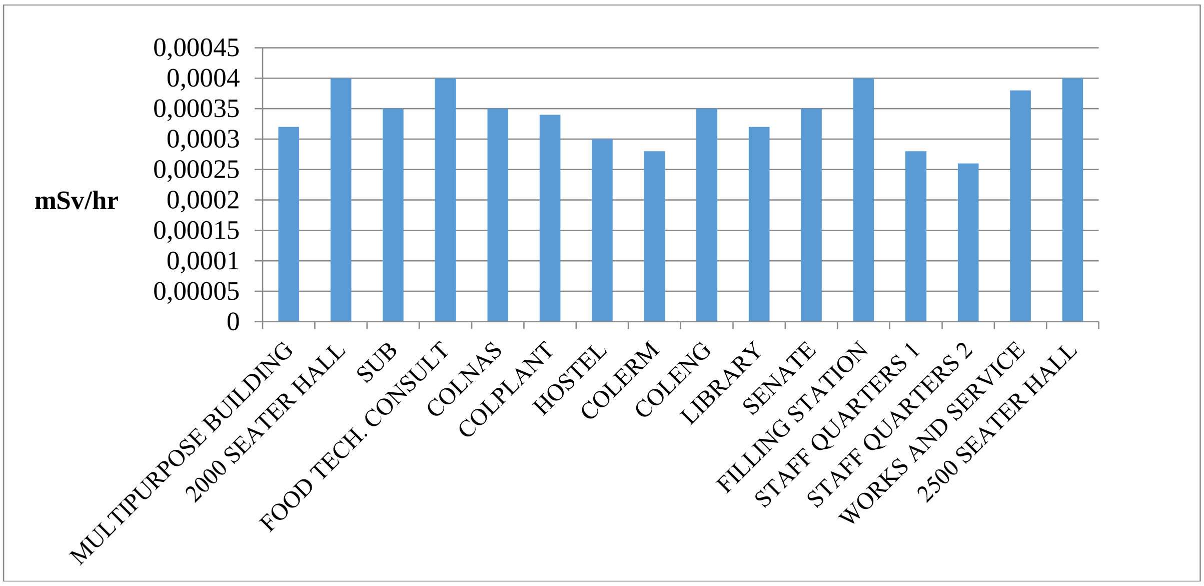

Figure 6: **Graph showing mSv/hr against concrete floor location**

CONCLUSION

The gamma dose rate within the Federal university of agriculture, Abeokuta main campus has been measured in this study and the mean annual dose equivalent calculated. Thus, the mean annual dose equivalent 0.82mSv/yr resulting from the mean absorbed dose rate in the study area was blow 1.0mSv/yr as recommended by the ICRP (ICRP, 2009) as the maximum permissible dose for the public. Hence, we conclude that the main campus of the Federal University of Agriculture Abeokuta is free from radiological contamination; making the area safe for the members of the community and for all forms of human activities.

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