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ASSESSMENT OF NATURAL BACKGROUND RADIATION IN AN INDUSTRIAL AREA OF IGBESA, OGUN STATE, NIGERIA

Dada O.J*, Akingbade F.S, Dada M.O, Akindele B.A, Olowosebioba A.A

[1*,2,4,5]Department of Science Laboratory Technology, Physics with Electronics Unit, Ogun State Institute of Technology, Igbesa, Nigeria.

[3]Department of Physics, Lagos State University, Ojo, Lagos State.

*Corresponding author. Email: dada.oluwadamilare@ogitech.edu.ng ; Tel: +2347057230223.

ABSTRACT

The research investigated the natural background radiation of Igbesa community; situated in Ogun State, Nigeria with coordinates 6.5286^{o} N, 3.1353^{o} E. This was achieved using a radiation survey meter (RADEYE G10 - ER) to measure the radiation dose exposure rate in micro sievert per hour (mSv/hr). Values were taken by placing the survey meter 1-meter above the ground level at 40 different points to measure background environmental radiation. The dose rates obtained range from 0.08 to 0.22mSv/hr. The average dose rate was 0.13 mSv/hr with a standard deviation of 0.03 mSv/hr. Technically; the average dose rate of the community obtained in this study is less compared to the recommended level of 1 mSv/annum by the international commission on radiation protection (ICRP) for non–occupational population exposure.

Keywords: Dose, Gamma radiation, ICRP, Igbesa, RADEYE G10-ER.

1. INTRODUCTION

The contribution level of radioactivity to the soil and surrounding environment of a region depends primarily on the geological formation, geographical conditions, human factors, and industrial activities of the region. Primordial radionuclides naturally reside in the earth's crust as a

result of magma intrusion, solidification, and weathering. This radionuclide disintegrates spontaneously into different daughter nuclides to achieve a stable nuclide. However, as they disintegrate, they emit radiation and therefore contribute to the average public radiation exposure.

The other source of radiation exposure emanates from energetic cosmic rays of extra-terrestrial origin. Over 98% of the general public exposure to radiation is from natural radionuclides such as ^{238}U, ^{232}Th, and ^{40}K and their progenies (Farai and Jibiri, 2000).

Assessment of the impact of natural radioactivity on humans is very important because it will help in evolving the national average for human environments, which can serve as a benchmark for introducing new technologies and lifestyles, thus helping to improve the state of health of man in areas with essentially high natural radiations. Due to the nature of the environment, man is continuously exposed to varying amounts of ionizing radiation doses. It has been established that out of the total radiation dose received by the man on the earth, about 96.1% is from natural sources while the remaining percentage is from man-made sources (Chongankar *et al.,* 2003). The main components of natural background radiations are extra-terrestrial cosmic rays and the radiation due to the radioactivity of some primordial elements in the earth principally from decay-series elements which are ^{238}U, ^{232}Th, and non-decay ^{40}K.

Apart from the inescapable natural background radiation sources, the radiation exposure to man in his environment can also arise from activities such as mining, farming, radiological accidents, and nuclear weapon testing (Jibiri and Famodimu, 2013). It has been a global interest to carry out the study of naturally occurring radiation and environmental radioactivity and the results from such studies are being used to assess the radiation hazard of the exposed population.

Radionuclides of natural origin come from two main sources: cosmogenic and primordial sources. Cosmogenic radionuclides are products of cosmic radiations interactions with atmospheric molecules, while primordial radionuclides are created with the earth (Isinkaye *et al.*, 2018). Cosmogenic radionuclides include ^{3}H, ^{7}Be, ^{14}C, and ^{22}Na while primordial radionuclides

are long-lived radionuclides such as ^{40}K, ^{238}U, ^{235}U, and ^{232}Th and their daughters. Constant amounts of cosmogenic radionuclides are usually observed in the earth's environment due to the balance between the rate at which they are produced and the rate at which they decay (Mikhail, 2008). The main contributors to the environmental background radiation are the terrestrial radionuclides, ^{40}K, ^{226}Ra, and ^{232}Th, which are not uniformly spread in soils, and they vary according to the geology and geography of different environments (UNSCEAR, 2000). Their concentrations in soils and rocks depend on the mineral make-up of the under-laying bedrock (Maphoto, 2014). Good knowledge of the natural radioactivity content of soils and rocks plays a major role in radiation protection practices and geoscientific research (Einsenbud, 1963).

As the human race depends on the environment in which the radionuclides are abundantly present, avoidance of interaction with radionuclides is virtually impossible. The interconnection of radionuclides with the human biological system leads to different chemical and physical expressions in terms of symptoms which also depend on the severity of the exposure (Fajemiroye *et al.,* 2015). The nature of the exposure depends on the absorbed dose rate as well as the effective dose equivalent. Knowledge of these parameters will enable health care providers to determine the best line of care for patients so diagnosed. Also, the knowledge of the dose accruing to the populace assists in forming the basis for the assessment of the degree of radioactive contamination or pollution in the environment. Since the quantity of background radiation in an environment also depends though to a lesser extent upon man activities and soil uses (Olarinoye *et al*., 2010). Consequently, the soil of barren areas should show a different quantity of radioactivity when compared with that of the cultivated soil. Increased radioactivity resulting from the usage of chemical fertilizers in Upper Egypt has been reported by (Uosif, 2014). When the dose rate is within the limit stated by I.C.R.P, the effect of radiation is insignificant and most time no effect is noticed, although the effect of low radiation is yet to be completely understood

(ICRP, 1990). In this study, solutions are provided for the level of radiation exposure to humans and the environment for a safe living.

Igbesa is an industrial and farming area, so the industrial activities of the area are on a rise and have been for decades. Therefore, there is a need to investigate the effect of the monotonous industrial activities of the area on lives and properties in that areaIn our attempt to achieve this, we measured natural background radiation levels at different places in Igbesa Community, Ogun State, and this measurement was achieved via the observation of the radiation dose rate exposed to students, staff, and members of the general public within the campus of Ogun State Institute of Technology, Igbesa, and effective dose equivalent of Ogitech, Viju, Ogun Guangdong FTZ, and Igbesa Community.

2. MATERIALS AND METHOD

2.1 Study area and sampling description

Igbesa community is one of the border areas shared by Ogun and Lagos State with a geographical latitude of 6.53^{o}N and a Longitude of 3.14^{o}E. Igbesa is a region under Ado-Odo/Ota Local government area with a population of 285,142 out of 527, 242 recorded by the Nigeria Population Census in 2006. Igbesa is one of the most industrialized areas in Ogun State with more than fifty running industries. The geology of the area is sedimentary which has no significant contribution to the environmental radiation level of the area.

Measurements were taken uniformly around the Igbesa community, Ogun state with the use of a handheld *RADEYE G-10 Gamma* survey meter. A total number of forty points (Tables 2 to 5) in four locations (Table 1) were chosen for the survey work in the community. All the locations are linked by roads which makes them easily accessible. Radeye PRD was used for this study. The measurements were taken 1-meter above the ground surface. Five repeated readings were taken at each point of the sampled locations and the average was calculated for further analysis.

Table 1. Locations and codes.

S/N	Location	Code	Coordinates
1	Ogitech	A	6^o 32`38``N $3^o$07`06``E
2	Igbesa community	B	6^o 32`45``N $3^o$07`16``E
3	FTZ	C	6^o 32`59``N $3^o$07`19``E
4	Viju	D	6^o 33`05``N $3^o$07`00``E

A= Ogitech with 10 surveyed points, **B** = Igbesa community with 10 surveyed points, **C**= FTZ with 10 surveyed points, **D**= VIJU with 10 surveyed points.

2.2 Counting method

Radeye PRD is used for the survey as it is reliable, portable, and efficient. it is a digital survey meter that measures the strength and composition of radioactive sources. The survey meter was taken to the locations raised 1m away from the ground level to detect the radioactive contribution to the natural background radiation in the community.

3. RESULTS AND DISCUSSION OF RESULTS

There is variation in measured dose rates from 0.080 to 0.22 (Figure 1). The statistics of the data yielded a mean of 0.13035 and a standard deviation of 0.03424 which is less than the least value measured during the survey as compared with Oladipupo and (Yabagi, 2015). The geologic formation of the investigated locations is of the type that has an insignificant contribution to the natural background radiation of these areas as the region is purely sediments (weathered layers). So any rise or irregularities in this background radiation are attributed to the industrial and farming activities taking place within the investigated locations which could result from the use of fertilizers and industrial effluents/wastes when compared to (Farai and Jibiri 2000).

In the premises of ogitech, Igbesa community, Ftz, and viju, the measured absorbed radiation doses are below the alarming value or standard measure that was stated or set by the I.C.R.P to harm lives if equal or greater than its asserted value. However, with this present safe condition of the investigated areas, the values are not in close range as they differ highly at some points within the surveyed areas. And this over a long period may accrue to a certain value if the activities

promoted in such areas are not controlled or subsided. The following points within identified locations are disparate largely from other points within certain locations which makes the overall absorbed dose rate means or averages of those locations to be higher than those locations having points readings with close range. The points are C1, C6, D2, D7, and D8. These are found obvious in the bar charts presented in Figure 1.

Table 2. Location and its surveyed points' codes (OGITECH**).**

S/N	Location	Code
1	School Gate	A_1
2	Generator stand	A_2
3	SLT Dept	A_3
4	ICT Dept	A_4
5	Engineering	A_5
6	Buss Admin	A_6
7	Cafeteria	A_7
8	Mosque	A_8
9	Chapel	A_9
10	Mass Com.	A_{10}

Table 3. Location and its surveyed points' codes (IGBESA).

S/N	Location	Code
1	Aina	B_1
2	Obanla Hotel	B_2
3	Panoda	B_3
4	Roundabout	B_4
5	LCDA	B_5
6	Technical	B_6
7	Esa-Igbe	B_7
8	Elero	B_8
9	Palace	B_9
10	Bolagbe	B_{10}

The two companies, Viju (located at) and FTZ, are more than a kilometre away from the community (B = Igbesa community) and Ogitech (Ogun State Institute of Science and Technology), and their absorbed dose rates are seen to be the highest (at C1), second to the highest (C6) in figure 4 and third position (at D2) in figure 5 above in magnitude with absorbed dose rates of 0.22, 0.216 and 0.192 respectively. These are shown in the last two diagrams of a 4 –row and 1- column array of diagrams labeled Figure 1.

The companies are situated close to one another with Ogitech being approximately a kilometer away and Igbesa community, 2km away. Such relatively less distance reflects in the natural background radiation of the citadel of learning and therefore has made the environ to be exposed to a slightly higher dose rate and the absorbed dose rates are relatively higher at A10 and A2 which corresponds to mass communication department and generator stand, of Ogitech, respectively and least background radiation in the citadel of learning was measured at SLT department which is point A3 on the bar chart Figures 1 and 2.

Table 4. Location and its surveyed points' codes (FTZ company).

S/N	Location	Code
1	Gate Entrance	C_1

Table 5. Location and its surveyed points' codes (Viju's Company).

2	Workshop	C_2
3	Store	C_3
4	Motor Pack	C_4
5	Security Post	C_5
6	Junction	C_6
7	Wakdat	C_7
8	Food Seller	C_8
9	Trailer Pack	C_9
10	Old Gate	C_{10}

S/N	Location	Code
1	1st Gate	D_1
2	2nd Gate	D_2
3	Entrance	D_3
4	Packing space	D_4
5	Trailer pack 1	D_5
6	Trailer pack 2	D_6
7	Motor pack	D_7
8	2nd Gate	D_8
9	Security post	D_9
10	Trailer park 3	D_{10}

Therefore, the aforementioned condition or state could be attributed or attached to the influence of the industrial effluents /wastes released in to the atmosphere or surrounding to attain mobility through diffusion or outflow and thereby slightly and monotonously raising the background radiation of its neighborhoods with the inclusion of the institution.

The attenuation of the intensity of radiation from industrial effluents/wastes increases with distance from point of discharge and consequent to this, its effect is least within Igbesa community. And therefore could suffice to say that it is the reason behind having the second to the lowest point value at Igbesa location as shown in row two diagram of Figure 1 and diagram in Figure 2. This point corresponds to point B7 (Esa igbe).

Measurements taken within the Igbesa community are within close ranges and less than the safe limit dose (recommended public dose) and therefore suffices to say that lives and properties within the community are safe and not posed radiation danger (UNSCEAR, 2000).

By comparing the average of the four locations using Figure 3, it is seen on the mentioned bar plot that, FTZ has the highest average absorbed dose rate, followed by Viju, followed by Ogitech and Igbesa community with the least average absorbed dose rate of gamma radiation. And this prominent bar of FTZ is probably a consequence of the open or direct exposure/discharge of the industrial effluents/wastes. While viju company is only slightly different (not as obvious as FTZ) from Ogitech and the Igbesa community.

The general overview of plots, Figure 1 and Figure 2, is that points C1 and C2 are with highest and second to the highest absorbed dose rates and these correspond to points within FTZ company. So many lives and properties that dwell therein at these points are exposed to relatively higher dose rates, however still within a safe limit and therefore have an insignificant effect on lives. The third to the highest and the lowest dose rates are seen in Table 5 to be measured at points, D2 and D3, of Viju company.

All the surveyed points are less than the safe limit recommended by I.C.R.P and therefore one could say that the investigated areas operate within the range of natural background radiation and are very habitable to lives. No single area was predicted to have negative impact on lives consequent to the measure.

Figure 1. Measured Gamma Radiation Plots for the four Locations

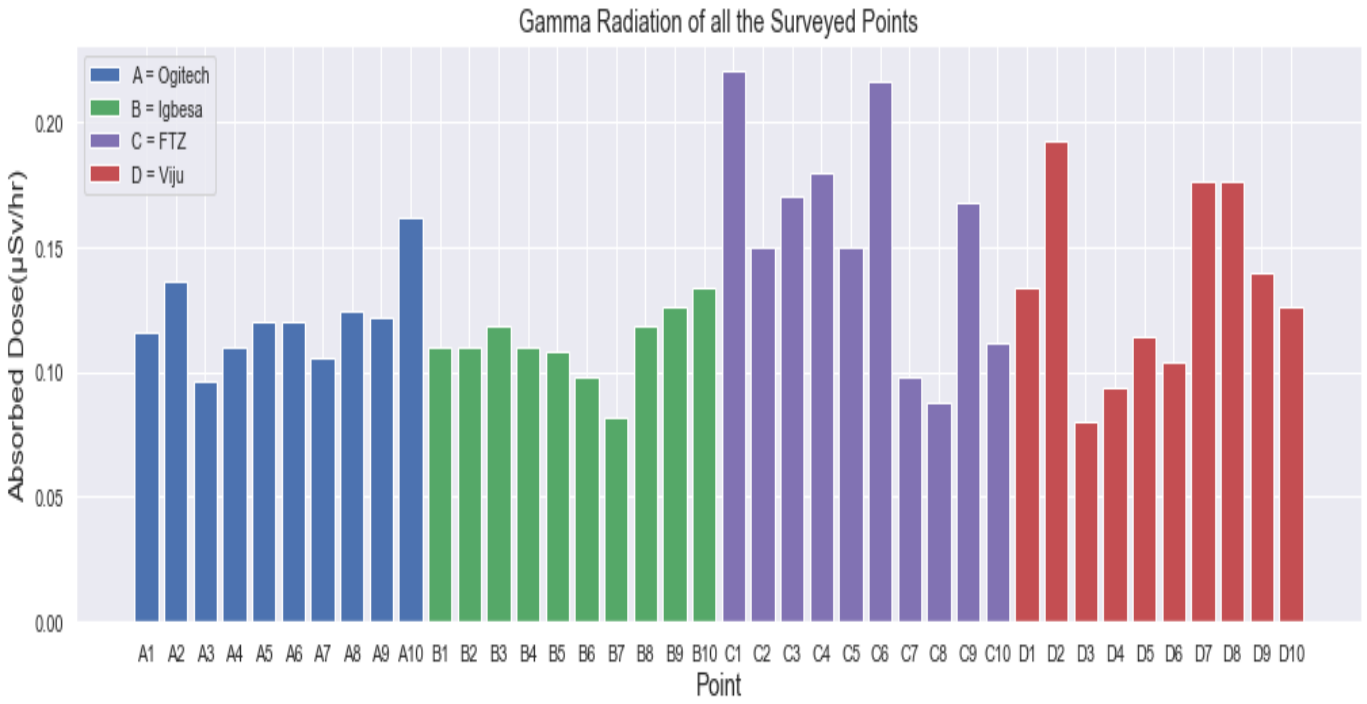

Figure 2. Gammaradiation plot of all the surveyed points.

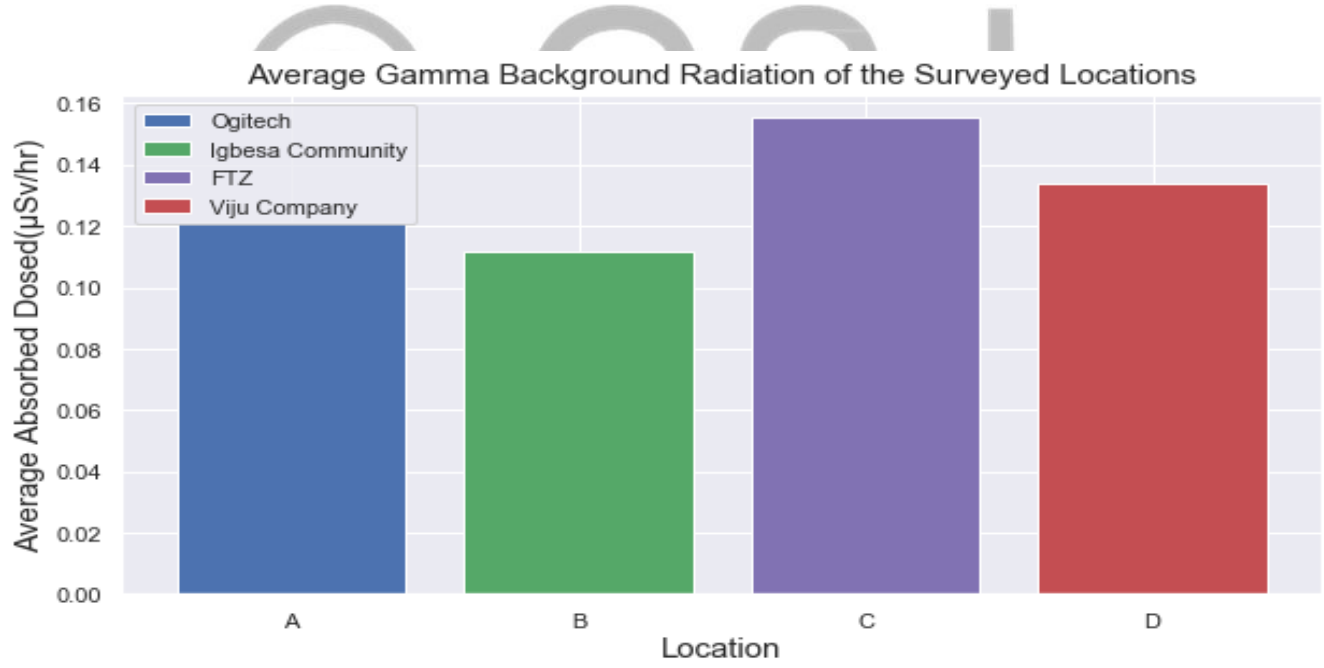

Figure 3. Average gamma radiation plot of the four locations.

4. CONCLUSION

The International Commission of Radiological Protection (I.C.R.P) recommends an annual dose limit of an effective dose of 1mSv. The absorbed dose rate is measured at each point within

any designated location and the average absorbed dose limits of all locations are less than the recommended public dose limit. The average absorbed dose rate of all the locations found was 0.13035, which is about 13 percent of the recommended safe limit.

In conclusion, Ogitech, Igbesa Community, FTZ, and Viju are free of radiation hazards; this is because the highest the dose level (0.22) was measured at a point C1 which corresponds to the Gate position or entrance of FTZ company is lesser than the 1mSv effective dose limit set up by International Commission of Radiological Protection (I.C.R.P) and thus implies that all investigated areas have acceptable and risk-free natural background radiation level.

5. RECOMMENDATION

It is strongly recommended that companies' effluents or industrial wastes should be properly managed and treated to avoid future surge in natural background radiation in their premises and neighbourhoods as they were observed having relatively higher gamma radiations than other investigated locations.

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