Evaluation Of Background Radiation Level At Shanu Village In Minna, Niger State, Nigeria.

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ABSTRACT: An evaluation of the level of background radiation was carried out at Shanu village in Minna, Niger state, Nigeria. A portable Geiger-Mueller tube-based environmental digital radiometer (Digilert Nuclear Radiation Monitor, S.E International, Inc. USA) calibrated by gamma (γ) rays from cesium (Cs) source was used for the measurement. A total of ten (10) points was surveyed across the village for level of background radiation. The radiation dose rate varies from 0.0268mR/hr to 0.0311mR/hr. In all ten points surveyed the mean dose rate was 0.0128mR/hr with a standard deviation of 0.000879mR/hr. This is about 17% deviation from the standard background radiation value of 0.011mR/hr. This result could simply be attributed to natural sources (cosmic and terrestrial) and also the possibility of radionuclide sources in the environment. The average annual effective dose obtained from this study is 1.1213mSv/y which is still less than the current average radiation dose to the world's population from natural sources of radiation of 2.4mSv/y as reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

Keywords: Radiation, radioactivity, dose rate, count rate, dosimeter, global Positioning System

INTRODUCTION

Background radiation is a natural occurrence which has been our constant companion since the birth of the universe. Radon contributes the largest amount of radiation to our environment. It is a radioactive gas which is a disintegration product of the earth"s soil and rocks radioactive isotopes. There are natural and man-made sources of radiation, the natural sources are thus; cosmic rays (from the sun, through the atmosphere down to the earth surface), terrestrial sources (rocks and soil of the earth crust), and within the human body (our living tissue contains trace amount of radioactive potassium and carbon, since birth). Agricultural product like banana also contains high amount of radioactive materials. Man-made sources of radiation that contributes to our natural background exposures are; test of nuclear weapon, nuclear power stations, and medical uses of radio nuclides. We are constantly exposed to low levels of background radiation. The extent of radiation level varies depending on location. Exposure to radiation can cause adverse health effects, including genetic defects in children of exposed parents, mutations in the DNA and leukaemia. Radiation cannot be completely eliminated from our environment, to some extent; our exposure to them can be controlled. There are several ways to control radiation doses, such as; by limiting the time spent in areas where radioactive materials are, maintaining distance from sources of radiation and shielding of radioactive sources. Long term effects are associated with humans exposed to radiation. When the dose and dose rate is within accepted level, its effect is small and most time not noticed. The Nuclear Regulatory Commission (NRC), the Food and Drug Administration (FDA) and other federal and state agencies regulate medical uses of radiation. These agencies give guidance and laid down rules on limiting the radiation doses to humans based on medical procedures, in protecting the workers, patients and equipment. This research work therefore, intends to evaluate the level of background radiation in Shanu Village, Minna, Niger state, Nigeria.

STUDY AREA

The administrative capital of Niger state is Minna. The city has an estimated land mass of about 6784 square kilometre, making it one of the largest in land mass in Nigeria. Minna lies on latitude 9^0 $36'50''$North and longitude 6^0 $33'25''$East on the geological base of basement complex rocks (Migmatite-Gnesis) and sedimentary rocks. The town has a mean annual record precipitation of 1300mm; the highest mean monthly rainfall is in September with almost 300. On average, the raining season starts between the 11th to 20th April and lasts between 190-200 days. Temperature rarely falls below 22^0C in the city with its peaks at 40^0C in (February – March) and 35^0C in (November - December). Shanu village is a rural settlement bounded by Bosso and Dutsen Kura in Minna, Niger state, Nigeria. Its geographical coordinates are 9.63578^0North, 6.51224^0East It has an area of 875 km sq. The populace of the village are predominantly farmers. The village is sparsely populated, the vegetation is mainly grassland with little trees, effect of erosion is also visible and traces of weathered rocks can be found at the entrance of the village.

Fig. 3.1 *Map of Shanu village showing points covered curled from Google Earth.*

MATERIALS AND METHODS

Background radiation level was evaluated in Shanu village, using a handheld Geiger-Müller tube-based environmental radiation dosimeter (Digital Nuclear Radiation Monitor, S.E International, Inc. USA), a GPS (Global Positioning System), a stop watch, a 9V battery and a locally made retort stand (support for the radiation dosimeter). The radiation dosimeter is specifically designed to serve as a low level survey radiometer. It was calibrated with $^{137}_{55}Cs$ (Cesium) gamma (γ) source. It is also capable of measuring dose rate in 0-20 mR/hr range. It is set to total Count which will accumulate the radiation counts over time. This is a useful feature especially for the determination of the level of background radiation. These features make it an ideal choice for gamma (γ) dose rate measurement from the environment, geological sites (for radioactive minerals). The GPS (Global Positioning System) is used along with the radiometer in taking the coordinates of the point being measured by the radiometer. The points chosen for background radiation measurements were selected randomly but evenly distributed to cover the entire village. These include plain field, farmland, construction site and residential areas. The radiometer (dosimeter) was suspended in air via the locally made retort stand, one meter above the ground level (EML, 1983) in an undisturbed open area. At each point, a total count for 10 minutes was recorded; further two successive readings were recorded to ensure accuracy. The total count method was employed to cater for all possible forms of radiation possible, be it alpha (α), beta (β) or gamma (γ) radiations. The readings for the randomly chosen points were taken successively, shown in table 3.1. The three successive total count readings from each point were converted to their equivalent in dose rate by dividing the readings obtained by a factor of 1000. The dose rate conversion was in milli- Rad per hour (mR/hr). The average dose rate and standard deviation was also taken and tabulated in the next chapter. For each successive points, the geographical coordinates were recorded simultaneously taking into consideration the northings, easting and elevation.

RESULT AND DISCUSSION

A total of ten (10) points was surveyed randomly across Shanu village for background environmental radiation. The dose rate obtained at each point is presented in table 4.1. The dose rate varies from 0.0268mR/hr to 0.0321mR/hr, for all the ten (10) points randomly surveyed; the mean dose rate was 0.0128mR/hr with a standard deviation of 0.000879mR/hr. Generally, there are no radiation generators around the village. In table 4.1, is a chart of the results obtained for mean dose rate of the study area for external background radiation, these obtained data were then plotted alongside the standard external background radiation value of 0.011mR/hr as advised by the US Nuclear Regulatory Commission (USNRC), (CFR, 1979) in fig. 4.2. In table 4.1, the method for conversion employed was;
Dose rate (mR hr) = each data point time (min) 1000;
Where; mR/hr is mili-Rad per hour.
From the expression above, the multiplication by factor 1000 is used in order to convert from the primary dose rate of count per 10 minutes to mili-Rad per hour.

Table 3.1 *Raw data collected form site.*

LOCATION	COORDINATE		ELEVATION (m)	COUNT RATE 1: RAD/10MIN	COUNT RATE 2: RAD/10MIN	COUNT RATE 3: RAD/10MIN	AVERAGE RAD/10MIN
	North(^{0})	East(^{0})					
POINT 1	9.63578	6.51224	262.8	119	146	139	134.66667
POINT 2	9.63551	6.51008	261.0	129	133	122	128.00000
POINT 3	9.63361	6.50885	257.1	140	133	144	139.00000
POINT 4	9.63256	6.50722	257.6	115	115	114	114.66667
POINT 5	9.63054	6.50648	225.6	121	127	129	125.66667
POINT 6	9.63203	6.50612	253.9	130	135	119	128.00000
POINT 7	9.63441	6.50653	253.6	136	129	127	130.66667
POINT 8	9.63565	6.50874	262.0	125	129	141	131.66667
POINT 9	9.63677	6.50925	259.9	133	121	117	123.66667
POINT 10	9.63653	6.51052	266.5	121	129	133	127.66667
						TOTAL	128.36667

Table 4.1 *Converted data from study area.*

LOCATION	North(^{0})	East(^{0})	ELEVATION (m)	DOSE RATE 1 :mR/hr	DOSE RATE 2: mR/hr	DOSE RATE 3: mR/hr	AVERAGE :DOSE RATE mR/hr	SSD: mR/hr
POINT 1	9.63578	6.51224	262.8	0.0119	0.0.146	0.0139	0.0311	0.001401
POINT 2	9.63551	6.51008	261.0	0.0129	0.0133	0.0122	0.0303	0.000557
POINT 3	9.63361	6.50885	257.1	0.0140	0.0133	0.0144	0.0321	0.000557
POINT 4	9.63256	6.50722	257.6	0.0115	0.0115	0.0114	0.0268	5.77E-05
POINT 5	9.63054	6.50648	225.6	0.0121	0.0127	0.0129	0.0291	0.000416
POINT 6	9.63203	6.50612	253.9	0.0130	0.0135	0.0119	0.0305	0.000819
POINT 7	9.63441	6.50653	253.6	0.0136	0.0129	0.0127	0.0307	0.000473
POINT 8	9.63565	6.50874	262.0	0.0125	0.0129	0.0141	0.0301	0.000833
POINT 9	9.63677	6.50925	259.9	0.0133	0.0121	0.0117	0.0293	0.000833
POINT 10	9.63653	6.51052	266.5	0.0121	0.0129	0.0133	0.0294	0.000611
TOTAL MEAN							0.0128	
TOTAL STANDARD DEV.								0.000879

Fig. 4.1 *Dose rate for points in Shanu village.*
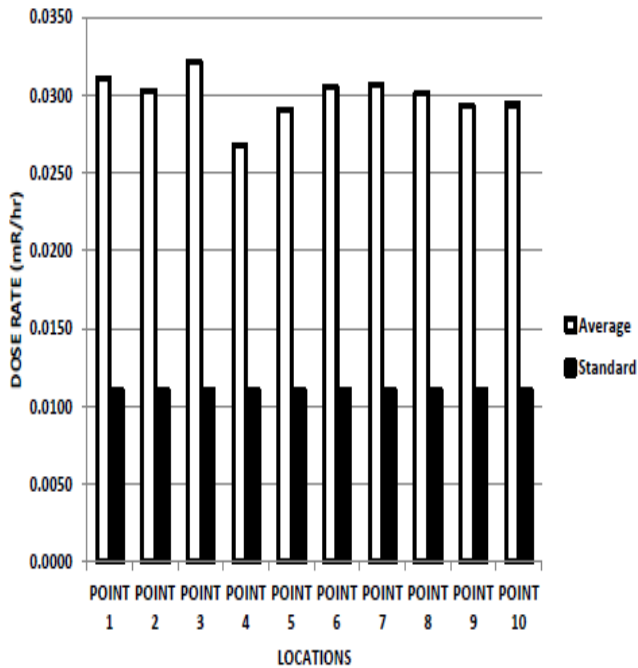

Fig. 4.2 *Dose rate for points in Shanu village compared with the standard value.*

EXPOSURE	SIGNIFICANCE
0.011mR/hr, Continuous whole body	Background radiation, sea level out of door
0.011mR/hr, Continuous whole body	Radiation inside wooden house at sea level
0.011mR/hr, Continuous whole body	Background radiation, ground level
0.625mR/hr	Limit for occupational exposure of whole body
9.375mR/hr	Limit for occupational exposure of hand
0.0625mR/hr	Limit for non-occupational exposure
Less than 2mR/hr and less than 100mR/hr; in any 7 consecutive days	Unrestricted area, no sign or control required
Less than 2mR/hr or greater than 100mR/hr; in any 7 consecutive days	Radiation area, sign required
Greater than 5mR on one hour to a major portion of the body	Radiation area, sign required

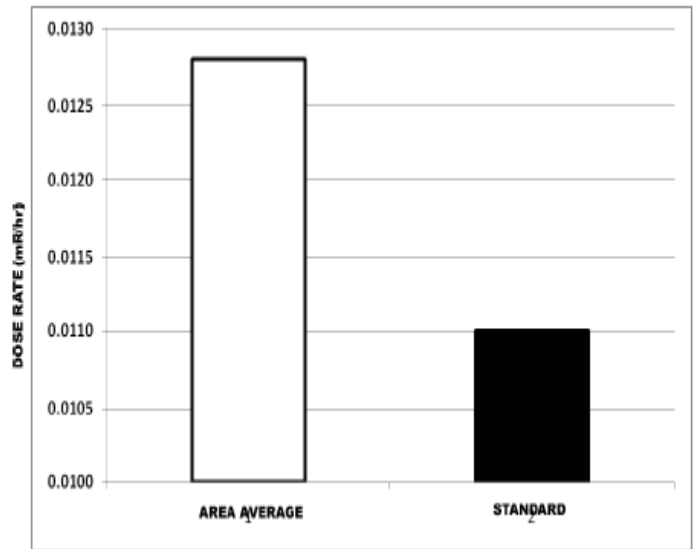**Table 4.2** *Standard external radiation levels (CFR, 1979).*

Fig. 4.3 *Average count rate of the studied area with the standard value*

It can be observed that point 4 has the lowest dose rate of 0.0268mR/hr; the highest dose rate was 0.0321mR/hr at point 3. The overall dose rate of 0.0128mR/hr was obtained for the background radiation level of the area studied. It is however higher than the standard external radiation level of 0.011mR/hr recommended by the US Nuclear Regulatory Commission (USNRC), (CFR, 1979). For the overall dose rate of the studied area is plotted alongside the standard external background radiation level, and the result is shown in fig. 4.3.

CONCLUSION

The high level of background radiation observed at the surveyed site could only be attributed to natural sources (terrestrial and cosmic). For the background radiation level is above the recommended standard for external background radiation advised by the US Nuclear Regulatory Commission (CFR, 1979), though, the elevation above the Regulatory Commission"s standard could be considered moderate. However, the geology of Minna ascertains that the soil has a large deposit of granite. Although, it is very well known fact that granites contain high concentration of potassium (K), thorium (Th) and uranium (U) (Ivanovich and Harmon, 1982). Thus the general average of 0.0128mR/hr dose rate for the study area represents about 16% deviation from the standard value recommended by the US Nuclear Regulatory Commission.

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