Journal of the Nigerian Association of Mathematical Physics
***Volume32,(November, 2015*), pp 351 – 356**

Assessment of Absorbed Radiation Dose Rate in Air in Two Local Government Areas of Delta State, Southern Nigeria

Francis A. Dawodu

Science Laboratory Technology, Delta State Polytechnic, Ogwashi-Uku.

Abstract

Assessment of absorbed radiation dose rate in two Local Government Areas of Delta State was conducted between October 2014 and May 2015 in Oshimili North and South. The radiation doses in air for each town in both Local Government Areas was carried out by placing the Gieger Mueller counter and stop watch in five locations and taking the mean. The annual effective dose rate in μSv year^{-1}was calculated for each town. The study found that the highest mean absorbed dose rate of 113 nGyh^{-1} was obtained in Anwai in Oshimili south Local Government Area, while the least absorbed dose rate was obtained in okwe also in Oshimili South Local Government Area. The highest mean absorbed dose rate recorded in Anwai might be due the presence of granite rocks and nearness to River Niger, where there could be some deposits of toxic materials. The results also show that the absorbed radiation in ten of the eleven locations is smaller than the world average.

1.0 Introduction

Background radiation is radiation from natural sources and may come from several origins such as cosmic rays, radioactive rocks, radioactive contamination of materials, fallout and other effects, radioactive potassium and carbon in the body, and x-rays from television screens [1].

The background radiation received by a person in a year is roughly equal to the dose that would be received in 5 minutes due to a 1 curie source of cobalt-60 placed one metre away.

Background radiation has increased in the environment owing to technological advancement, for example some isotopes used in the medical physics such as Iodine-131 with a half-life of 8.0 days and activity of 8μc; sitting of nuclear power reactors in the sea shore. It is trite to note that natural background radiation levels vary in the environment as a result of underlying rock, soil compositions, cosmic radiation and artificial sources from human activities.

The exposures from the sources and the effective doses combine in various ways at the locations based on the concentration of the radionucleids in the environment, in the materials, body and also the latitude and height of the location above the ground [2].

Bamidele in Neimman, 1993 asserted that “Today, naturally occurring radioactive materials or sources deliver a large collective dose to the world population than do all man-made (artificial) sources combined.” In developing country like Nigeria, the main source of human radiation is made up of 94% of annual population exposures [3].

2.0 Materials and Method

2.1 Study Area

The measurement was conducted between October 2014 and May 2015 and carried out in two Local Government Areas of Delta State: Oshimili South and Oshimili North (See fig.1).

Oshimili South

Asaba, the capital of Delta State, is also the headquarters of Oshimili South LGA. The LGA has a land area of approximately 500 square kilometres and a population of about 149,306 people who are mainly farmers and fishermen. It is situated along the bank of the River Niger, whose many tributaries make up the Niger Delta. The sandy beaches of the river presents a

Corresponding author: Francis A. Dawodu, E-mail: francisdawodu28@yahoo.com, Tel.: +2347061528796

beautiful sight and is a good ground for recreation and tourism. The Niger Bridge links Asaba with Onitsha in Anambra State. Asaba, whose people are Igbo, is also the seat of a major traditional ruler, the Asagba of Asaba. Other communities are Oko and Okwe.

Oshimili North

Oshimili North LGA with headquarters at Akwukwu-Igbo was created out of the defunct Oshimili LGA in December, 1996. It has a population of about 115,316people who are predominantly farmers and fishermen spread amongst these areas; Akwukwu-Igbo, Atuma, Illah, Ebu, Ukala, Ibusa, Okpanam and Ugbolu.

The eleven (11) towns (See Table 1) considered in this study are: Ibusa, Okpanam, Akwuku-Igbo, Ugbolu, Illah, Okala-Okuta in Oshimili North Local Government Area of Delta State. Others are: Okwe, Asaba (Cable point), Oko-Amakon, Anwai and Iyi-Abi in Oshimili South Local Government Area of Delta State.

Oshimili North lies on Latitude 6.32^0N and longitude 6.64^0E, while Oshimili south lies on Latitude 6.09^0N and Longitude 6.68^0 E.

Delta State in which the two LGAs are situated has a population of 4,098,291 with a land area of $16{,}842m^{2.}$ It is bounded in the North by Edo State,North West by Ondo state,East by Anambra, Imo and Rivers State, South East by Bayelsa State. Delta State is a low-lying State without remarkable hills, it has wide coastal belt interlace with rivulets and streams, which form part of the Niger Delta.

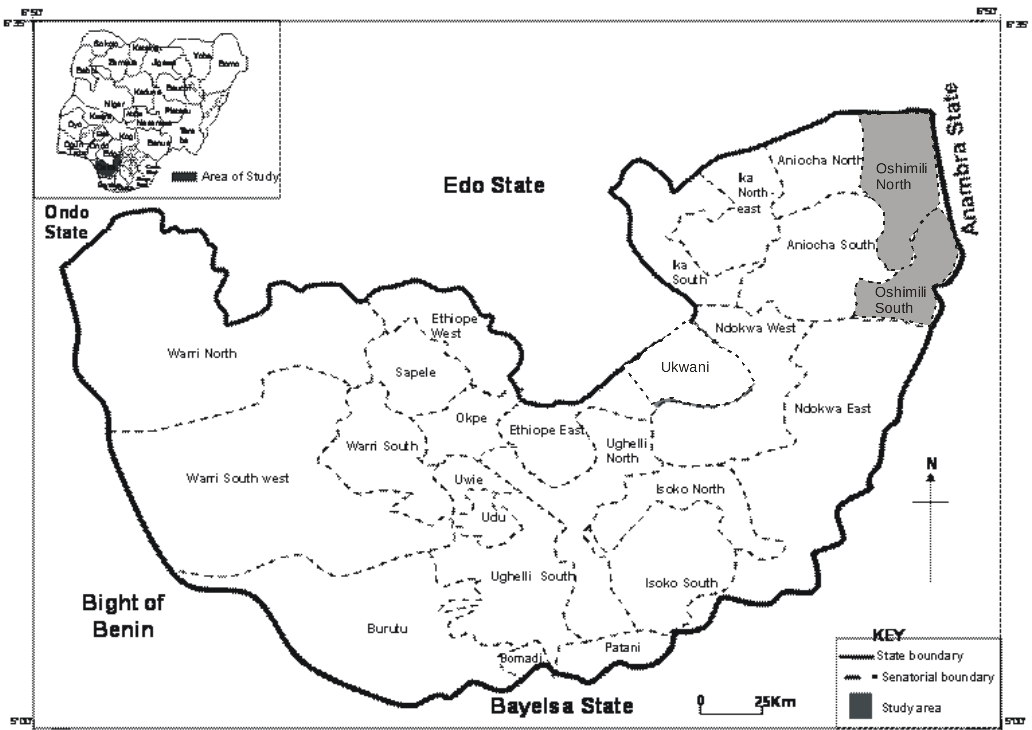

Fig. 1 I : Map of Delta State Showing Study Area

Source: Modified after Ministry of Lands, Survey and Urban Development Asaba, 2008

Table 1: Names of Study Locations

Oshimili North L.G.A.		**Oshimili South L.G.A.**	
1.	Ibusa	1.	Okwe
2.	Okpanam	2.	Asaba (cable point)
3.	Akwuku-igbo	3.	Oko-Amakon
4.	Ugbolu	4.	Anwai
5.	Illah	5.	Iyi-Abi
6.	Okala-okuta		

2.2 Measurement Technique

The radiation dose in air for each location was done by correctly placing the Geiger Mueller Counter and stop watch in five (5) locations within a town and taking the mean radiation. The Geiger Mueller Counter (Digilert 50 had been calibrated by the secondary standard Dosimetry Laboratory at the Nigerian Nuclear Regulatory Agency at University of Ibadan).

The radiation meter which was in the best possible way to detect low level alpha, beta and gamma radiations was expected to measure radiation parameters in units dose rate, exposure rate and activity.

2.3 Instrumentation

A wide range of Geiger Mueller radiation counters are being used worldwide for the measurement of radiation parameters.
For field work in this study, the halogen-quenched Geiger Mueller tube with mica and window was used along other field instruments and accessories such as:

Mica Window: density 1.5-2.0 mg/cm
Operating Range: 1Sv/hr-01 to 500
CPM : 1-50,000 counts
Total : 1-60,000 counts
Energy sensitivity: 1000 CMP/MR/hr
Referenced to Cs-137
Metre accuracy: 15%
Temperature range: -10-50^{0}c.

A total of eleven (11) locations were monitored in the study. Measurements were taken in all the 11 locations by recording five (5) successive readings obtained at 10-minute intervals.
The mean value of the absorbed dose rate was determined for each town. The Digilert 50 Radiation meter was placed at a height of about 1 metre above the ground.

2.4 Annual Effective Dose Rate to Population

The annual effective dose rate to the population wascalculated by employing the following equation:
He = DTF………………………… (1)
where D is the calculated total dose rate, T is occupancy time
= f x 24 x 365.25 hy^{-1} ………………………………. (2)
where f = 0.2 for outdoor measurements or f = 0.8 for indoor measurements.
Since all measurements were carried out outdoor, f = 0.2 was utilized in calculating occupancy time T. therefore T = 0.2 x 24 365.25 hy^{-1}
= 1753.2
but effective dose rate is: He = DT x F. where F = conversion factor = 0.7 SvGy^{-1}
He = D(T x F)
= Dose (1753.2 x 0.7)
= Dose x 1227.24

2.5 The Geiger-Mueller tube

A diagram of a Geiger-Mueller tube is shown in Figure 2

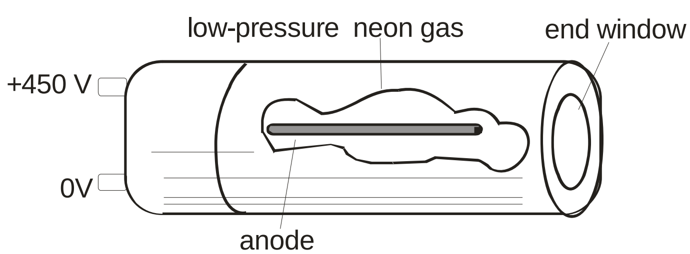

Figure 2: A Schematic Diagram of Geiger-Mueller tube.

The device (Fig. 2) is basically a gas-filled cold-cathode diode, in which the anode is a metal rod fixed along the axis of a cylindrical cathode. The anode should be thin, so that an intense electric field is produced near it when a potential is connected between the anode and cathode. The end of a tube is closed by 'window', the thickness of which varies from tube to tube depending on the type of radiation it is designed to detect.
The thickness of the end window is quoted in mg cm^{-2}; for alpha-particles it is about 2, for beta-particles about 25 and for gamma-rays many hundred. The tube contains neon at about 10 cm of mercury pressure, and a potential of about 450 V is applied between anode and cathode.
When a particle enters through the end window ions are produced in the gas; the positive ions travel towards the cathode while the electrons move towards the anode (figure 3). As they move they produce further ions by collisions, a process known as **secondary ionization**, and an avalanche of ions reaches the detecting electrodes. For an electron about 10^8 ions are produced in a few microseconds. This pulse is amplified in an external circuit and detected as either a meter reading or a sound. To prevent continuous secondary ionization a little bromine gas is added to the tube, acting as a 'quenching agent' and absorbing the kinetic energy of the positive ions.

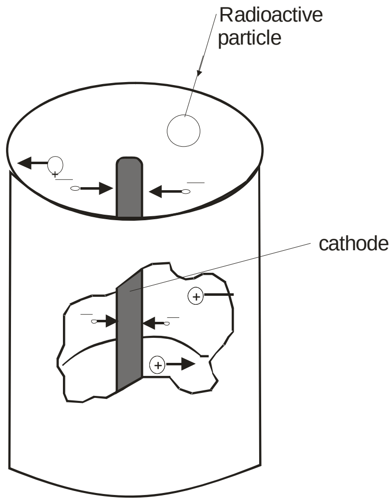

Figure 3: A Diagram showing ionization potential of Geiger-Mueller tube.

A typical Geiger tube can detect separate particles as long as they arrive more than 200 microseconds apart and therefore it has a maximum count rate of 500 counts per second.
If the characteristics of the Geiger tube (the anode voltage related to the count rate) are recorded as shown in figure 4, it can be seen that the tube should be operated in the so-called plateau region. In this area a small change of anode potential will have little effect on the count rate.

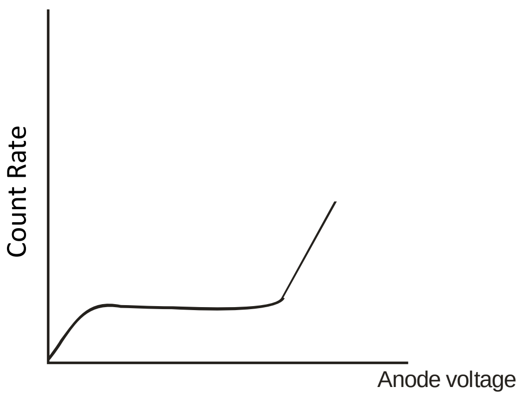

Figure 4: A Graph counts rate versus Anode Voltage
The Geiger tube may be fitted to a variety of detectors for investigating the activity of a radioactive source.
(a) a scaler- this device simply records the total number of pulses;
(b) a speaker and an amplifier- this will give audible signal that becomes a continuous crackle when the activity is high;
(c) A ratemeter- this actually records the count rate;
dN/dt and the output may be fed to a meter or to a storage facility such as a Vela.
If a Geiger tube with a thin end window is used in a darkened room, flashes of light may be observed in the tube when it is used to detect particles from an alpha source [5].

3.0 Results and Discussion

Table 2(a): Radiation Counts/Mins in Oshimili North

Towns	**Locations**					**Mean Absorbed dose nGyh^{-1}**	**Effective Dose (µSv year^{-1})**
	1	2	3	4	5		
Ibusa	34	31	35	36	32	33.6	41.24
Okpanam	41	42	44	40	39	41.2	50.56
Akwuku-Igbo	27	26	28	27	25	26.6	32.64
Ugbolu	27	26	28	26	27	26.8	32.89
Illah	58	57	59	60	57	58.2	71.43
Okala-Okuta	34	35	34	33	35	34.2	41.97

Radiation counts/mins collected from five locations of six selected major towns in Oshimili North LGA of Delta State, Nigeria.

Table 2 (b): Radiation Counts/Mins in Oshimili South

Towns	Locations					Mean Absorbed Dose $nGyh^{-1}$	Effective Dose ($\mu Sv\ year^{-1}$)
	1	2	3	4	5		
Okwe	17	18	16	17	16	16.8	20.62
Asaba (Cable Point)	41	39	40	42	41	40.6	49.83
Oko-Amakon	45	46	44	43	47	45	55.23
Anwai	113	114	116	112	110	113	138.68
Iyi-Abi	23	22	24	22	21	22.6	27.74

Radiation counts/mins collected from five locations of five selected major towns in Oshimili South LGA of Delta State, Nigeria.

The mean absorbed rate and effective yearly dose measured in eleven (11) locations from the 2 Local Government Areas as shown in Tables 2(a) and 2(b). The highest mean absorbed dose rate of 113 $nGyh^{-1}$ was obtained in Anwai in Oshimili south local Government Area, while the least absorbed dose rate was obtained in Okwe in the same Oshimili South LGA.

Except for Anwai in Oshimili south (whose dose rate was exceedingly high) the mean absorbed dose rates were high for towns in Oshimili North Local Governments which ranges from 26.6 $nGyh^{-1}$ to 58.2 $nGyh^{-1}$.

The least value of absorbed dose rate was obtained in Okwe (16.8 $nGyh^{-1}$). The mean absorbed dose rate in this town ranges form 16-18 $nGyh^{-1}$.The annual effective dose (calculated) obtained is shown in the last columns of tables 2(a) and 2(b). The maximum value of annual effective dose is 138.68 $\mu Sv\ year^{-1}$and the least value is 16.8 $\mu Sv\ year^{-1}$. The highest value of annual dose rate obtained in this study is higher than the dose rate of 24.6 $\mu Sv\ year^{-1}$ in the population dose distribution to soil radioactivity as reported by Obed et al [7]. The highest value from the present is higher than the world average of 70.0 $\mu Sv\ year^{-1}$obtained by [6].

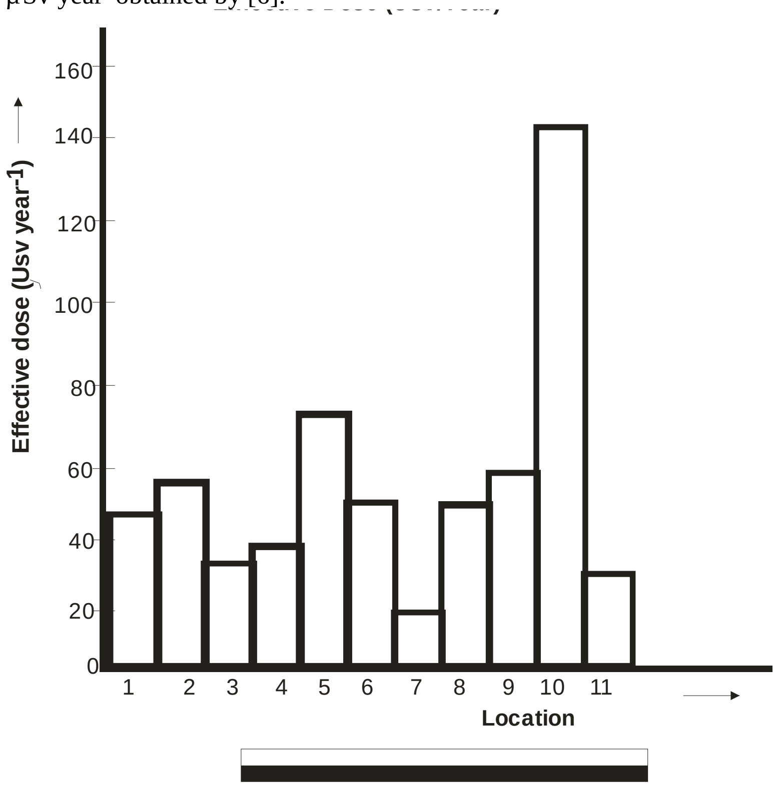

Figure 5: Bar-graph of annual effective dose in eleven towns of Oshimili North and South Local Governments of Delta state.

4.0 Conclusion

The mean absorbed dose rates and annual effective dose estimated in the two Local Government Areas of Delta State, South South, Nigeria have being measured. The result of this work does not relate altitude of the towns as having significant effect on the level of background radiation since no location has mean absorbed dose rate as low as 13.5 $nGyhr^{-1}$which is the minimum absorbed dose rate obtained [6].

The highest mean absorbed dose rate recorded in Anwai (fig. 5)may be due to the presence of granite rocks and nearness to River Niger, where there could be some deposits of toxic materials.

In conclusion, the results show that the absorbed radiation dose in ten (10) of the eleven (11) locations is smaller than the world average. However, no matter how low, all levels of ionizing radiations are hazardous to human health.

5.0 References

[1] Gibbs, K. (1990), *Advanced Physics*, 2nd ed, India: Cambridge University Press.

[2] Bamidele, L (2014), *Assessment of radiation absorbed dose rate in air in two high Altitude towns of Osun State, south western Nigeria*, Journal of Laboratory Sciences (JLS), 2(1), 2014.

[3] Neimann E.G. (1983), *Radiation Biophysics.* In Biophysics eds- W.Hoppe, W. Lohmann, H. Marki and H. Zeigler. Springer – verlag, Berlin, Germany, Pp. 299.

[4] UNSCEAR (1988), Exposure from Natural Radiation Sources. United Nations Scientific Committee on effects of Atomic Radiation 1988 report, Vol. 2 Annex A.

[5] Adams, S. and Allday, J. (2000), *Advanced Physics*, Italy: Oxford University Press, Pp 430.

[6] UNSCEAR (2000), *Exposure from Natural Radiation Sources.* United Nations Scientific committee on the effects of Atomic Radiation 2000 report, Vol. 1. Annex B, Pp. 86.

[7] Obed, R.I., Farai I.P, and Jibiri, N.N (2005), *Population dose distribution due to soil Radioactivity concentration levels in 18 areas across Nigeria.* J. Radiol.Prot. 25: 305-312