International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

In-Situ Background Radiation Measurements from Indiscriminate Dumps Sites in Sokoto Metropolis, Sokoto State, Nigeria

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Abstract: ***This study presents the result of In-Situ background ionizing radiation measurement from 65 indiscriminate dumpsites within the central city of Sokoto. A portable radiation survey meter Digilert 50 was used for the measurements. The measurement was carried out in the midday hours to ascertain the maximum response of the Digilert 50 at 1m above the ground called gonadial level of measuring ionizing radiation. And the location of each measurement was equally marked by the Global Positioning System (GPS) for future references and further review of the results of these findingsThe values of the mean background ionization radiation were in the range of 0.011 to 0.065*** mR/hr ***and an average of 0.024*** mR/hr ***against the global limit of 0.013*** mR/hr ***with a significantly higher upper limit than the global average. The calculated averages of annual effective dose significantly 0.841 and 5.466*** $mSvyr^{-1}$ ***lower and upper limits and an average of 2.017*** $mSvyr^{-1}$ ***respectively. This is significantly higher than 1.00*** $mSvyr^{-1}$ ***global limit.This showed that radiation exposurelevel to the public from indiscriminate dumpsites in Sokoto metropolis is a processor to a radiological impacts that needs a further research and immediate attention. The major approach for inhabitants should be a clean cultural practices of food covering and proper husbandry of portable water to mimic elevated exposure through inhalations and ingestion.***

Keywords: Ionizing radiation, dumpsites, Digilert 50, Sokoto

1. Introduction

The In-Situ background measurement of terrestrial gamma radiation is on the assumptions of its existence in a laterally uniform distribution in the environment, which varies with vertical contribution from the soil towards the horizons approximately 10-30 cm upwards[1-3].

The disposed unwanted hazardous materials from industrial and domestic activities generated and dumped indiscriminately around dwellings are inseparable aspects of human food chains thereby threatening the good health of living systems [4-6]. The history of human activities have revealed that millions of tons of wastes have been generated and it is the way this waste are dispersed, handled, stored, and disposed of, that account to the risk of environmental and public health of the inhabitants [7-10].

In a study by Jibiri *et al.,*[11], it was reported that staple food stuffs consumed in Nigeria have traces of radionuclide in them. When wastes are disposed in dumpsites, the refuse landfills becomes liable recipients of varying contaminations of radioactive materials that could contribute to the amount of background radiation in a given location [12]. It has as well been established by Akinloye and Olomo, [13] that vegetation and environmental fields in some wide areas in Nigeria contain traces amount of radionuclides that could contribute to the ambient radioactivities. It is therefore imperative to carry out measurement of different dimensions on different stratum of radiation in the environment at a given time in order to adequately quantify and determine the risk to the population. To achieve these, we have outlined steps to measure the background gamma radiation level of different areas within the suburb and metropolis of Sokoto state. So that the results of this measurement could be used as a reference value to evaluate effects of indiscriminate dumpsites from radioactivity point of view. Some of the indiscriminate dumpsites are spread within the suburb and environs of the Sokoto metropolis with a continuous disposal of wastes on daily basis. Figure 1, 2 and 3 below showthe dumpsites at a view in parts of market, homes and other human endavours.

Figure 1: Scattered and hips of Dumpsite around living places in a densely populated area in Sokoto Metropolis.

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Figure 2: Scattered and hips of dumpsites along roadside road side in *Minannata* area, Sokoto.

Figure 3: Dumpsite around *Kasuwa Yarkure* Market in Sokoto

2. Materials and Methods

A portable radiation survey meter Digilert 50 with a Halogen-quenched Geiger-Mueller tube and an effective diameter of 1.75” (45 mm), Mica window density of 1.5 - 2.0 mg/cm^2 was used for the In-Situ measurement in this study. It has a gamma sensitivity of approximately 7.5 CPS/mR/hr referenced to ^{60}Co and smallest detectable level for I-125 is 0.02 μCi at contact. It has an accuracy of ± 15% over the entire operating range. It is capable of detecting Alpha, Beta, Gamma and X-rays within the temperature range of -10° to +50° C which is equivalent to 14° to 122° F to measure the exposure level in the field. We have adopted the *In-situ* background radiation measurement approach in this work in order avoid variation between normal sample points and perturbed sampled through perceived homogenization with other substance in the laboratory environment that add to radiation detection during *In-Vitro* measurements. This will also enable samples to maintain their original environmental characteristics. Measurements were conducted at 65 locations of dumpsites with a respective geographical positioning system (GPS) so as to measure the precise location of sampling. The reading of the instrument was taken after every 15 minutes for at least 5 times then the average values obtained are recorded as presented in table 1 below. This is to enhance the maximum response of the Digilert 50, the measurements were conducted within the midday hours as reported by Tobiska *et al.,* [14]. The Digilert 50 radiation meter was held on retort stand to a height of 1.0m above the ground which is known as the gonadial level with its window facing the Dumpsites and then vertically downward as recommended by Avwiri *et al.,* [15]. In order to record the highest stable point of measurement, the detector was set on in a position to absorb radiation for the time set which was then recorded. This was used to evaluate annual absorbed dose rate from micro Rem per hourto micro-Sievert per year (mSvyr-1) by equation 1 below according to Avwiri and Agbalagba, [16].

$$1mRhr^{-1} = (0.96 \times 24 \times 365 / 100) mSvyr^{-1} \quad (1)$$

Table 1: Background ionization Radiation (BIR)within Sokoto Metropolis

Location Number	Geographic location (GPS)	Range of BIR Measurement mR/hr	Mean of BIR Measurement mR/hr	Absorbed Dose Rate $mSvyr^{-1}$
1	N13^{0}03.158’E005^{0}15.475’	0.019-0.024	0.021	1.598
2	N13^0 02.534’E005^{0}15.550’	0.023-0.028	0.026	1.598
3	N13^{0}02.507’ E005^{0}15.549’	0.022-0.023	0.022	2.775
4	N13^{0}02.465’ E005^{0}15.551’	0.01-0.019	0.014	2.775
5	N13^{0}03.961’ E005^{0}15.435	0.017-0.022	0.020	1.850
6	N13^{0}03.992’ E005^{0}15.430’	0.014-0.023	0.019	1.177
7	N13^{0}03.991’ E005^{0}15.454’	0.017-0.02	0.019	1.850
8	N13^{0}03.953’ E005^{0}15.517’	0.03-0.038	0.033	1.177
9	N13^{0}03.896’ E005^{0}15.515’	0.031-0.036	0.033	1.934
10	N13^{0}03.884’ E005^{0}55.438	0.02-0.023	0.022	2.271
11	N13^{0}03.926’ E005^{0}14.903’	0.012-0.015	0.014	3.448
12	N13^{0}03.979’ E005^{0}14.851’	0.021-0.024	0.022	1.682
13	N13^{0}03.972’ E005^{0}14.854’	0.013-0.016	0.014	1.934
14	N13^{0}03.906’ E005^{0}14.854’	0.02-0.025	0.023	1.598
15	N13^{0}03.986’ E005^{0}14.752’	0.026-0.028	0.027	1.009
16	N13^{0}03.966’ E005^{0}14.685’	0.039-0.044	0.041	1.934
17	N13^{0}03.960’ E005^{0}14.660’	0.019-0.022	0.020	1.934
18	N13^{0}04.019’ E005^{0}14.424’	0.019-0.027	0.023	1.766
19	N13^{0}04.022’ E005^{0}14.427’	0.015-0.024	0.019	2.355
20	N13^{0}04.060’ E005^{0}14.443’	0.01-0.014	0.012	1.766
21	N13^{0}04.036’ E005^{0}14.434’	0.021-0.026	0.023	5.466
22	N13^{0}04.053’ E005^{0}14.425’	0.02-0.027	0.023	2.018
23	N13^{0}04.316’ E005^{0}14.396	0.02-0.024	0.021	2.018
24	N13^{0}04.614’ E005^{0}14.596’	0.026-0.03	0.028	1.934
25	N13^{0}04.504’ E005^{0}14.574’	0.02-0.023	0.021	1.681
26	N13^{0}04.568’ E005^{0}14.532’	0.014-0.16	0.065	2.186
27	N13^{0}03.928’ E005^{0}13.314’	0.021-0.027	0.024	2.355
28	N13^{0}03.919’ E005^{0}13.294’	0.02-0.027	0.024	2.355
29	N13^{0}04.191’ E005^{0}13.536’	0.02-0.026	0.023	1.766
30	N13^{0}04.226’ E005^{0}13.544’	0.018-0.021	0.020	2.102
31	N13^{0}04.251’ E005^{0}13.542’	0.025-0.026	0.026	1.430
32	N13^{0}04.259’ E005^{0}13.636’	0.026-0.029	0.028	1.598
33	N13^{0}04.260’ E005^{0}13.615’	0.026-0.031	0.028	1.850
34	N13^{0}04.278’ E005^{0}13.608’	0.02-0.022	0.021	1.514
35	N13^{0}04.282’ E005^{0}13.641’	0.023-0.028	0.025	1.934
36	N13^{0}04.293’ E005^{0}13.682’	0.015-0.019	0.017	0.925
37	N13^{0}04.302’ E005^{0}13.695’	0.018-0.02	0.019	1.261
38	N13^{0}04.334’ E005^{0}13.699’	0.02-0.024	0.022	2.439
39	N13^{0}04.380’ E005^{0}13.676’	0.016-0.02	0.018	2.691
40	N13^{0}04.403’ E005^{0}13.660’	0.02-0.025	0.023	2.523
41	N13^{0}04.414’ E005^{0}13.659’	0.009-0.013	0.011	1.766

42	N13^{0}04.371' E005^{0}13.645'	0.013-0.016	0.015	2.018
43	N13^{0}04.372' E005^{0}13.747'	0.028-0.031	0.029	2.018
44	N13^{0}04.395' E005^{0}13.948'	0.026-0.037	0.032	2.186
45	N13^{0}04.436' E005^{0}13.948'	0.028-0.033	0.030	2.102
46	N13^{0}04.455'E005^{0}14.004'	0.02-0.023	0.021	2.271
47	N13^{0}04.463'E005^{0}14.065'	0.023-0.026	0.024	2.691
48	N13^{0}04.481' E005^{0}14.139'	0.023-0.026	0.024	2.523
49	N13^{0}04.517' E005^{0}14.298'	0.021-0.029	0.026	2.018
50	N13^{0}04.526' E005^{0}14.342'	0.02-0.027	0.025	1.682
51	N13^{0}04.524' E005^{0}14.395'	0.024-0.029	0.027	2.018
52	N13^{0}04.536' E005^{0}14.383'	0.028-0.038	0.032	1.514
53	N13^{0}04.544' E005^{0}14.415'	0.029-0.03	0.030	2.439
54	N13^{0}04.556' E005^{0}13.451'	0.022-0.027	0.024	2.186
55	N13^{0}03.302' E005^{0}13.070'	0.019-0.022	0.020	0.841
56	N13^{0}03.303' E005^{0}13.722'	0.02-0.029	0.024	1.681
57	N13^{0}03.302' E005^{0}13.690'	0.017-0.019	0.018	1.766
58	N13^{0}03.377' E005^{0}13.566'	0.027-0.031	0.029	2.607
59	N13^{0}03.404' E005^{0}13.548'	0.023-0.03	0.026	1.850
60	N13^{0}03.569' E005^{0}13.465'	0.006-0.014	0.010	1.850
61	N13^{0}03.619' E005^{0}13.226'	0.018-0.022	0.020	1.598
62	N13^{0}03.734' E005^{0}13.349'	0.02-0.023	0.021	1.598
63	N13^{0}03.736' E005^{0}13.378'	0.029-0.033	0.031	2.775
64	N13^{0}03.739' E005^{0}13.476'	0.02-0.024	0.022	2.775
65	N13^{0}03.637' E005^{0}13.865'	0.021-0.024	0.022	1.850
Mean	Mean	0.021-0.027	0.024	2.017
BIR Standard Value 0.013				1.00

3. Result and Discussion

Tables 1 above is the results obtained from the *In-Situ* background ionizing radiation (BIR) measurements from indiscriminate dumpsite within Sokoto metropolis with the respective comparison to the mean globalstandard BIR and absorbed dose rate. The table also show the background ionization radiation rate and effective absorbed dose from different dumpsite in central Sokoto city. The value of the mean background ionization radiation varies from 0.011 to 0.065 mR/hr. The lower limit of this value shows a fairly lower BIR in comparison with the global limit of 0.013 mR/hr but with a significantly higher upper limit than the global average. The mean BIR from the table also unveils a significant radiological hazards to the public from indiscriminate dumpsites in the range of 0.841 to 5.466 $mSvyr^{-1}$ with a calculated annual average of 2.017 $mSvyr^{-1}$ which is significantly higher than 1.00 $mSvyr^{-1}$ global limit.

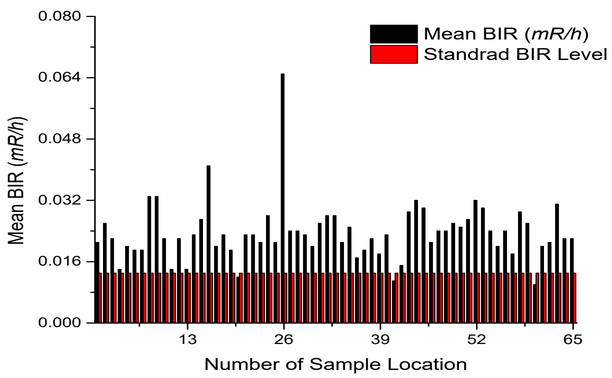

Figure 1: A cluster Column charts of Mean BIR Levels in comparison with the Standard BIR Level

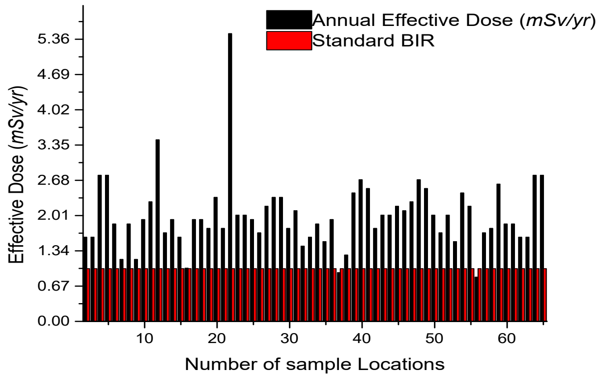

Figure 2: A cluster Column charts of Mean Annual effective dosein comparison with the Standard BIR Level

Figure 1 above shows the comparison of mean BIR levels of all the 65 indiscriminate dumpsites measured in this finding while Fig. 2 is a cluster column chart of mean annual effective dose calculated from the mean BIR in comparison with the standard BIR limit of exposure to the public.

Conclusion

The high values of both background ionizingradiation and effective annual absorbed doseobtained within these dumpsites may be a function of some medical wastes, can food wastes, primordial sources within the soil, chemical wastes and relative hazardous materials littered in the dumpsites.

This is a precursor that the inhabitants are in a dangers of inhalation and ingestion of relative ionizing radionuclide sources that could be dispersed into water, through soil and potential heavy wind which could be contaminated.Hence, pedestrians and residents around indiscriminate dumpsites areas are in a dangers of exposure to different relatively highamount of radiation from these dumpsites which may result to a grave health effects. Therefore, a further and detailed study is in anticipation due to concerns of elevated exposure of inhabitants to radiological impact.

1) Conflict of Interest

The authors declare no conflict of interest.

2) Acknowledgment

The authors gratefully acknowledges Sokoto State University and TETfund for the IBR grant awards 2015/2016 which became the corner stone of success for the research which produces this paper. We also acknowledge the V.C Prof. Nuhu Yakubu and Dr. Manir Arshad for their efforts and supports.

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