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Measurement and Estimation of Background Radiation Exposure from Indiscriminate Waste Dumps in Arkilla Industrial Area, Sokoto, Nigeria

A.A. Ibrahim[1] and Y.M. Ahijjo[2]
[1]*Department of Mathematics, Sokoto State University, Nigeria*
[2]*Department of Physics, Usmanu Danfodiyo University Sokoto, Nigeria*

Abstract: *This study was conducted to measure the background radiation exposure from indiscriminate waste dumps in Arkilla Industrial Area of Sokoto State. All measurements were performed by a hand held survey meter Digilert 50 which is calibrated in USA. In order to account for average human height of exposure to background radiation, 1 meter above the ground (see level) was maintained during the measurement of 44 sample points. Also to avoid effects of other sources of radiation from the ground during measurement, the detector was placed 6 meter away from buildings due to unwanted effects of the materials used in the buildings. Average, minimum and maximum annual background radiation measurements were determined at 2.429, 1.346 and 4.037* $\mu Svhr^{-1}$ *respectively which are significantly higher than global average level of 1.00* $\mu Svyr^{-1}$ *by UNSCEAR. The average annual effective dose from background radiation in Arkilla industrial area was fairly less than global limit. Comparison of this results with world averages shows that indiscriminate waste dumps is contributing to the overall background radiation of the inhabitants. This is therefore a precursor for further assessment to ensure the safety of the dwelling from radioactivity point of view.*
Keywords: *Effective dose, Arkilla- Sokoto, Digilert 50, Background radiation*

I. Introduction

An assessment of background radiation was conducted throughout the entire suburb and metropolis of Sokoto State, Nigeria in order to assess the health and environmental impact of indiscriminate waste disposal littered around occupational and dwelling places on the inhabitant. As a result of the survey, areas around Arkilla industrial hub where a well dense population of the state is often registered was stratified and adequately sampled due to its importance in the state. This is to use the results obtained for determining the anthropogenic radiological status of Sokoto State then used it as one of the baseline data in the assessments of the environmental impacts.

Human exposure to ionizing radiation from the environmental sources is a continuous phenomenon (WHO/UNEP, 1988 and Wilson and Spengler, 1996). The increase in human population and dramatic urbanization is leading to a huge burden of waste disposal in the environment (Whitmore, 1988; Vriheid *et al.*, 2002 and UNPD, 2012).

Natural background radiation from the disposed wastes around us, building materials, air, food, outer space, and even elements in own systems could account for the upsurge of unexplained ailments (Howard, 2000 and Ahijjo and Umar, 2015). The habit of waste disposal has been seen to increase the larger populations of the world today to Gamma radiation within living places as well as occupational environment (Beral *et al.*, 1993 and Büyükuslu *et al.*, 2009).

Since human existence and the current dramatic increase in waste disposal due to increase in consumer pattern, then ascertaining the amount of background radiation from this waste as a contributor to external dose to the world population and it's assessment of gamma radiation dose is of general importance (Nwanta and Ezenduka, 2010). To buttress this point well, the environment acts as a links for the food chain and biological systems depending on its radiological contents and the uptake process by the roots to plants and to animals, hence, it is the basic precursor of the radiological tendencies of all the components of life.

The present study is aimed at assessing the level of exposure to background radiation and associated dose rates from indiscriminate waste dumps in the industrial area of Arkilla, Sokoto State, Nigeria.

II. Materials And Method

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. Arkilla industrial area is the part of Sokoto suburb where the Northern Nigerian Cement Company is situated. It is located between latitudes N13^{0}00.801' and N13^{0}00.801' and longitudes E005^{0}11.544' and E005^{0}12.380'. It habours one of the richest lime stone deposits in Nigeria which supports the establishment of the said Cement Company in the vicinity (Adeleye and Akande, 2004).

The samples were taken from all the accessible garbage dumps in the sampling locations along the longitudinal and latitudinal grid lines. This was done with respective recording of the dose rate from the background and where the samples were taken. The measurement of gamma radiation dose rate was done from June 2015 to August 2016.

Gamma radiation dose measurements was carried out at the meeting points of the latitudinal and longitudinal lines to maintain the reference points of the measurement. Dose measurements were subsequently performed at point locations using Digilert 50 a health and safety instrument that measures alpha, beta, and gamma radiation and at least three measurements were conducted in the measuring point using the detector. It is detector of Halogen-quenched Geiger-Muller tube with mica end window. It has a Mica window density of 1.5 – 2.0 mg/cm^2. It displays 4-digit liquid crystal with mode indicators. The operating range is 0.001 to 50 *m*R/hr or o.o1 to 500 *u*Sv/hr. Its energy sensitivity is 1000CPM/*m*R/hr in reference to Cs-137. 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 hour to micro-Sievert per year (mSvyr-1) by equation 1 below according to Avwiri and Agbalagba, 2012.

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

III. Result And Discussion

The measurement was conducted at 44 locations in the Arkilla area at 1 m above the ground using the hand held background measuring instrument. The average values of the measured doses are shown in Table 1 below. From Table 1, the mean measured background radiation is 0.028 $\mu Svhr^{-1}$. The lowest annual background radiation was found to be 1.346 $mSvyr^{-1}$ in Arkilla industrial area. The highest annual background radiation was 4.037 $mSvyr^{-1}$ which is higher than the global average background radiation of 1.00 $mSvyr^{-1}$ according to International Commission on Radiation Protection (ICRP).

Table 1:- Sample point's codes, Geolocation of points and mean background radiation

S/n	Points Codes	Locations	Range B/R $mRhr^{-1}$	Mean B/ R $mRhr^{-1}$	Absorbed Dose Rate $mSvyr^{-1}$
1.	ARK_1	N13^{0}02.348'E005^{0}12.375'	0.015-0.02	0.018	1.513
2.	ARK_2	N13^{0}02.394'E005^{0}12.366'	0.023-0.026	0.025	2.102
3.	ARK_3	N13^{0}02.419'E005^{0}12.380'	0.021-0.026	0.024	2.018
4.	ARK_4	N13^{0}02.415' E005^{0}12.398'	0.029-0.033	0.031	2.607
5.	ARK_5	N13^{0}02.402' E005^{0}12.402'	0.034-0.036	0.035	2.943
6.	ARK_6	N13^{0}02. 413'E005^{0}12.345'	0.029-0.032	0.030	2.523
7.	ARK_7	N13^{0}02.271' E005^{0}12.385'	0.023-0.029	0.027	2.271
8.	ARK_8	N13^{0}01.994' E005^{0}11.065'	0.023-0.025	0.024	2.018
9.	ARK_9	N13^{0}01.885' E005^{0}11.957'	0.016-0.021	0.019	1.598
10.	ARK_{10}	N13^{0}01.818' E005^{0}11.953'	0.017-0.02	0.018	1.514
11.	ARK_{11}	N13^{0}01.771' E005^{0}11.966'	0.02-0.023	0.021	1.766
12.	ARK_{12}	N13^{0}01.763'E005^{0}12.021'	0.022-0.025	0.023	1.934
13.	ARK_{13}	N13^{0}01.676' E005^{0}12.044'	0.024-0.028	0.026	2.186
14.	ARK_{14}	N13^{0}01.653' E005^{0}12.017'	0.025-0.027	0.026	2.186
15.	ARK_{15}	N13^{0}01.635' E005^{0}12.046'	0.043-0.048	0.045	3.784
16.	ARK_{16}	N13^{0}01.641' E005^{0}12.087'	0.024-0.028	0.026	2.186
17.	ARK_{17}	N13^{0}01.630' E005^{0}12.146'	0.025-0.033	0.029	2.439
18.	ARK_{18}	N13^{0}01.804' E005^{0}12.169'	0.034-0.038	0.036	3.027
19.	ARK_{19}	N13^{0}01.851' E005^{0}12.171'	0.025-0.03	0.027	2.271
20.	ARK_{20}	N13^{0}01.873' E005^{0}12.143	0.047-0.048	0.048	4.037
21.	ARK_{21}	N13^{0}01.885' E005^{0}12.130'	0.022-0.026	0.024	2.018
22.	ARK_{22}	N13^{0}01.926' E005^{0}12.067'	0.021-0.024	0.022	1.850
23.	ARK_{23}	N13^{0}01.764' E005^{0}11.827'	0.027-0.039	0.032	2.691
24.	ARK_{24}	N13^{0}01.747' E005^{0}11.848'	0.026-0.029	0.028	2.355
25.	ARK_{25}	N13^{0}01.748' E005^{0}11.874'	0.038-0.048	0.043	3.616
26.	ARK_{26}	N13^{0}01.719'E005^{0}11.923'	0.025-0.036	0.029	2.439
27.	ARK_{27}	N13^{0}01.719' E005^{0}11.782'	0.025-0.028	0.026	2.186

28.	ARK$_{28}$	N13^{0}01.690' E005^{0}11.800'	0.046-0.049	0.048	4.037
29.	ARK$_{29}$	N13^{0}01.684' E005^{0}11.757'	0.015-0.018	0.016	1.346
30.	ARK$_{30}$	N13^{0}01.671' E005^{0}11.746'	0.02-0.026	0.023	1.934
31.	ARK$_{31}$	N13^{0}01.653' E005^{0}11.714'	0.027-0.032	0.029	2.439
32.	ARK$_{32}$	N13^{0}01.654' E005^{0}11.778'	0.033-0.036	0.034	2.859
33.	ARK$_{33}$	N13^{0}01.515' E005^{0}11.640'	0.023-0.03	0.027	2.271
34.	ARK$_{34}$	N13^{0}01.497' E005^{0}11.620'	0.025-0.032	0.029	2.439
35.	ARK$_{35}$	N13^{0}01.464' E005^{0}11.578'	0.024-0.032	0.028	2.355
36.	ARK$_{36}$	N13^{0}01.383' E005^{0}11.547'	0.022-0.029	0.024	2.018
37.	ARK$_{37}$	N13^{0}01.559' E005^{0}11.183'	0.021-0.028	0.023	1.934
38.	ARK$_{38}$	N13^{0}01.517' E005^{0}11.078'	0.034-0.036	0.035	2.943
39.	ARK$_{39}$	N13^{0}01.363' E005^{0}11.306'	0.025-0.037	0.031	2.607
40.	ARK$_{40}$	N13^{0}01.268' E005^{0}11.342'	0.024-0.03	0.027	2.271
41.	ARK$_{41}$	N13^{0}01.238' E005^{0}11.378'	0.043-0.048	0.046	3.868
42.	ARK$_{42}$	N13^{0}01.173' E005^{0}11.452'	0.038-0.049	0.043	3.616
43.	ARK$_{43}$	N13^{0}00.986' E005^{0}11.642'	0016-0.022	0.018	1.514
44.	ARK$_{44}$	N13^{0}00.801' E005^{0}11.544'	0.025-0.031	0.028	2.355

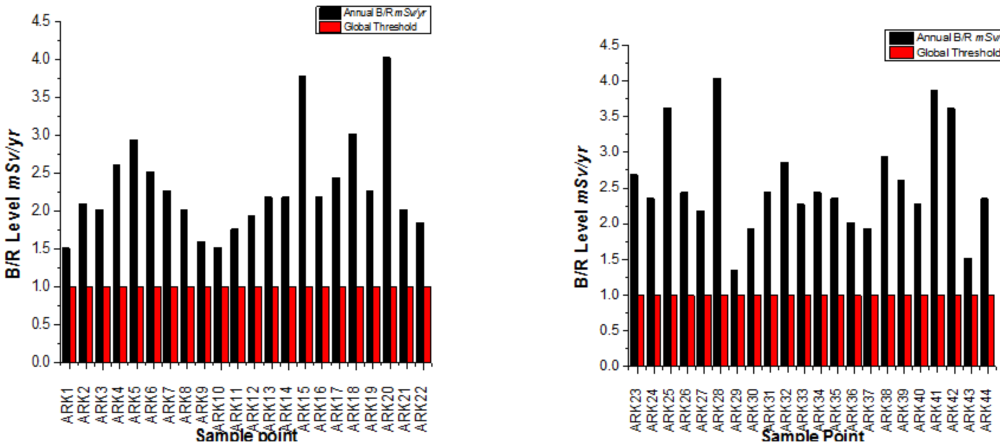

Figure 1 a&b: Bar charts of Sample points against respective background radiations

Pashazadeh *et al.*, (2014), have reported a finding of this nature in Bushehr city to determine background radiation and it corresponding annual effective dose to the public. Similar study was reported by Pinka Sankoh *et al*., (2013) where indiscriminate wastes dumps of Granville Brook in Freetown around homes and working places was investigated. Olusosun Dumpsite in Ojota Lagos was also measured to assess the level of radioactivity from indiscriminate waste disposed around human endavours by Oladapo *et al.*, (2012).

IV. Conclusion

This study have assessed the level of background radiation from indiscriminate nature of waste dumps that could lead to unexplained health risk in the Arkilla Industrial Area, Sokoto State, Nigeria. The average measured background radiation from 44 sample points during this study was 2.429 $mSvyr^{-1}$. This research has revealed that the average annual effective dose is significantly above the worldwide averages of UNSCEAR 2000. The results from this study will stand as a reference and baseline data that will be useful in assessing contribution to radiation in the industrial area of Arkilla environment from future activities.

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