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BIR Measurement of Michika LGA with Calculated Risk Factors and GIS Maps

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ABSTRACT
In recent times, increased in human exposure to both natural and man made background ionizing radiation and the associated risk factors have drawn the attention of researchers all over the world.Therefore, the need for radiation protection which greatly depends on our understanding of their existence, distribution, contamination, interactions, and activity with many elements suchas air,food etc. The purpose of this study is to evaluate the outdoor ambient background ionizing radiation levels of Michika local government area of Adamawa State, Nigeria, and ascertain the radiation danger (by calculating the risk factors) that the local population faces from these levels. Sixteen nine data points were selected with the help of GIS and surveyed using a portable radiation alert Ranger from S.E International, Inc. (USA), with serial number R313227 and calibrated at the National Institute of Radiation Protection and Research, University of Ibadan, Nigeria. The risk factors such AEDE, ELCR etc were calculated using the recommended conversion and occupancy factors. The results shows that the mean dose rate of 195.15nGyh-1 is very high when compared with the recorded world weighted average of 59.00 nGyh-1. Also high are the mean value of AEDE (0.240mSvy-1) and ELCR value 0.83 x 10-3 mSvy-1 which is almost thrice the world average value of 0.29 x 10-3mSvy-1

Keywords: *Background ionizing radiation, Radiation, GIS, Michika, Nigeria*

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I. INTRODUCTION

Humans are exposed to radiation from both natural and man-made sources and these radiation exposure is term background radiation. This is taken to be the total radiation dose received at a location if a specific radiation source is not available [1]. As mentioned above, background radiation comes from a variety of sources, including primary and secondary cosmic radiation, terrestrial radiation from radon gas—the largest naturally occurring source of radiation exposure for humans—natural radium, uranium, and thorium and their decay products, internal radiation from radioactivity in the body, and artificial or man-made radiation from things like medical exposure, office equipment use, weapon testing, and nuclear technology. According to [2], [3], the background radiation levels in offices may rise in tandem with an increase in the usage of technological equipment. Generally speaking, natural radiation sources account for over 87% of the radiation dosage that humans receive and this is according to the United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) [4]. Energetic protons, electrons, gamma rays, and so forth are examples of cosmic rays from space [5], [6]. The main determinants of cosmic radiation exposure are latitude, solar activity, and altitude [6]. Radionuclides in the food, earth,spices, construction materials, air, and even some elements in our bodies can all be natural sources of exposure.

Background radiations are unavoidably present for humans in both public and occupational settings [7]. and latitude and longitude have an impact on the level or degree of exposure. The reason is due to the uneven distribution of radionuclides in the environmental media. Therefore, radiation protection, greatly depends on our understanding of their existence, distribution, contamination, interactions, and activity with many elements (such as air, soil, food, tissues, food spices, etc.) [8]. Hence, the top 30 centimeters of the soil are where most exposure to this type of outdoor natural terrestrial radiation comes from [8].

Due to their ability or capacity to penetrate, gamma rays are the primary source of external radiation exposure for humans from all source types [9]. The first physical disturbances from which subsequent radiation effects develop are chemical and physical alterations that necessitate the target's direct adsorption of energy from the incident radiation [10]. The impacts then begin with the basic changes or alterations at the cellular, molecular, tissue, and entire body levels and these changes have the potential to cause a variety of health issues, including irritation, inherited illnesses, radiation-induced cancer, and in severe cases instantaneous death [11], [12]. Moreover, radiation from external sources, such as linear accelerators, can also cause exposure to natural radiation and this can be ingested, inhaled, or enter the bloodstream through wounds. The amount of radiation that is absorbed or received, which is measured in gray (Gy) units, determines how much harm radiation can inflict to the body's tissues or organs [10]. Depending on the type of radiation and the susceptibility of various tissues and organs, an absorbed dose may cause harm [4], [13]. The potential for harm caused by ionizing radiation is measured using the effective dosage and the type of radiation and the sensitivity of tissues and/or organs are taken into consideration when calculating the effective dosage in a sievert [14]. Ionizing radiation exposure can result in damage and clinical manifestations such as radiation bone necrosis, cancer induction, cataractogenesis, free radical generation, and chromosomal change, [15]. Prior research or studies have demonstrated that there is a significant chance that human activity will increase the background ionizing radiation level in the environment. As a result, certain human activities have significantly contributed to the ozone layer's depletion, which has raised the amount of cosmic rays that reach the earth's surface and alters background radiation [16], [17].

The average yearly effective dosage from natural background radiation worldwide is 2.4 mSv, and this is according to the UNSCEAR study [18] In mines for instance, the level is very high and it has been noted that, in terms of radiation protection, large levels of background radiation exposure can occur outside of mines as well and can get to a point where it is irreversible [19]. As a result, UNSCEAR divided the yearly effective dose rate into four categories as shown in Table 1.

Table 1: Categories of effective dose rate

Categories	Level
Low	Defined as 5mSvy-1 and lower (or almost twice the global average of 2.4mSv y-1)
Medium	Defined as 5 – 20 mSv y-1,
High	Defined as 20 – 50 mSv y-1
Extremely high	Defined as > 50mSv y-1

Sourtce: UNSCEAR, [19].

In several nations or countries, background radiation levels have been determined. It has been observed that background radiation in China and India accounts for approximately 2.29mSv y-1 (96.7%) of the 2.393 mSv y-1 yearly effective dose [20]. Whereas, a mean background exposure dose of 0.5 mSv y-1 and a mean radon exhalation rate of 3.24 Bq m-3 h-1 were measured in Greece by Stoulos et al.,[21]. Additionally, numerous research have been carried out in Nigeria to ascertain the amount of background radiation, and the findings of these studies have revealed variances in the background radiation dosage levels between states and between places within a state [22]–[32].

There was no research on background radiation exposure levels for Michika in Adamawa State of Nigeria found in the literature search, thus necessitated this study. Michika's population is predominantly made up of farmers and animal rearers, who spend most of their time outside of a building. As a result, people are exposed to radiation from a variety of sources, including soil, light beams, and other materials whose high radionuclide levels have been shown to be potential sources of radiation exposure [20]. Determining the outdoor terrestrial radiation levels in all of Michika local government region is therefore essential. Therefore, the purpose of this study is to evaluate the outdoor ambient background ionizing radiation levels of Michika local government area of Adamawa State, Nigeria, and ascertain the radiation danger (by calculating the risk factors) that the local population faces from these levels. The outcome of this work serves as the baseline radiological data for next investigations in all of the communities studied.

II. MATERIALS AND METHODS

The Study Area

Michika LGA is situated in Adamawa state, northeast geopolitical zone of Nigeria. The LGA is bothered by the Mubi, Hong, and Madagali LGAs and part of Borno state and the Republic of Cameroon. The estimated population of Michika is put at 304,772 inhabitants with the vast majority of the area's population made up of members of the kwamwe ethnic group. The latitude is 13.38^0 and the longitude is 10.62^0 see Figure 1 for map of study area.

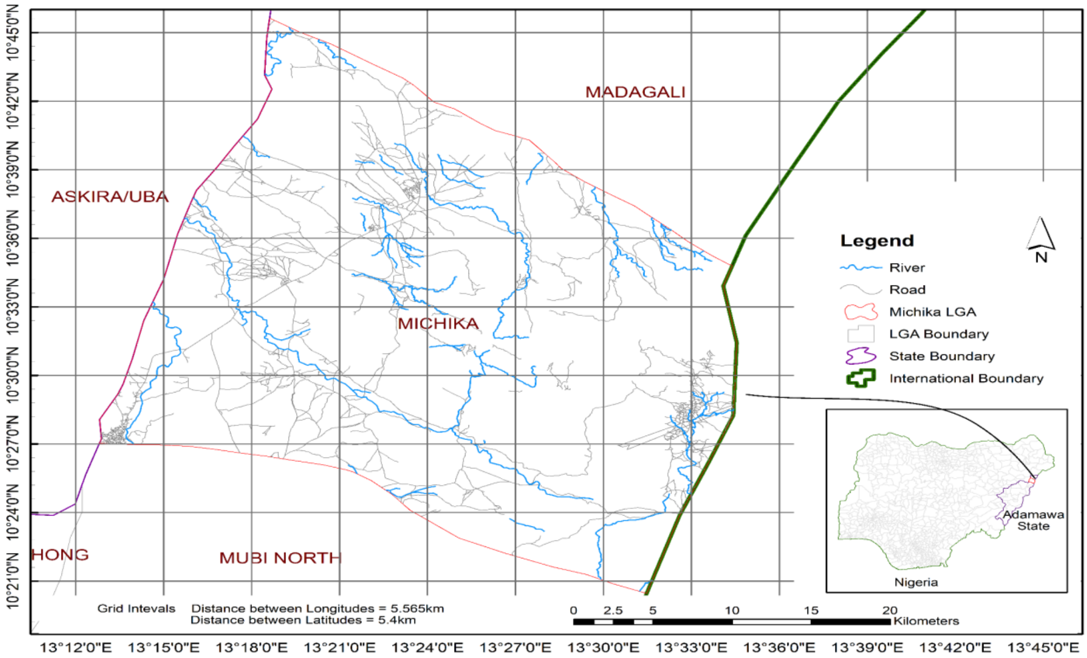

Figure 1: Map of Michika LGA of Adamawa state, divided into grids of approximately 5.5km by 5.4km (shown by the lines), showing the administrative boundaries, roads and rivers.

Procedure for Measuring Radiation

In order to preserve the original environmental features of the samples, an in situ method of measuring background ionizing radiation was chosen. The local government's background ionizing radiation (BIR) levels were measured with a nuclear radiation monitor meter. The meter is a portable radiation alert Ranger from S.E International, Inc. (USA), with serial number R313227 and calibrated at the National Institute of Radiation Protection and Research, University of Ibadan, Nigeria. The International Atomic Energy Agency (IAEA) has recognized this Nigerian secondary standard laboratory, which is a branch of the Nigeria Nuclear Regulation Authority (NNRA).

Moreover, in order to ensure that the equipment was faultless, accurate, and in working order, prior to the radiation measurements, pre-operational, functionality, and quality inspections were performed on it before the monitoring exercise. The metre has a Geiger Muller tube that can detect α-particles, β-particles, γ-rays, and X-rays between -10°C and 50°C in temperature. When radiation enters the Geiger tube, an electrical pulse is produced and after counting this pulse, the CPU shows the result in CPM, mR/h, or µSv/h units on the LCD. There are sixty-nine data points in which measurements were taken and this cover the entire LGA (see Figure 2). Additionally, the locations were carefully selected to equally cover the study region using a GIS program with the GIS application used to construct the coordinates for each of the sixty-nine reading data point. Every data point within the research areas was precisely located using a Geographic Positioning System (GPS). This study followed the National Council on Radiation Protection and Measurements'[33] recommendation to acquire data between 1300 and 1600 hours, as this is when the radiation meter responds to radiation the maximum.

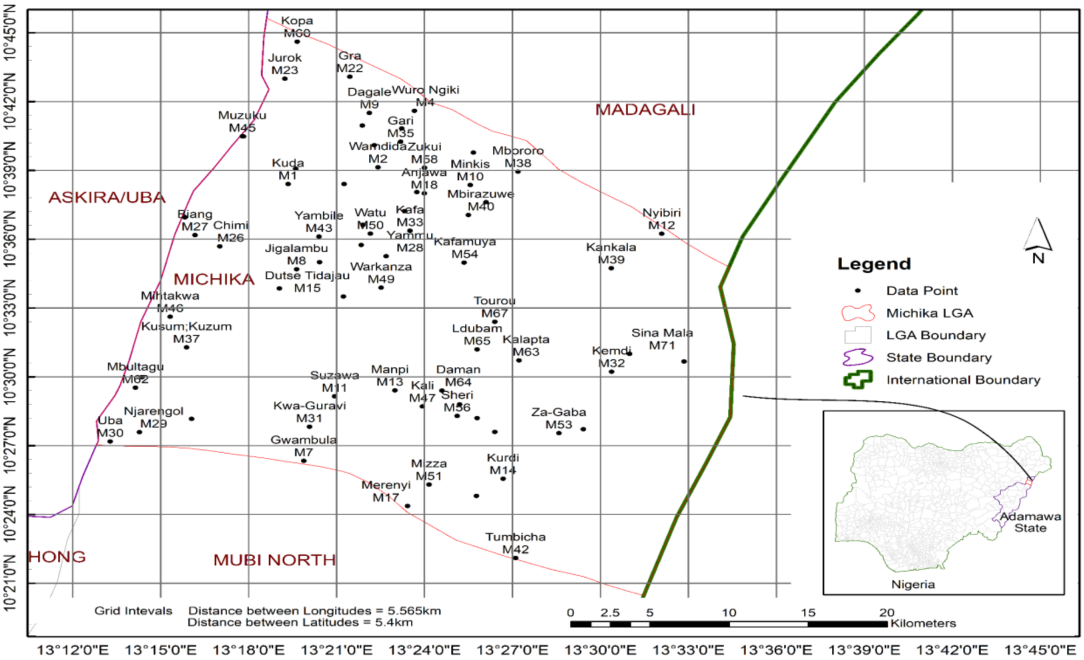

Figure 2: Map of Michika LGA of Adamawa state, divided into grids of approximately 5.5km by 5.4km (shown by the lines), showing the generated sample points. Background Dose Rate measurements were taken from these points.

III. RESULTS AND DISCUSSION

Occupancy and Conversion factor

The occupancy factor is the proportion of a person's total radiation exposure duration [18]. Eight thousand seven hundred and sixty hours, or 8760 hours, were used in a year. UNSCEAR [4] recommended indoor and outdoor occupancy factors of 0.8 and 0.2, respectively. The count rate per minute (CPM) reading from the nuclear radiation meter was converted to milli-roentgen per hour (mRh-1) using the relation.

Count rate per minute (CMP) = 10^{-3} roentgen x Q.F [1]

where Q.F., or the quality factor, is one for the external environment.

Tables 2 present the in-situ ionizing radiation results for the communities under study in the local government. These include a comparison of the absorbed dose rate, equivalent dose rate, annual effective dose, excess lifetime cancer risk, and radiation contour maps of the areas studies.

Table 2: Hazard Indices from all LGAs of the State

S/N	Sample area	Geographical Location	BIR (uSv/hr)	BIR (mSv/hr)	Absorbed Dose Rate (nGy/hr)	Equivalent Dose (mSv/yr)	Annual Effective Dose Equivalent (O) (mSv/yr)	Excess Life Cancer Risk (µSv/yr)
1	Kuda	N13º 19' E10º 38'	0.24	0.024	208.80	2.018	0.256	0.896
2	Wamdida	N13º 22' E10º 39'	0.27	0.027	234.90	2.271	0.288	1.008
3	Mujuru	N13º 25' E10º 24'	0.29	0.029	252.30	2.439	0.309	1.082
4	Wuro Ngiki	N13º 23' E10º 41'	0.33	0.033	287.10	2.775	0.352	1.232
5	Kubur-Shosho	N13º 17' E10º 40'	0.32	0.032	278.40	2.691	0.341	1.194
6	Kwatabe range	N13º 26' E10º 37'	0.19	0.019	165.30	1.598	0.203	0.711
7	Gwambula	N13º 19' E10º 26'	0.28	0.028	243.60	2.355	0.299	1.047
8	Jigalambu	N13º 19' E10º 34'	0.21	0.021	182.70	1.766	0.224	0.784
9	Dagale	N13º 22' E10º 41'	0.14	0.014	121.80	1.177	0.149	0.522
10	Minkis	N13º 25' E10º 38'	0.19	0.019	165.30	1.598	0.203	0.711
11	Suzawa	13º 20' 10º 29'	0.22	0.022	191.40	1.190	0.235	0.823
12	Nyibiri	13º 32' 10º 36'	0.28	0.028	243.60	2.355	0.299	1.047
13	Manpi	13º 22' 10º 29'	0.32	0.032	278.40	2.691	0.341	1.194

14	Kurdi	13º 26' 10º 25'	0.18	0.018	156.60	1.514	0.192	0.672
15	Dutse Tidajau	13º 21' 10º 33'	0.27	0.027	234.90	2.271	0.288	1.008
16	Michika	13º 23' 10º 37'	0.2	0.02	174.00	1.682	0.213	0.746
17	Merenyi	13º 23' 10º 24'	0.18	0.018	156.60	1.514	0.192	0.672
18	Anjawa	13º 24' 10º 37'	0.21	0.021	182.70	1.766	0.224	0.784
19	Bassa;Bazza	13º 19' 10º 33'	0.26	0.026	226.20	2.186	0.277	0.970
20	Jidil	13º 23' 10º 38'	0.31	0.031	269.70	2.607	0.331	1.159
21	Kwalia	13º 21' 10º 40'	0.29	0.029	252.30	2.439	0.309	1.082

S/N	**Sample area**	**Geographical Location**	**BIR (uSv/hr)**	**BIR (mSv/hr)**	**Absorbed Dose Rate (nGy/hr)**	**Equivalent Dose (mSv/yr)**	**Annual Effective Dose Equivalent (O) (mSv/yr)**	**Excess Life Cancer Risk (μSv/yr)**
22	Gra	13º 21' 10º 43'	0.22	0.022	191.40	1.190	0.235	0.823
23	Jurok	13º 19' 10º 42'	0.25	0.025	217.50	2.102	0.267	0.935
24	Leprosy Village	13º 22' 10º 40'	0.19	0.019	165.30	1.598	0.203	0.711
25	Kobabpale	13º 19' 10º 39'	0.24	0.024	208.80	2.018	0.256	0.896
26	Chimi	13º 17' 10º 35	0.22	0.022	191.40	1.190	0.235	0.823
27	Biang	13º 16' 10º 36'	0.24	0.024	208.80	2.018	0.256	0.896
28	Yammu	13º 22' 10º 35'	0.28	0.028	243.60	2.355	0.299	1.047
29	Njarengol	13º 14' 10º 27'	0.28	0.028	243.60	2.355	0.299	1.047
30	Uba	13º 13' 10º 27'	0.26	0.026	226.20	2.186	0.277	0.970
31	Kwa-Guravi	13º 20' 10º 27'	0.22	0.022	191.40	1.190	0.235	0.823
32	Kemdi	13º 30' 10º 30'	0.29	0.029	252.30	2.439	0.309	1.082
33	Kafa	13º 23' 10º 36	0.23	0.023	200.10	1.934	0.245	0.858
34	Mandara	13º 25' 10º 39'	0.41	0.041	356.70	3.448	0.437	1.530
35	Kusum;Kuzum	13º 15' 10º 31'	0.18	0.018	156.60	1.514	0.192	0.672
36	Mbororo	13º 27' 10º 38'	0.38	0.038	330.60	3.196	0.405	1.418
37	Kankala	13º 30' 10º 34'	0.08	0.008	67.86	0.656	0.083	0.266
38	Mbirazuwe	13º 25' 10º 37'3	0.09	0.009	80.04	0.774	0.098	0.343
39	Kankila	13º 15' 10º 36'	0.33	0.033	287.10	2.775	0.352	1.232
40	Tumbicha	13º 27' 10º 22'	0.41	0.041	356.70	3.448	0.437	1.530
41	Yambile	13º 20' 10º 36'	0.09	0.009	80.04	0.774	0.098	0.343
42	Vilegwa	13º 21' 10º 38'	0.14	0.014	121.80	1.177	0.092	0.322
43	Muzuku	13º 17' 10º 40'	0.28	0.028	243.60	2.355	0.299	1.047
44	Mihtakwa	13º 15' 10º 32'	0.096	0.0096	83.52	0.807	0.102	0.357
45	Kali	13º 23' 10º 28'	0.12	0.012	104.40	1.009	0.128	0.448
46	Za-Girta	13º 29'	0.23	0.023	200.10	1.934	0.245	0.858

		10º 27'						
47	Warkanza	13º 22' 10º 33'	0.06	0.006	50.46	0.488	0.062	0.217
48	Watu	13º 22' 10º 36'	0.22	0.022	191.40	1.190	0.235	0.823
49	Mizza	13º 24' 10º 25'	0.41	0.041	356.70	3.448	0.437	1.530
50	Sina Gali	13º 32' 10º 30'	0.34	0.034	295.80	2.860	0.363	1.271
51	Za-Gaba	13º 28' 10º 27'	0.09	0.009	80.04	0.774	0.098	0.343
52	Kafamuya	13º 25' 10º 34	0.04	0.004	38.28	0.370	0.047	0.165
53	Gandaji	13º 21' 10º 36	0.06	0.006	48.72	0.471	0.060	0.210
54	Sheri	13º 25' 10º 28'	0.39	0.039	339.30	3.280	0.416	1.456
55	Mayo Lugungel	13º 16' 10º 28'	0.28	0.028	243.60	2.355	0.299	1.047
56	Zukui	13º 24' 10º 39'	0.09	0.009	81.78	0.791	0.100	0.350
57	Makzu	13º 21' 10º 35	0.23	0.023	200.10	1.934	0.245	0.858
58	Kopa	13º 19' 10º 44	0.14	0.014	121.80	1.177	0.149	0.522
59	Tudun Wada	13º 20' 10º 35'	0.09	0.009	80.04	0.774	0.098	0.343
60	Mbultagu	13º 14' 10º 29'	0.16	0.016	139.20	1.346	0.171	0.599
61	Kalapta	13º 27' 10º 30'	0.13	0.013	113.10	1.093	0.139	0.487
62	Daman	13º 24' 10º 29'	0.17	0.017	147.90	1.430	0.181	0.634
63	Ldubam	13º 25' 10º 31'	0.27	0.027	234.90	2.271	0.288	1.008
64	Mavoumaø	13º 26' 10º 27'	0.32	0.032	278.40	2.691	0.341	1.194
65	Tourou	13º 26' 10º 32'	0.09	0.009	80.04	0.774	0.098	0.343
66	Wandaø	13º 25' 10º 28'	0.28	0.028	243.60	2.355	0.299	1.047
67	Zawanday	13º 25' 10º 28'	0.22	0.022	191.40	1.190	0.235	0.823
68	Para Hussara	13º 14' 10º 29'	0.29	0.029	191.40	1.190	0.235	0.823
69	Sina Mala	13º 31' 10º 31'	0.14	0.014	121.80	1.177	0.149	0.522
Minimum			0.044	0.0044	38.28	0.370	0.047	0.165
Maximum			0.41	0.041	356.70	3.448	0.437	1.530
Mean value			0.23	0.02	195.15	1.81	0.24	0.83

Tables 1 present the result of the in-situ exposure rates and the estimated radiological parameters of the various communities in the study area while figure 8 and 9 show graphical representation of the hazard indices. The rate of radiation exposure measured around the study area ranged from 0.0044 to 0.041mRh-1, with a mean value of 0.02mRh-1. Communities of Mandara, Tumbicha and Mizza have the highest rate of exposure with value of 0.041mRh-1 which exceeded the recommended permissible limit of 0.013mRh-1 [34]-[36] while community of Kafamaya has exposure rate value of 0.0044. “The result from Table shows that 82.6% of the sample points exceeded the permissible BIR level for the general public, these could be attributed to the presence of commercial activities such as markets where different food items are sold and construction materials like cement, granites, asphalt, which have been recognized to contain some radioactive elements [36]. While the variation and high exposure rate level is attributed to the different human activities carried out in the different sampling locations and their geophysical characterization. The high BIR levels are indicative suggestion that the environment is radiologically contaminated; although the dose rate at these levels may not constitute any immediate health hazards to the residents of the areas, but there is the potential for long-term health hazards in the future.

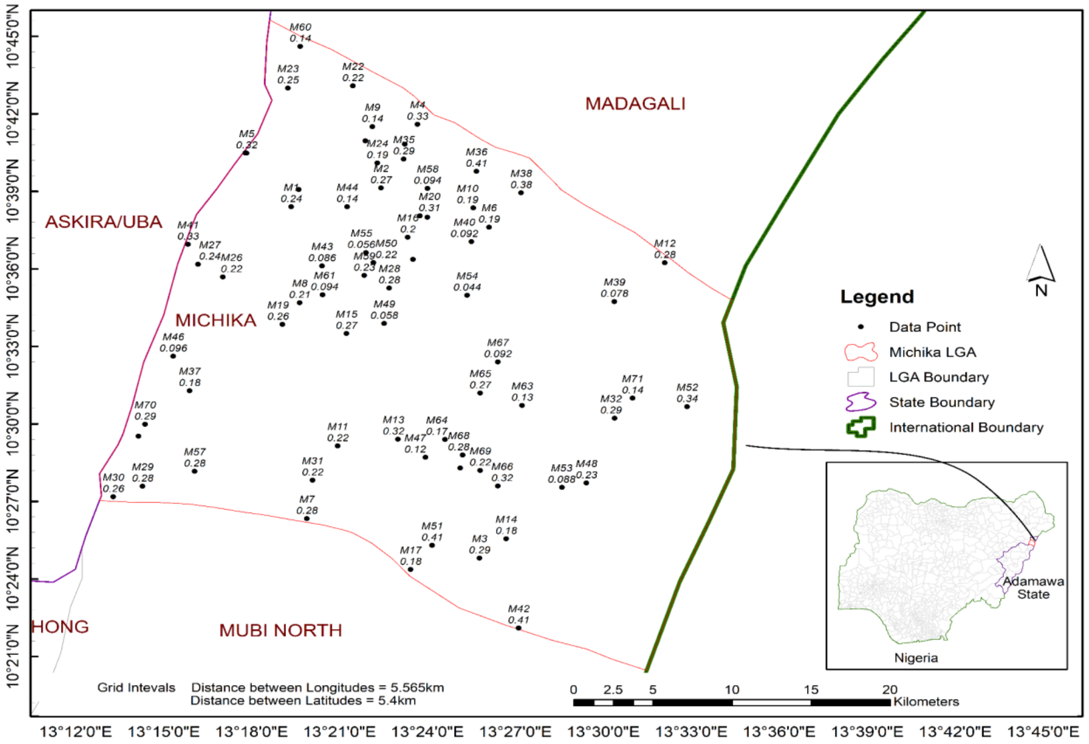

Figure 3: Map of Michika LGA of Adamawa state, showing the sample points, labeled with a unique local identification code (i.e. M1 to M71) and their individual dose rate result readings. Measurements were taken from these points in uSv/hr.

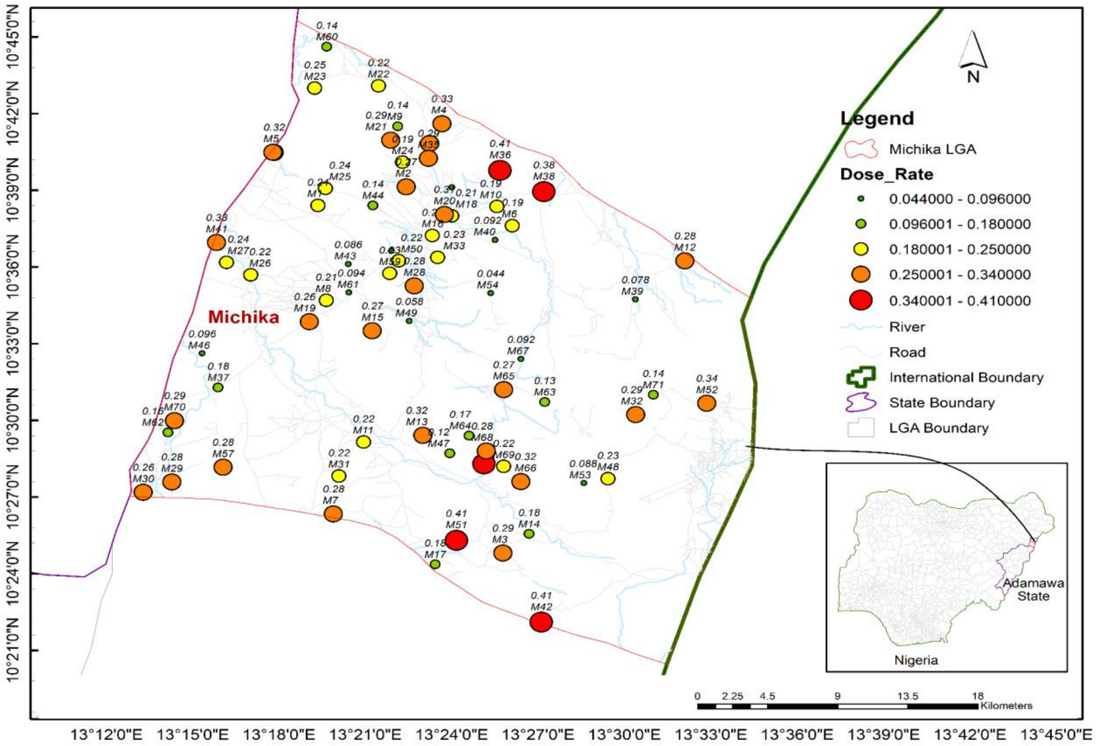

Figure 4: Map of Michika LGA of Adamawa state, showing the sample points labeled with the unique local identification code and the average dose rate for each point. Dose rate values are symbolized using graduated colors and symbols. (See Legend for interpretation).

Absorbed Dosage Rate

The total energy absorbed from ionizing radiation per unit mass of tissue is known as the radiation dose to an organism, and the energy absorbed over time is known as the dose rate. Through the use of the conversion factor, the exposure dose rate, expressed in µRh-1, was translated into an absorbed dosage rate [37].

$$1_{\mu R/hr} = 8.7_{\frac{nGy}{hr}} = \frac{8.7x10^{-3}}{1/8760}\mu Gyy^{-1} = 76.212\mu Gyy^{-1} \qquad (2)$$

The estimated absorbed dose rate in the study area range between 38.28 and 356.70nGyh-1 with a mean value of 195.15nGyh-1. The mean dose rate is very high when compared with the recorded world weighted average of 59.00 nGyh-1 [37], [38] and the recommended safe limit of 84.0 nGyh-1 [18] for outdoor exposure. Also, the mean dose rates are higher than the values 97.44±12.17, 99.18±21.78, 97.44±20.42, 119.19±17.90, 124.41±33.21, 141.30±31.31nGyh-1 earlier reported by Benson and Ugbede [39] and Agbalagba [37]

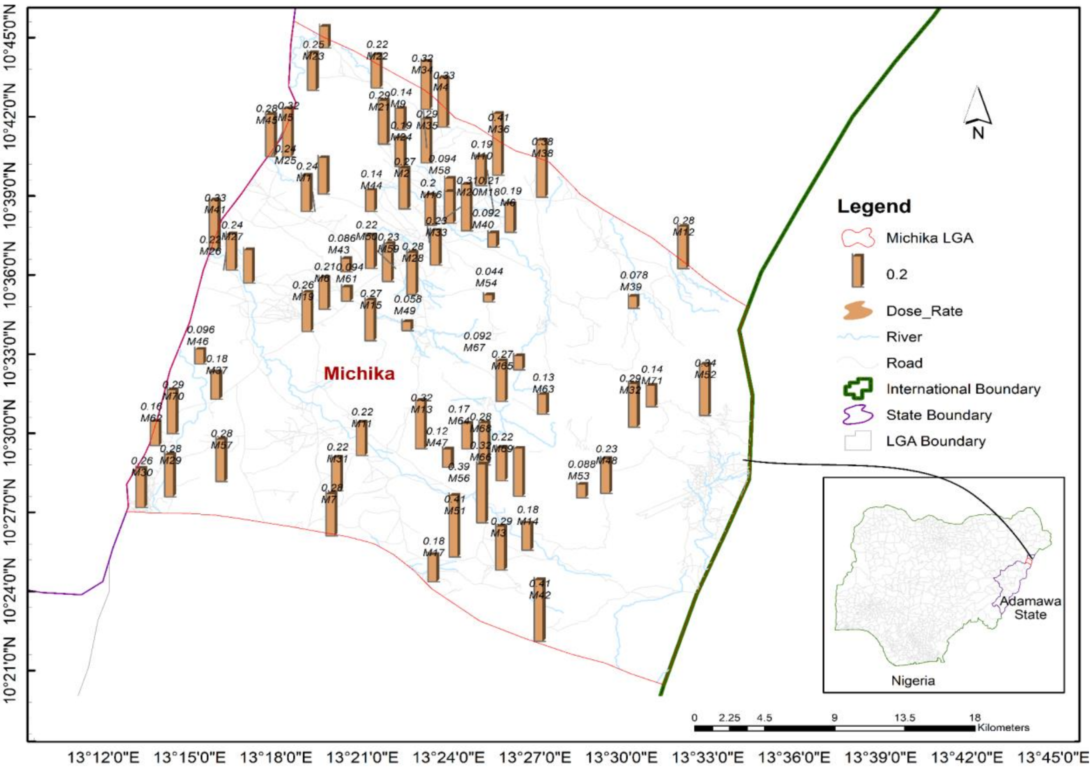

Figure 5: Map of Michika LGA of Adamawa state, showing the sample points labeled with the unique local identification code and the average dose rate for each point. Dose rate values are symbolized using proportional Columns. (See Legend for interpretation).

Exposure or Equivalent Dose Rate (Outdoor)

The radiation exposure is the amount of radiation in the immediate neighborhood or an area, and the dosage is the amount of radiation that is expected to be absorbed by the individual. We determine the whole body equivalent dose rate during a one-year period by using the National Council on Radiation Protection and Measurement recommendations [38]:

1mR/hr = $\frac{0.96\,x\,24\,x\,365}{100}$ **mSv/yr** **[3]**

The equivalent dose rate over 1 year ranged from 0.370mSvy-1 to 3.448mSvy-1 with a mean value of 1.81mSvy-1. The average or mean equivalent dose rate value obtained in the study area exceeded the recommended ambient level of 1.00 mSvy-1 by ICRP [34] for the general public.

Annual Effective Dose Equivalent(AEDE)

The estimated absorbed dose values were utilized to determine the annual effective dosage equivalent that the inhabitants of the study areas were exposed to. The UNSCEAR [4] recommends a dose conversion factor of 0.7 Sv/Gy for the conversion coefficient between the absorbed dose in air and the effective dose received by adults, and an occupancy factor of 0.2 for outdoor use. The following equation [35] was used to determine the annual effective dosage equivalent:

$$\text{AEDE (Outdoor) } (\text{mSvy}^{-1}) = \text{Absorbed dose } (\eta\text{Gyh}^{-1}) \times 8760 \text{ h} \times 0.7\text{Sv/Gy} \times 0.2$$
$$= \text{Absorbed dose } (\eta\text{Gyh}^{-1}) \times 1.2264 \times 10^{-3} \qquad [4]$$

Absorbed dose rate values obtained were used to calculate the Annual Effective Dose Equivalent (AEDE)for the study area, AEDE range from 0.047 to 0.437mSvy-1 with a mean value of 0.240mSvy-1. The value for the mean AEDE is higher than those reported by Ononugbo and Mgbemere [40], and also higher by 0.17 than the world average value of 0.07 (for outdoor) mSvy-1 [37] but within ICRP and UNSCEAR recommended permissible limits of 1.00 mSvy-1 for the general public [19], [34]. This could be an indication that the studied communities of the LGA might be radiologically contaminated due to the varieties of activities taking place in the LGA as the value obtained is well above the world average normal annual effective dose level for outdoor.

The Excess Lifetime Cancer Risk(ELCR)

The excess lifetime cancer risk for all of the communities in Michika were determined using the estimated values of AEDE and the following equation [35]:

$$\text{ELCR mSvy-1} = \text{AEDE} \times \text{Average duration of life (DL)} \times \text{Risk factor (RF)} \qquad [5]$$

where AEDE, DL and RF are the annual effective dose equivalent, duration of life (70 years) and the risk factor(Sv-1), fatal cancer risk per sievert. For low dose background radiations which are consider to produce stochastic effects, ICRP 60 uses value of 0.05 for the public exposure [19], [41].

The excess life cancer risk (ELCR) exposure ranges from 0.165 x 10-3 to 1.530 x 10-3 mSvy-1 with a mean value of 0.83 x 10-3 mSvy-1 in the study areas. The overall average ELCR value obtained in this study is almost thrice the world average value of 0.29 x 10-3mSvy-1 [41]. This result obtained for ELCR indicates that the chance of contacting cancer by residents of the study area who will spend all their life time in Michika LGA is likely.

Overall, the overall results obtained shows a significant elevation of the radiation level in the study area compared to other parts of the world, but these values may not constitute immediate health hazard to the resident of these communities/areas investigated within the Michika L.G.A.

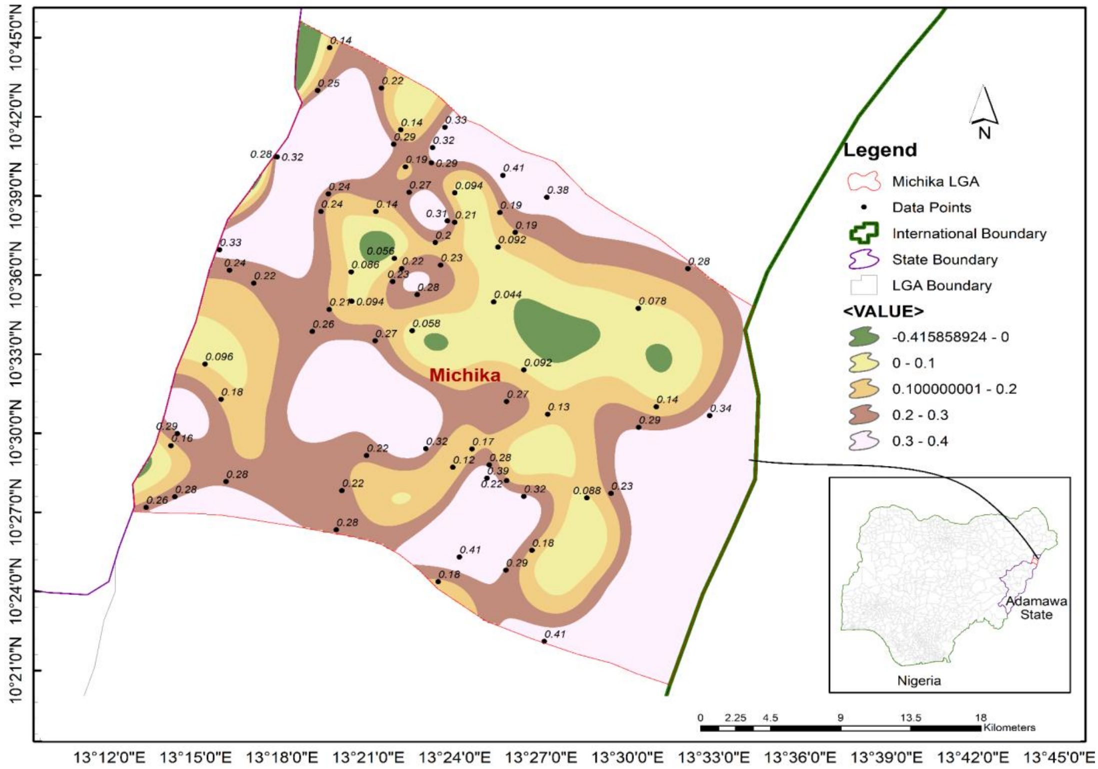

Figure 6: Digital Elevation Model (DEM) image of Michika LGA of Adamawa state, generated using the Dose Rate values as the as "Z" factor. (See legend for DEM interpretation). "Z" values used here were measured in uSv/hr.

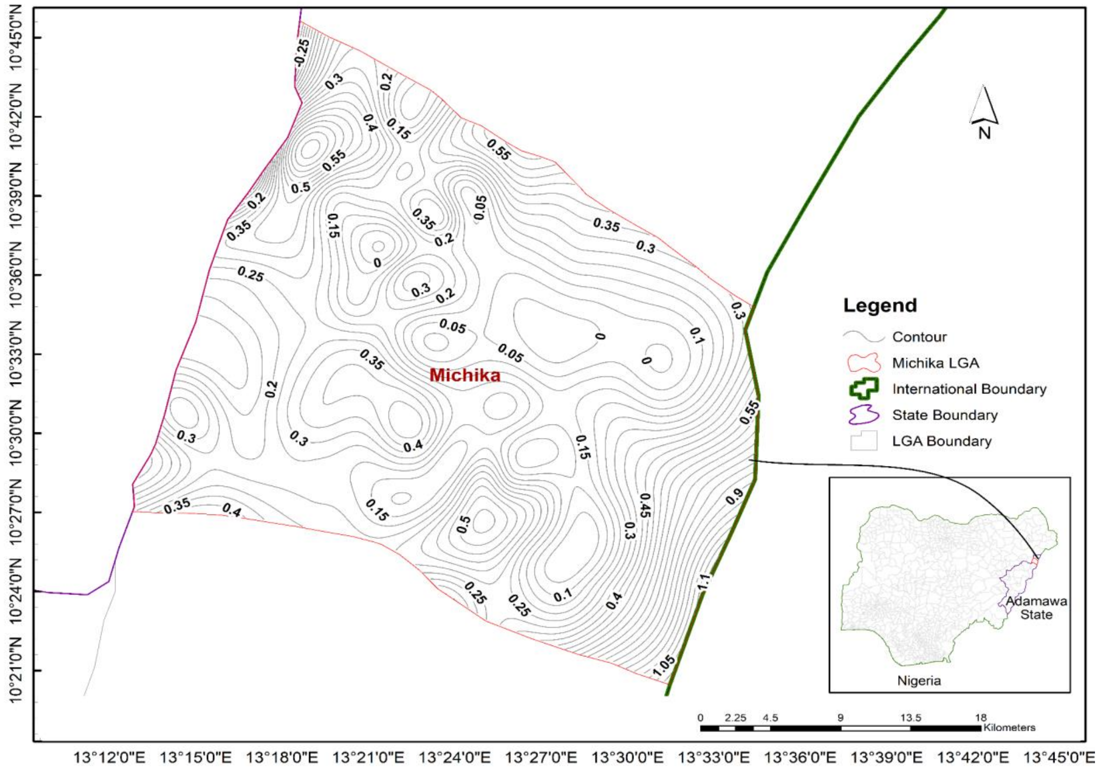

Figure 7: Contour map, generated from the information in map 6 above. "Z" values used here as shown on the contour line, are the Dose Rate measurements taken in uSv/hr.

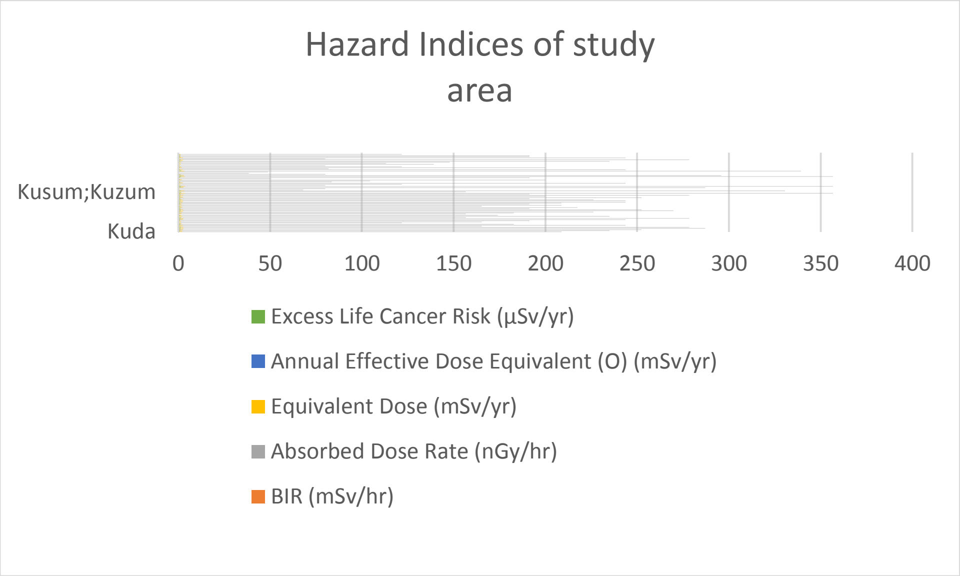

Figure 8: Hazard Indices of the study area

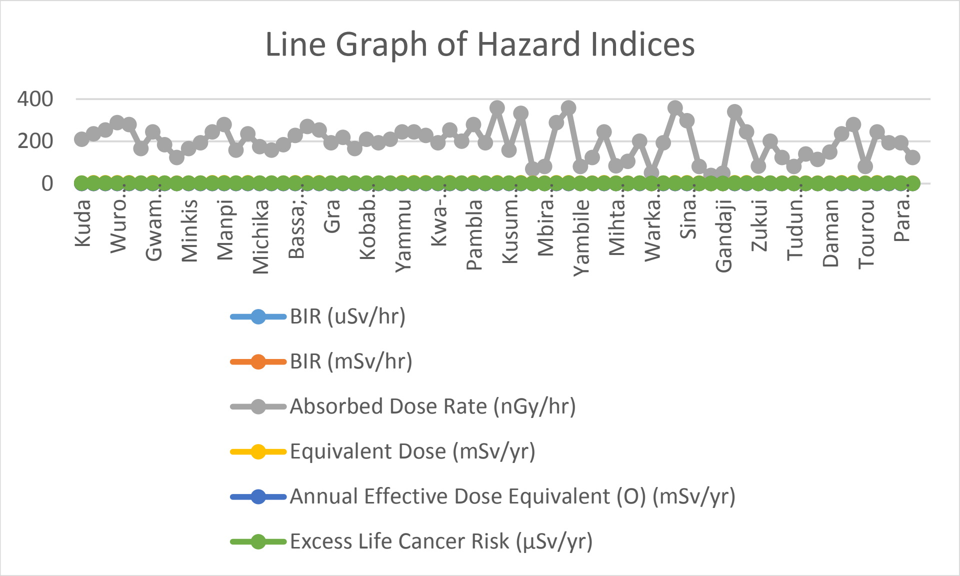

Figure 9: Line graph of the Hazard indices

IV. Conclusion

Majority of Michika LGA localities' background radiation levels have been investigated using a portable radiation alert Ranger (series number R313227) from S.E International, Inc. (USA). The results showed that majority of the regions had background ionizing radiation levels over the ICRP allowed range (see Table 2), but no immediate health impacts are anticipated. The majority of the studied sites had absorbed doses over the global allowed limit of 84 nGyh-1, and the increased lifetime cancer risk surpassed the safe level of 0.29 × 10-3. Even though this exposure does not have any immediate health effects, it is still advised that radiation protective measures and awareness campaigns be implemented in the local government region.

References

[1]. International Atomic Energy Agency. IAEA Safety Glossary 2016 version. Terminology used in nuclear safety and radiation protection 2016. Available at: http://www-ns.iaea.org/standards/safety-glossary.asp. Accessed on 3 January 2018.
[2]. Arena V. Ionizing radiation and life. St. Louis; The C. V. Mosby Company: 1971.
[3]. Obed RI, Farail P, Jibiri NN. Population Dose Distribution due to soil Radioactivity concentration levels in 18 cities across Nigeria. J Radiol. Protec. 2005;25:305-12.
[4]. UNSCEAR (2000). United Nation Scientific Committee on the effects of Atomic Radiation Report to the General Assembly, New York: United Nation; 2000.
[5]. Al Mugren KS. Assessment of natural radioactivity levels and radiation dose rate in some soil samples from historical area, Al-Rakkah, Saudi Arabia. Nat Sci. 2015; 7:238–247.

[6]. Amekudzie A, Emi-Reynolds G, Faanu A, Darko EO, Awudu AR, Adukpo O, Quaye LAN, Kpordzro R, Agyemang B, Ibrahim A. Natural radioactivity concentration and dose assessment in shore sediments along the coast of Greater Accra, Ghana. World Appl Sci J. 2011;13(11):2338–2343.

[7]. Radiation and your health. Available at: http://www.cdc.gov/nceh/radiation/decay.htm. Accessed on 3 January 2024

[8]. Attia TE, Shendi EH, Shehata MA. Assessment of Natural and Artificial Radioactivity levels and radiation hazards and their relation to heavy metals in the industrial area of Port Said city, Egypt. Journal of Earth Science and Climate Change. 2014;5(1-2).

[9]. Erees FS, Akozcan S, Parlak Y, Cam S. Assessment of dose rates around Manisa (Turkey). Radiat Meas. 2006;41(5):593–601.

[10]. UNSCEAR. In Sources; Effects and risks of ionizing radiation. 1998 Report to the General Assembly with annexes: United States Publication E88x 17 (United Nations) New York; 1998.

[11]. Tchokossa P, Olomo JB, Balogun FA. Assessment of radionuclide concentrations and absorbed dose from consumption of community water supplies in oil and gas producing areas in Delta State, Nigeria world. Journal of Nuclear Science and Technology. 2011;77-86.

[12]. Senthilkumar B, Dhavamani V, Ramkumar S, Philiminathan P. Measurement of gamma radiation levels in soil samples from Tthajavur using Gramma- ray spectrometry and estimation of population exposure. Journal of Medical Physics. 2010;35:48-53.

[13]. Ononugbo CP, Nte F. Measurement of Outdoor Ambient radiation and evaluation of radiological risks of coastal communities in Ndokwa East, Delta state, Nigeria. Advances in Research. 2017;9(6):1-11.

[14]. World Health Organisation. Guidelines for drinking water quality. Third Edition Incorporating the first and second Addenda, Recommendations; WHO Geneva. 2008;1:1–200.

[15]. James IU, Moses IF, Vandi JN, Ikoh UE. Measurement of indoor and outdoor background ionizing radiation levels of Kwali general hospital, Abuja. J. Appl. Sci. Environ. Manage. 2015;19(1):89-93.

[16]. Foland CK, Kirland TK, Vinnikoov K. Observed climatic variations and changes (IPCC scientific assessment). New York: Cambridge University Press. 1995;101-105.

[17]. Bamidele L. Measurement of ionizing radiation in high altitude town of Imesi-Ile, Osun State, Southwestern Nigeria. Environmental Research Journal. 2013; 7(4-6):79-82. ISSN: 1994-5396

[18]. National Council on Radiation protection and Measurements (NCRP). Limitation of exposure to ionizing radiation, NCRP report No.116. March Nobel, B. J 1990. An introduction to radiation protection, Macmillan family Encyclopedia, 2nd Edn. 1993;16–118.

[19]. Rafique M, Rahman SU, Basharat M, Aziz W, Ahmad I, Lone KA, Ahmad K, Matiullah.

[20]. Evaluation of excess life time cancer risk from gamma dose rate in Jhelum valley. Journal of Radiation Research and Applied Sciences. 2014;7:29-35.

[21]. Hendry JH, Steven LS, Anderzeh W, Mendi S, Werner B, Cardis E, et al. Human exposure to high natural background radiation: what can it teach us about radiation risk? J Radiol Prot. 2009;29(0):A29-42.

[22]. Stoulos S, Manolopoulou M, Papastefanou C. Assessment of natural radiation exposure and radon exhalation from building materials in Greece. J Environ Radioactivity. 2003;69:225-40.

[23]. Oladipupo MD and Yabaji JA. Measurement of background gamma radiation levels in the main campus of Ibrahim Badamasi Babangida University Lapai, Niger State Nigeria. Adv Appl Sci Res. 2015; 6(6):95-8.

[24]. Olarinoye IO, Sharifat I, Baba-Kutigi AN, Kolo MT, Aladeniyi K. Measurement of background gamma radiation levels at two tertiary institutions in Minna, Nigeria. J Appl Sci Environ Manage. 2010;14(1):59-62.

[25]. Sadiq AA, Agba EH .Background radiation in Akwanga, Nigeria. Work. Liv Environ Protec. 2011; 8(1):7-11.

[26]. Ramli TA, Aliyu AS, Agba EH, Saleh MA. Effective dose from natural background radiation in Keffi and Akwanga towns, Central Nigeria. Int J Radiat Res. 2014;12(1):47-52.

[27]. Avwiri GO, Nte FU, Oghenevovwero EE. Assessment of background ionization radiation of oil spillage site at obodo creek in Gokana L.G.A of Rivers State, Nigeria. Brit J Appl Sci Techn. 2014; 4(36):5072-9.

[28]. Oladele BB, Arogunjo AM, Aladeniyi K. Indoor and outdoor gamma radiation exposure levels in selected residential buildings across Ondo State, Nigeria. Int J Radiat Res. 2018;16(3):363-70.

[29]. Ugbede FO, Benson ID. Assessment of outdoor radiation levels and radiological health hazards in Emene Industrial Layout of Enugu State, Nigeria. Int J Physical Sci. 2018;13(20): 265-72.

[30]. Felix BM, Robert RD, Emmanuel WM. Assessment of indoor and outdoor background radiation levels in Plateau State University Bokkos Jos Nigeria. J Environ Ear Sci. 2015;5(8):22-8.

[31]. Jwanbot DI, Izam MM, Gambo M. Measurement of indoor background ionizing radiation in some science laboratories in University of Jos, Jos-Nigeria. Sci World J. 2012;7(2):5-8.

[32]. Emelue HU, Eke BC, Oghome P, Ejiogu BC. Evaluation of radiation emission from refuse dumpsites in Owerri Nigeria. IOSR J Appl Physics. 2013;4(6):1-5.

[33]. Olubosede O, Akinagbe OB, Adekoya O. Assessment of radiation emission from waste dumpsites in Lagos state of Nigeria. Int J Comput Engr Res. 2012;2(3):806-11.

[34]. Avwiri GO, Esi E, Agbalagba EO. Gamma Spectroscopy analysis of produced water from selected flow stations in Delta State, Nigeria. International Journal of International Monitoring and Analysis. 2013;1(5):167-174.

[35]. ICRP: International Commission on Radiological Protection. The Recommendations of the International Commission on Radiological Protection: Annals of the ICRP Publication Elsevier. 2007;103:2-4.

[36]. Osimobi JC, Agbalagba EO, Avwiri GO, Ononugbo CP, GIS mapping and background ionizing radiation (BIR) assessment of solid mineral mining sites in Enugu State, Nigeria. Open Access Library Journal. 2015;2:1-9.

[37]. Agbalagba EO, Avwiri GO, Ononugbo, CP, GIS mapping of impact of industrial activities on the terrestrial background ionizing radiation levels of Ughelli metropolis and its Environs, Nigeria. Environmental Earth Science. 2016; 75:1425

[38]. Agbalagba OE, Assessment of excess lifetime cancer risk from gamma radiation levels in Effurun and Warri city of Delta state, Nigeria. Journal of Taibah University for Science. 2017;11(3):367-380.

[39]. Monica S, Visnu Prasad AK, Soniya SR, Jojo PJ, Estimation of indoor and outdoor effective doses and lifetime cancer risk from gamma dose rates along the coastal regions of Kollam district, Kerala. Radiation Protection and Environment. 2016; 39(1):38-43.

[40]. Benson ID, Ugbede FO, Measurement of background ionizing radiation and evaluation of lifetime cancer risk in highly populated motor parks in Enugu city, Nigeria. IOSR Journal of Applied Physics. 2018;10(3):77-82.

[41]. Ononugbo CP, Mgbemere CJ, Dose rate and annual effective dose assessment of terrestrial gamma radiation in Notre fertilizer plant, Onne, Rivers State, Nigeria. International Journal of Emerging Research in Management and Technology. 2016; 5(9):30-35.

[42]. Taskin H, Karavus M, Ay P, Topuzoghi A, Hindiroglu S, Karaha G (2009) Radionuclide concentrations in soil and lifetime cancer risk due to the gamma radioactivity in Kirklareli, Turkey. J Environ Radioact 100:49–53