ASSESSMENT OF ENVIRONMENTAL RADIOACTIVITY LEVELS IN JIMETA AREA OF METROPOLITAN YOLA, ADAMAWA STATE

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Abstract

A radiological survey was carried out over Jimeta area of metropolitan Yola, Adamawa State, using a portable radiation alert monitor 4 of S. E. International, Inc. USA. The study showed that a mean whole body dose equivalent rate of 0.83 ± 0.11 mSv/y and mean absorbed dose rate of 1.19 ± 0.17 mGy/y resulted from total environmental radiation in Jimeta. Allowing for a cosmic radiation of 0.28 mGy/y the mean absorbed dose due to the environmental radioactivity is therefore 0.91 mGy/y. These values are lower than the 1 mSv/y recommended to the average individual member of the public by International Commission on Radiological Protection (ICRP). Hence residents of Jimeta are not unduly exposed to health risk due to environmental radiation exposure.

Introduction

Man's environment has two sources of ionizing radiation, natural and man-made. The natural radiation exposure arises mainly from the radioactive decay process of primordial radioactive elements and their decay products in the geological environment, and the presence of high energy gamma rays from the sun and outer space (cosmic rays). The level of the environmental radioactivity depends on the amount and distribution of the natural radionuclides such as ^{238}U, ^{232}Th and ^{40}K in that environment, the altitude and latitude of the location and the spacing of nuclear process industries (NCRP, 1987).

In living tissues, the ionization of atoms by these radiations may lead to biological changes and some of these changes may result in adverse health effects (International Atomic Energy Agency, IAEA, 1987). These health effects may be somatic and/or genetic (Gonzalez, 1994).

In Nigeria, environmental radioactivity data are very scanty, with many regions having no data at all. Consequently this poses problems such as detecting areas of high environmental radioactivity levels in the country, studies of radiation related illness in such areas and control of industrial radioactive activities in the country.

The objective of this study is to assess the levels of environmental radioactivity in the Jimeta area of metropolitan Yola. Specifically the study will among, other things, ascertain if the radiation level is below the 1mGy which is the ICRP recommended dose limit for members of the public (ICRP, 1990). The study area, Jimeta encompasses Yola North and part of Yola South Local Council areas of Adamawa State, and is located in the North -Eastern axis of Nigeria. It is an urban settlement of about 350,000 people (National Population Commission 1991) and serves as the

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political capital site of Adamawa State. The land area extends from Latitude 09.13° N and Longitude 12.6° E to Latitude 09.17° N and Longitude 12.9° E. The map of the study area is given in figure 1.

Method

A portable solid state Geiger-Mueller tube (Radiation Alert Monitor 4) manufactured by S. E. International, Inc. USA. was used to conduct in situ measurement of the Radiation dose equivalent levels in Jimeta area. The area was divided into 19 measurement sites, with a distance spacing of about 1.5 km (fig. 1). The spacing distance was selected to enhance effective coverage within the limit of available resources. An in situ radiation measurement was carried out at each of the sites in the month of February, 1999 and repeated in September, 2006. A solid state GM counter called radiation alert monitor 4 was used for the measurements. The environmental parameters for the month of February, 1999 were as follows: Mean maximum temperature, 38°C; mean relative humidity 46% and mean average wind speed 5.1 km/hr, while in September, 2006 these parameters were Mean maximum temperature, 31°C; mean relative humidity 70% and mean average wind speed 3.21 km/hr. The preference of in situ measurement to laboratory analysis is because the samples maintain their environmental characteristics (NCRP, 1987).The survey monitor was maintained at one meter above the ground level. At least two measurements were taken per site per day between 12 noon and 3.0 pm. This was repeated three other times on different days to take account of any fluctuation in environmental temperature. The monitor senses ionizing radiation by means of a GM (Geiger - Mueller) tube with a thin mica end window. The sensor is LND 712 halogen - quenched uncompensated GM tube with mica window 1.5 - 2.0 mg/cm² thick. The tube is fully enclosed inside the instrument. The equipment was factory calibrated Approx. 1000 CPM/mR/hr for cesium 137. The instrument provides a direct measurement of exposure rate in mR/h. The mean values of the exposure rate were converted to the absorbed dose rate by multiplying with 76 and a further multiplication with 0.7 resulted in the whole body equivalent dose rate (NCRP, 1987).

Results and Discussions

The radiation exposure levels, the absorbed dose and equivalent rates for the total environmental radiation in Jimeta are shown in Table 1. The whole body dose equivalent rate ranged from 0.61 mSv/y to 1.03 mSv/y with an average value of 0.83 ± 0.11 mSv/y. The mean whole body dose of 0.83 ± 0.11 mSv/y is lower than the 1 mSv/y recommended to the average individual member of the public (ICRP, 1990). The absorbed dose rate ranged from 0.87 mGy/y to 1.47 mGy/y with an average of 1.19 ± 0.17 mGy/y. The comparison of these results with values obtained in 2006 survey as (table 2) shows that the mean values absorbed dose rate, exposure rate and the wholebody equivalent dose rate has increased from 1.1852 to 1.1973 mGy/y ; 0.0156 to 0.0158 mR/h ; 0.8296 to 0.8381 mSv/y respectively since 1999 Mean maximum temperature, 38°C; mean relative humidity 46% and mean average wind speed 5.1 km/hr. These increases could be attributed to increase in human activities (viz; municipal wastes and automobile exhaust) during this period. However there were sites in which these quantities have decreased as shown in figure 1. This study covered both the dry and raining seasons as indicated by the environmental parameters for the measurement months and the results shows that the variation in

the environmental parameters for these periods has not significantly affected radiation levels. The values obtained are much lower than the average equivalent dose rate of 45.22 mSv/y and average absorbed dose rate of 64.60 mGy/y resulting from total environmental radiation obtained by Uwah and Inyang (1998), for Calabar, which was very close to the permissible dose limit for uniform irradiation of the whole body set at 50 mSv/y for occupational exposure (ICRP,1990; Gonzalez, 1994). The value obtained in this study are in good agreement with the values of other studies (Kathren, 1984, 1985) which gave the mean annual exposure levels from natural radiation exposure to range from about 1.3 mSv in the tropics to 2.2 mSv in the temperate zone. The values are also lower than the average annual effective dose equivalent of 2 mSv from natural sources of radiation in areas of normal background (UNSCEAR 1982). Using the dose rate of 0.28 mGy/y (world average, UNSCEAR 1982), as the contribution of the ionizing component part of cosmic radiation, the mean absorbed dose due to the environmental radioactivity was obtained as 0.91 mGy/y.

The low dose level experienced in Jimeta area could be due to low industrial activities in the area hence, there is little or no contribution to environmental radiation resulting from industrial pollution. The low level dose also indicates that the underlying soil/rock has low concentration of primordial radionuclides.

The findings of this study imply that residents of Jimeta are not unduly exposed to health risk resulting from environmental radiation exposure. Any illness traceable to radiation in the area might be due to other sources like medical, toxic chemical and heavy metals.

The area therefore provides a good baseline for assessing environmental radioactivity in the Country.

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Table 1: Absorbed dose and Equivalent rates for total environmental radiation in Jimeta in 1999

Location	Site No.	Exposure rate (mR/h)	Absorbed dose rate (mGy/y)	Whole body Equivalent dose rate (mSv/y)
Vinikilang	1	0.0155 ± 0.0035	1.178 ± 0.269	0.825 ± 0.188
Mubi Rd/by pas Junction	2	0.0155 ± 0.0021	1.178 ± 0.161	0.825 ± 0.113
Mubi round- about	3	0.0171 ± 0.0004	1.3 ± 0.027	0.91 ± 0.019
Union bank round-about	4	0.0152 ± 0.0021	1.155 ± 0.161	0.809 ± 0.113
Ribadu square	5	0.0115 ± 0.0002	0.874 ± 0.018	0.612 ± 0.013
Govt. House Junction	6	0.0148 ± 0.0	1.125 ± 0.00	0.787 ± 0.0
Police round-about	7	0.0129 ± 0.0004	0.98 ± 0.027	0.686 ± 0.019
F. C. E	8	0.0179 ± 0.0018	1.36 ± 0.134	0.952 ± 0.094
Jada st. Karewa	9	0.0126 ± 0.0070	0.958 ± 0.528	0.67 ± 0.370
Karewa ext.	10	0.0183 ± 0.0005	1.391 ± 0.036	0.974 ± 0.025
Bekaji Junc.	11	0.0153 ± 0.0025	1.163 ± 0.188	0.814 ± 0.132
Hospital Rd. by Gemba Rd.	12	0.0174 ± 0.0041	1.322 ± 0.313	0.926 ± 0.219
Total Station Mustapha way	13	0.013 ± 0.0007	0.988 ± 0.054	0.692 ± 0.038
Lake gareio Junc.	14	0.0185 ± 0.0021	1.406 ± 0.161	0.984 ± 0.113
PZ Junction	15	0.0152 ± 0.0042	1.155 ± 0.322	0.809 ± 0.226
Royal Hospital	16	0.0145 ± 0.0007	1.102 ± 0.054	0.771 ± 0.038
Kofore Rd.	17	0.0193 ± 0.0040	1.467 ± 0.307	1.027 ± 0.215
Army barrack Rd.	18	0.0178 ± 0.0013	1.353 ± 0.101	0.947 ± 0.071
Comm.Quts	19	0.014 ± 0.0021	1.064 ± 0.167	0.745 ± 0.117
Mean		0.0156 ± 0.002	1.185 ± 0.170	0.830 ± 0.119

Table 2: Comparison of Measurements taken in 1999 and 2006.

Site No	Exposure rate (mR/h)		Absorbed dose rate (mGy/y)		Whole body Equivalent dose rate (mSv/y)	
	2006	1999	2006	1999	2006	1999
01	0.01833333	0.0155	1.393333	1.178	0.975333	0.8246
02	0.01833333	0.0155	1.393333	1.178	0.975333	0.8246
03	0.01966667	0.0171	1.494667	1.2996	1.046267	0.90972
04	0.019	0.0152	1.444	1.1552	1.0108	0.80864
05	0.01133333	0.0115	0.861333	0.874	0.602933	0.6118
06	0.012	0.0148	0.912	1.1248	0.6384	0.78736
07	0.01633333	0.0129	1.241333	0.9804	0.868933	0.68628
08	0.015	0.0179	1.14	1.3604	0.798	0.95228
09	0.01366667	0.0126	1.038667	0.9576	0.727067	0.67032
10	0.01333333	0.0183	1.013333	1.3908	0.709333	0.97356
11	0.012	0.0153	0.912	1.1628	0.6384	0.81396
12	0.01833333	0.0174	1.393333	1.3224	0.975333	0.92568
13	0.014	0.013	1.064	0.988	0.7448	0.6916
14	0.021	0.0185	1.596	1.406	1.1172	0.9842
15	0.01733333	0.0152	1.317333	1.1552	0.922133	0.80864
16	0.01333333	0.0145	1.013333	1.102	0.709333	0.7714
17	0.016	0.0193	1.216	1.4668	0.8512	1.02676
18	0.01533333	0.0178	1.165333	1.3528	0.815733	0.94696
19	0.015	0.014	1.14	1.064	0.798	0.7448
Mean	0.01575439	0.01559474	1.197333	1.1852	0.838133	0.82964

Figure 2: Graph of the exposure rate in mR/h for the various sites