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Measurement of Background Ionizing Radiation Along the Kubanni River Basin In Zaria, Nigeria

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Abstract

Certain types of rivers are surrounded by radioactive materials. This is the case with the Kubanni River with the Research Reactor located very close to it. Exposure to background ionizing radiation like exposure to any other type of ionizing radiation results in critical health challenges. Measurement of the background ionizing radiation profile along the Kubanni River was carried out. The radiation levels were measured using gamma scout (model GS2 with serial number A20). The radiation levels were: Fadama Area 0.221±0.032,Maje Road0.859±0.216,TudunWada Bridge0.537±0.421,Kano/Kaduna Bridge0.806±0.161,University Dam0.824±0.025 and Kampagi Hill0.645±0.142 mSv/year. Health implications of the results obtained are discussed.

Keywords: Gamma-scout, Radiation profile, ionizing radiation, Radiation dose, Kubanni River, Kaduna, Nigeria

1.0 Introduction

Encountered in everyday activities in various forms and different intensities is radiation. Radiation has been found to be beneficial on one hand and harmful on the other hand. Some of the harmful effects are: cancer, cataract, gene mutation destruction of bones and blood cells and it can cause the death of an individual [1]. These radiations come from three main sources namely: cosmic radiation, terrestrial radiation and radioactivity in the human body [2]. It is the spontaneous decay of the nuclei of heavy isotopes that leads to emission of radiation. Some of these decays include: background ionizing radiation profiles for Rivers are therefore crucial since they enable us to assess the level of risk of exposure to the regular users of the river water and environment. It has been established that chronic exposure to even low dose rate of nuclear radiations from rivers has the potential to induce cytogenetic damage in human beings[3].Of particular concern for background ionizing radiation is the incidence of the invisible, odourless, colourless radioactive gas ^{222}Rnwhich is a member of the Uranium radioactive series. Estimates show that, of, the 2.4mSv/yr annual exposure from all ionizing sources, 40% is contributed by internal exposure to radon alone [3].A strong correlation between radon exposure (inhalation) and the prevalence of lung cancer have also been reported [4].Radon-222results from the radioactivity of Uranium-238 and itself decays with a half- life of 3.82 days. When it is inhaled it penetrates into the lung. Its most dangerous daughters are the emitters$^{218}P_o$and $^{214}P_o$ which emits particles with energy of 6.0MeV and 7.69MeV respectively. The continuous deposition and interaction of such high energy particles with the lung leads to its damage and the incidence of lung cancer. ^{222}Rn finds its way through water, through diffusion and convection and through the sediment under the water.

Therefore regular and periodic monitoring of the background ionizing radiation level should be carried out to assess the health risks to people living around the vicinity of the River, and the farmers that maybe exposed to danger. In this work the background ionizing radiation levels along the Kubanni River andits immediate environs are assessed to enable the determination of the level of risk to which farmers and other people are exposed to and compared to internationally accepted levels. This is needful because beside the natural sources of background ionizing radiation, a

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number of activities occur such as blacksmithing, applications of fertilizers by the farmers, deposition of pharmaceutical wastes from Ahmadu Bello University (ABU) and paper wastes from ABU printing press.

2.0 Materials and Methods

In collecting the data, gamma-scout (model GS2 with serial number A20) was used. The background radiations were measured at Fadama Area, Maje Road, Tundun Wada Bridge, Kano-Kaduna Bypass Bridge, University Dam and Kanpangui Hills. The selection switch of the gamma-scout was adjusted to the right hand side in order to detect the types of radiation in count per minute. The data measured were read onthe displayscreenofthe gamma-scout. The sampling site coordinates are shown in Figure1.The measured counts per minute were converted into μRh^{-1}. One count per minute is equivalent to $0.1\mu Rh^{-1}$ and $1\mu Rh^{-1}$ is equal to $8.764nGyh^{-1}$. The annual equivalent dose was than obtained using the equation:

$$D\ (mSvyr^{-1}) = D\ (nGyh^{-}1) \times 0.7SvGy^{-1} \times 8760hyr^{-1} \times 0.2x\ (10^{3}\ mSvx10^{-9})$$
$$= 1.2264xD\ (nGyh^{-1}) \quad (1)$$

3.0 Results and Discussion

Table 2 shows the location in the countrywhere background radiation levels weremeasured. The values at these locationsare also shown in Table 2. The dose of Zaria was compared with those of other Nigerian towns (Table 3) as reported by [5].The values obtained in this work for the different locations under investigation range from221.4 - 859.8μSv/yr. This range is below the one obtained by [5] that is 943- 1755 μSv/yr. This resultsshowsthat thedose equivalent levels of Kubanni River are well belowglobal average effective dose from naturalsources which is estimated at 2400 μSv/yr and that of theUnited Kingdom, estimated at 1860μSv/year andcomparable with that of U.S.Awhich is 900 μSv/year [6].The highest levels have been recorded inMaje Roadwith a dose equivalent of859.8μSv/year followed by the University Dam with a value of 824μSv/year (Figure1).

The study shows that the absorbed dose rate due toterrestrial gamma radiation of 0.563 mSv/year, inZaria, Kaduna State North –Central of Nigeria, is very lowcompared to the world average of 70 mSv/year [7]. Thisvalue is about 1% of the world average. This shows that the backgroundradiation burden on the masses of the Zaria town andits consequent health hazard is not significant.The data obtained in this work can reliably serve asthe regional baseline data for the assessment of anyfuture environmental radioactivity contamination or pollutionfrom nuclear accidents, nuclear weapons tests,radioactive waste dumps or industrial emissions in theregion studied in respect of dose rate. The values obtained in this work areconsistently less than, the worldwide average dose of 2.4mSv/yr for a human being [8].

Table1: Sampling Sites Coordinates

Sampling Location	Sampling SitesCoordinates	Elevation
Fadama Area	N11° 8.609'E007 ° 41.006'	655 m
Maje Road	N11°8. 613'E7 ° 40.993'	674 m
Tudun Wada Bridge	N11°9.907 'E7° 40.883'	686 m
Kano/Kaduna Bridge	N11° 5. 015'E7 ° 39.071'	676 m
University Dam	N11° 5. 131'E7° 39.071'	673 m
Kamphaghi	N11°10.395'E007° 36.860'	702 m

Table 2: Dose Equivalent Per Year Per Location

LOCATION	EQUIVALENT DOSE MEAN(mSv/yr)	EQUIVALENTMEAN DOSE(μSv/yr)
Fadama Area	0.221±0.032	221.4±31.6
Maje Road	0.859±0.216	859.8±21.6
Tudun Wada Bridge	0.537±0.421	537.4±42.0
Kano/Kaduna Bridge	0.806±0.161	806.1±161.2
University Dam	0.824±0.025	824.0±25.3
Kampagi Hill	0.645±0.142	644.9±14.2

Table 3: Dose equivalent in some Nigerian Cities

TOWN	DOSE EXPOSURE PER YEAR(μSv/Year
ZARIA	562.7±27.6
Lagos	943.2 ± 35.9
Ibadan	1146.9 ± 20.1
Ijebu Ode	1279.0 ± 14.0
Awka	976.0 ± 42.7
Benin City	1249.8 ± 78.8
Owerri	1009.8 ± 28.1
Port-Harcourt	1073.6 ± 39.1
ENUGU	1026.6 ± 148.6

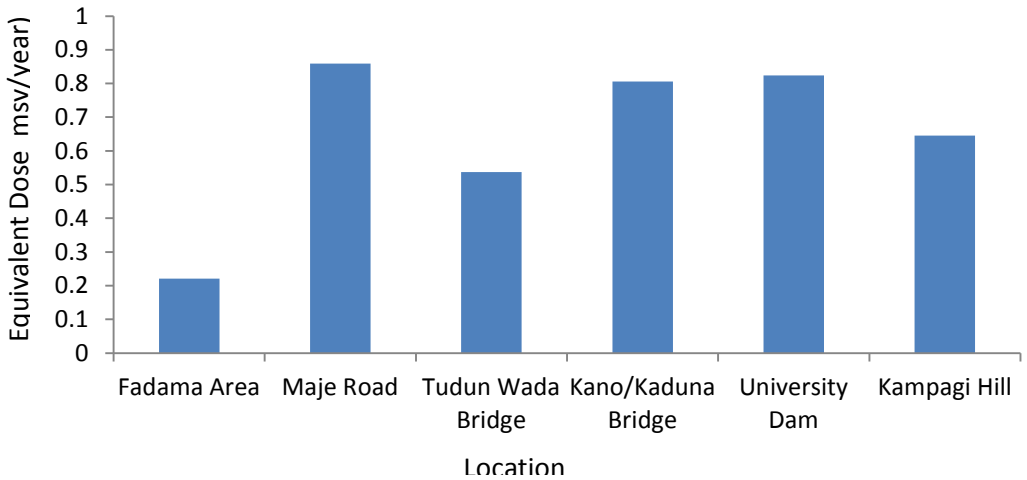

Figure 1: Equivalent dose mean at various locations

4.0 Conclusion

The present study has been carried out to establishbaseline data regarding concentration levels ofnaturally occurring radiationin Kubanni River water and the corresponding radiation doses in Zaria, Kaduna State of Nigeria. Measured mean values of radiation dose for the 6 sampling sites are foundto be less than the world's average values. Calculatedvalues of external radiation doses are also comparable withthe world average of about 0.5 mSv per year. To estimatethe potential radiological health risk in water, thedose rate associated radioactive nuclides such U, Th, K, Ra, and Cs in water of area studiedshould be investigated as well. However, the datagenerated here may be useful for the introduction ofradiation safety standards by the authorized organizationsfor the protection of general population fromradiation hazards owing to water sources.

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