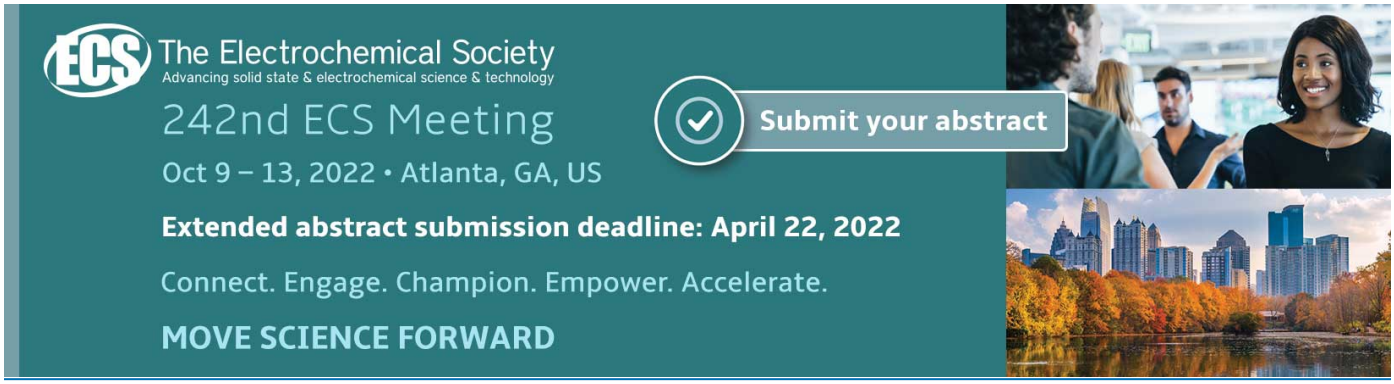
Radiometric survey of natural radioactivity concentration and risk assessment on dwellers around Ijako active dumpsite in Ogun State



Radiometric survey of natural radioactivity concentration and risk assessment on dwellers around Ijako active dumpsite in Ogun State

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Abstract. Radiometric assessment of natural radioactivity concentration around Ijako dumpsite was done using hand held gamma spectrometer. A total of 10 in situ measurements were taken at the site. The U-238, Th-232, and K-40 radioactivity concentration obtained were used to assess the radiological hazard level in the area. Comparing the mean results of radiological parameter obtained with world average; Radium equivalent was far less than 370Bqkg-1, External hazard was less than 1, Annual effective dose equivalent was less than 0.08mSvy-1, Gamma index was less than 1, and Excess life cancer risk was less than 0.29 × 10-3. This implies that Ijako dumpsite poses no radiological hazard to the general public.

Keywords: Radiometric survey, Risk assessment, Residential area, Gamma spectrometer, Dumpsite

1. Introduction

In radiation science, radiometric is the detection/measurement of radiation. It is the initial step taken for assessment of radiological safety in the environment [1]. Elevated natural radioactivity concentration level in an environment is a risk factor that can adversely affect the general public. The danger of terrestrial radiations also known as environmental background radiation depends on the nature of the energy released from the radionuclide atoms. Since rocks and soils host the natural radionuclides that release radiation energy to the environment, it establishes the fact that geological composition of an area influences the background radiation [2-3]. U-238, Th-232, and K-40 were identified as primary resident radionuclides in rocks/soils that release radiation into the environment.

Their released radiations are in both indoor and outdoor air. Anthropogenic radiation sources add small amount to the total level of background radiation found in human activity/residential areas. Accidental discharges of ionizing radiation from anthropogenic source are possible and can elevate radioactivity concentration level in an area [4-6]. Dumpsite holds both household and commercial waste materials of diverse radiation release rates. The possibilities of dumping radioactivity enhancement waste that can have adverse effect on dwellers around Ijako dump site exist. Without radiometric study around the site, dweller could be exposed to radiological risks unknown to them, if anthropogenic radiation source has been dumped. It is a reported fact that environmental pollution such as refuse dumping, use of fertilizers and so on can influence elevated radiation level [7-8]. Several studies on human activity influence on environmental safety, lay credence to the need for periodic assessment and monitoring, as embarked upon by the present study. Lambert et al [9] has reported that the continuous and excessive application of chemical fertilizers like phosphate and NPK, can adversely affect the environment since such activities can release trace elements and other naturally occurring radionuclides into the environment amongst many others.

2. The Study Area and Geology

Ijako is located along Sango – Abeokuta express way. The study area falls within Ogun state, southwestern Nigeria (Fig. 1a). The state is bounded by Oyo state and Osun state to the north, Ondo state to the east, Benin Republic to the west, and Lagos state to the south. The dumpsite used is located in Ado-Odo local government area of Ogun state (Fig. 1b). The study area is under a tropical climate, with rainy and dry seasons respectively. The rainy season is distributed from March to November, while the dry season covered the rest of the months. The temperature distribution varied from 27.2 to 33.7°C annually. The geology of Nigeria is underlain by the Pan-African mobile belt that separates West Africa from Congo Cratons [10-11]. Separation of this region is believed to have been as a result of thermotectonic events for years [12]. The Basement and Sedimentary terrains are the major geological settings in Nigeria [4, 6], with the two settings well represented in Ogun state. The geology of the study area is chiefly on the Nigerian Dahomey Basin. The lithostratigraphy sequences underlying the study area are Abeokuta, Ewekoro, Oshosun, Ilaro, Benin Formations, and Alluvium (Fig. 2). The area of study falls on Benin Formation, which is also called Coastal Plain Sands as revealed in Fig. 2.

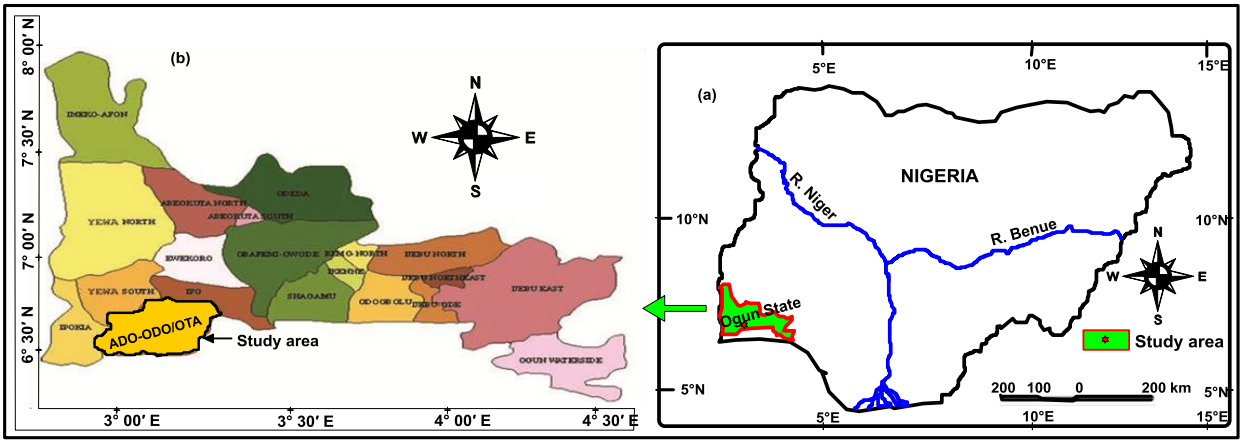

Fig. 1. (a) Map of Nigeria showing Ogun State. (b) Local government map of Ogun state showing the study area

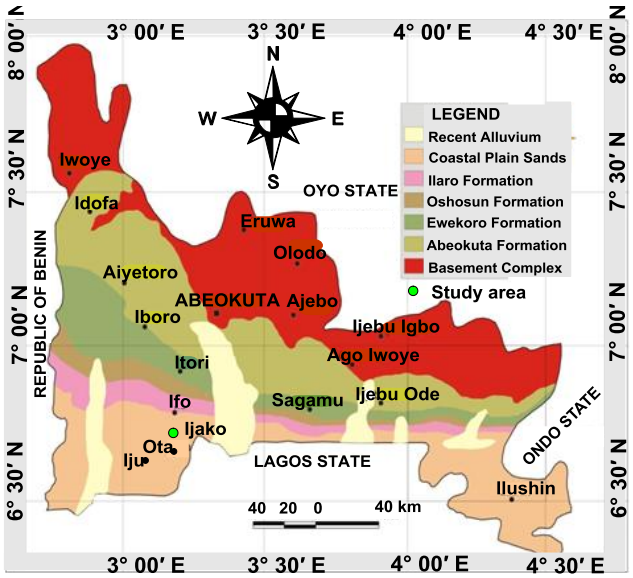

Fig. 2. Geological map of Dahomey Basin showing the study area

3. Measurement method and calculations

Ten (10) in-situ measurements of natural radioactivity concentrations of U-238, Th-232, and K-40 and dose rate were taken around the residential areas that are closed to Ijako dumpsite in order to determine the radiological safety of the people living around the dumpsite. On each measurement location, the hand held gamma spectrometer was positioned at a distance of 1 meter above the ground, to take the reading. Radionuclide concentration activity reading was taken for 3 minutes, four (4) different reading was taken and the average was recorded as the result for that location. Maps of U-238, Th-232, and K-40 radioactivity concentrations of the study area are presented in Figures 3 to 5 as well as the correlation plot between measured and calculated dose rate (see Figure 6).

Radiological parameters were calculated to determine the risk level of exposure around ijako dump site. The parameters studied are Radium equivalent (Ra_{eq}), external hazard index (H_{ex}), outdoor annual effective dose equivalent ($AED_{outdoor}$), Gamma index (Iγ), and Excess life cancer risk (ELCR). Equations 1 to 5 were employed for the radiological parameter calculations respectively [13-14].

$$Ra_{eq} = C_{Ra} + 1.43C_{Th} + 0.077C_K \quad (1)$$

$$H_{ex} = \frac{C_U}{370} + \frac{C_{Th}}{259} + \frac{C_K}{4810} \leq 1 \quad (2)$$

$$AED_{Outdoor} = Absorbed\ Dose\ (nGyhr^{-1}) \times 8760hryr^{-1} \times 0.2 \times 0.7SvGy^{-1} \quad (3a)$$

$$Absorbed\ Dose\ (nGyhr^{-1}) = 0.462C_U + 0.604C_{Th} + 0.0417C_K \quad (3b)$$

$$I\gamma = \frac{C_U}{150} + \frac{C_{Th}}{100} + \frac{C_K}{1500} \leq 1 \quad (4)$$

$$ELCR = AED_{outdoor} \times DL \times RF \quad (5)$$

where C_U, C_{Th} and C_K are activity concentration of Uranium, Thorium and Potassium respectively, DL is the average lifespan (70 years) and RF is risk factor (Sv^{-1}) which is 0.057, for stochastic effects from low-dose background radiation [1,5].

4. Results and discussion

Radiometric survey of natural radioactivity concentration and risk assessment on dwellers around Ijako active dumpsite in Ogun State was done in the present study, Figure 3 to 5 shows the spatial distribution pattern of the measured radionuclide levels of the study area. The measured activity concentration level increased as one advances closer to the dumpsite. This trend is true for the three (3) studied radionuclides. Figure 6 shows the correlation of calculated dose rate to measured dose rate, the positive value implied the same trend. Both the measured and the calculated dose rate were within permissible limit and below world average of 57nGyhr-1 [1, 4].

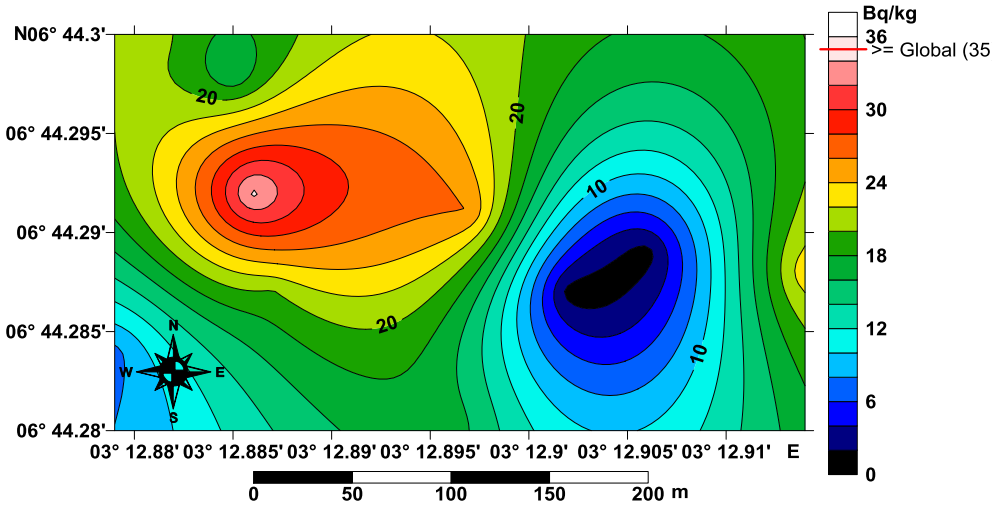

Fig. 3. Spatial distribution of u-238 in the study area

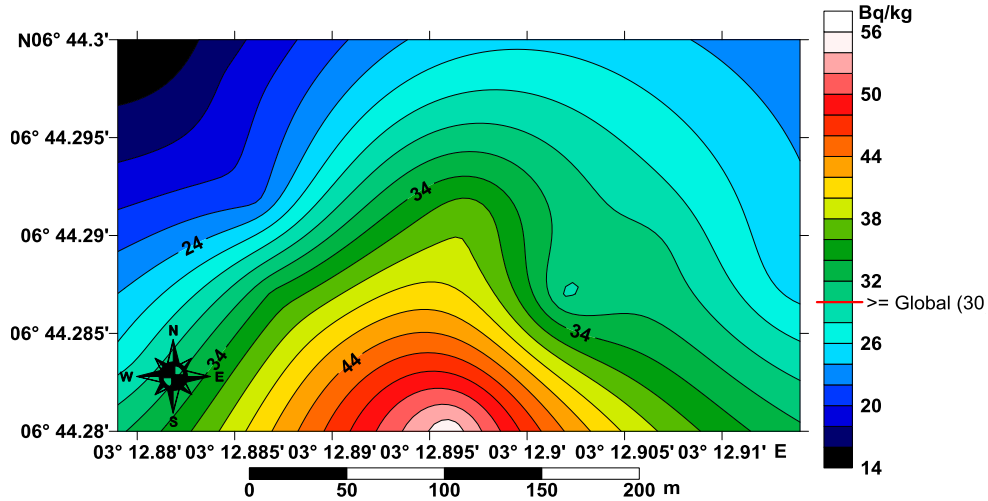

Fig. 4. Spatial distribution of Th-232 in the study area

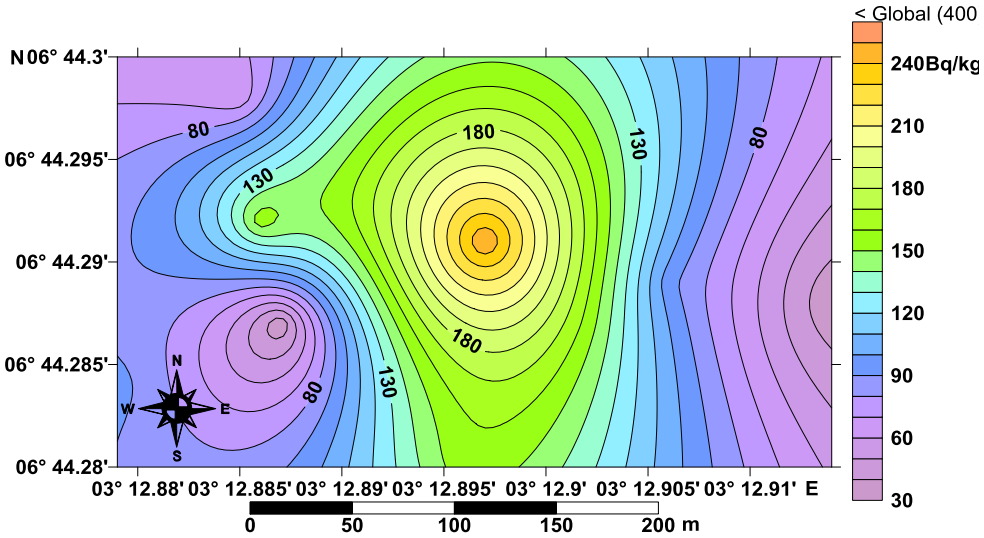

Fig. 5. Spatial distribution of K-40 in the study area

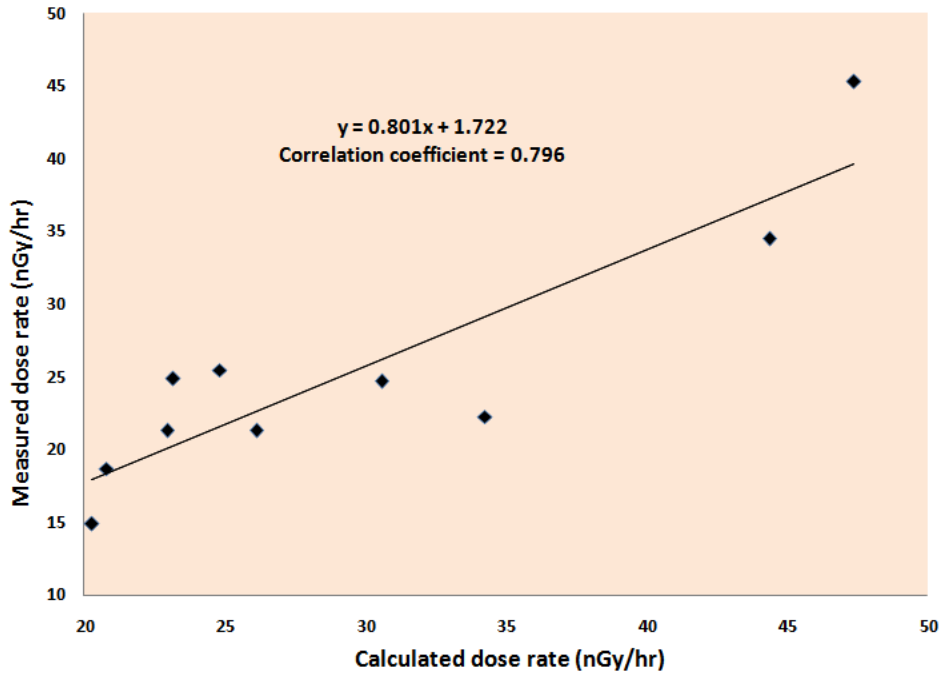

Fig. 6. Plot of calculated against measured dose rate in the study area

To assess the radiological implication of the activity concentration measured to the public, a comparison of the calculated parameters was made with the set world limits. Table 1 shows the obtained results for the 10 study points and the total mean. It was observed that all the calculated radiological parameters were well below the world recommended average values. This implied that the dump site is not influencing the background radiation of the area and it also has no immediate radiological adverse implication to the dwellers around and the public at large.

Table 1. Calculated Radiological Parameters in Ijako

S/No.	Ra_{eq} $BqKg^{-1}$	H_{ex}	$AED_{outdoor}$ mSy^{-1}	I_{γ}	ELCR $\times 10^{-3}$
1	52.378	0.141441	0.028151	0.3759	0.098528
2	71.5194	0.193156	0.037518	0.4977	0.131313
3	76.8178	0.207502	0.042002	0.545967	0.147005
4	47.5926	0.128544	0.025511	0.3356	0.08929
5	46.1405	0.124636	0.024869	0.323833	0.087042
6	99.2176	0.267958	0.054415	0.717467	0.190453
7	60.7149	0.163994	0.032046	0.420933	0.112159
8	108.8771	0.294015	0.058108	0.7758	0.203378
9	53.1721	0.143568	0.028429	0.383467	0.099502
10	55.6757	0.150328	0.030441	0.409	0.106542
Mean	67.21057	0.181514	0.036149	0.478567	0.126521
World Avg	370.0000	≤1	0.080000	≤1	0.290000

5. Conclusion

Radiometric survey of natural radioactivity concentration and risk assessment on dwellers around Ijako active dumpsite in Ogun State, Nigeria was done using RS 125 hand held gamma spectrometer. All measured and calculated dose rate and radiological parameters were within world set limit. The study therefore concludes that the area around Ijako active dumpsite has no adverse radiological health implication on dweller and the public.

Acknowledgement

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