Assessment of Radiation Emission from Waste Dumpsites in Lagos State of Nigeria

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Abstract
This paper takes a look at the total radiation emanating from waste dumpsites in two cities of Lagos state Nigeria. This was achieved using a radiation survey meter (RADALERT50) to measure the radiation exposure rate in micro sievert per hour (μSvhr^{-1}). Readings were taken by placing the detector at gonad level i.e. about 1 meter above the ground level in five sampling locations; this was done at an interval of 5meters away from the point of reference up to 30 meters. The results obtained revealed that the annual absorbed dose rate measurements taken inside the five dumpsites are 29.80μSvhr^{-1}, 28.05μSvhr^{-1}, 19.29μSvhr^{-1}, 17.53μSvhr^{-1} and 15.78μSvhr^{-1}. This is far lower than the average of 70μSvhr^{-1} recommended by UNESCO on effect of Atomic Radiation.

Keywords: Radiation Emission, Waste dumpsites, absorbed dose rate.

Introduction
Wastes constitute an environmental and public health nuisance in major cities all over the world. Thus, governments consider waste management as an essential social service whose budgetary provision is made in line with population projections (Eja *et.al*, 2010, P. 110-123). Hazards posed by such dumpsite are not only in term of odour and presence of disease causing micro-organism, but can arise from the radiation emanating from such dumpsite (Ojoawo *et.al*, 2011, P.661-666). Various radioactivity measurement have shown the existence of traces of radionuclide in books (Imtiaz *et.al*, 2005, P. 169-174) and in the staple food consume in Nigeria (Jibri *et.al*., 2007, P.53-59, Eyebiokin *et al*, 2005, P.187-191). It has also been established that vegetation and environmental fields in Nigeria contain traces of radionuclides (Akinloye and Olomo, 2005, P. 219-225). All these, are contained in the domestic waste which are indiscriminatly dumped on open fields (Ojoawo *et.al*, 2011, P.661-666), farms soils (Jibiri *et.al*, 2011, P.1039-1049), Quarry sites (Odunaike *et.al* 2008, P.174-176), rivers (Farai and Oni, 2002, P.94-97), well and boreholes (Jibiri *et.al*, 2010, P.291-297), industries (Iyang *et.al* 2009, P.97–100) and even on road sides and mechanic workshops (Nworgu *et.al*, 2011, P. 801-805). In addition, industrial waste that are liable to contain traces of radionuclide are also dumped indiscriminately. Consequently, the radionuclide content in the waste dumpsite, if not properly managed emit mixed radiation to the environment (Eja *et.al*, 2010, P. 110-123). Radiation emission characterization of watse dumpsites (Odunaike *et.al*, 2008, P.174-176) and measurement of radiation level in refuse dumps (Odunaike *et.al*, 2008, P.174-176) shows the level and long term effects of these radiations if not properly monitored. The 2011 Fukushima Daiichi nuclear disaster displaced thousand of people and its effects is still been felt even in places far from the site (Tanabe, 2011, P. 1135-1139).The proper monitoring and evaluation of the radiation emanating from dumpsites in order to provide accurate data as part of environmental monitoring research for proper assessment of radiation exposure rate of the metropolis motivated this study.

Materials and Methods
This paper measures and calculates the absorbed dose of radiation in some selected dumpsites in Igando and ikotun area of Lagos state. In igando, we have the dumpsite I and dumpsite II, while in Agodo we have the dumpsites III, dumpsite IV and dumpsite V. The effects of the radiation on those living around the sites is also considered. The measurement is achieved by using a portable radiation survey meter with serial number 22205 to measure the dose rate or exposure in mixed field. The operating range for measurement can be obtained for subdivisions of mR/hour, μSv/hour, CPM (Count per minute), CPS (Count per second) depending on the level of radiation. The meter uses 9V battery. The radiation exposure rate measurement was carried out using a survey meter device as described above, this meter record dose rate in micro sievert per hour (μSvhr^{-1}). Seventeen readings were taken altogether from five sampling locations, and every 5 meters away from the first two locations at Igando and Ikotun in Lagos state. The detector was placed at gonad level i.e. about one meter above ground level for effective detection, the detector was switched on to absorb radiation for a few seconds and the highest stable point was recorded. The procedure was repeated at each location and three readings in micro sievert per hour (μSvhr^{-1}) were recorded at each location in which an average value in micro sievert per hour (μSvhr^{-1}) was determined. This was converted to annual absorbed dose rate in micro sievert per year (μSvyr^{-1}).

Study Area
The study was carried out in Lagos state, with Seventeen readings taken. Five readings were taken from Igando and Ikotun dumpsite, and twelve readings were taken for every 5 meters away from Igando dumpsite in Lagos state. Lagos state is an administrative division created on May 27, 1967 and is located in the southwestern part of the country and has Ikeja as its capital.

Lagos state lies within latitude 6^o and 35^oN and longitude 3^o and 45^oE, with population of about 17,553,924 (Lagos state Social Security Exercise 2006 Cencus). Lagos state covers an area of approximately $3,475.1km^2$. Lagos state is divided into five administrative division which are futher divided into 16 local government areas. These local government are: Agege, Alimosho, Ifako-ijaye, Ikeja, Kosofe, Mushin, Oshodi-isolo, shomolu, Apapa, Eti-osa, Lagos island, Lagos mainland, Surulere, Ajeromi-ifelodu, Amuwo-odofin, Ojo, Badagry, Ikorodu. The sampling locations are Igando dumpsite (dumpsite I, dumpsite II) in Igando, Lagos state, and Agodo dumpsite (dumpsite I, dumpsite II, dumpsite III) in Ikotun, Lagos state. Also readings were taken for every 5 meters away from Igando dumpsite

Annual dose equivalent helps to determine the absorbed dose rate per year (µ Sv/yr). The relation below is used to calculate the annual dose equivalent as used to calculate the annual dose equivalent above.

$$D = \sigma \times \mu \times 24 \times 365.25 \ (\mu Sv/yr) \quad \ldots\ldots\ldots\ldots(1)$$ (Marilyn *et al*., 1995, P. 296)

Where: D = Annual absorbed dose rate in micro sievert per year.

σ = Absorbed dose rate in micro sievert per hour.

μ = Occupancy factor, 0.2

mean annual absorbed rate is calculated using the equation (2)

$$\bar{X} = \frac{\sum x}{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where: $\bar{X}$ = Mean annual absorbed dose rate in micro sievert per year

$\sum$ = Summation

x = Annual absorbed dose rate in micro sievert per year

n = Number of locations

Results And Discussion

Zero meters as indicated in the tables shows the measurement taken inside the dumpsites, other measurement are taken at the specified distances away. From table 2.0, the annual absorbed dose rate inside dumpsite I is $29.80\mu Svyr^{-1}$, the mean annual absorbed dose rate from 5 meters to 30 meters away from the dumpsite is $21.04\mu Svyr^{-1}$. The graph 1.0 shows that, the farther the distance away from the dumpsite, the lesser the value of the absorbed dose rate. The amount of radiation generated inside dumpsite I with annual absorbed dose rate $29.80\mu Svyr^{-1}$ is higher than that generated inside dumpsites II, III, IV and V with annual absorbed dose rate of $28.05\mu Svyr^{-1}$, $19.29\mu Svyr^{-1}$, $17.53\mu Svyr^{-1}$ and$15.78\mu Svyr^{-1}$ respectively as seen from tables 3.0 to 6.0, the high value obtained in dumpsite I compared to the other four dumpsites is attributed to the high level of waste generated due to high population, this area is used for residential and commercial purposes. From table 3.0, the annual absorbed dose rate inside dumpsite II is $28.05\mu Svyr^{-1}$, the mean annual absorbed dose rate from 5 meters to 30 meters away from the dumpsite is $16.95\mu Svyr^{-1}$. The graph 2.0 follows the same trend as that of the figure I except that the values are lower due to the congestion in the area of figure I. Also, the amount of radiation generated inside dumpsite II with annual absorbed dose rate $28.05\mu Svyr^{-1}$ is higher than that generated inside dumpsites III, IV and V with annual absorbed dose rate of $19.29\mu Svyr^{-1}$, $17.53\mu Svyr^{-1}$ and$15.78\mu Svyr^{-1}$ respectively. As seen from tables 3.0 to 5.0, the annual absorbed dose rate for dumpsite III, IV and V is $19.29\mu Svyr^{-1}$, $17.53\mu Svyr^{-1}$, and $15.78\mu Svyr^{-1}$ respectively. The low value obtained from the three dumpsites mentioned above is attributed to the low level of waste generated in this area, due to low population. The values obtained are lower compared to the result obtained from Obed *et al* (2005, P.305-312), with an average of $24.5\mu Svyr^{-1}$ as reported in situ gamma spectroscopic measurement. All values discussed above is comparable, though lower than both result obtained from the investigation of radiation level in waste dumpsite across Lagos metropolis, Nigeria, with a mean annual absorbed dose rate $21.8\mu Svyr^{-1}$ reported by Odunaike *et al*. 2008, P. 174-176) and that obtained from (Obed *et al*. 2005, P. 305-312) with an average of $24.5\mu Svyr^{-1}$ as reported in situ gamma spectroscopic measurement. However, world's average is $0.06\mu Gyh^{-1}$ approximately $70\mu Svyr^{-1}$ (Ademola, 2008, P. 93-99), this is higher than the result obtained in this study.

Conclusion

The radiation dose rate characterization of the waste dumpsites in two cities (Igando and Ikotun) of Lagos Metropolis and some meters away from two of the dumpsites has been investigated in this study, and a mean annual absorbed dose rate obtained from the five dumpsites is 29.80μSvyr^{-1}, 28.05μSvyr^{-1}, 19.25μSvyr^{-1}, 17.53μSvyr^{-1}, and 15.78μSvyr^{-1} respectively. Despite the fact that all levels of ionizing radiation are hazardous to human health (Imtiaz *et al*., 2005, P. 169-174) the exposure level of the emitted radiation on the populace of the two cities is low when compared with Nigeria and World average which is 70μSvyr^{-1}. Hence, fear of serious health hazards arising from the exposure to radiation emanating from these dumpsites should not be entertained. However, focus should be on the proper management of the waste generated in the city to prevent outbreak of mutation, cancerous diseases and also to prevent the radiation emitted from this dumpsites from getting into exposed foods sold in this areas. It will be advantageous to improve the environment and conserve natural resources; these can be achieved by locating waste dumpsites far away from residential areas, discouraging builders not to build houses near dumpsites. Waste to wealth approach should be incorporated by the government as well as carrying out regular investigations to monitor the level of radiation emission from dumpsites in the city to avoid high level of radiation emission outbreak in subsequent years.

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Table 1.0: Locations at which the measurements were taken.

DUMPSITES	LOCATION
DUMPSITE I	IGANDO, LAGOS.
DUMPSITE II	IGANDO, LAGOS.
DUMPSITE III	AGODO, IKOTUN EGBE, LAGOS.
DUMPSITE IV	AGODO, IKOTUN EGBE LAGOS.
DUMPSITE V	AGODO, IKOTUN EGBE LAGOS.

Table 2.0: Radiation measurement for Dumpsite I

LOCATION NUMBER	DISTANCES (D)	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	AVERAGE ABSORBED DOSE RATE (μSvhr^{-1})	ANNUAL ABSORBED DOSE RATE (μSvyr^{-1})
1	0 METERS	0.017	0.016	0.017	0.017	29.80
2	5METER AWAY	0.016	0.016	0.017	0.016	28.05
3	10METERS AWAY	0.014	0.013	0.014	0.014	24.54
4	15METERS AWAY	0.012	0.012	0.011	0.012	21.04
5	20METERS AWAY	0.011	0.010	0.011	0.011	19.29
6	25METERS AWAY	0.010	0.010	0.010	0.010	17.53
7	30METERS AWAY	0.010	0.009	0.009	0.009	15.78

TABLE 3.0: Radiation measurement for Dumpsite II

LOCATION NUMBER	DISTANCES (D)	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	AVERAGE ABSORBED DOSE RATE (μSvhr^{-1})	ANNUAL ABSORBED DOSE RATE (μSvyr^{-1})
8	0 METERS	0.016	0.016	0.015	0.016	28.05
9	5METER AWAY	0.016	0.015	0.015	0.015	26.30
10	10METERS AWAY	0.012	0.013	0.012	0.012	21.04
11	15METERS AWAY	0.010	0.010	0.010	0.010	17.53
12	20METERS AWAY	0.009	0.009	0.010	0.009	15.78
13	25METERS AWAY	0.008	0.007	0.007	0.007	12.27
14	30METERS AWAY	0.005	0.005	0.004	0.005	8.77

TABLE 4.0: Radiation measurement for Dumpsite III

LOCATION NUMBER	DISTANCES (D)	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	AVERAGE ABSORBED DOSE RATE (μSvhr^{-1})	ANNUAL ABSORBED DOSE RATE (μSvyr^{-1})
15	0 METERS	0.011	0.010	0.011	0.011	19.29

TABLE 5.0: Radiation measurement for Dumpsite IV

LOCATION NUMBER	DISTANCES (D)	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	AVERAGE ABSORBED DOSE RATE (μSvhr^{-1})	ANNUAL ABSORBED DOSE RATE (μSvyr^{-1})
16	0 METERS	0.010	0.009	0.011	0.010	17.53

Table 6.0: Radiation measurement for Dumpsite V

LOCATION NUMBER	DISTANCES (D)	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	ABSORBED DOSE RATE (μSvhr^{-1})	AVERAGE ABSORBED DOSE RATE (μSvhr^{-1})	ANNUAL ABSORBED DOSE RATE (μSvyr^{-1})
17	0 METER	0.010	0.008	0.009	0.009	15.78

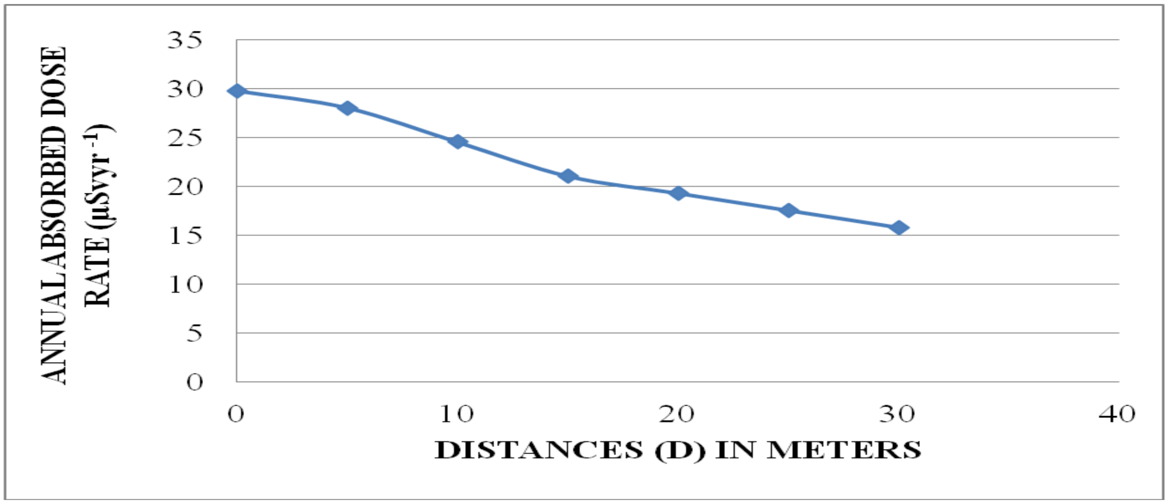

Figure 1.0: Graph of annual absorbed dose rate against distance for dumpsite I

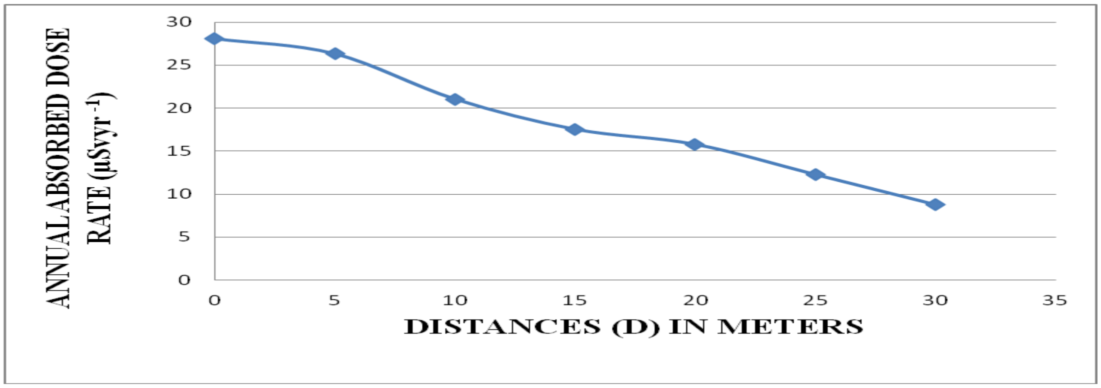

Figure 2.0: Graph of annual absorbed dose rate against distance for dumpsite II

Figure 3.0: Map of the study area