Measurement of Radiation of Refuse Dumpsites in Some Selected Areas of Kaduna Metropolis, Kaduna, Nigeria

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ABSTRACT-
This work examines the levels of radiation emanated from the refuse dumpsites in some selected areas in Kaduna states, Nigeria. A total of five dumpsites were investigated out of which three met the minimum required radiation dose for both radiation workers and non radiation workers. Radiation measurement was carried out with the IM-3000 meter placed at 1.80m high above the ground with varying distances. The average level of radiation for sites, Sabon Tasha, Tudun Wada, Kawo, Hayin DanMani and Kakuri are 0.231rem/yr, 0.149rem/yr, 0.179rem/yr, 0.163rem/yr and 0.232 rem/yr respectively
Keywords: Radiation, Dumpsites, Background, ionizing, hazards

INTRODUCTION

Industrial and domestic wastes contain various substances which includes radioactive material result from the processing chemicals. Additionally, leftovers from common foods have small amounts of pollutants or radioactive elements. The public is exposed to radiation risk when these waste dumps are disposed of without proper management, especially when radioactive substances are included Odunaike *et al.*, (2008).

NATURAL RADIOACTIVITY

This is the spontaneous disintegration of the nucleus of an atom during which alpha particle, beta particle and gamma rays or combination of any or all the three radiations and energy are released. The phenomena of spontaneous emission of highly penetrating radiation from heavy element of atomic weights greater than about 206 occurring in nature and is called natural radioactivity. The elements which exhibit this property are called radioactive elements. The atom of radioactive element emits radiations composed of three different kinds of rays (alpha, beta and gamma). In the process, the element breaks up leading to an irreversible self-disintegration. The activity of spontaneous disintegration is unaffected by an external agent like high temperature, high pressure, large electric and magnetic field (Marilyn and Maguire, 1995).

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ARTIFICIAL RADIOACTIVITY

An ordinary material not normally radioactive is made radioactive by bombarding it with radioactive particles.

Artificial disintegration was first achieved by Rutherford when he disrupted nitrogen nucleus with energetic α- particles, to produce first of all isotope of fluorine. The fluorine nucleus being unstable disintegrates as shown in the equation below:

$$^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn + \ \ Energy \qquad (1)$$

RADIATION

Radiation is a process in which energetic particles or energetic waves travel through a vacuum or through matter containing media that are required for their propagation. Radiation is a fact of life, we live in a world in which radiation is naturally present everywhere ICRP(1990). Light and heat from nuclear reaction in the sun are essential to our existence.

Radioactive materials occur naturally throughout the environment and our bodies contain radioactive materials such as carbon – 14, polonium – 120 and potassium – 140 quite naturally (Tait, 1980). All life on earth has evolved in the presence of this radiation since the discovery of X – rays and radioactivity more than 100 years ago, we have found ways of producing radiation and radioactive materials artificially. The first use of X – rays was in the medical diagnosis, within six months of their discovery in 1895 by Wilhelm Roentgen(Keffer, 1990). So, a benefit from the use of radiation was established very early but equally some of the potential danger of radiation become apparent in the Doctors and Surgeons who over exposed themselves to X – rays in the early 1900's. Since then, many different applications of radiation and radioactive materials have been developed. Radiation is classified according to the effects it produces on matter; we have ionizing and non-ionizing radiation(Farai, , 2006).

Ionizing radiation includes cosmic rays, X – rays and the radiation from radioactive materials. Non-ionizing radiation includes ultraviolet light, radiant heat, radio waves.

Refuse dumps can be regarded as primary sources of environmental health hazards to the general public in major cities of the world.

Besides the offensive odour that emanates from them, there are radiation emissions that can be detrimental to health (Ari,1986). Thus, waste management is considered by governments as an essential service which has to be put in place following population growth projections (Semart, 1973). Towns and cities that have experienced rapid growth have had to contend with the increased levels of waste generation. Urbanization and development bring about higher concentration of commercial, infrastructural, industrial and government activities in such urban areas(Paul & Tripler, 2004).

Human activities have always generated waste. In Nigeria with a population of about 187 million people (National Population Commission, 2017), waste is still a problem with several challenges to be addressed. The constituents of these wastes, which are usually complex blends of biodegradable and non-biodegradable substances, are compositions of both the domestic and industrial wastes that are disposed of (Bathesda, 1989).

Land filling is one of the most common methods of waste disposal globally (Tait, 1980). Its management and operation is relatively convenient and low cost, making it favourable for low and middle income countries.

As much as this is an alternative to waste management, it still poses environmental hazards in varying degrees based on its location from residential areas. Indiscriminate and arbitrary waste dumping is still a problem faced in most developing countries.

This may pose a health risk to the population as this can have effects on the soil and underground water by way of pollution which can also lead to land degradation (Keffer, 1990).

Background ionizing radiation (BIR) is constantly emitted by refuse dumps and also Naturally Occurring Radioactive Materials (NORM) in the soil. These emissions occur when weathering processes occur (ICRP, 1990). A huge percentage of human radiation exposure comes from natural sources, with the earth itself being one of the sources (REC., 2002). Radon gas particularly is capable of producing alpha rays upon decay and may pose increased risk to cancers, eye cataracts if inhaled.

The measurement and characterization of the radiation exposure dose rates emanating from waste dumpsites are imperative as it shows the level of risk and possible long term effects on people, if not adequately managed. Radiation is the emission of energy in the form of particles or waves (Emelue *et al*., 2013). Ionizing radiation is produced by radioactive materials that decay spontaneously whereas it damages any living tissue in the human body in a unique way ICRP (1990). Radioactive pollution, which is the release of these radioactive materials into the environment, mutates DNA thereby causing abnormal growth and possibly cancer since it remains in the atmosphere for years, slowly diminishing over time Farai *et al*., (2006). Estimates of dose contribution of ionizing radiation in the environment showed that 85% are derived from natural radionuclides while 15% are from cosmic rays and nuclear processes (Obed *et al.*, 2005). A number of studies have measured the activity concentration of natural radionuclides in soil in order to determine level of contamination (Obed *et al.*, 2005). Recent science proposed existence of some threat from any exposure to radiation as effects from small or even moderate exposures may not be noticeable since the damage occurs at the cellular level Odunaike (2008) . The probability that cancer will result from radiation exposure increases as the dose increases Emelue *et al*.,(2013). The likelihood of developing cancer, not the gravity of the cancer, will be on the increase with increasing radiation dose. Cancer risk does not materialize until years after the exposure such as 50 years after exposure for breast cancer Odunaike (2008).

Measurement Sites

Kaduna State was created on the 27th May, 1976, it lies on latitude (9^0 03^lN and 11^0 32^lN) of the equator and longitude (6^0 05^lE and 8^0 38^lE) of Greenwich Meridian.

The state has land mass of 46,053 SqKm which is about 5% of total land mass of Nigeria. According to 2006 census, the state has a population of about 6,116,503.

Kaduna State share boundaries with Zamfara, Katsina, Plateau, Niger, Nassarawa, Bauchi and FCT to the south. The map of Kaduna State indicating the studied sites is shown in figure 1 below.

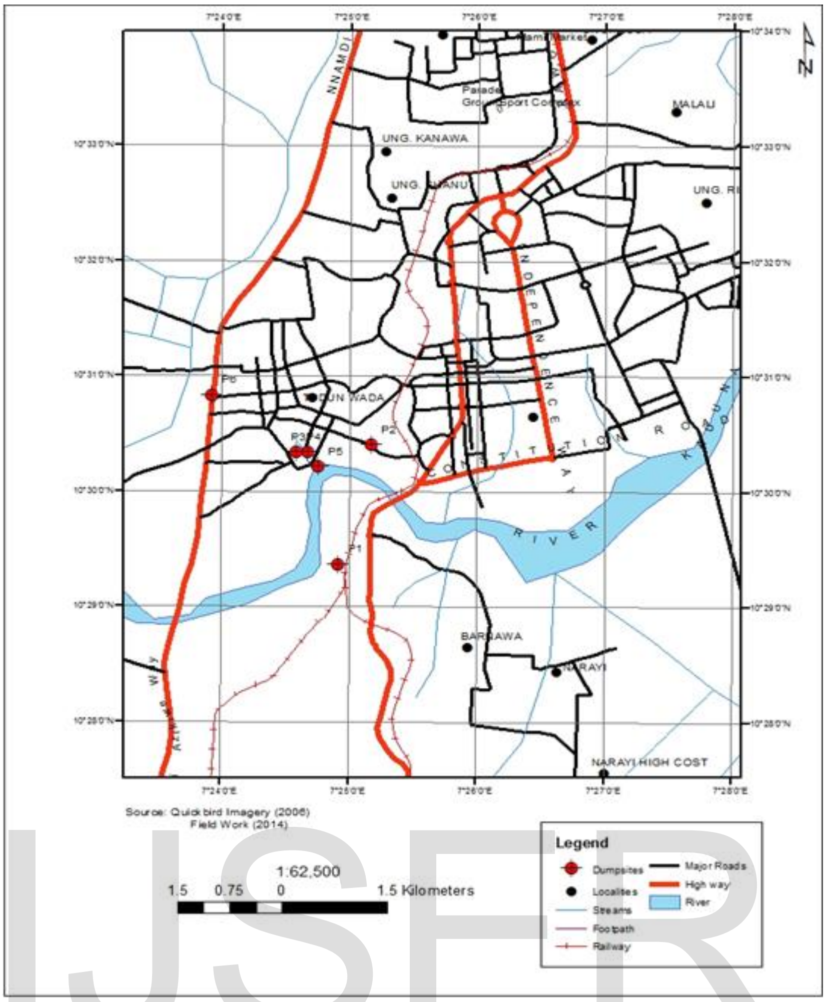

Figure 1: Map of Kaduna Metropolis showing major dumpsites

MATERIALS AND METHODOLOGY

Measurements of background radiation and radioactivity are of great importance and interest in medical physics not only for many practical reasons, but also for more fundamental scientific reasons (Paul and Trippler, 2004).

It is the direct result of the action of the sun (such as neutrino, pion, meson). High-energy cosmic rays interact with stable nuclei from the atmosphere to produce cosmogenic radionuclides, which are radionuclides produced by nuclear processes. The reaction $^{14}N(n,p)^{14}C$ produces carbon-14, one of the well-known cosmogenic radionuclides (radiation-dosimetry.org). Geiger-Muller, Radex Meter, Gas-filled detector, scintillation detectors and the semiconductor detectors are some of the instruments that could be used to measure these radiations.

Table 1: The selected waste dumpsites and locations and associated wastes

DUMPSITE NUMBER	WASTE DUMPSITE AND LOCAL GOVT	ASSOCIATED WASTES
1	SABON TASHA, CHIKUN	DOMESTIC WASTES, ELECTRONIC WASTES, SPOILT FOOD STUFFS,
2	TUDUN WADA, KADUNA SOUTH	ANIMAL WASTES, DOMESTIC WASTES, ELECTRONIC WASTES, FOOD WASTES, WOOD, CERAMIC, ETC
3	KAWO, KADUNA NORTH	ANIMAL WASTES, DOMESTIC WASTES, ELECTRONIC WASTES, FOOD WASTES, WOOD, CERAMIC, ETC
4	HAYIN DAN MANI, RIGACHIKUN	ANIMAL WASTES, DOMESTIC WASTES, ELECTRONIC WASTES, FOOD WASTES, WOOD, CERAMIC, ETC
5	KAKURI, KADUNA SOUTH	ELECTRONIC WASTES, INDUSTRIAL WASTES, ANIMAL WASTES, DOMESTIC WATES, FOOD, CERAMIC, WOOD SHAVINGS,

MATERIALS AND METHODOLOGY

In this research, the IM-3000 meter was used. The IM-3000 is a versatile gamma radiation detector designed for a wide range of applications involving the detection of abnormal or elevated radiation levels. It could also be used to determine background radiation of a place and it has exposure rate from 0.05 μSv/hr to 10Sv/hr, 5 μSv/hr to 1 KR/hr, dose rate 0.01 μSv to 10 Sv, 1 μR to 1 KR, dose.

The IM-3000 is compact, light weight and water proof. Its performance is versatile and it has a user friendly interface. Because of its portability, this makes the device perfectly suitable for monitoring and detection of radiological hazards.

The various radiation values corresponding to distance (5 m to 30 m) were measured using the measuring tape at five different locations in the morning, afternoon and evening using the IM-3000 meter. The meter was placed at a height of 1.5 m above the ground in each case. Also, three radiation values/readings were measured and recorded after one minute for each distance from the source of radiation and the mean radiation was calculated for accuracy.

RESULTS AND DISCUSSION

Table 2: RADIATION MEASUREMENT FOR SABON TASHA

Distance (meter)	**Morning** (µSv/h)	**Afternoon** (µSv/h)	**Evening** (µSv/h)
5	0.29	0.29	0.25
10	0.25	0.27	0.24
15	0.23	0.25	0.23
20	0.23	0.23	0.21
25	0.20	0.20	0.20
30	0.19	0.19	0.17

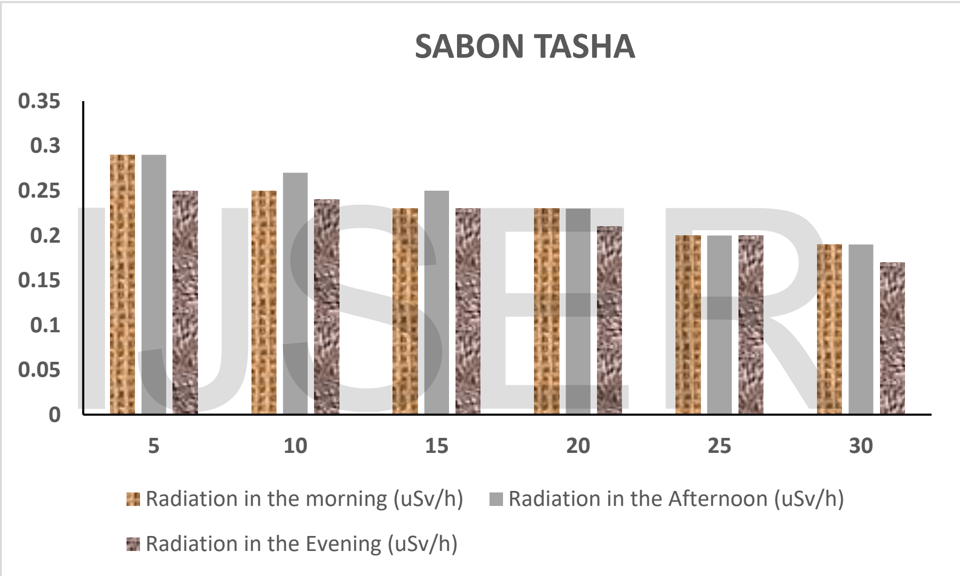

Figure 2:Radiation measurement of dumpsite at Sabon Tasha

Table 3: RADIATION MEASUREMENTS FOR TUDUN WADA

Distance (meter)	**Morning** (μSv/h)	**Afternoon** (μSv/h)	**Evening** (μSv/h)
5	0.22	0.24	0.22
10	0.19	0.21	0.18
15	0.17	0.2	0.17
20	0.14	0.18	0.16
25	0.12	0.16	0.15
30	0.11	0.14	0.13

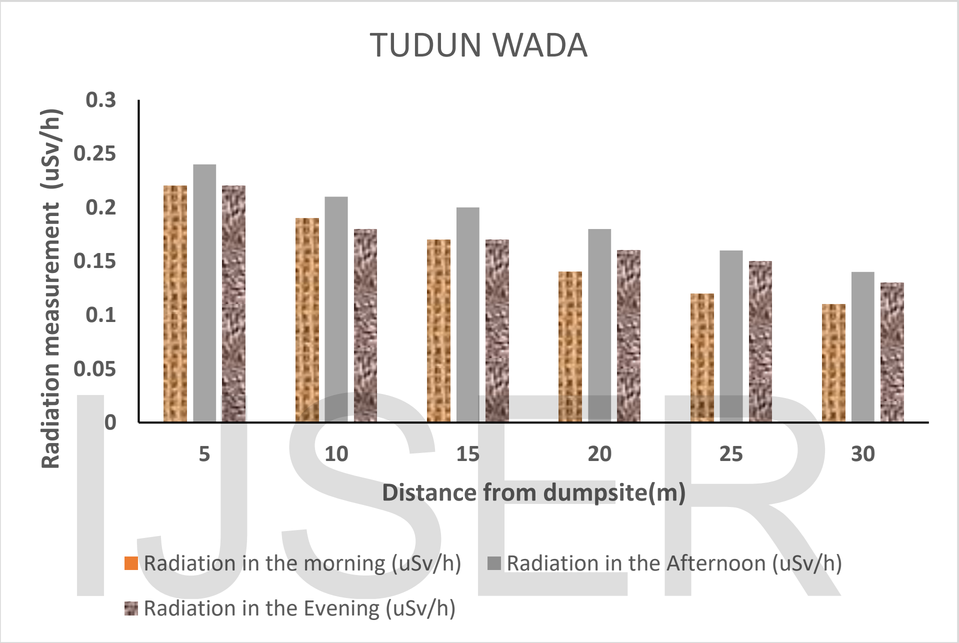

Figure 3: Radiation measurement of dumpsite at Tudun Wada

Table 4: RADIATION MEASUREMENT FOR KAWO

Distance (meter)	**Morning** (µSv/h)	**Afternoon** (µSv/h)	**Evening** (µSv/h)
5	0.25	0.24	0.22
10	0.26	0.22	0.21
15	0.25	0.21	0.2
20	0.24	0.21	0.18
25	0.22	0.20	0.16
30	0.19	0.17	0.15

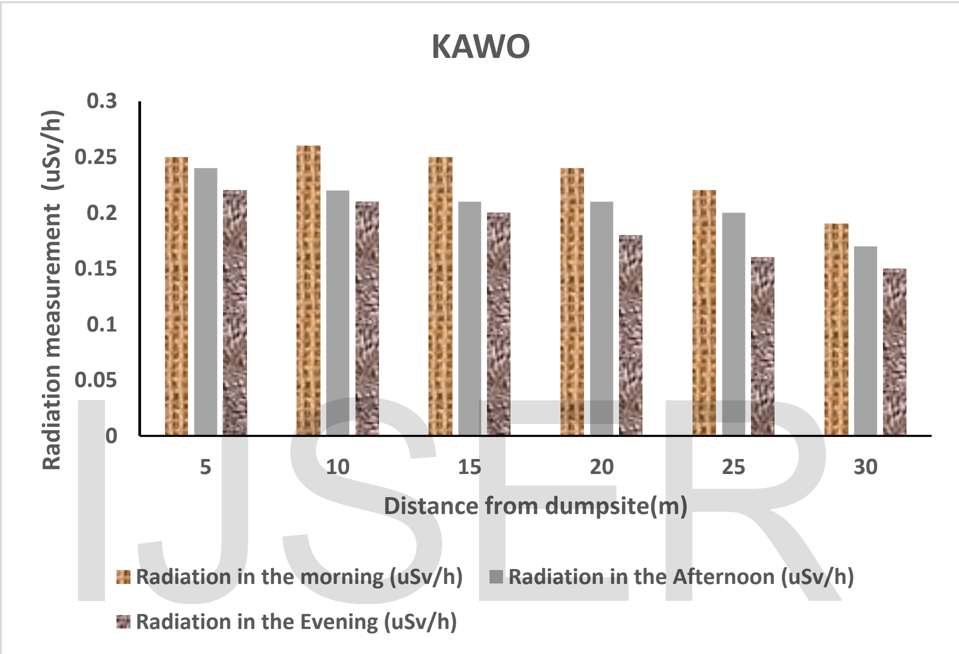

Figure 4: Radiation measurement of dumpsite at Kawo

Table 5: RADIATION MEASUREMENT FOR HAYIN DAN MANI

Distance (meter)	**Morning** (µSv/h)	**Afternoon** (µSv/h)	**Evening** (µSv/h)
5	0.23	0.24	0.26
10	0.17	0.22	0.19
15	0.18	0.22	0.17
20	0.15	0.2	0.19
25	0.15	0.17	0.16
30	0.13	0.16	0.14

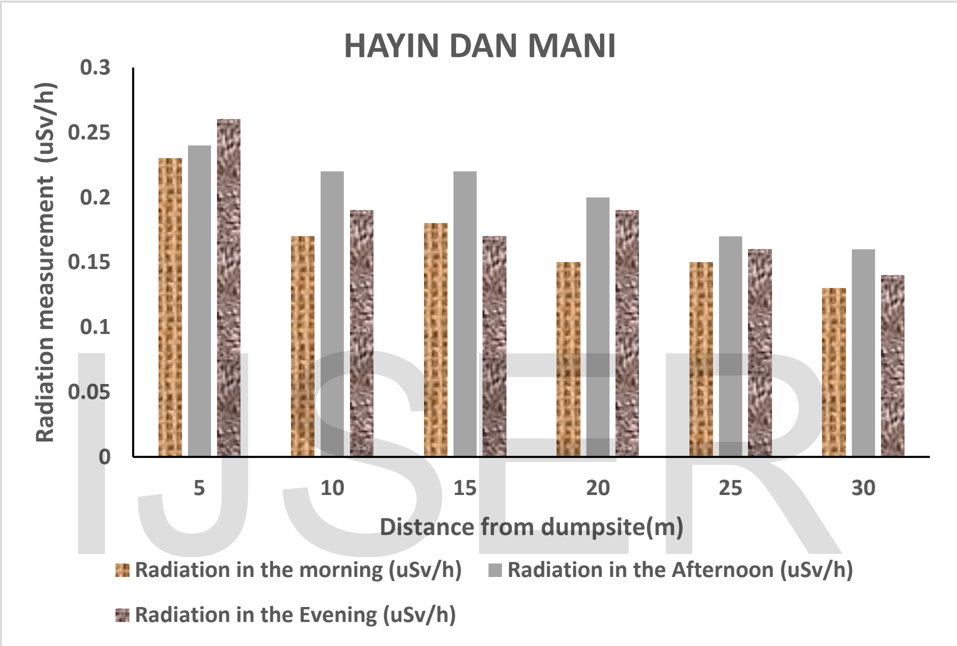

Figure 5: Radiation measurement at Hayin Dan Mani Dumpsite

Table 6: RADIATION MEASUREMENT FOR KAKURI

Distance (meter)	**Morning** (µSv/h)	**Afternoon** (µSv/h)	**Evening** (µSv/h)
5	0.3	0.35	0.33
10	0.3	0.32	0.32
15	0.29	0.29	0.28
20	0.26	0.25	0.24
25	0.24	0.22	0.21
30	0.19	0.18	0.18

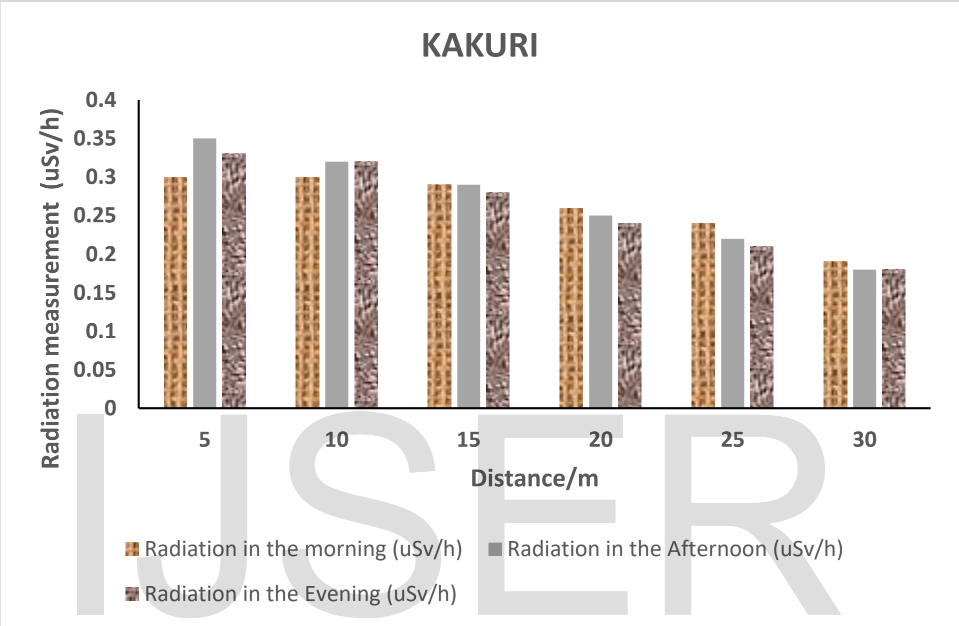

Figure 6: Radiation measurement of dumpsite at Kakuri

RESULTS AND DISCUSSION

The values of the radiation obtained in the morning, afternoon and evening for the five sites named are recorded in Tables 2 to 6. These values are in µSv/h. Therefore the average radiation in the morning, afternoon and evening for each site is obtained by adding the individual radiations obtained and dividing by the number of readings recorded.

The detection of the level of ionizing radiations was successfully achieved using the IM-3000 meter. Data were collected from various sites and using these data, graphs of radiation (µSv/h) against distance(m) were plotted for each of the sites. An average radiation was determined for each site.

Consequently, average radiation per day and average radiation per year were calculated in milli Rem, (mRem) and Rems.

The international commission on Radiological Protection (KRP) has recommended certain Maximum Permissible Exposure (MPE) to radiations that are believed to result in no appreciable injury to persons. The ICRP requires that, the maximum recommended dose of radiation should not exceed 5,000 m Rem per year which is equivalent to 5 Rem per year for radiation workers and 200 mRem per year which is equivalent to 0.2 Rem per year for non-radiation workers (Hay and Hughes, 1978).

It is observed that, the detected level of radiation in the study sites are 0.231 ± 0.2 Rem/yr, 0.149 ± 0.4 Rem/yr, 0.179 ± 0.3 Rem/yr, 0.163 ± 0.5 Rem/yr and 0.232 ± 0.3 Rem/yr for Sabon Tasha, Tudun Wada, Kawo, Hayin DanMani and Kakuri respectively.

Comparing these values of detected levels of radiation in sites Tudun Wada, Kawo and Hayin DanMani do not exceed the recommended level of radiation for both radiation workers and non-radiation workers and hence, there sites are safe. But, on the other hand, sites Sabon Tasha and Kakuri do not exceed the recommended radiation level for radiation workers but exceed that of residents along the dumpsites.

It is worth noting that these sites are exposed to the general public who are non radiation workers. These are the people that have no knowledge of the effects of radiation on human beings. Therefore, there is urgent need to evaluate the refuse in the sites to avoid the effect they may cause.

CONCLUSION

The average level of radiation for sites, Sabon Tasha, Tudun Wada, Kawo, Hayin DanMani and Kakuri are 0.231rem/yr, 0.149rem/yr, 0.179rem/yr, 0.163rem/yr and 0.232 rem/yr respectively.

The level of radiations from sites Tudun Wada, Kawo and Hayin DanMani are safe for both radiation and non-radiation workers as they met the ICRP standard of radiation while those of Sabon Tasha and Kakuri are safe for radiation workers (< 5 Rem/yr) but not safe non-radiation workers (> 0.2 Rem/yr).

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