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Measurement of Radiation of Refuse Dumpsites in Some Selected Areas of Kaduna State, 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 six dumpsites were investigated out of which four met the minimum required radiation dose for both radiation workers and non radiation workers. Radiation measurement was carried out with the RADEX 1503 meter placed at 1.80m high above the ground with varying distances. The average level of radiation for sites, A, B, C, D, E and F are 0.149 Rem/h, 0.162 Rem/h, 0.198 Rem/h, 0.229 Rem/h, 0.215 Rem/h and 0.239 Rem/h respectively.***

Keywords--- Radiation, Dumpsite, Radioactivity, Beta

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1. INTRODUCTION

Environmental pollution is one of the greatest problems the world is facing today. The indiscriminate waste dump causes soil pollution which can lead to unstable and wasteful utilization of resources given rise to dwindling wildlife, more land degradation and increasing generation and indiscriminate disposal of commercial, industrial and domestic wastes (Phiri *et al.*, 2005).

The air and water in area closed to these dumpsites are contaminated, hence aerobic respiration becomes difficult for living creatures and water becomes scarce for drinking. Soil pollution is the misuse of land in a way which makes it unfit for man's future needs, such as growth of food or construction of buildings.

Industrial and domestic wastes contain various substances which includes radioactive material result from the processing chemicals. Also, the remnants from staple food contain traces of radioactive materials or contaminants. The disposal of these refuse dumps without adequate management, particularly the radioactive contaminants expose the populace to the radiation hazard.

In 1896, Henri Becquerel accidentally discovered that wrangle potassium sulfate crystals and an invisible radiation that can darken a photograph plate when the plate is covered to exclude light.

After a series of experiments, he concluded that the radiation emitted by the crystals was of a new type; one that requires no external stimulation and was so penetrating that it could darken protected photographic plates and ionize gases. This process of spontaneous emission of radiation by uranium was soon to be called radioactivity.

Radioactivity

We have two types of radioactivity: natural and artificial radioactivity

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 (α, β and γ). 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.

When a radioactive element undergoes radioactive decay, it may emit either α particle or γ - rays. This change the atomic number of the elements, hence a new element is formed. For example, radium – 226 decays by emitting an α - particle to turn into new element called radon. Radium – 226 has a mass number 226 and an atomic number of 88 and hence it is denoted by $^{226}_{88}Ra$. The α - particle it emits is a helium nucleus denoted by $^{4}_{2}He$. So when radium 226 emits an α - particle, we can write nuclear equation as

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

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:

$$^{4}_{2}He + ^{14}_{7}N \rightarrow ^{18}_{9}F \rightarrow ^{17}_{8}O + ^{1}_{1}H + \text{Energy} \qquad 2$$

2. 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. 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. 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. 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.

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

It has been prepared by the International Atomic Energy Agency (IAEA) in corporation with the national radiological protection board (United Kingdom) as a board over-view of the subject of ionizing radiation, it effects and uses, as well as the measures in place to use it safely.

As the United nation agency for nuclear science and it peaceful application, the IAEA offer a broad spectrum of expertise and programmes to foster the safe use of radiation internationally. It has statutory responsibility for the development of safety standards that are put in place to manage the wide variety of application that use Radiation. It provides assistance to its member states on the application of those standards through training courses and advisory services. It also facilitates information exchanging through conferences and publications.

When ionizing radiations pass through matter, they may interact with whole atoms, electrons or neutrons. In this case, the radiations can be referred to as incident particles or photons and the particles with which they interact are usually described as target particles. The interaction process is often described as a collision as many interactions involve long range forces, such as electrostatic force that do not require close contact, with these reservations, however, the interaction may be regarded as collision between the incident and the target particles.

Measurement Sites

Kaduna State was created on the 27th May, 1976, it lies on latitude ($9^{O}03^{l}$N and $11^{O}32^{l}$N) of the equator and longitude ($6^{O}05^{l}$E and $8^{O}38^{l}$E) 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, Kaduna, Nassarawa, Bauchi and FCT to the south. The map of Kaduna State indicating the studied sites is shown in figure 1.1 below.

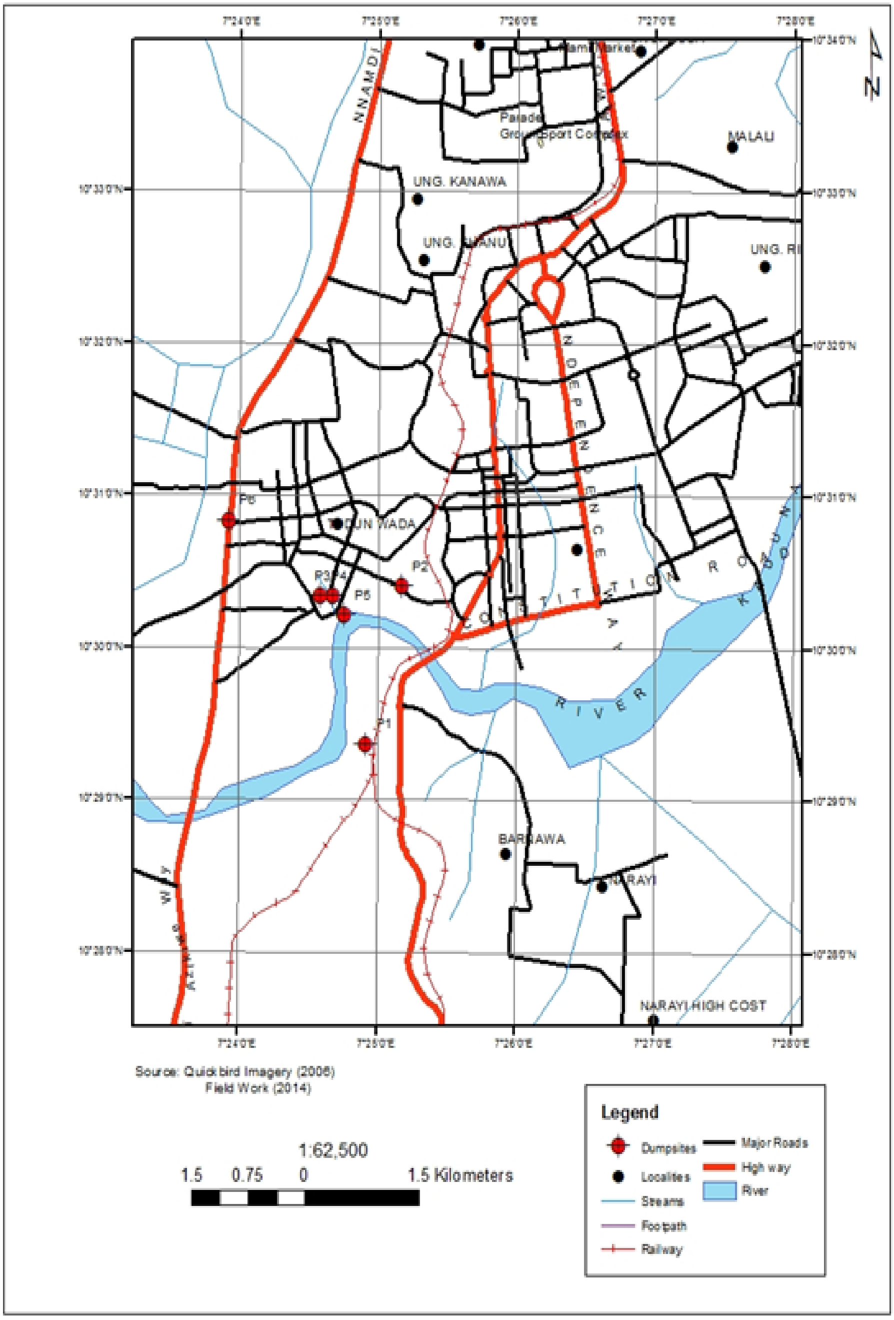

Fig 1.1: Map of Kaduna metropolis showing the dumpsites

3. 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 (Quindos *et al.*, 1994).

The radiation originates from the action of stars, which are vast nuclear reactors. It is the direct result of the action of the sun (such as neutrino, pion, meson). Cosmo-genic radionuclide arises from the collision of highly energetic cosmic ray particles with stable element like Geiger-Muller, Radex Meter, Gas-filled detector, scintillation detectors and the semiconductor detectors could be used to measure these radiations.

However, in this project, the RADEX 1503 meter was used. The RADEX 1503 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 RADEX 1503 is compact, light weight and water proofed. Its performance and its user friendly interface make it the perfectly suitable device for monitoring and detections of radiological hazards. The device is portable and economically cost effective.

4. MATERIALS USED

The materials used in carrying out the practical are as follows:

i. RADEX 1503 meter
ii. Measuring tape
iii. Stop watch

The figure 3.1 below show the pictures of the above mentioned instruments used in carrying out the practical.

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The various radiation values corresponding to distance (5 m to 30 m) were measured using the measuring tape at six different locations in the morning, afternoon and evening using the RADEX 1503 meter. The meter was placed at a height of 1.5 m above the ground in each case. Also, two 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.

5. RESULTS AND ANALYSIS

From the measurements carried out at the study areas, values of ionizing radiations were obtained at different locations for different time intervals in the morning, after and evening.

SITE A (ASABA ROAD, KAKURI, KADUNA)

For distances 5 m to 30 m, the values of radiations in μSv/h were obtained in the morning, afternoon and evening.

In the morning, the radiation values varies from 0.11 μSv/h to 0.22 μSv/h, in the afternoon, the radiation values varies from 0.14 μSv/h to 0.24 μSv/h while that of the evening varies from 0.13 μSv/h to 0.22 μSv/h. Table 4.1 shows the radiation values obtained in the morning, afternoon and evening for this site while fig 1 shows a plot of Radiation (μSv/h) against Distance (m) for the site.

TABLE 4.1: RADIATION VALUES FOR SITE A

S/N	Distance (meter)	Radiation in the Morning (μSv/h)	Radiation in the Afternoon (μSv/h)	Radiation in the Evening (μSv/h)
1.	5	0.22	0.24	0.22
2.	10	0.19	0.21	0.18
3.	15	0.17	0.20	0.17
4.	20	0.14	0.18	0.16
5.	25	0.12	0.16	0.15
6.	30	0.11	0.14	0.13

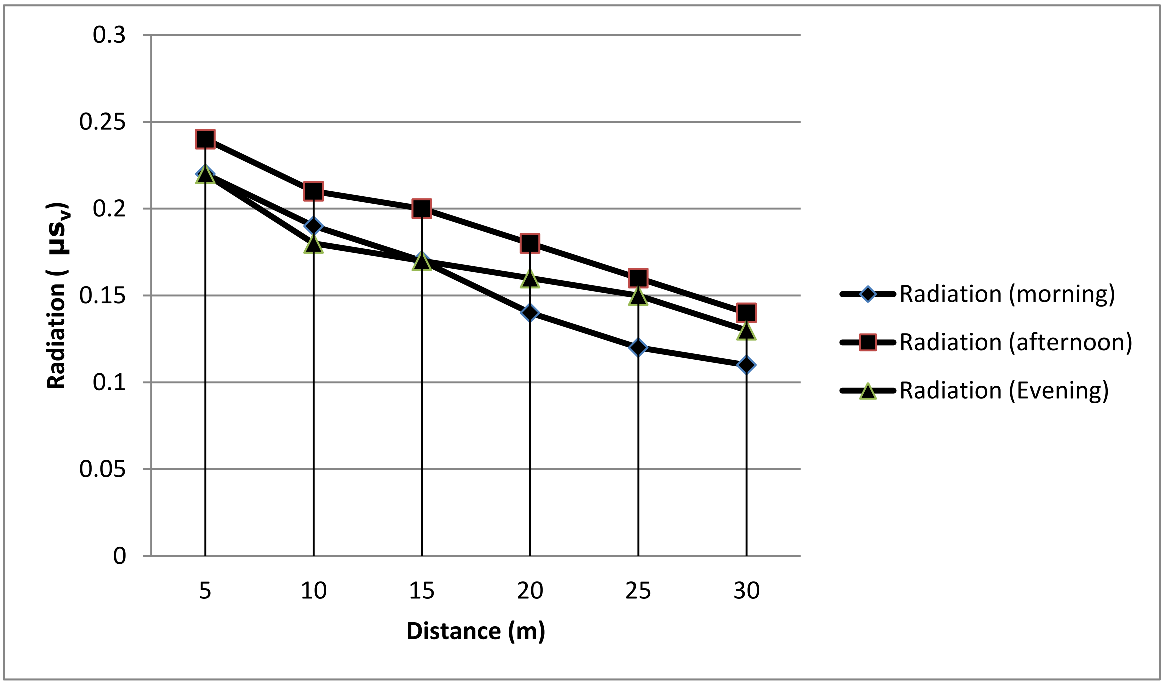

Fig.2: Plot of Radiation (μSv/h) against Distance (m) for site A

SITE B (BASHAMA ROAD, TUDUN WADA, KADUNA)

The values of radiations for distances 5 m to 30 m were obtained in the morning, afternoon and evening. In the morning, the radiation varies from 0.12 μSv/h to 0.23 μSv/h while in the afternoon, it varies from 0.15 μSv/h to 0.26 μSv/h values of radiation in the evening varies from 0.13 μSv/h to 0.24 μSv/h. The various radiation values obtained in the morning, afternoon and evening for this site are shown in fig. 2, that is, a plot of Radiation (μSv/h) against Distance (m) obtained in the site.

TABLE 4.2: RADIATION VALUES FOR SITE B

S/N	Distance (meter)	Radiation in the Morning (μSv/h)	Radiation in the Afternoon (μSv/h)	Radiation in the Evening (μSv/h)
1.	5	0.23	0.26	0.24
2.	10	0.21	0.24	0.22
3.	15	0.18	0.22	0.19
4.	20	0.16	0.19	0.18
5.	25	0.13	0.17	0.14
6.	30	0.12	0.15	0.13

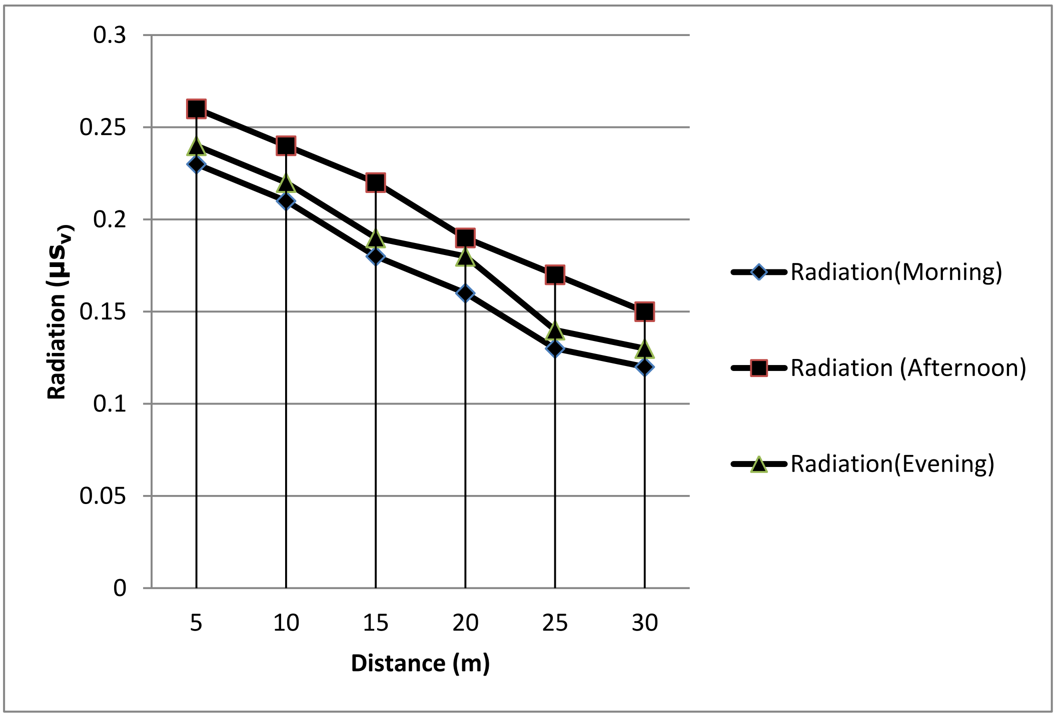

Fig 3: Plot of Radiation (µSv/h) against Distance (m) for site B

SITE C (MASHI ROAD, TUDUN WADA, KADUNA

The values of radiations for distances 5 m to 30 m were obtained in the morning, afternoon and evening. In the morning, the radiation varies from 0.16 µSv/h to 0.26 µSv/h while in the afternoon, it varies from 0.185 µSv/h to 0.30 µSv/h values of radiation in the evening varies from 0.17 µSv/h to 0.28 µSv/h. The various radiation values obtained in the morning, afternoon and evening for site C are shown in fig.4.

TABLE 4.3: RADIATION VALUES FOR SITE C

S/N	**Distance (meter)**	**Radiation in the Morning (µSv/h)**	**Radiation in the Afternoon (µSv/h)**	**Radiation in the Evening (µSv/h)**
1.	5	0.26	0.30	0.28
2.	10	0.25	0.265	0.26
3.	15	0.235	0.24	0.255
4.	20	0.20	0.225	0.21
5.	25	0.19	0.205	0.20
6.	30	0.16	0.185	0.17

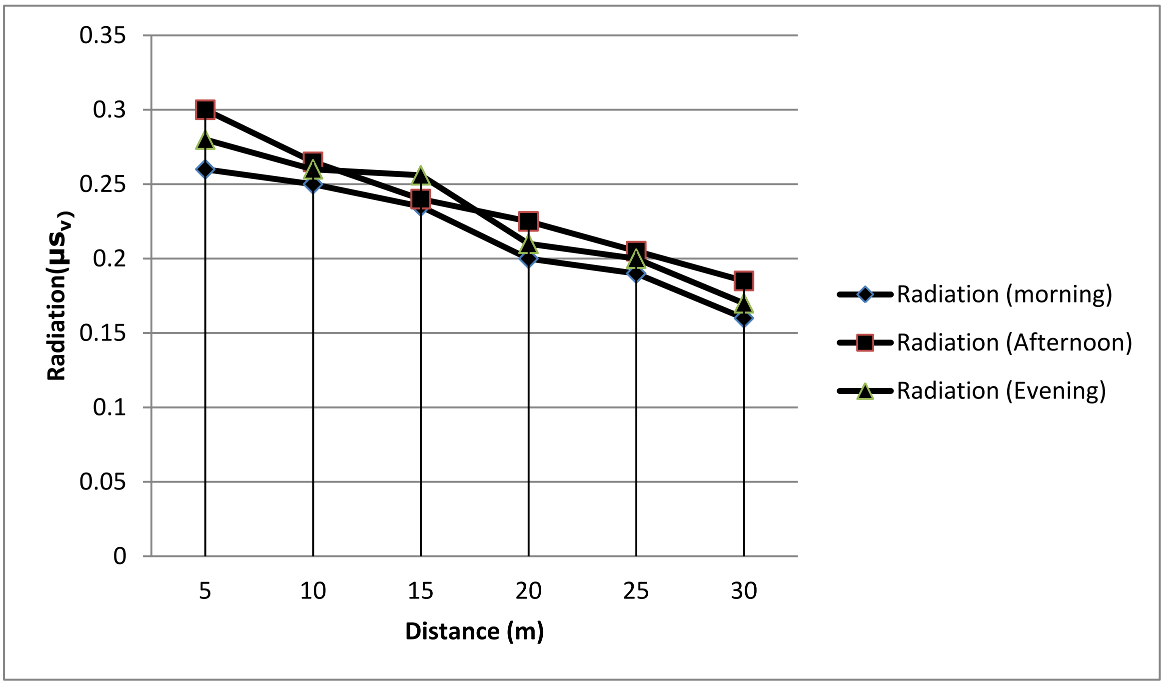

Fig.4: Plot of Radiation (μSv/h) against Distance (m) obtained in site C

SITE D (MASHI ROAD, TUDUN WADA, KADUNA)

The various values of radiations for distances, 5 m to 30 m were obtained in the morning, afternoon and evening for this site. In case of the morning, the radiation varies from 0.20 μSv/h to 0.29 μSv/h in the afternoon, it varies from 0.22 μSv/h to 0.35 μSv/h while that of evening varies from 0.20 μSv/h to 0.32 μSv/h. Table 4.4 shows the various radiation values obtained for site D in the morning, afternoon and evening while fig.4.4 Shows a plot of Radiation (μSv/h) against distance (m) obtained in site D.

TABLE 4.4: RADIATION VALUES FOR SITE D

S/N	Distance (meter)	Radiation in the Morning (μSv/h)	Radiation in the Afternoon (μSv/h)	Radiation in the Evening (μSv/h)
1.	5	0.29	0.35	0.32
2.	10	0.27	0.33	0.30
3.	15	0.25	0.30	0.26
4.	20	0.23	0.27	0.23
5.	25	0.22	0.24	0.21
6.	30	0.20	0.22	0.20

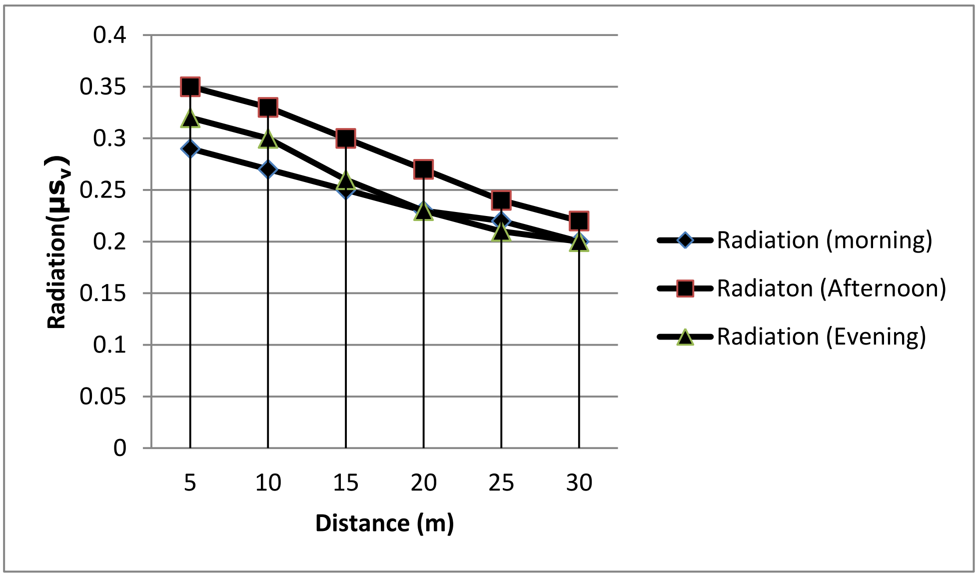

Fig.5: Plot of Radiation (μSv/h) against Distance (m) obtained in site D.

SITE E (KANKARA ROAD, TUDUN WADA, KADUNA)

Radiation values for various distances, 5 m to 30 m were obtained in the morning, afternoon and evening for this site. Morning radiation values vary from 0.19 μSv/h to 0.28 μSv/h while those of afternoon and evening vary from 0.215 μSv/h to 0.33μSv/h and from 0.202 μSv/h to 0.295 μSv/h respectively..

TABLE 4.5: RADIATION VALUES FOR SITE E

S/N	**Distance (meter)**	**Radiation in the Morning (μSv/h)**	**Radiation in the Afternoon (μSv/h)**	**Radiation in the Evening (μSv/h)**
1.	5	0.28	0.33	0.295
2.	10	0.255	0.295	0.27
3.	15	0.245	0.27	0.255
4.	20	0.21	0.245	0.235
5.	25	0.205	0.22	0.21
6.	30	0.19	0.215	0.205

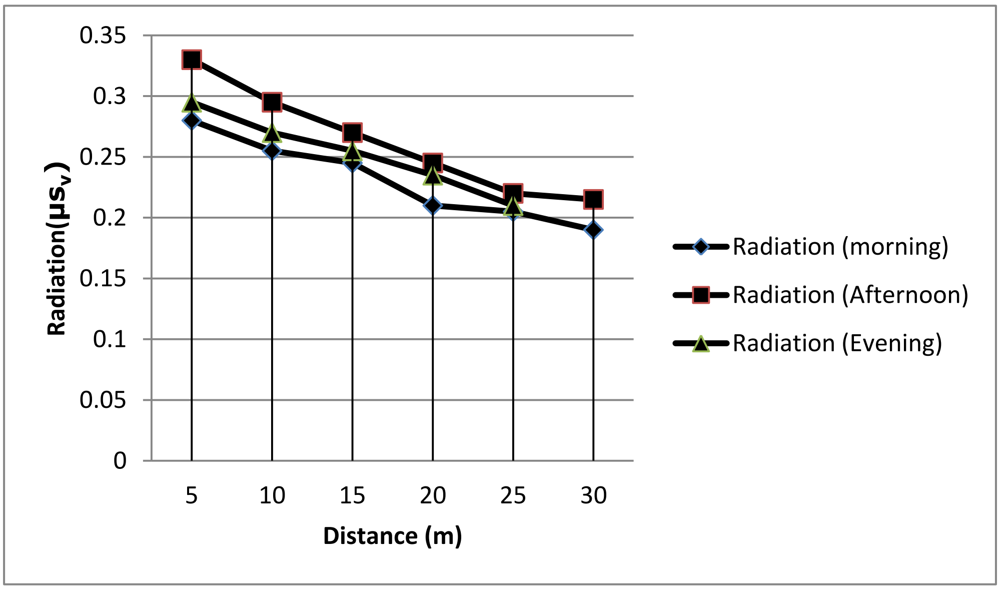

Fig.6: Plot of Radiation (μSv/h) against Distance (m) obtained in site E

SITE F (DUTSI MMA ROAD, TUDUN WADA, KADUNA)

As done for previous sites, morning, afternoon and evening radiations were obtained for this site. Morning radiation varies from 0.195 μSv/h to 0.29 μSv/h while afternoon radiation varies from 0.23μSv/h to 0.38 μSv/h. Evening radiation varies from 0.202 μSv/h to 0.33 μSv/h. Table 4.6 shows radiation values obtained in the morning, afternoon and evening for site F while fig 6 shows a plot of Radiation (μSv/h) against Distance (m) obtained in site F.

TABLE 4.6: RADIATION VALUES FOR SITE F

S/N	**Distance (meter)**	**Radiation in the Morning (μSv/h)**	**Radiation in the Afternoon (μSv/h)**	**Radiation in the Evening (μSv/h)**
1.	5	0.29	0.38	0.33
2.	10	0.275	0.35	0.31
3.	15	0.25	0.30	0.30
4.	20	0.235	0.27	0.285
5.	25	0.22	0.26	0.24
6.	30	0.195	0.23	0.20

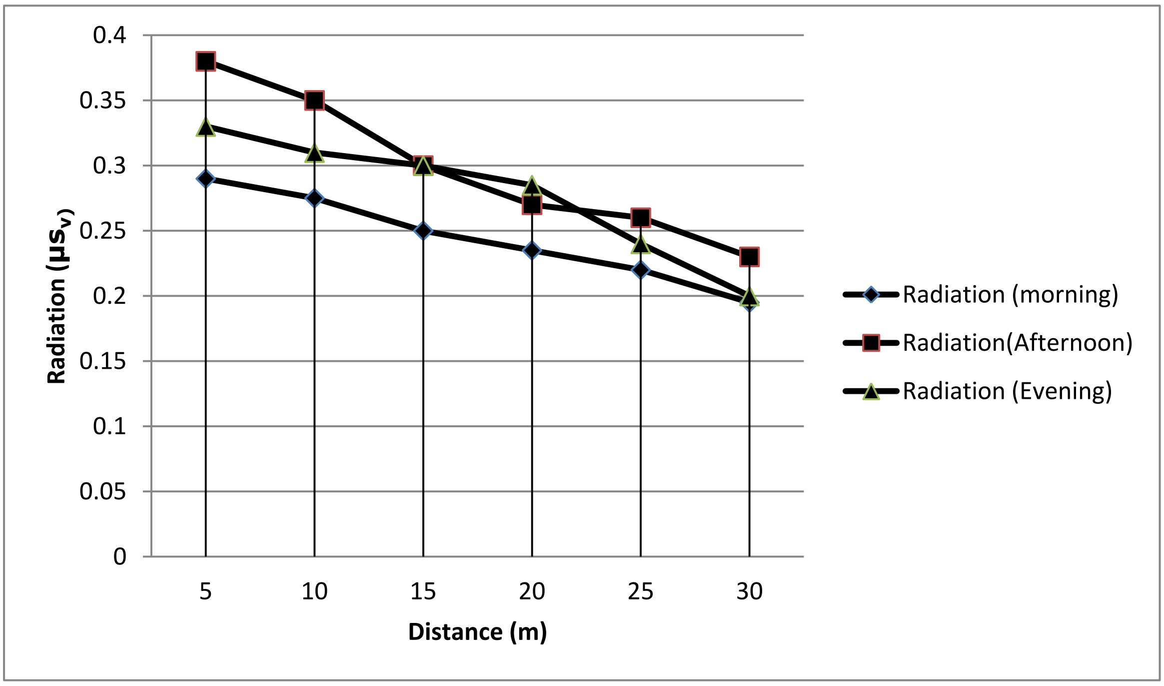

Fig.7: Plot of Radiation (μSv/h) against Distance (m) obtained in site F

6. DATA INTERPRETATION AND DISCUSSION

The values of the radiation obtained in the morning, afternoon and evening for sites named A, B, C, D, E and F are recorded in tables 4.1 to 4.6. 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 RADEX 1503 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 A, B, C, D, E and F. 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 done of radiations 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 (Muragashan, 2007).

It is observed that, the detected level of radiation in the study sites are 0.149 Rem/h, 0.162 Rem/h, 0.198 Rem/h, 0.229 Rem/h, 0.215 Rem/h and 0.239 Rem/h respectively.

Comparing these values of detected levels of radiation in sites A, B, and C 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 D, E and F do not exceed the recommended radiation level for radiation workers but exceed that of non-radiation workers.

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.

7. CONCLUSION

The average level of radiation for sites, A, B, C, D, E and F were found to be 0.149 Rem/h, 0.162 Rem/h, 0.198 Rem/h, 0.229 Rem/h, 0.215 Rem/h and 0.239 Rem/h respectively. The level of radiations from sites A, B and C are safe for both radiation and non-radiation workers as they met the ICRP standard of radiation while those of sites D, E, and F are safe for radiation workers (< 5 Rem/h) but not safe non-radiation workers (> 0.2 Rem/h). The average level of radiation for sites, A, B, C, D, E and F were found to be 0.149 Rem/h, 0.162 Rem/h, 0.198 Rem/h, 0.229 Rem/h, 0.215 Rem/h and 0.239 Rem/h respectively.

The average level of radiation for sites, A, B, C, D, E and F were found to be 0.149 Rem/h, 0.162 Rem/h, 0.198 Rem/h, 0.229 Rem/h, 0.215 Rem/h and 0.239 Rem/h respectively.

8. REFERENCES

- Ari, L. H. (1986). Conversion table of Units and Engineering (P. 125 – 128), Non-Division, Runcorn Cheshire Press.
- Bethesda, M. D. (1989). NCRP Report No. 98 guidance on radiation received in space activities.
- Hay, G. and Highes, D. (1978). First year Physics for Radiographers, (2nd Edition), Brilliere Tindall Publishers, London P. 245.
- ICRP Publication (1990). Recommendation of the International commission on Radiation Protection Vol. 21.
- John, M. W. (2002). The Molecular Chemistry P. 42, 920-921. Journal of Science Research Vol. 7, No.1, 2007.
- Keffer, J. (1990). Radiation Biology, (P. 62 -67), Humbug University Press.
- Paul, A. and Tripler, G. M. (2004). Physics for Scientist and Engineers, 5th Edition. Susan Frennimore Brennan.
- Radiation Exposure Conversion (2002). Retrieved on 4th of April, 2012 from; www.unitonverter.org at 2:45pm.
- Semart, H. (1973). Fundamental Physics, P 189 – 190, London Holt Rinehart Publishers.
- Tait, W. H. (1980). Radiation Detection, P 109 – 158 United Kingdom Butter Worth and Com. Publishers Ltd.
- www.search EHS website open source radiation safety training, module 2: Background and other sources of exposure. Princeton University.