POWER SPECTRUM ANALYSIS OF RADIATION LEVELS AND HEAVY METALS OF SELECTED DUMPSITES IN MAKURDI METROPOLIS, BENUE STATE

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ABSTRACT

Radiation levels and heavy metals concentration from some selected dumpsite were measured in view to identify its effect on humans and the environment in Makurdi metropolis. These were carried out using radiation alert inspector. Heavy metals concentration of Chromium, Manganese, Iron, Copper and Lead from the soil samples of the dump sites was analysed using a AA-700 Dual Atomizer Atomic Absorption Spectrophotometer. Results obtained reveal that, the radiation level from the various dumpsites ranged between a maximum value of 7mSv at 6 minutes and a minimum value of 4mSv at 9 minutes, which is lower than the recommended safety limit of 15mSv as stipulated by the International Commission on Radiological Protection. With this, there is no immediate health hazard on those living around the dumpsites but if not controlled and precautions taken, adverse health effect may occur. Heavy metal analysis in these dumpsites show that Iron has the highest Mean Concentration while Chromium has the lowest Mean Concentration. However, the Concentration of Copper was higher than the safety limit stipulated by EU, UK and NESREA. High concentration of Copper could lead to health effects such as vomiting, diarrhoea and lung failure.

Keywords: Radiation emission, Heavy metal analysis, Dumpsites Makurdi.

INTRODUCTION

Dumpsites growth on a daily basis in developing towns or cities because of disposal of wastes, which has led to pollution on both the environment and humans. These environmental effects come in different forms such as unpleasant odour or various diseases causing micro-organisms (Ojoawo *et al.*, 2011). Waste can be defined as the left over, used products, whether liquids or solids having no economic value or demand which must be disposed or thrown away. Vegetation and environmental open fields in Nigeria contain traces of radionuclides.

It is therefore of great importance to measure the levels of different components of radiation present in the environment at a given time. Farm soils, quary sites, rivers, wells, boreholes industries and mechanic workshops are potential sources where radiation levels emanate (Jibiri *et al*., 2011; Odunaike *et al*., 2008; Farai and Oni, 2002; Iyang *et al*., 2009).

A research by Jibiri *et al.* (2007) reports that staple foodstuffs consumed in Nigeria also contains traces of radionuclides. The dumping of large amount of waste materials in sites without adequate soil protection measures, results in ground water pollution (Avwiri *et al*., 2011). Dumpsite contain a mixture of waste which range from agricultural, chemical, toxic, medical, metal scraps and domestic waste. Alpha rays, Beta rays and Gamma rays are the basic emission because of radiation from dumpsites. Most dumpsite soils in Eastern Nigeria as in other parts of the country are extensively used for cultivating varieties of edible vegetables and plant-based foodstuff without proper routine assessment of the associated health and ecological risks (Obasi*et al.*, 2012). This practice is scientifically unacceptable in this errand as such, there is need for proper assessment of dumpsite waste soils to ensure environmental sustainability.

MATERIALS AND METHOD

The spectrum analysis of radiation levels and heavy metals of dumpsite soil was carried out using Radiation alert inspector with a detector connected to it (AA-700 Dual Atomizer Atomic Absorption Spectrophotometer). Some of the key materials used in this research includes sample of chaffs (from grinding engines), soil samples, filter paper, 25ml of 2mole Hydrochloric Acid (HCL), sample divider, 210mm micro sieve and desiccator.

Radiation Measurement

Radiation was measured using a radiation alert inspector placed 2m above the ground with the detector facing down and readings taken at 60 seconds interval for 1 hour.

Average values of the radiation measurement were used to carry out spectral analysis using cubic spin interpolation to determine the emission rate given as

(Kiusalaas, 2010).

$$k_{i-1}(x_{i-1}-x_i)+2k_i(x_{i-1}-x_{i+1})+k_{i+1}(x_i-x_{i+1}) = 6\left(\frac{y_{i-1}-y_i}{x_{i-1}-x_i}-\frac{y_i-y_{i+1}}{x_i-x_{i+1}}\right) \quad (1)$$

$$i = 1, 2, 3, \dots, n-1$$

with k(a) = k(b) = 0, since a and b are the extreme points for a natural spline. If the data points are equally spaced at intervals h, then $x_{i-1} - x_i = x_i - x_{i+1} = -h$, and hence equation (1) simplifies to (Kiusalaas, 2010).

$$k_{i-1}+4k_i+k_{i+1}=\frac{6}{h^2}(y_{i-1}-2y_i+y_{i+1}),$$
$$i = 2, 3, \dots, n-1 \quad (2)$$

For $x \in (i, i+1)$, the spline interpolating function, $f_{i,i+1}(x)$ is given by (Kiusalaas, 2010):

$$f_{i,i+1}(x)=\frac{k_i}{6}\left[\frac{(x-x_{i+1})^3}{x_i-x_{i+1}}-(x-x_{i+1})(x_i-x_{i+1})\right]-\frac{k_{i+1}}{6}\left[\frac{(x-x_i)^3}{x_i-x_{i+1}}-(x-x_i)(x_i-x_{i+1})\right]+\frac{y_i(x-x_{i+1})-y_{i+1}(x-x_i)_{i+1}}{x_i-x_{i+1}} \quad (3)$$

Equations (2) and (3) are used for the implementation of cubic splines interpolation and are implemented using the 'Spline' function in MATLAB. The results were further converted to mSv/year using 1cps = 0.01

$$D = \partial \times \mu \times k \times 60 \times 1 \quad (4)$$

where ∂ is the absorbed dose in Gyh, μ is 0.2 – the occupancy factor and K is 0.7 – the conversion factor.

Heavy Metal Analysis

Surface samples were collected from four different dumpsites. The samples were sieved to remove stones and dried in an oven for about 2-3 hours at 150^0C to remove moisture. After one hour of cooling, the soil samples were grinded into fine powder. 5g of each sieved sample was weighed and packed in a transparent plastic container and sealed for 30days before analysis.

Determination of Heavy Metals

The gross sample was divided using a sample divider in stages to a small analysis sample representative of the original gross sample (5g). It was transferred into an air-tight glass bottle and 25ml of 2 mole Hydrochloric Acid (HCl) was added into airtight bottle for digestion. The bottle was inserted into an oven at 105^0C for two hours after which the bottle was removed from the oven and allowed to cool with the aid of a dessicator. The content of the bottle was then transferred into another clean bottle with the aid of a filter paper. The filtrate was used for the analysis of Chromium, Lead, Iron, Copper and Manganese using AA-700 dual Atomizer Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Table 1: Mean Value of Radiation Measured from the Dumpsites

Dumpsites	First Mean Value (cps)	Second Mean Value (cps)
Bensasa	45.12±11.61	45.40±10.22
Chaffs	42.89±10.30	37.63±8.47
Mechanic	41.58±10.02	42.82±10.28
Saw dust	27.77±8.24	29.32±8.27

Spectral Analysis Graph Interpretation.

The results gotten from the radiation measured from the various points of measurement at the various dumpsites was used to carry out Cubic Splin Interpolation presented in Figures 1 to 3.

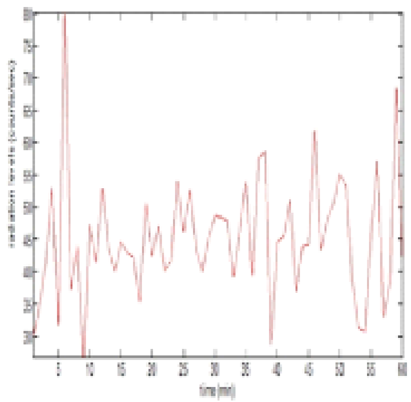

Figure 1: Raw data for the first point at BENSASA

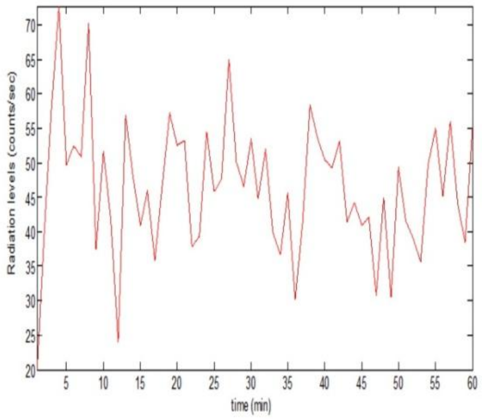

Figure 2: Raw data for the second point of BENSASA

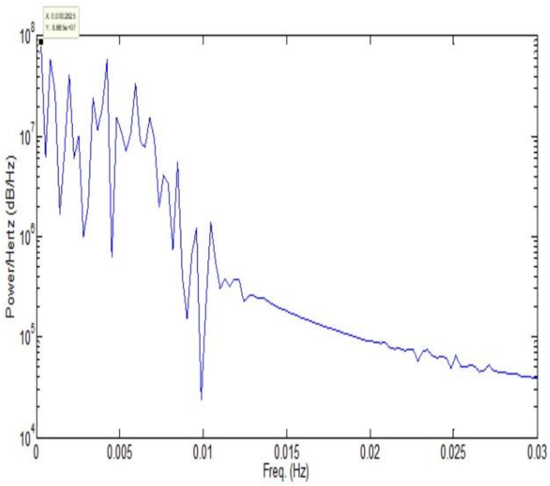

Figure 3: Power spectrum for chaffs dumpsite

The results obtained from the AA-700 Dual Atomizer Atomic Absorption Spectrophotometer (AAS) analysis of soil samples collected from four (4) different dumpsites in Makurdi, Benue State in milligram per liter(mg/l) is presented in Table 2.

Table 2: Concentration (mg/l) of metals in soil samples from four dumpsites in Makurdi

Sample	**Cr**	**Mn**	**Pb**	**Fe**	**Cu**
Metal	1.33	26.89	16.00	158.22	60.46
Bensasa	1.33	23.69	2.25	91.58	11.70
Wood	0.00	0.39	0.50	11.74	4.04
Grinding	1.33	3.40	0.50	130.09	2.97
MEAN	1.33	13.59	4.81	97.91	19.79

The metal concentration presented in Table 2 given in mg/l is then converted to milligram per kilogram (mg/kg) (Stumpf, *et al*. 2009)

$$\frac{DF}{m} x\, C \tag{5}$$

The concentration of the metals in the soil samples in milligram per kilogram (mg/kg) is presented in Table 3.

Table 3: Concentration (mg/kg) of Metals in Samples from four sites

Sample ID	**Cr**	**Mn**	**Pb**	**Fe**	**Cu**
Bensasa	18.52	329.03	31.25	1271.96	162.56
Chaffs	18.52	47.26	6.94	1806.89	41.31
Mechanic	0.00	373.59	222.22	2197.48	839.75
Saw Dust	18.52	5.40	6.94	163.03	56.13
MEAN	18.52	188.82	66.84	1359.84	274.94

The measured radiation from Figure 1 shows an average high emission rate of 7mSv at 6mins which could be as a result of high emitting radiation wastes like empty medians bottles; Dumpsite B results shows that the level of radiation decreases as time increases, which indicates that substances disposed have a short lifespan. Hence, there is no immediate effect on those residing or staying close to the dumpsite. It decreases at a rate of 4mSv in 9mins. Unlike the first and second site studied, the level of radiation increases as time increases, this could be because of high radiation emitting wastes that are disposed at the site (metal scrap, condemned oil, etc.). The distribution graph shows slow decrease of radiation as frequency increases, which could be as a result of absorption or decay of radioactive wastes into the soil. Emissions from the generating power source could have given rise to high emission rates, which leads to slight health disorders such as fatigue, headache and increase in heart heat.

Metal Concentration in soil

Chromium Mean Concentration obtained was below the EU standard limit of 180mg/kg in soil but was above the UK standard of 6.4mg/kg.

From the study carried out, Lead had high concentration on the site 3, this was as a result of waste containing high contents of Lead such as condemned battery etc. It's Mean Concentration was below EU and UK standard limit (300mg/kg and 70mg/kg) but was higher than the safety limit (1.6mg/kg) by NESREA.

Iron concentration in site 1 and 4 have higher concentrations level, this was as a result of the presence of metal particles, scraps, and worn out engine parts during grinding. This justifies the presence of heavy metals in staple food (Jibiri *et al*, 2007).

The Mean Concentration of copper is found to be above the standard limit of 140mg/kg, 63mg/kg and 70-80mg/kg in soil by EU, UK and NESREA. This trends to cause leaching of copper down from the soil profile, which affects ground water reserve.

CONCLUSION

This work reveals that, the radiation level from the various dumpsites ranged between a maximum value of 7mSv at 6 minutes and a minimum value of 4mSv at 9 minutes, which is lower than the recommended safety limit of 15mSv as stipulated by the International Commission on Radiological Protection. The results show there is no immediate health effect on those living around the dumpsites but if not controlled and precautions taken, adverse health effect may occur. Heavy metal analysis in these dumpsites show that Iron has the highest Mean Concentration while Chromium has the lowest Mean Concentration. The Concentration of Copper was higher than the safety limit stipulated by EU, UK and NESREA. High concentration of Copper could lead to health effects such as vomiting, diarrhoea and lung failure.

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