

Environmental Impact of Mpape Dumpsite Solid Waste on Soil Quality, Abuja Nigeria

Alkali Mohammed

Department of Environmental Management, Faculty of Environmental Sciences, Nasarawa State University, Keffi.

Abstract

This study examined the impact of dumpsite on soil and plant quality in Mpape, Abuja FCT. The study employed both transect and quadrant techniques in collecting soil and plant samples. The soil samples were taken in both rainy and dry season for three months each at the depth of 0-30cm using soil auger. A total of forty-eight soil sample and thirty- two plant samples were collected, totaling eighty samples in and around Mpape Dumpsite and taken to Abuja Environmental Protection Board (AEPB) laboratory in Asokoro Abuja and analyzed to determine the level of heavy metals which included lead, mercury, iron, cadmium, silver and copper, using standard measurements. The result from the laboratory analysis were subjected to statistical analysis using Analysis of Variance and paired sample t-test to determine the mean difference between the months, seasons and the mean difference between the heavy metals concentration and FEPA Limits. From the analysis there was high concentration of heavy meals in Mpape Dumpsite in both raining and dry season. Also, a substantial concentration of the heavy metal is found in the plant samples responsible for the retardation in growth in fruits from the selected plants analyzed.

Keywords: Environmental, Impact, Dumpsite, Soil, Quality, Waste.

Introduction

Global waste crisis, among other environmental issues, confronting mankind in both developed and developing countries threatens the assimilative and carrying capacity of the earth which is our life support system. This modern world functions as a throw-away society and the price for that is a growing problem of how to handle the waste that is generated as precious space for it is decreasing. The solution is not just reducing, recycling and composting but also a complete re-education of how we live (Blight and Mbande, 1996). Evidence abounds that as far back as 10,000 BC, human beings were involved in lid waste management. It has been 4ocumented that nomadic hunters before then simply left their waste as they move along and would not stay longer where excessive waste have accumulated but as human population started growing, nomadic hunters abandoned that life-style and adopted a secondary habit of proper waste disposal. Athens had the first municipal waste dumps in about 500 B.C., China developed sanitation systems, while ancient Rome had extensive regulations, which established public and private. According to Delong (1993). The problems of refuse collection, disposal and environmental sanitation in urban areas are indeed in most third world countries enormous and in most cases have engaged the attention of every government. It is an indisputable fact that waste is the most visible and serious environmental problem facing Nigeria's uripan and semi urban centres. These problems have been compounded by many factors including inappropriate planning for waste management particularly waste co11ction, waste storage, waste disposal, population growth and rapid technological development (Bartone, 1991).

Today, most developing nations do not have management structures and have not developed waste management strategies to address these problems and their attendant risks adequately. Most importantly, there is little or no sanitation culture among Nigerians (Iniefioke, 2004). This has been demonstrated by what is happening in almost all Nigerian cities, which has now led to the re-introduction of monthly sanitation day exercise in some of the federation including FCT. It will be recalled that this exercise was set aside at the inception of civilian administration in Nigeria in 1999, with the belief that sanitation should be a way of life of the people and should be carried out by all Nigerians without any coercion but surprisingly the present situation has proved every one wrong, confirming that there is no sanitation culture among Nigerians (Bartone, 1991).

During the colonial era, pollution caused few problems and received little attention (Habitat and UNEP, 1998). The generation of solid waste has now increased rapidly in direct proportion to the rate of population increase. As population increases, the problem of waste disposal becomes more complex and overwhelming especially in urban areas. According to Scheu, (2001) the fundamental approach to waste in its management: comprises the collection and packaging of waste, the manipulation of the waste and final disposal. The problem here is not just that of generation nor collection but also that of disposal and its effects on the quality of soils. The open dumping of solid waste apart from being unsanitary and an aesthetic creates breeding space for residents, flies, mosquitoes and other disease carrying vector, open waste dumping another method of solid waste disposal constitute serious problems and health risk, (Magaji, 2005). Few of such disposal sites are scientifically selected, well planned or properly managed which are usually accessible to scavenger and animals. In many instances the waste is sometimes set on fire to achieve some degrees of volume reduction (Murti, 1986).

Soil is mostly polluted around dumpsite because the seepage of water through the dump waste leaches out undesirable component that pollute. The soil, which is the medium of the transition. Contaminants like heavy metal, acid mine, cyanides, radioactive substance and industrial chemicals are substance that are not only dangerous in themselves but can greatly react in a way that their total effects will always be greater than the sum of the effects taken independently with other materials (Fjar, Geyer and Okun, 1968).

The overall consequences of continue dumping of waste in a site that does not meet accepted standard will thus lead to large-scale environmental degradation which will eventually result in the contamination of soils which is very dangerous to health.

In Nigeria the present methods of handling waste in most cities are either of the following:

- (a) Waste collection vehicle which comes at a particular time of the day for people to empty their waste are then transported to disposal sites;
- (b) Control bins are provided at strategic locations for people to empty their refuse, or central collection. Dumpsite is allocated where the refuse is then collected, transported and deposited in. This is the practice where the houses are either not accessible to the vehicle or are too many to be covered.
- (c) Bins are provided in front of houses for the occupants to empty their waste which are then collected by the designated waste collectors and transported to disposal site. This is practiced where there are accessible roads.

Solid waste collection, transportation and disposal in Nigeria determine the standard of solid waste management. Since various authorities find it difficult to collect and transport the refuse generated by the people in most urban cities (Kano, Kaduna, Benin, Port Harcourt, Aba, to mention a few), the standard of management is very low. The difficulties associated with waste collection and

transportation in Nigeria results from several factors such as inadequate standard facilities in waste generating premises; poor town planning, poor maintenance of vehicles for collection and transportation as well as financial constraints.

In the Federal Capital Territory (F.C.T), the Abuja Environmental Protection, Board (AEPB) is responsible for controlling, removing and disposal of all waste generated in the capital city. The Board processes and distributes dustbins to both private and residential homes and public places, with the help of equipment's such as compacting trucks and tippers, the board, through the department of solid waste, has adopted the landfill strategy for disposal of solid wastes.

Materials and Methods

Types and Sources of Data

The source & of data that were employed for this research are of two types, namely: primary and secondary sources.

Statistical Analysis

The soil and plant samples were subjected to laboratory analysis; the statistical technique that was used in analyzing the data was based on inferential statistics which specifically include Analysis of Variance (ANOVA) and Paired sample t-test. Analysis of variance (ANOVA) was used to determine the variation within and between the sample points and the mean seasonal difference between the heavy metals concentration in the soil and plant samples which include pawpaw, cowpea, potato and spinach. Paired sample t-test was used to determine the difference between the levels of heavy metal concentration against FEPA limit.

Laboratory Analysis

Four plant samples which include cowpea, spinach, potato, pawpaw and eight soil samples were collected from different points lettered A to F and G to H for control sample values around and within the dumpsite were analyzed for several parameters. The following parameters were investigated in the soil and plant samples, viz: Soil pH, Mercury, Copper, Silver, Iron, Zinc, Cadmium, and Salinity. In the analysis log of each soil sample was weighed using an analytical balance and dissolved in 100ml of de-ionized water. The pH of the samples was recorded using CORNING pH meter by introducing the meter probe into the prepared samples. The Salinity and Total Dissolved Solids of the samples were measured by introducing the probe of the Hach CO 150 conductivity meter. The heavy metals parameters were analyzed using the Jenway 3340 ION selective meter.

The particle size distribution was carried out using SIEVE SHAKER MACHINE which sieves, ranging between the ranges of 2.0mm-63.5µm aperture. 100g of each sample was introduced into the machine; the machine was electrically operated to sieve contents. Every retained particle on each sieve was weighed to determine the soil textures.

Result and Discussion

Levels of Physical Properties and Heavy Metal Contents for Dry Season

The data in table 4.1 indicate that of all the physical properties and heavy metals content considered only Mercury and Conductivity value was below the safety limit set by Federal Ministry of Environment Agency (FEPA). All others have their values above FEPA safety limits. Silver, Iron, Zinc and Cadmium have their value about three times or more than the safety limit set by the Federal

Ministry of Environment Agency (FEPA). Similarly, the mean values of physical properties of soil samples from dumpsite are much higher than the mean values of soil samples from areas surrounding the dumpsite which serves as control. The value for Cadmium from soil samples from the dumpsite is four times the value of soil samples from the surrounding areas of the dumpsite, Zinc is about thirteen times while iron is about three times and Mercury thirteen times below FEPA limit. Conversely the pH values, electrical conductivity, temperature values of the soil samples from the dumpsite are lower than the value of the soil samples from the surrounding areas.

Levels of Physical Properties and Heavy Metal Contents for Rainy Seasons

The data on table 4.2 shows that the mean value for temperature is about 24 degrees centigrade for wet season, the pH is a little bit outside the safety limit of Federal Ministry of Environment Agency, (FEPA), and electrical conductivity is within the safety limit, Mercury is above FEPA safety limit. Similarly, copper, silver, iron, zinc and cadmium are all above FEPA safety limit. However, the values of soil samples from Mpape dumpsite when compared with the samples from the surrounding areas shows that pH values are lower than that of the mean values of soil samples of the area than surrounding that serves as control.

Conversely electrical conductivity values of dumpsite soil samples is much higher than that of the control. Furthermore mercury, copper, silver, iron, zinc and cadmium content of dumpsite soil samples are very much higher than the mean values.

Seasonal Variation

The variation in the mean values of dumpsite soil samples when compared to Federal Ministry of Environment Agency, (FEPA) safety limit set standard shows that all the parameters considered exceeded the safety limits except pH. For copper, silver, iron, zinc and cadmium their contents are three times or more than the safety limits, whereas mercury content of dumpsite soil sample is slightly higher than the safety limit of FEPA.

Comparison of the mean value for plants and control analysis

A close look at Table 1 shows that the most of the plant samples parameters tested in the dumpsite were higher than that of the control samples. pH is high in the plant samples taken from dumpsite than that of control sample points which includes pawpaw, potato, cowpea and spinach. Heavy metals like mercury have high concentration in all the plant samples but copper result shows the highest value of 1.03mg/l in cowpea and lowest value of 0.68mg/l in pawpaw. Iron is high in all the plant samples with the highest concentration of 1.04mg/l in potato, cowpea and spinach and the lowest 1.02mg/l in pawpaw. Zinc result shows the highest value of 1.06mg/l in pawpaw and 1.03mg/l level of concentration in both cowpea and spinach. Cadmium shows low level of concentration in all the plant samples.

Test of Variation

ANOVA and T-test was conducted and its related tables, graphs and rule for interpretation and decision making are shown in the pages following. The level of significant was chosen at the 0.05 level and the rule is that, if $P > 0.05$ then the variation is not significant at the 0.05 level, but if $P < 0.05$ then, the variation is significant at the 0.05 level. A Post ANOVA test called Post Hoc tests (multiple Comparisons) was also computed to determine how significant variation was between the

combinations of two groups. Means Plots for each variation is also presented here. A General postulated Hypothesis that there is no significant variation in the parameters measured in soil and plant samples (Temperature, pH, Conductivity, Mercury, Copper, Silver, Iron, Zinc and Cadmium) during dry and rainy season months on the dumpsite and surrounding were subjected to statistical analyses and the results are shown below.

Variation in value of Dumpsite soil samples rainy season.

A specific Hypothesis that there is no significant variation in the level of heavy metals in dumpsite soils between months of July, August and September (Rainy season) was tested using the analysis of Variance (ANOVA) technique.

Table 2. ANOVA Summary Dumpsite Rainy Season

ANOVA							
Element/Season Source of Sum of Df Mean F Si. variance Squares Square							
Temperature on in Dumpsite Rainy Season	Between Groups	7.508	2	3.754	3.819E 31		.000
Within Groups	.000	15	.000				
Total	7.508	17					
PH on in Dumpsite Rainy Season	Between Groups	5.924	2	2.962	5.312		.018
Within groups	8.365	15	.558				
Total	14289	17					
Conductivity on in Dumpsite Rainy Season	Between groups	458139.111	2	229069.556	52.749		.000
Within Groups	65 139.833	15	4342.656				
Total	523278.944	17					
Mercury on in Dumpsite Rainy Season	Between Groups	2.351	2	1.176	7.784		.005
Within Groups	2.266	15	.151				
Total	4.617	17					
Copper on in Dumpsite Rainy Season	Between Groups	52.930	2	26.465	44.875		.000
Within Groups.	8.846	15	.590				
Total	61.776	17					
Silver on dump site in rainy season	Between Groups	.786	2	.393	18.819		.000
Within groups	.313	15	.021				
Total	1.099	17					

Iron on Dumpsite in Rainy Season	Between Groups	38.377	2	19.819	30.390	.000
Within groups	9.471	15	.631	:		
Total	47.848	17		:		

Sources: Author's field work, 2021.

Given the ANOVA table above for dumpsite soil sample for Rainy season, Cadmium value were tested and found that the p values was greater than alpha we therefore accept the null hypothesis that is there is no significant variation in Copper value at 0.05 confidence level. As for pH, Conductivity, Mercury, Copper, Silver, Iron and Zinc values in the Rainy season soil dumpsite sample was tested and the p values is less than alpha therefore we reject the null hypothesis and adapt the alternative hypothesis H_1 that is there is significant variation of PH, Conductivity, Mercury, Copper, Silver, Iron and Zinc value in the dry season soil samples at 0.05 confidence level.

Variation in values of mean dumpsite plant samples rainy season.

Table 3. ANOVA for mean plant samples rainy season.

ANOVA						
Elements		Sum of Squares	Df	Mean Square	F	Sig.
Temperature on Dumpsite	Between Groups	68.238	5	13.648	.888	.501
	Within Groups	460.959	30	15.365		
	Total	529.196	35			
PH on Dumpsite	Between Groups	10.658	5	2.132	6.482	.000
	Within Groups	9.865	30	.329		
	Total	20.523	35			
Conductivity on Dumpsite	Between Groups	1.621E7	5	3242662.757	1.395E3	.000
	Within Groups	69716.265	30	2323.876		
	Total	1.628E7	35			
Mercury on Dumpsite	Between Groups	120.718	5	24.144	17.372	.000
	Within Groups	41.693	30	1.390		
	Total	162.410	35			
Copper on Dumpsite	Between Groups	88.743	5	17.749	47.846	.000
	Within Groups	11.129	30	.371		
	Total	99.871	35			
Silver on Dumpsite	Between Groups	9.996	5	1.999	11.433	.000
	Within Groups	5.246	30	.175		
	Total	15.242	35			
Iron on Dumpsite	Between Groups	104.648	5	20.930	7.799	.000
	Within Groups	80.512	30	2.684		
	Total	185.161	35			
Zinc on Dumpsite	Between Groups	91.284	5	18.257	65.771	.000
	Within Groups	8.327	30	.278		
	Total	99.612	35			
Cadmium on Dumpsite	Between Groups	61.359	5	12.272	2.369	.063
	Within Groups	155.403	30	5.180		
	Total	216.761	35			

Sources: Author's field work, 2021.

Given the ANOVA table 4.13 above that there is no significant variation of Temperature, Cadmium value in the rainy and dry season combined samples were tested and found that p values was greater than alpha, therefore we accept the null hypothesis, that is there is no significant variation of Temperature and Cadmium value in the rainy and dry season combined samples at 0.05 confidence level pH, Conductivity, Mercury, Copper, Silver and Zinc value 'c tested and round at the p values were less than alpha so therefore we reject the null hypothesis and adapt the alternative hypothesis H_1 . That is there is significant variation of PH, Conductivity, Mercury, Copper, Silver and Zinc value in the combined rainy and dry season months at 0.05.

Table 4. ANOVA for Dumpsite Parameter in All the Months (Wet and Dry Season Combined).

ANOVA							
Elements	Sum	of	Df	Mean	F	Sig.	
Squares	Square						
Temperature on Dumpsite		Between Groups	68.238	5	13.648	.888	.501
Within Groups	460.959		30	15.365			
Total	529.196		35				
PH on Dumpsite		Between Groups		5	2.132	6.482	.000
Within Groups							
Total							
9.865	30	.329					
20.523	35						
Conductivity on Dumpsite		Between Groups	1.621E7	5	3242662.757	1.3953	.000
Within	69716.265		30	2323.876			
Total	1.628E7		35				
Mercury on Dumpsite		Between Groups	120.718	5	24.144	17.372	.000
		Within Groups	41.693	30	1.390		
Total	162.410		35				
Copper on Dumpsite		Between Groups	88.743	5	17.749	47.846	.000
Within groups	11.129		30	.371			
Total	99.871		35				
Silver on Dumpsite		Between Groups	9.996	5	1.999	11.433	.000
Within Groups	5.246		30	.175			
Total	15.242		35				

Iron on Dumpsite	Between Groups	104.648	5	20.930	7.799	.000
Within Groups	80.512	30	2.684			
Total	185.161	35				
Zinc on Dumpsite	Between Groups	91.214	5	18.257	65.771	.000
Within Groups	8.327	30	.278			
Total	99.612	35				
Cadmium Dumpsite	Between Groups	61.359	5	12.272	2.369	.063
Within Groups	155.403	30	5.180			
Total	216.761	35				

Sources: Author's field work, 2021.

Given the ANOVA table 4 above that there is no significant variation of Temperature, Cadmium value in the rainy and dry season combined samples were tested and found that p values was greater than alpha, therefore we accept the null hypothesis, that is there is no significant variation of Temperature and Cadmium value in the rainy and dry season combined samples at 0.05 confidence level pH, Conductivity, Mercury, Copper, Silver and Zinc value 'c tested and round at the p values were less than alpha so therefore we reject the null hypothesis and adapt the alternative hypothesis H_1 . That is there is significant variation of PH, Conductivity, Mercury, Copper, Silver and Zinc value in the combined rainy and dry season months at 0.05.

Conclusion

There is significant variation in the concentration in the value of the analyzed metals in the dumpsite and the control site. This is evident because the dumpsite has impacted on the soil and plants. That Mppae dumpsite was not designed before construction as such there is no provision for control and treatment of leachate at the dumpsite. Contaminated leachate is released from the waste dump into the soil and water in and around the study area. Leachate from the dumpsite flows into the watershed that flows to Miatama and Asokoro resulting from lack of technical expertise necessary for solid waste management planning an operation.

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