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SOURCES OF LAND POLLUTION AND RESIDENTS' WELLBEING IN BIDA, NIGERIA

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Abstract
Land is required for various uses in both the urban and rural areas and it requires adequate planning and control to ensure harmonious development and functional efficiency of these uses. However, the rate of natural resource consumption and production of human waste products is now so great that the health and well being of all ecosystems on the planet is affected. This study examined the activities that cause land pollution and assessed the health effects on residents of Bida, Nigeria, with specific reference to those residents in close proximity to contaminated sources. The survey-based research used primary and secondary sources of data. Primary data were collected through a structured questionnaire, direct observations, open-ended conversation and field measurements. A total of 40 households were selected using the multi-stage sampling method. Soil samples were taken from a dung hill in the study area. Parameters that were determined include appearance, odour, and the level of concentration of lead, cadmium and nitrate. The study reveals a very high concentration of lead (360.46mg/kg) and cadmium (3.864mg/kg) in soil samples. The sources of contamination were waste discharges from open landfills, fertilizer, herbicide, household and commercial wastes and cow dung. Residents identified the major health effects of land pollution as diarrhea, gastroenteritis, malaria and yellow fever. The paper recommends effective waste collection and management, and conversion of the waste to organic fertilizer for increased food production and improved public health.

Keywords: *Land, Pollution, Health effects, Bida.*

Introduction

The way in which human beings currently use land will affect the future of the world, this is because the impacts of human activities are becoming more significant as population grows and the ability to exploit natural resources becomes more refined. The rate of natural resource consumption and production of human waste products is now so great that the health and well being of all ecosystems on the planet is affected. (Wenner et al., 2013).

The definition of land varies with the context in which it is used and the circumstances under which it is considered. Land from the physical perspective can be defined as the entire solid portion, especially the exposed surface of the earth as opposed to the oceans and seas (Bello, 2007). Land is required for various uses in both the urban and rural areas and is a major factor of production and a vital element in the socio-economic development of any country or society (Federal Ministry of Housing and Urban Development, 2003). Thus, as a nation grows in size and rural areas become urban centres and urban centres become large metropolitan areas, there is always an increased competition as well as demand for land for different purposes. This therefore, requires adequate planning and control to ensure harmonious development and functional efficiency of these uses.

Environmental health on the other hand, can serve as a significant indicator of the health status of a population. According to WHO (1993), environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psycho-social factors in the environment.

Considering the close connection between different land uses and environment health, this study, therefore, seeks to unravel the implication of activities that trigger land pollution on the quality of lives of residents in Bida.

Conceptualization and Literature Review

This study is anchored on the concepts of Healthy Cities and Ecological Footprints.

Healthy City Concept

A healthy city is a city that is continually creating and improving the physical and social environment and expanding those community resources which enable people to mutually support each other in performing all the functions

of life and developing their maximum potentials. It is a term used in public health and urban design to stress the impact of policy on human health. Healthy city concept has an history that dates back to the mid 19th century but the modern form has its roots in the WHO's Health for All strategy and more specifically, the Ottawa Charter for Health Promotion, a World Health Organization initiative on Healthy Cities and Villages in 1986.

The goal of the concept is to maximize disease prevention through a "whole system" approach, which integrates multi-disciplinary action across risk factors. The key principles of all Healthy settings include community participation, partnership, empowerment and equity. The Healthy Cities programme is the best-known example of a successful Healthy settings approach.

The Concept of Ecological Footprint

Ecological footprint was first conceived in the early 1990s by William Rees and Mathis Wackernagel. It was designed as a tool in the training of urban planners to understand the effect of human activities on the ecosystem. The ecological footprint measures how fast we consume resources and generate waste.

Wackernagel and Rees 1995 compared a city to a large animal grazing in a meadow where they posed the ecological footprint as "How large a pasture is necessary to support that city indefinitely to produce all its 'feed' and to assimilate all its waste sustainably". This represented in Figures 1 and 2 below:

Fig.1: The Concept of Ecological Footprint

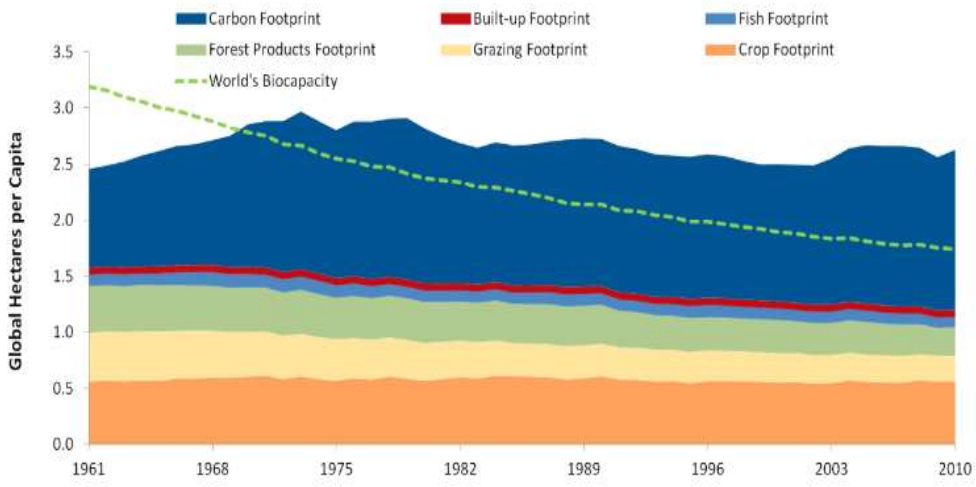

Fig.2: The trend of Concept of Ecological Footprint
Source: Global Footprint Network, 2015

Humanity's Ecological Footprint per capita by components compared to per capita biocapacity on the planet between 1961 and year 2010. The dashed green line shows bio capacity per person. The results are shown in global hectares where one hectare equals 2.47 acres.
The relevance of the model to this study becomes evident when looking at the upshot of different activities engaged in by organizations and individuals on the environment as well as on people's health.

Waste disposal in Relation to Ecosystems, Public Health and Safety.
The term waste is defined in several ways. Waste is anything unwanted kept aside for future use. We have liquid wastes and solid wastes which are biodegradable or non- biodegradable. The solid wastes are further classified into municipal, industrial, construction and demolition, agro based, hazardous or toxic, and infectious or healthcare wastes.
An average Nigerian produces about 0.5kg of solid waste per day. The amount and the nature depend on the socioeconomic stature of the person. People in high income bracket produce more wastes and naturally those in low income bracket produce less. Culture and climate also determines the nature of the waste (Adewumi, *et al.,* 2005; Nnaji, 2015). Industrialization and rapid population growths in many cities and towns have led to faster rate of wastes generation than they are collected, transported and disposed (Federal

Ministry of Environment (2005),. In addition to domestic wastes, other sources of wastes generation are from agriculture and livestock, industries mostly Small and Medium Enterprises (SMEs), as well as hazardous and infectious wastes from hospitals.

Wastes are of two types- biodegradable and non-biodegradable. Biodegradable wastes are perhaps more dangerous as they lead to degradation of natural resources, damage to ecosystems, promote vector breeding and disease transmission. In tropical African countries, the results of improperly managed solid waste are evident in public health-related disease incidence causing ill health, sometimes leading to serious morbidity and mortality. Poorly managed waste dumpsites, untreated sludge, and wastewater are sources of proliferation of rodents, which transmit typhoid fever, rabies, and other infectious diseases. They also lead to prolific breeding of flies, cockroaches, and mosquitoes, which transmit diarrhea, gastroenteritis, malaria, yellow fever, dengue, mosquito-borne encephalitis, filariasis and helminthiasis. Non-biodegradable wastes such as plastics, metals and glass may cause nuisance, injuries, biodiversity loss and long term persistence in the ecosystems (Toqeer, *et al.,* 2019).

The challenges pose by indiscriminate waste disposal and consequent land pollution constitute a serious environmental issue. These environmental issues are the priority of all the Sustainable Development Goals, thus, more than half of SDGs have directly address the environment or the sustainable use of natural resources (UNEP, 2015; OECD, 2015; UNEP, 2016d; Lucas *et al.,* 2016; Reid *et al.,* 2017). Twelve SDGs promote human well-being through the sustainable use of natural resources, and ten can be achieved only if the efficiency of natural resource use is substantially improved (UNEP 2015).

For example, SDG 2 is related to food, hunger and agriculture, SDG 3 is on human health, economic growth and employment, SDG 15 focuses on land and biodiversity, SDG 13 addresses the climate, SDG 6 focus is on water while SDG 14 talks about oceans. Other related non-environment goals are not formulated in clear and quantitative terms (Gupta and Vegelin, 2016; Elder and Olsen, 2018) and these include (SDG 8), industry (SDG 9) and cities (SDG 11) (International Resource Panel 2014; International Resource Panel 2015; OECD 2015; Lucas et al. 2016; Elder and Olsen 2019).

The Study Area

Bida is a traditional town that is located southwest of Minna, capital of Niger State in Nigeria. The town is located on latitude 9^0 5′ 0" North and Longitude 6^0 1'0" East of the equator. It experiences distinct dry and wet seasons. Inter-tropical continental air mass is responsible for dry season while tropical maritime air mass prevalence brings about wet condition in Bida. The wet season usually last for about 200 days from April to October and dry season is between November and March. The rainy season has three months of heavy rain and the peak shifting between July and August while the dry season lasts between 5 to 6 months. The mean annual rainfall is between 1000mm to 1,500mm. The mean annual temperature is between 26.5°C and 27.8°C with maximum between March and June while the minimum is between December and January (Adefolalu, 1988; Odekunle, 2006; Odekunle et al, 2007 and Abaje et al., 2012).

Abaje, I.B., Ati, O.F. and Iguisi, E.O. (2012). Recent Trends and Fluctuations of Annual Rainfall in
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Bida is the headquarters of the Nupe Kingdom. The leadership style of the ancient town of Bida is emirship; its local governments are traditionally affiliated and are accountable to the emir in customary governance (El-Kanti, 2008; Encyclopedia Britannia, 2014).

The urban landscape structure of Bida features the expansion of residential areas and commercial activities which has given birth to an unplanned development. Bida is known for its crafts, especially brass and copper chalice, metal products, glass beads and bangles, raffia hats and mats making, locally dyed cotton and silk cloth (part of the contributory factors to pollution in the study area) (Encyclopedia Britannica, 2014). As depicted in figure 3, the observable land-uses as one enters the town from the west are a mixture of residential, commercial, educational and industrial land-uses. In the east,

commercial land-use dominate other land-uses while industrial land-use is predominant in the northern part of the town where commercial and residential land-uses are also significantly represented. In the southern part of the town, combinations of residential, educational, agricultural and commercial land-uses are found juxtaposed.

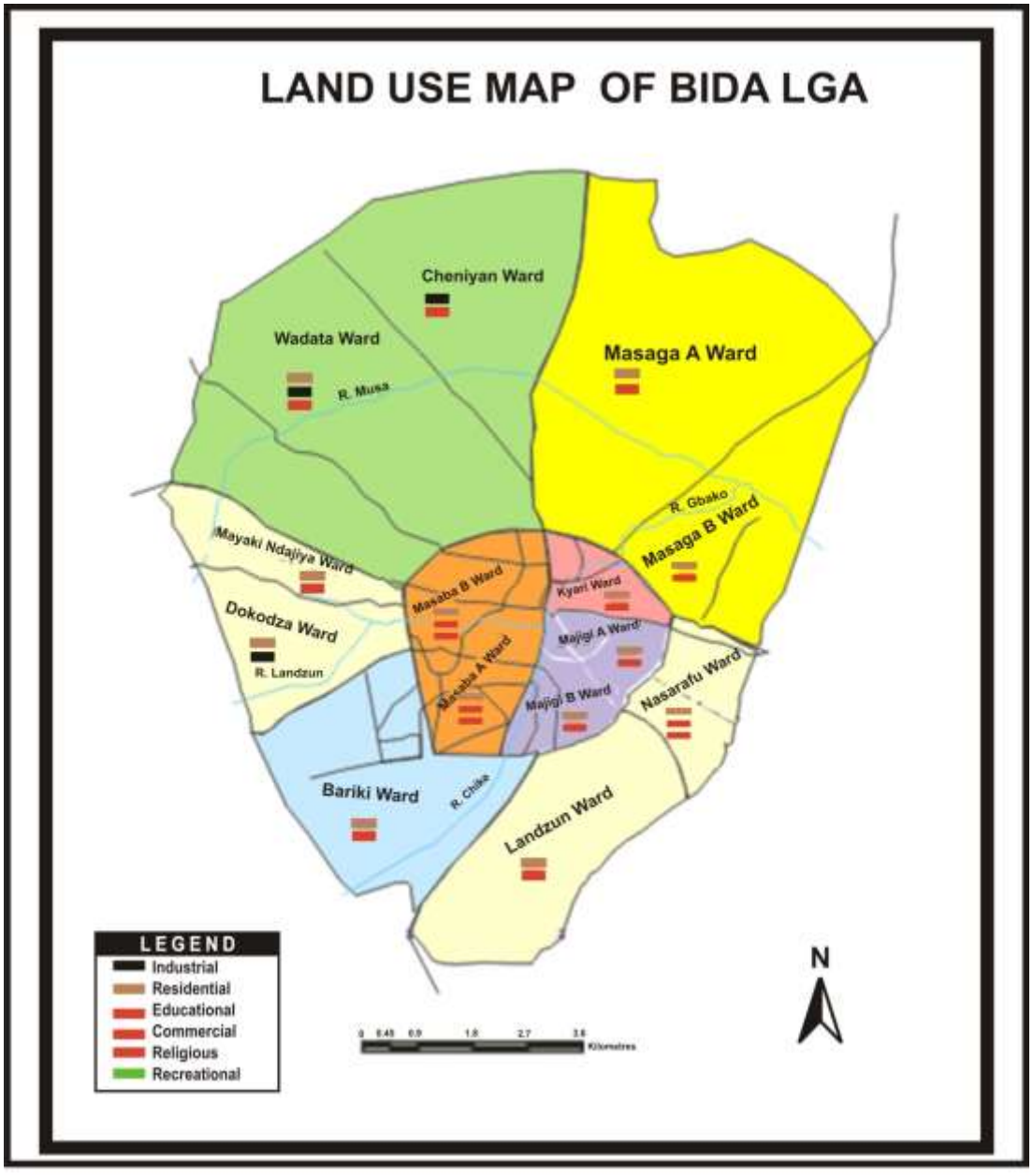

Fig 3: Land Use Map of Bida LGA
Source: Jiyah, 2014. Adapted from Surveying and Geo- informatics Department, The Federal Polytechnic, Bida (2012)

Methodology

The case study design was adopted. This involved a cross-sectional data using secondary and primary data sources. Primary data were collected through a structured questionnaire, direct observations, open-ended conversation and field measurements. A structured questionnaire was employed to elicit credible information needed for the study.

Multi-stage sampling method was adopted to select sampled households. The first stage involved the division of Bida LGA into two geographical entities based on the two political constituencies – Bida North and Bida South (Fig. 4), each of these constituencies has seven wards. At the second stage, the two constituencies were further divided into fourteen wards. The selected wards are Wadata, Cheniyan, Masaba A, Masaba B, Masaga A, Masaga B and Kyari in Bida North; and Majigi A, Majigi B, Landzun, Dokodza, Nasarafu, Mayaki Ndajiya and Bariki in Bida South (Fig. 4).The fourteen wards were then divided into streets. One major street was randomly selected as representative of each ward. A total of 400 houses were counted in the selected streets. Systematic random sampling technique was used to select 40 households which is 10% of the total houses (Table 1). The first building was selected at a random start of the 5th building. A sampling interval of 10 was repeatedly added to select subsequent households.

Table 1: Sample Frame and Sample Size

Constituency	No	Ward	Name of Streets	Sample Frame	Sample Size (10%)
Bida North	1	Wadata	Emir's palace	20	2
	2	Cheniyan	FGGC road	37	4
	3	Masaga A	Chiriko	28	3
	4	Masaga B	Fogun	28	3
	5	Kyari	Etsu Musa	29	3
	6	Masaba A	Kotaworo	23	2
	7	Masaba B	AP round about (Bangie)	32	3
Bida South	1	Landzun	Banwuya	34	3
	2	Bariki	Pichi	30	3
	3	Majigi A	Laruta	20	2

	4	Majigi B	Hajiya lolo	28	3
	5	Nasarafu	Banyagi	31	3
	6	Mayaki Ndajiya	Former Corper's logde	20	2
	7	Dokodza	Prison's services	40	4
Total	14	14	14	390	40

Source: Authors, 2014.

The questionnaire was structured to obtain information on socio-economic characteristics including Mode of waste disposal, incidence of illicit waste disposal on the land; effects of solid waste on the communal outlook and mode of treatment of polluted land.

The data generated from pre-coded, open-ended and fixed choice questions were coded using Microsoft Access. The data were analysed using the Statistical Package for Social Sciences (SPSS) Version 20.

The experimental research technique used for the study was the measurement of digested soil sample in the laboratory.

Soil samples were taken from a residential dung hill in the study area. Parameters that were determined through laboratory tests include appearance, odour, and the level of concentration of heavy metals, such as lead, cadmium and nitrate. The concentration of heavy metals was compared with the minimum permissible standard given by the Federal Environmental Protection Agency (1998) as shown in Table 2.

Table 2: Metal Limit Discharge into Land and Surface Water

Limit discharge into surface water and land (mg/l milligram per litre)		
Chlorine (free)	1.0	-
Cadmium, Cd	Less than 1	-
Chromium (trivalent and hexavalent)	Less than 1	-
Copper	Less than 1	-
Lead	Less than 1	-
Mercury	0.05	-
Nickel	Less than 1	-
Selenium	Less than 1	-

Silver	0.1	-
Zinc	Less than 1	-
Total Metals	3	-
Calcium (as Ca^{2+})	200	-
Magnesium (as Mg^{2+})	200	-
Boron (as B)	5	5
Nitrate (as NO3)	20	-

Source: FEPA, 1988.

Research Results and Discussions

Methods of Waste Disposal

Land pollution is a major threat to the environment as there are different ways through which land is contaminated. This could be through agricultural activities of men, solid and liquid waste disposal as well as various forms of spills on the land especially oil spillage (Plate 1). The analysed data in table 3 revealed that 50% of the total respondents burned their refuse after use; 35% disposed their solid waste in the road side government provided large refuse bins; 7.5% used private collectors who move round to collect the refuse for disposal. However, 7.5% respondents poured off their refuse in river channel. The implication is that the ugly side of urbanization is showcased here because it takes time before the sanitation officers go round for the collection of refuse; this gives rise to a lot of unpleasantness in form of obnoxious odour and ugly heaps which serves as a breeding ground for vectors of various diseases including cholera and malaria fever. Another implication is that the prevalent on- site burning of refuse have a considerable effect on air quality.

Table 3: Methods of Waste Disposal

Waste Disposal Means	Respondents	Per cent
On-site burning	20	50.0
Government collector	14	35
Private collector	3	7.5
Water channel	3	7.5
Total	**40**	**100.0**

Source: Field work, 2014.

Plate 1: An Oil Soaked Mechanic Workshop Ground at Ilorin garage
Source: Field work, 2014.

Plate 2 shows a heap of refuse in front of the main market on the major Abuja – Ilorin high way in Bida.

Plate 2: A Dump Site in Front of New Market
Source: Field work, 2014.

As presented in table 4, 77.5% of the respondents said the various means of waste disposal site were near their residence while 20% said the points were not near them, nevertheless, a small percentage of 2.5% did not give any reply.

Table 4: Location of Dumpsite Near Building

	Respondents	**Per cent**
Dumpsite	31	77.5
No dumpsite	8	20
No Response	1	2.5
Total	**40**	**100.0**

Source: Field work, 2014.

Shown in figure 4 is the distance between the respondents' location and waste dumping site. 22.5% of the respondents said the distance was less than 1m, 20% said the distance was between 1m to 3m, 10% had the distance between them and the dumping site to be 4m to 6m whereas 12.5% and 17.5% of the responses had a distance of 7m to 9m and more than 10m between them respectively, nonetheless, 17.5% did not respond to the question on the distance separating the respondent and the dumping site.

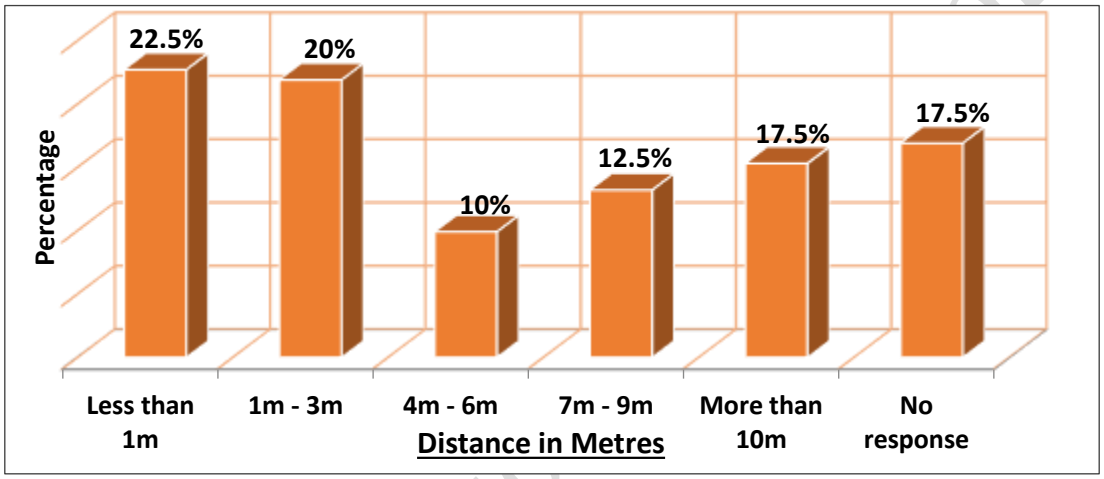

Figure 4: Distance between Dumping Site and Residents
Source: Field work, 2014.

The use of bush/dumpsite for defecation as shown in table 5 revealed that 37.5% of the total respondents resorted to the use of bush as convenience, of this percent; Masaga B with 5.0% had the highest percentage.

Table 5: Bush/ Dump site Used For Toileting Across Ward

Ward	Bush/ Dump site				Total	% of total
	Bush	% of total	Not Bush	% of total		
Wadata	1	2.5%	2	5.0%	3	7.5%
Cheniyan	1	2.5%	1	2.5%	2	5.0%
Masaga A	1	2.5%	1	2.5%	2	5.0%
Masaga B	2	5.0%	1	2.5%	3	7.5%
Kyari	1	2.5%	3	7.5%	4	10%
Masaba A	1	2.5%	2	5.0%	3	7.5%
Masaba B	1	2.5%	2	5.0%	3	7.5%

Landzun	1	2.5%	2	5.0%	3	7.5%
Bariki	1	2.5%	1	2.5%	2	5.0%
Majigi A	1	2.5%	2	5.0%	3	7.5%
Majigi B	1	2.5%	3	7.5%	4	10%
Nasarafu	1	2.5%	2	5.0%	3	7.5%
Mayaki Ndajiya	1	2.5%	2	5.0%	3	7.5%
Dokodza	1	2.5%	1	2.5%	2	5.0%
Total	**15**	**37.5%**	**25**	**62.5%**	**40**	**100.0%**

Source: Field work, 2014.

The Use and Frequency of use of Fertilizer on Farmland

The frequency of the use of fertilizer on the farm and cottage farming as presented in table 6 shows that 72.5% of the respondents frequently used fertilizer; 15% used it less frequently; 10% of the respondents used fertilizer occasionally while the question was not applicable to 2.5% of the total respondents. This implies relatively high application of fertilizer on farm land among farmers in the study area.

Table 6: Frequency of Use of Fertilizer on the Farm

Usage	Respondents	Per cent
Frequently	29	72.5
Less frequently	6	15
Occasionally	4	10
Not applicable	1	2.5
Total	**40**	**100.0**

Source: Field work, 2014.

The Use and Frequency of use of Herbicide as Weed Control

Table 7 shows that 40% of the respondents used herbicide for weed control; 50% did not use any while the question was not applicable to the remaining 10% respondents.

Table 4.47: Use of Herbicide for Weed Control

Response	Respondents	Per cent
Herbicide	**16**	**40**
No herbicide	**20**	**50**
No Response	**4**	**10**

Total	**40**	**100.0**

Source: Field work, 2014.

The frequency of herbicide use shows that 22.5% of the users used it annually, 7.5% used it bi-annually; 5.0% responded that they use herbicide around their abode on a quarter of a year basis while 5.0% used it occasionally, and the question was not applicable to 60%. The high negative response to the use of herbicide was due to the fact that many buildings have paved floors and some employed other method of weed control like machine and manual cutting of grasses (Table 8). The paved floor can lead to urban heat island, a contributing factor to climate change.

Table 8: Duration of Use of Herbicide

Duration	Respondents	Per cent
Annually	9	22.5
Bi-annually	3	7.5
Quarterly	2	5.0
Occasionally	2	5.0
No Response	24	60
Total	**40**	**100.0**

Source: Field work, 2014.

When asked about the side effects of the chemical(s) used, 50% of the respondents said it can lead to respiratory infection and infertility; 17.5% said it can lead to death of soil organisms while 32.5% did not respond as shown in Table 9.

Table 9: The Effect of Herbicide on Health

Herbicide effect	Respondents	Per cent
Respiratory infection and infertility	20	50
It can kill the soil organism	7	17.5
No response	13	32.5
Total	**40**	**100.0**

Source: Field work, 2014.

Scientific Soil Test

The use of fertilizer on the farm and other activities like cassava processing, car wash and salon corroborate the level of land pollution in the study area. According to research results of the study and as reported in table 10, the soil is contaminated by Cadmium, Nitrate and lead.

The limit discharge of lead and cadmium is less than 1 gm/l while Nitrate is 20 mg/l. The tested soil sample in table 10 reveals a very high concentration of lead at 360.460 mg/kg and cadmium at 3.864 mg/kg. Nitrate however was 2.002 mg/g; this is 18 mg/g below the limit discharge.

Table 10: Soil Quality Test

Sample	**Content**		
	Cadmium (mg/kg)	**Lead** (mg/kg)	**Nitrate** (mg/g)
Soil	3.864	360.460	2.002

Source: Field work, 2014.

The soil sample was taken from a dung hill to determine the level of concentration of lead, cadmium and nitrate in the land. Cadmium can be found in cigarettes, fertilizers used in agriculture and in low levels in all foods but in highest levels in shellfish, liver, and kidney meats (Josep, 2009). The digested sample revealed high concentration of heavy metals (lead) on the land; this connotes a high risk of ill-health, mostly of carcinogenic origin.

Conclusion and Recommendation

From the foregoing, it can be inferred that there is land pollution of varying degree in Bida and it is expedient that a drastic measure be put in place to curb or arrest the situation if the environment will be sustained for the good of the present generation without jeopardizing the future of the generation yet unborn.

Likewise, there is need for effective waste collection and management, instead of indiscriminate disposal of refuse on the right of way. Waste managers should also look at the types of waste and choice of technology by using various management methods like sorting and recycling which will provide employment opportunities for communities and add value to the end product

in form of organic fertilizer. Thus, waste can be viewed as a resource and not as a nuisance

In addition, waste management strategies based on ecosystem approach either by Government or private bodies to educate the masses on NESREA policies should be embraced in order to improve public health enhancing productivity of the people

Finally, there is the need for community participation in form of advocacy programmes to address the waste issues as well as to showcase the value of waste in the managerial processes.

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