SPATIAL DISTRIBUTION OF DUMPSITES IN DOKA AND GABASAWA DISTRICTS OF KADUNA METROPOLIS, NIGERIA

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DECLARATION

I decleare that the work in this thesis entitled " SPATIAL DISTRIBUTION OF DUMPSITES IN DOKA AND GABASAWA DISTRICTS OF KADUNA METROPOLIS, NIGERIA" was conducted by me and has not been presented in the department or anywhere for a degree. All quotations and source of information are duly acknowledged by means of references.

_____ _____

ADAMU Usman Date

CERTIFICATION

This thesis entitiled "**SPATIAL DISTRIBUTION OF DUMPSITES IN DOKA AND GABASAWA DISTRICTS OF KADUNA METROPOLIS, NIGERIA**" by Adamu Usman meets the regulation governing the award of the degree of Master of Science (GIS and Remote Sensing) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge.

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DEDICATION

This work is dedicated to my late brother Abdulrahman Ahmed Samari. May his soul rest in perfect peace. (ameen)

ACKNOWLEDGEMENTS

Gratitude to Almighty Allah and appreciation to my able supervisors: Dr. B.A. Sawa and Dr.I.A. Abdulhammed for their immense commitment, contribution and sacrifice to make sure this work is accomplished.

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ABSTRACT

Soild waste dumpsites is a global environmental issue and constitute problem in today's world. The study identified and mapped the legal and illegal dumpsites in the area and also analyzed the proximity of the dumps to residence in the area. The GPS (Garmin map 60) was used to collect the coordinates of the dumpsites. The data collected from the field were analyzed using the ArcGIS 9.3 software. Buffer of 200m, 300m, and 400m were constituted to show the proximity of the dumpsites to residences. The result of the analysis revealed that most of the dumpsites were situated close to the residential area and most were within the radius of 200 meters. Also questionnaire was used to generate opinions of the residents on the methods of solid waste disposal and the effects on the surrounding; the data collected was analysed using excel and SPSS software. The results showed that most of the wastes generated from these dumpsites are in form of polythene bags, plastic bottles, plastic bottles all generated. It furthers shows that there are no formal disposal dumpsites in Doka and Gabasawa most of the legal dumpsites are located within the Central Business Districts and high income earners residential areas, in low income areas both municipal and industrial wastes are disposed in an uncontrolled manner. Based on the foregoing it was recommended that sensitization of the general public on the dangers associated with indiscrimate refuse disposal should be put into practice.

TABLE OF CONTENTS

Title.....i

Declaration.....ii

Certification.....iii

Dedication..... iv

Acknowledgement.....v

Abstract.....vi

List of Table.....vii

List of Figures.....viii

List of Plates.....xi

CHAPTER ONE: INTRODUCTION

1.1 Background of the study.....1

1.2 Statement of Research Problem.....4

1.3 Aims and Obejectives of the study.....8

1.4 Scope of the study.....9

1.5 justification of the Study.....9

1.6 Organization of the study.....10

CHAPTER TWO: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction.....12

2.2 Conceptual Frame work.....12

2.2.1 Waste.....12

2.2.2 Classification of Wastes.....13

2.2.2.1 Types of Solid Waste.....14

2.2.3 Waste Generation.....14

2.2.3.1 Scavenging.....17

2.2.3.2 Recycling.....18

2.2.3.3 Reuse.....18

2.3 Solid Waste Management.....19

2.4Current Waste Management In Nigeria 20

2.4.1 Waste Generation and Composition.....20

2.4.1.1Temporary Waste Storage.....21

2.4.1.2 Private Sector Participation Federal.....22

2.4.1.3Informal Private Sector.....23

2.5 Solid Waste Management In Kaduna Metropolis.....24

2.6.Literature review.....25

2.6.1. Application of RS and GIS in Waste Management.....29

CHAPTER THREE: STUDY AREA AND METHODOLOGY

3.1 introduction.....31

3.2 The Study Area.....31

3.2.1 Location.....31

3.2.2 Climate.....33

3.2.3.Relief and Drainage.....33

3.2.4 Geology.....33

3.2.5 Soils and Vegetation.....34

3.2.6 Population and Peole.....34

3.2.7 Socio-Economic Activities.....35

3.2.8 Ecological Chanlleges.....36

3.3 Methodology.....36

3.3.1 Type of Data Used.....36

3.3.2 Sources of Data.....36

3.3.3 Data Collection Procedure.....37

3.3.3.1 Sampling Technique.....37

3.3.3.2 Data Processing…….....39

3.3.3.3 Location of Dumpsites and Map Production.....39

3.3.3.4 Buffering..... 40

3.4 Data Analysis.....40

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction.....41

4.2 Socio-Demographic Characteristics of Respondents.....41

4.2.1 Occupation of Respondents…….....41

4.2.2 Educational Level of Respondents …….....43

4.2.3 Household Survey…….....43

4.2.4 Monthly Income of Respondents.....44

4.2.5Categories of Waste Generated…….....45

4.2.6 Characteristics rating of different methods of solid waste disposal.....47

4.2.7 Waste Disposal …….....47

4.2.8 Risked Posed by Unsafe dumpsites….....49

4.2.9Rate of Occurrence of Dumpsites Risk…….....50

4.3.1 Trends of Occurrence…….....51

4.3.2Frequency of Solid Waste 52

4.3.3 Location of Waste Disposal…….....53

4.3.4Solid Wastes Services…… 54

4.3.5 Suggestions to Improve the Services.....55

4.4 Spatial Analysis……...55

4.1.1 Spatial Distributions of Legal and Illegal Dumpsites……..….55

4.1.2 Buffer Analysis……..……..……58

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction.....61

5.2 Summary.....61

5.3 Conclusion.....63

5.4 Recommendations.....64

References.....66

Appendix.....75

LIST OF TABLES

Table 3.1 The number of Respondents Sampled in each Districts.....39

Table 4.1 Distribution of Resondnets by occupation.....42

Table 4.2 Level of Education.....43

Table 4.3 Number of Persons in Household.....44

Table 4.4 Monthly Income 45

Table 4.5 Categories of household waste generated…….....…….46

Table 4.6 Methods of Solid Waste Storage.....47

Table 4.7 Method of waste disposal commonly used .....….....48

Table 4.8 Rating of waste disposal methods……...…….……48

Table 4.9 Risks Posed by Dumpsites to the study Area.....49

Table 4.10 Rate of risk occurrence across place of residence……...51

Table 4.11 Category of people more vulnerable to the frequency of the

Occurrence of risk posed in the study area.....….....52

Table 4.12 Frequency of Solid Wsate Disosal by theResidence of the StudyArea…….….53

Table 4.13Location of waste disposal…….…..53

Table 4.14 Suggestion to Improve the services.....55

Table 4.15 Legal and Illegal Dumpsite…….……..…56

LIST OF FIGURES

Figure 3.1 Map of the Study Area.....32

Figure 4.1 Rate of occurrence of Dumpsite Risk……..….50

Figure 4.2 Level of Satistcation to Solid Waste Services in Study Area.....54

Figure 4.3Location of legal and illegal dumpsites……..57

Figure 4.4:Map of the Study Area showing buffers around legal and illegal dumpsite…59

LIST OF PLATES

Plate 1: The Researcher at a typical scene of legal dumpsites.....79

Plate 11: The Researcher at a tyical scene of illegal dumpsites.....80

CHAPTER ONE : INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Waste Management is a global environmental issue and in Urban areas, it is one of the major problems facing city planners all over the world. The problem is especially severe in developing countries where increased urbanization, poor planning and lack of adequate resources contribute to the poor state of Municipal Solid Waste Management (Mwanthl, Nyabola and Tenambergen, 1997; Mato, 1999; Obirih and Post, 2002). Proper management of solid waste is critical to the health and well being of urban residents (World Bank, 2003).

It is a bit complex to summarize the total meaning of the term solid waste in a single definition (United State Environmental Protection Agency (USEPA, 2005).

According to USEPA (2005) solid waste is defined as any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant or air dried material, including solid, liquid, semi solid or contained gaseous material resulting from industrial, commercial mining, agricultural operation and from community activities. Solid wastes includes commercial and residential wastes generated in metropolis or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. Though the definition of the term will remain same there is a large variation in solid waste from country to country and the type of solid waste depends on the commodity usage and lifestyle of the people. At all level of the socio-economic development, human beings produce solid waste and have been producing it since civilization.. The Federal Government has instituted

National Integrated Municipal Solid Waste Management Intervention Programme in seven cities of Nigeria. The seven cities are Maiduguri, Kano, Kaduna, Onitsha, Uyo, Ota, and Lagos. Lagos state government established municipal solid waste management policy to 2

encompass private sector participation in waste collection and transfer to designated landfill sites (Ogwueleka, 2003).

Generally municipal solid waste is collected and deposited in sanitary landfill, such unscientific disposal attract birds, rodents and fleas to the waste dumping site and create unhygienic conditions (Suchitra, 2007). The degradation of the solid waste results in the emission of carbon dioxide (CO2), methane (CH4) and other trace gases. The unscientific landfill may reduce the quality of the drinking water and causes the disease like jaundice, nausea, asthma (Amar, 2008).

Nowadays, there is a general agreement on the best practices for sustainable management of urban solid wastes, and there are isolated experiences throughout the world applying these principles. However, the goal of sustainable waste management seems far from being reached. Reduction of waste production is still more a hope than an achievement in most countries. The net waste production increases as population grows, and the per capita generation of waste is also increasing, particularly in developing countries (World Bank, 1999). Waste recovery processes have been applied successfully but the amounts of wastes being diverted to these processes are generally small.

The solid waste materials in cities are the natural outcome of human activities. Most of our cities and municipalities in third world countries is a major concern of the government due to the health problems associated with improper disposal of waste. The rapid growth of population and urbanization decreases the non-renewable resources and disposal of waste matter and toxic waste haphazardly are some of the major environmental issues posing threats to the existence of human being. The most common problems associated with improper management of solid waste include diseases transmission, fire hazards, odor

nuisance, atmospheric and water pollution, aesthetic nuisance and economic losses (Basagaoglu,1997).

Management of solid waste in our cities posed serious challenges due to the absence of the appropriate and organized waste management culture and technologies. This arising largely from financial and technological constraints (Golit, 2001). The management of solid waste is becoming ever more problematic due to rapid population growth combined with increased levels of resource consumption, and the inability of many municipal governments to provide adequate waste-disposal services within their jurisdictions (Hardoy, et al, 2001; Myers, 2005; UN-Habitat, 2009). Doka and Gabasawa has over time experienced rapid urbanization sprawling settlements leading to populations growth which in turn have the effect of increasing the generation of solid waste dumpsites and with efforts to clean the districts proven abortive. That's why the researcher has interest in finding solutions to some of these problem using Remote Sensing and Geographic Information.

Remote sensing is one of the excellent tools for inventory and analysis of environment and its resources, owing to its unique ability of providing the synoptic view of a large area of the earth's surfaces and its capacity of repetitive coverage. Its multispectral capability provides appropriate contrast between various natural features where as its repetitive coverage provides information on the dynamic changes taking place over the earth surface and the natural environment (Navalgund and Kasturirangan, 1983). Remote sensing data can be an aid in identification and location of garbage dumping sites and in monitoring the changes in land use within and near hazardous waste and sanitary landfills (Radhakrishnan & Adiga, 1996).

Technological development in computer science has introduced geographic information system (GIS) as an innovative tool in landfill process (Kontos, Komilis and Halvadakis, 2003).

GIS combines spatial data (maps, aerial photographs, satellite images) with the other quantitative, qualitative and descriptive information databases. This technology offers an analytical frame work for data synthesis that combines a system capable of data capture, storage, management, retrieval, analysis and display. When remotely sensed data are combined with other landscape variables organized with in a GIS environment provide an excellent frame work for data capture, storage, synthesis, measurement and analysis. For assessing a site as a possible location for solid waste land filling, several environmental and political factors and legislations should be considered (Savage, Diaz and Golueke, 1998).

1.2 STATEMENT OF THE RESEARCH PROBLEM

The existence of dumpsites in Kaduna is a known fact however, their spatial distribution has not been established in a coordinated manner in order to assess the risk they posed to the localities in which they are found. The establishment of Federal Environmental Protection Agency (FEPA) in 1988 was to control the growing problems of Waste Management and pollution in Nigeria, but their aim is still very far from being achieved.The environment is getting more contaminated every day due to lack of commitment in Nigeria, it seems few organizations are willing to take the responsibility of solid waste management.

Though the Local Governments show interest but solid waste management funding is so expensive,somuchsothatthere is no adequate finance to facilitate the funding(Agunwamba,1998). Many Nigerians consume useful household material and discard it as solid waste indiscriminately without regard for the environmental impacts that may

follow. lack of funds to build proper disposal facilities is one of the driving forces of indiscriminate solid waste disposal in Nigerian cities (Agunwamba, 1998).

According to the state agency responsible for waste management which is Kaduna Environment Protection Agency (KEPA), solid waste in Kaduna metropolis is to be dumped by the public at designated collection areas which are made up of metal boxes that are easily loaded on to trucks mechanically or made of blocks. Even where these are available, the waste are thrown in a more or less uncontrolled manner and the pile of waste does not allow free access to waste points and often produce unpleasant and hazardous choking smell from dumpsites. The present disposal situation is expected to deteriorate even more with on going rapid urbanization (Egunjobi, 1992). Solid waste management has remained an intractable environmental sanitation problem in Nigeria. This problem has manifested in the form of piles of indiscriminately disposed heaps of uncovered waste and illegal open-air dumpsites along major roads and at street corners in cities and urban areas. This problem is compounded by the rapid urbanization and population growth which has led to the generation of enormous quantities of solid waste which are often discarded by open dumping (Abah*et al* 2010).

Dumpsites are the major causes of environmental degradation and public health concerns in many developing countries including Nigeria. These waste dumps may contain a mixture of general waste and toxic, infectious or radioactive wastes and are susceptible to burning and exposure to scavengers. There are a number of major risks and impacts of the dumpsites on the environment. For instance, air pollution from open burning, due to emission of green house gases such as methane and carbon dioxide; the air emissions and leachates generated as a result of decomposition of waste may contaminate air, surface and groundwater sources; fire hazards and explosions cause public health risks as well (Abah*et al* 2010).

Management of solid waste in our cities, including Kaduna, continues to pose serious challenges due to the absence of the appropriate and organized waste management culture and technologies, arising largely from financial and technological constraints (Golit in Nwude, 2008).

The emission of greenhouse gases rats and fly infestation as well as nuisance effects are among the health and environmental impacts of poor solid waste management. In addition, scattering of wastes by wind and scavenging by birds, animals and waste pickers creates aesthetics nuisance. Odour emanating due to the degradation of the waste in the open dumpsites has nuisance effect and decreases the economic and social values in the locality. In many open-air dumpsites, the waste is directly exposed due to the absence of daily cover on the dumped waste and this attracts the animal and human scavengers (Abah*et al,*2010).

Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution in particular, the environmental quality and human health risks associated with the waste dumps. The World Health Organization estimated that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution (Abah*et al* 2010)

Most cities in the developing world are therefore, 'drowning' in waste. Solid waste dumpsites represent one of the most ever growing problems facing governments all over the world for which they seem to have no ready solutions. It has very great negative impacts for the public health and well being, affects the quality and sustainability of the environment as well as the efficiency and productivity of the economy (Sandra, 1995).

According to the state agency responsible for waste management which is Kaduna Environment Protection Agency (KEPA), solid waste in Kaduna metropolis is to be dumped by the public at designated collection areas which are made up of metal boxes that are easily

loaded on to trucks mechanically or made of blocks. Even where these are available, the waste are thrown in a more or less uncontrolled manner and the pile of waste does not allow free access to waste points and often produce unpleasant and hazardous choking smell from dumpsites. The present disposal situation is expected to deteriorate even more with on going rapid urbanization (Egunjobi, 1992).

Osazuwaand Abdullahi, (2008) electrical resistivity and induced polarization investigation at an open solid waste dumpsite, Kaduna, Nigeria. Ten survey profiles were laid around the perimeter of the dumpsite, as well as outside the waste disposal site to map the contaminated zones and to investigate the subsurface features responsible for the migration of the leachate. The survey was performed with multi-channel (42) ABEM Field equipment. Interpreted resistivity/induced polarization models from survey profiles at the margins of the dump showed a contamination plume extending below the groundwater table while water quality analysis from existing hand dug well near the dump showed elevations in pollutant concentrations exceeding the permissible limits. There is a strong correlation between the geophysical measurements and the physiochemical analysis. Migration of the contaminants is believed to be through interconnected pore spaces which are evident from the characteristics of the conductive nature of the geo-electric layers.

Nishanth, Prakash and Vijith (2010) determined suitable site determination for urban solid waste disposal using GIS and Remote sensing techniques in Kottayam Municipality, India. A GIS technique was employed for the research. The total buffer zone covers 24.61536 Km^2 areas. The results shows that 4.2909 km 2 area is very less suitable , 14.1833 km 2 area is less suitable, 3.90096 km^2 area is moderately suitable and 1.5824 km^2 area is highly suitable and 0.65773 km^2 area is very high suitable for dumping waste. High and very high suitable categories are found at the area between Manganam and Vadavathoor and also at

Mulavattam. The authors recommended that the main environmental issue which should be considered in disposal of hazardous solid waste is the location of its land filling.

These previous works were concerned with solid waste generation, and management in Nigeria as well as parts of Kaduna. To the best of my knowledge this study "Spatial Distribution of Solid Waste Dumpsites and their Effects on thesurrounding" have not being carried out in Doka and Gabasawa Districts ofKadunaState Metropolis using Remote Sensing and GIS.

Thefollowing research question are pertintent:

1. What are the different methods of waste disposal in the area?
2. What are the spatial distribution of legal and illegal dumpsites in Gabasawa and Doka Districts of Kaduna metropolis ?
3. What are the the potential risk posed by the dumpsites in the study area?

1.3 STUDY AIM AND OBJECTIVES

The aim of the study is to analyse the spatial distribution of solid waste dumpsites and their effect on the surrounding in Doka and Gabasawa Districts of Kaduna Metropolis. The aim will be achieved through the following objectives which are to:

(i) characterise the different methods of solid waste disposal by the residents of the study area.

(ii) map out the spatial distribution of legal and illegal dumpsites within the study area.

(iii) ascertain the potential risk posed by the dumpsites to the surrounding.

(iv) assess the dumpsites that violets KEPA regulation in the study area.

1.4 SCOPE OF THE STUDY

This study focuses on The Spatial Distribution of Solid Wastes Dumpsites in Doka and Gabasawa in Kaduna Metropolis.

The study covers only Doka and Gabasawa districts of Kaduna Metropolis. The study specifically dealt with the identification and mapping of legal and illegal dumpsites in the study area, determine the area covered and not covered as well as analyze the environmental problems associated with the spatial distribution of dumpsites in the area. On the temporal basis, the study covered waste dumpsites as at 2004 to 2014.

1.5 JUSTIFICATION OF THE STUDY

There is an increasing commercial, residential and infrastructural development due to population growth , urban expansion and this directly affects the amount of waste generation and disposal. Thus, it is of vital importance to study the solid waste dumpsites location as well as the spatial distribution for both planning intervention, management purposes, as well as the data generated thus would form a data base for consultation in subsequent similar situations.

Poor distribution of solid waste dumpsites has lead to the following health problems which includes as a result of uncollected watses often end up in drains, causing blockages that result in flooding and unsanitary conditions, open and overflowing bins attract stray dogs, which has been a major cause of spread of rabies, open waste bin also attracts stray and domestic cattles. Cattle in the city cause nuisance by blocking the traffic on the roads, Cattle that graze on the waste bin end up eating the plastic along with the vegetable matter, which proves to be fatal for them. The milk obtained from the cattle that feed on watse can be contaminated and

can prove to be unsafe for human health, Flies breed in some constituents of solid wastes, and they are very effective vectors that spread disease, Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tire and other objects.

Mosquitoes spread diseases, including malaria and dengue, Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of water supplies, ponds and lakes. Chemical watses (especially persistent organics) may be fatal or have serious effects if ingested, inhaled or touch and can cause widespread pollution of water supplies.Methane (one of the component of landfills gas) is much more effective than carbon dioxide as a green house gas, leading to climate change and so on.

1.6 ORGANIZATION OF THE STUDY

The outline of the study is as follows: Chapter One is an introduction to the study, which consists of background to the study, statement of reserach problem, research questions, aim and objectives, scope and delimitation of the study and justification of the study.

Chapter Two presents conceptual frame work and literature review which focused on definination of waste, classification of waste, waste generation, waste collection,waste transportation, waste disposal and waste management in the world.

Chapter Three describes the study area and methodology: the study area, location, climate, relief and drainage, geology, soils and vegetation, population and people, socio- economic activities and ecological challenges while the methodology consists of types of data used, sources of data, data collection procedure and data analysis. Chapter Four: present results and discussions. Lastly, Chapter Five: Summaries and concludes the study with the recommendations.

CHAPTER TWO : CONCEPTUAL FRAME WORK AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the conceptual framework and the review of related literature on the spatial distribution of Dumpsites in Doka and Gabasawa Districts of Kaduna Metropolis. The essence of the presentation is to review literature relevant to the study.

2.2 CONCEPTUAL FRAME WORK

2.2.1 Wastes

'Waste'according to Basel convention are substances or objects which are disposed or are intended to be disposed or required to be disposed off by provision of natural laws.The United Nation Statisctics Division (2011) see wastes as materials that are prime product for which the generator has no further use in term of his/her own purposes of production, transformation or consumption, and of which he she wants to dispose.

Waste is defined as any unwanted material that is due for discarding. But technically, waste is considered as a resource in the wrong place (Abdullahi 2011).Mabogunje (1988) stated that waste is any unavailable material arising from individual, domestic, occupational, industrial or any human activity (which has no economic value) for disposal. Waste can also be defined as any substances which require being disposed. Waste can be classified waste into three major groups based on their sources and composition namely; solid, liquid and Gaseous. Solid waste occupies a geographical space. It does not decompose easily, and also does not evaporate like the gaseous waste. This work is concerned with the solid waste.

Waste is something for which we have no further use and which we wish to get rid of. Solid wastes arise from unusable residues in raw materials, leftovers, rejects and scrap from process operations, used or scrap packaging materials and even the saleable products

themselves when they are finally discarded. Equally, Waste is defined as any substance or object which the holder discards or intends to discard. Solid waste can be classified based on composition, source as well as physico-chemical properties. The classes of solid waste based on source are: municipal (domestic, institutional and commercial), agricultural, mining and mineral, radioactive and industrial wastes. Among these sources, industrial and municipal wastes contribute the highest volume annually. For the purpose of this study, municipal solid waste is considered.

2.2.2 Classification of Wastes

The United Kingdom Environment Council (2000) employed source classification to identify the major sources of waste; as municipal sources, commercial and industrial, agricultural sources, demolition and construction activities, dredged spoils, sewage sludge and mining and quarrying operations. Classifying wastes by their sources is a useful way of determining the relative contributions of the different sectors of society to the waste stream and how to plan for their collection and disposal.

Frequently, the material composition of the waste stream is also used to classify wastes into such types as organic waste, paper and cardboard, plastic, glass, ceramics, textiles, metal and inert waste. Surreywaste.info (2008) identified nine main types of materials on the basis of material composition namely: paper/card, plastic film, dense plastic, textiles, miscellaneous combustibles, glass, ferrous metal, garden waste and food waste. Therefore, components and amounts of waste generated vary for different towns and cities. In addition, a number of determinants account for the type of waste generated, these include; levels of economic development, seasons of the year, and public attitudes (consumption patterns, as well as lifestyles) (Sanyanga andMasundire, 1999).The methods for handling and disposing of waste differ considerably.

2.2.2.1 Types of solid waste

The solid wastes are subdivided into the following:

(a) Garbage. Garbage is the solid or semi-solid waste incidental to preparing, cooking, and serving food, and cleaning of food service items. It does not include rubbish. Garbage is classified as edible or non-edible. Edible garbage is that part of the garbage which is suitable for animal food such as scrap meat and vegetables. Non-edible garbage is that garbage which cannot be used for animal food, such as tea leaves, bones, and egg shells.

(b) Rubbish. Rubbish consists of wastes which originate in food service facilities, barracks, wards, quarters, and offices. It includes items such as wastepaper, plastics, wood, metal, glass, ashes, and broken or damaged crockery. Rubbish may be classified as combustible or non-combustible depending upon whether or not it can be burned.

2.2.3 Waste Generation

Waste generation is primarily a function of people's consumption patterns and thus is based on their socioeconomic characteristics (Bernstein, 1999). It includes activities in which materials are identified as; no longer of any value and so are either thrown away or gathered together for disposal (Theodore and Theodore, 1996). The increasing amount of waste arising from urban areas and its consequent disposal has been one of the major environmental and economic problems in most developing countries (Brunner and Fellner, 2007; Blight, 2008). This has been acknowledged by most governments, however rapid population growth overwhelms the capacity of most municipal authorities to provide even the most basic services.

Low income groups and the very poor typically generate low volumes of organic waste. For example, in Tashkent, Uzbekistan; there is little food to go around and the parts that are not consumed by the household members are used for the domestic animals or composted to amend the garden soil. Those who are somewhat better off may share leftovers as well as old clothing with those needier (Bernstein, 1999). Also, in the late 1990s, it was estimated that each person in the world generated 200 kg of solid waste per year (UNCHS, 2001) and this was forecasted to increase with the growth in population. It is estimated that in 2006 the total amount of municipal solid waste generated globally reached 2.02 billion tonnes, representing a 7% annual increase since 2003. It is further estimated that between 2007 and 2011, global generation of municipal waste would have risen by 37.3%, equivalent to roughly 8% increase per year. Based on reports from its participants, the Basel convention estimated that about 318 and 338 million tonnes of hazardous and other wastes were generated for 2000 and 2001 respectively (Global Waste Management Market Report, 2007).

At a more regional study by Mukuka and Masiye (2002), a similar trend was revealed that there was a quasi linear relationship between population growth and waste produced in Lusaka (Zambia). A more alarming example was also found in Indonesia's region of Jabotatek, which includes Jakarta, where population growth was fast and waste generation rate was estimated at 50,000 m3/day or 7 million tonnes per year (Otten, 1996). The rate of increase in the quantity of waste generated in relation to the population size can only worsen urban environmental issues and planning as a whole.Total waste generated per year in Kaduna is estimated at 285,300 Kt. This is derived from an estimate of per capita waste generation of 0.50 Kg/day, and a total population of 1,563,300 for Kaduna metropolis (Abdullahi, Shaibu-Imodagbe, Mohammed, Sa'id and Idris, 2009; Ogwueleka, 2009).

In Kaduna metropolis the following types of wastes are generated; biodegradable,which includes things like food and kitchen waste such as meat trimmings or vegetable peelings,

yard or green waste and paper. These particular wastes are common in the residential areas also recyclable materials include paper and stationeries materials and non-biodegradable items such as glass, plastic bottles, other plastics, chemical, pesticides, dye, refining, rubbers, industries goods,metals and aluminum cans, these categories are easily accessible and commonly seen along the Ahmadu Bello way where related companies are located(Abdullahi, Shaibu-Imodagbe, Mohammed, Sa'id and Idris, 2009; Ogwueleka, 2009).

The Inert waste materials are those that are not necessarily toxic to all species but can be harmful or toxic to humans. These involve construction and demolition. Others identified include composite waste includes items that are composed of more than one material, typical examples are clothing and plastics such as children's toys are composite waste, and household hazardous waste comprises medicines, paint,batteries, light bulbs, fertilizer and pesticide containers and e-waste like old computers, printers, and cellular phones. These households hazardous waste cannot be recycled or disposed of with compared with other waste categories so the Central Business District of Kaduna metropolis is where this is highly concentrated. These categorization buttresses the findings of Igbaonugo (2004), which revealed municipal wastes consists of household waste, construction and demolition debris, sanitationresidue, and waste from streets. This garbage is generated mainly from residential and commercialcomplexes. With rising urbanization and change in lifestyle and food habits, the amount ofmunicipal solid waste has been increasing rapidly particularly in developing countries and its composition changing.

2.2.3.1 Scavenging

Waste picking is a widespread activity in nearly all cities of developing countries. Men, women and children survive selling or using valuables from materials that households and

enterprises throw away, such as food, paper, scrap metals, cloth, household goods and building materials etc. Some waste pickers work at a single site that holds an abundance of waste, like dumpsites or transfer stations. Others move from place to place, collecting materials from factories, offices, stores, schools, hospitals and residential areas, and dumpsters, vacant lots, canals, and rivers where people dump their refuse (Bernstein, 2004). In Onitsha, 40% of artisans and small-scale industries receive 48% of their raw materials from scavengers and are commonly refer to the informal sector in waste collection is significant. This sector is responsible for removing 30 percent of total generated waste in the urban areas (Ogwueleka, 2009).

Waste pickers are often regarded among the poorest of the poor. They are vulnerable because they have few assets and few alternative livelihood options if their earnings from waste picking are threatened. The vast majority are also independent, self-employed workers, so they have no social security or organizational support to help them through difficult times. In many countries municipalities take measures to formalize waste collection and recycling activities by organizing the labour often in teams or enforcing registration procedures. However, waste pickers are not provided with any benefits, i.e. health insurance or personal security, thus remaining extremely vulnerable to variety of social and health risks (Bernstein, 2004).

Changes in collection and disposal practices of solid waste management systems can profoundly affect waste pickers and their livelihoods. Closing existing dumps and opening new ones further away, and mechanizing collection can restrict if not eliminate many opportunities for waste picking, causing extreme hardship for people who are poor and vulnerable. Closing dumps can also displace families who cannot afford other places to live. Waste pickers are among the key stakeholders of municipa solid waste management systems (Bernstein, 2004).

2.2.3.2 Recycling

Recycling inorganic materials from municipal solid waste is often well developed by the activities of the informal sector although such activities are seldom recognized, supported, or promoted by the municipal authorities. Recycling of solid waste is a method of solid waste management that have been practiced since ancient time. For example, metal implements were melted down and re-casted in prehistoric time. Today, recyclable materials are recovered from municipal refuse and recycled (Chris, 2003).

2.2.3.3 Reuse

Recovered broken glass can be crused and used in asphalt pavement, aluminium is one of the smallest components of municipal solid waste.If each state in Nigeria generates equal amount of wood wastes, then 82 368 m^3 of wood wastes will be generated in the country per day, and 30 064 320 m^3 annually. Resource from wood wastes alone could meet more than Nigeria's needs in the wood-based raw materials for such industries as potash industry, since African wood species have been studied to have potentials for generating good amount of potash (Adewumi, Ogedengbe, Adepetu and Fabiyi, 2005). Interestingly, Poverty is closely associated with low levels of garbage generation and waste collection as well as high levels of waste sorting, re-use, and recycling. Poverty also is associated with residential proximity to dump sites as well as exclusion from municipal services (Bernstein, 2004).

2.2.4Solid Waste Management

Solid Waste Management is a polite term for garbage management. As long as humans have been living in settled communities, solid waste, or garbage, has been an issue, and modern societies generate far more solid waste than early humans ever did. Daily life in industrialized

nations can generate several pounds of solid waste per consumer, not only directly in the home, but also indirectly in factories that manufacture goods purchased by consumers. Solid waste management is a system for handling all of this garbage; municipal waste collection is solid waste management, as are recycling programs, dumps, and incinerators (Baron, 1995)

To the great benefit of archaeology, early solid waste management consisted of digging pits and throwing garbage into them. This created a record of the kinds of lives that people lived, showing things like what people ate, the materials used to make eating utensils, and other interesting glimpses into historic daily life. Baron (1995) stated that when human cities began to be more concentrated, solid waste management became a serious issue. Houses that did not have room to bury their garbage would throw it into the streets, making a stroll to the corner store an unpleasant prospect. In response, many cities started to set up municipal garbage collection, in the form of rag and bone men who would buy useful garbage from people and recycle it, or waste collection teams, which would dispose of unusable garbage.

Recycling inorganic materials from municipal solid waste is often well developed by the activities of the informal sector although such activities are seldom recognized, supported, or promoted by the municipal authorities. Recycling of solid waste is a method of solid waste management that have been practiced since ancient time. For example, metal implements were melted down and re-casted in prehistoric time. Today, recyclable materials are recovered from municipal refuse and recycled (Chris, 2003).

Reuse of organic waste material, often contributing to more than 50% of the total waste amount, is still fairly limited but often has great recovery potential. It reduces costs of the disposal facilities, prolongs the site's life span, and also reduces the environmental impact of disposal sites as the organics are largely to blame for the polluting leachate and methane problems (Chris, 2003).

Most of the municipal solid waste (MSW) in developing countries is dumped on land in a more or less uncontrolled manner. These dumps make very uneconomical use of the available space, allow free access to waste pickers, animals and flies and often produce unpleasant and hazardous smoke from slow-burning fires. On-site disposal has become increasingly popular during the past decade as a way of minimizing the waste problems as its source. The most widely used devices for onsite disposal are incinerators and garbage grinder. Garbage grinders are becoming increasingly prevalent in homes for disposal of kitchen food waste garbage in flushed sanitary sewer system (Arthur, 2010).

2.2.5Current Waste Management Situation in Nigeria

2.2.5.1Waste Generation And Composition

The importance of reliable information on both the quantity and composition of municipal solid waste for the effective planning of waste handling infrastructure has long been recognised. It shows the percentage of waste that can be recycled, reused, composted, and biologically stabilized (Dennison, Dodd and Whelan, 1996).

The total solid waste generation in Nigeria is rising steadily due to increase in population while scarcity of reliable data (Wilson, Velis, and Cheeseman, 2006) has made the per capita waste generation trend inconclusive. The estimate of waste generated per person in a day is 0.49 kg with households accounting for 90% of the urban waste (Solomon *et al.,* 2009). The generation per person in cities at particular time intervals vary from 0.13 in Oyo (Afon and Okewole, 2007) 0.25 kg/day (Dauda and Osita, 2003) in Maiduguri to 0.47 kg in Makurdi (Sha'Ato, Aboho, Oketunde, Eneji, Unazi and Agwa, 2006) and at the top of the range Abuja

with 0.57 average according to the waste audit report (2004). This is within the range of per person waste quantities in developing countries of 0.1 kg/day to 1.2 kg/day.

Solid waste generation is strongly influenced by time of year, traditions, personal income (AlJarrah and Abu Qdais, 2006; Imam *et al.*, 2008), household size (Bandara, 2007) and environmental awareness and concern. A study by Afroz *et al.,* (2010) found that individuals with higher income generated more waste than lower income people and respondents that were concerned about the environment generated less waste. In another study, the highest generationof waste was recorded in December due to festivities in the southern city of Ogbomosho in Nigeria illustrating the influence of time of year and traditions (Afon, 2007). Larger households have been found to produce less waste than smaller households (Poll, 2004; Jones, Nesaratnam and Porteous, 2008).

2.2.5.2 Temporary waste storage

Waste is temporarily stored without separation at the point of generation within households or at communal disposal sites in urban cities in Nigeria. It is a key aspect of the management strategy as it determines to a large extent the efficiency and effectiveness of collection. Within and around households, waste is stored in various sizes of bins and bin bags by the more affluent population and in used baskets and buckets by the less affluent (Abdullahi *et al.,* 2008). Unlike Abuja, the capital city in Nigeria, most environmental agencies have not made provision or specified collection containers (Imam *et al.,* 2008).

More than 50% of the population in the cities use communal disposal sites as temporary storage. Waste is transferred from point of generation to these sites situated within each area by household members or contracted private collectors (Dauda and Osita, 2003). The

communal disposal sites are open dumps characterized by uncontrolled emissions, presence of rodents and strong odour.

2.2.5.3 Private sector participation

The ineffectiveness of collection by the public sector in Nigeria, with uncollected waste of approximately 50%, has led to the birth of both formal and informal private sector participation (Kofoworola, 2007; Afon, 2007). Private sector participation is normally driven by the need to provide a solution for inadequate and/or overly expensive service provision (Cointreau-Levine, 1994; Ogu, 2000; Afon, 2007). The reason for adopting any one of the two options of formal or informal service usually depends on affordability and convenience (Afon, 2007).

2.2.5.4Formal private sector

The formal private sector service provision is generally characterized by cleaner collection methods from source of waste generation and proper disposal to final dumpsites. They operate under four types of participation; contracting, concession, franchise and open competition (Cointreau-Levine, 1994; Ogu, 2000). The services associated with the formal sector include street sweeping, collection and transportation of waste from households and evacuation from communal dumps usually without recycling or other treatment options carried out (Ogu, 2000; Hussain, 2008; Nzeadibe, 2009). The formal private sector encompasses:

(a) Contract; typically, a private firm is awarded a contract for a specific period by the govea specific period by the government for service delivery and is paid under terms of the contract (Cointreau-Levine, 1994). In Kaduna presently, a number of private firms have been

contracted to carry out these functions with the city zoned and allocated to each firm (Hussain, 2008).

(b) Concession; this is usually a long-term contractual agreement where the private firm builds the facility for the service while utilizing government owned resource (such as land). Ownership of facility is transferred to the government in some cases after a specified period of private ownership and operation or remains with the private firm (Cointreau-Levine, 1994). Lagos state is in the process of finding out the viability of this type of private sector partnership for waste incineration with energy recovery with a private firm (Oresanya, 2010).
(c) Franchise; franchise involves a competitive selection process for private firms, who solely provide service(s) in a specified zone and usually recover cost of service directly from customers regulated by the government (Cointreau-Levine, 1994). The private firms pay license fee to cover the cost of government monitoring and deposits a performance bond with the government.

(d) Open competition; open competition entails customers making private arrangements with individual firms of their choice for service provision (Cointreau-Levine, 1994). A license is granted by the government to qualified companies who can compete and operate within a zone with any number of other firms. Costs are recovered from direct billing of customers.

2.2.5.5 Informal private sector

Similar to many developing countries, the activities associated with informal waste management sector in Nigeria are scavenging of reusable and recyclable items from temporary and final disposal sites, and collection and transportation from households to communal dumps (Wilson *et al.,* 2006; Afon, 2007). Wilson *et al.,* (2006) describes the sector as small-scale and labour-intensive, with low technology and pay; no documentation

and largely unregulated and unregistered provision of waste management service. In addition, they do not pay taxes and are not licensed.

2.2.6Solid Waste Management in Kaduna Metropolis

The metropolis is made up of four urbanLocal Government Areas Kaduna North, Kaduna South, Igabi and Chikun. The city is with a population of 1,558,563 according to the 2006 census NPC, (2006). The Environmental challenges in the city include rapid urbanization, communal conflicts, poverty and decayed physical and social infrastructure. Kaduna state like many other urban centers is plagued with indiscriminate solid waste disposal problems. The Kaduna state government had applied various methods of interventions in solid waste management since 1970s through 1990s but had not achieved the desired success in ridding the Kaduna metropolis of solid waste menace (Hyuwa, 2010).

Equally, Hyuwa (2010) reported that as regards to method of waste disposal at the time a survey was carried out, about 38% of the people burnt their wastes,37% engaged the services of wheelbarrow boys, 8% engaged the services of refuse contractors, while only 3% were found to bury their waste. From the above information, it is clear that there was virtually no organized method of waste collection. Therefore, heaps of solid waste are always seen almost everywhere within the metropolis. The situation in Kaduna and Nigeria in general is quite different from what is obtainable in other developing countries where women are playing a key and significant role in waste collection, sorting and recycling. This is largely due to cultural construct and partly due to stigmatization associated with waste picking and recycling.

There are no data about the quantum of waste generated nor the role of women in waste collection, sorting and recyclingbut this study shows that women do play fringe roles in the informal sector of wasterecycling. At the household level, women do play a dominant role,

while at the dumpsites they are virtually absent. But at the recycling stage, women appear to be involved in some form of recycling of waste into locally made finished products as is the case in Kaduna.

2.3 LITERATURE REVIEW

Solid waste management has emerged as one of the greatest chanllenges facing state and local government environmental protection agencies in Nigeria, of which Kaduna state is not exempted. The volume of soild waste being generated continuees to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to parallel this growth. Solid waste mangement in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal of solid waste.

Most developing countries, Nigeria inclusive have solid waste management problems different from those foumd in industrialized countries in areas of composition density, political and economic frame work, waste amounts, access to waste for collection, awareness and attitude. The wastes are heavier, wetter and more corrosive in developing cities than developed cities.

One of the most important implications of wastes is the impact on economic activities. Labour and transport absorb the major part of the operating cost of wastes management services. It is usual for a city to employ between two to five workers for each 1000 persons. “Three worker per 1000 people may represent about 1% of the total national work force. Transportation is required on a scale of about one heavy vehicle per 15,000 persons. Thus,

waste management services can be up to 1% of the gross national product which means it one of the most expensive services in a city (Public Health Engineering Research Institute, 2001).

According to the World Health Organization (2006) residentof town and cities worldwide continuously roduce and dispose of large quantities of waste materials. The organization categotized waste disposed based on social status and standard of living, which are defined by such factors as education, income, culture technology and activities relating to each other.

However, waste materials produced in cities of the developed nations of the world are at variance with those produced in cities of the developing countries like Nigeria. The extend of development and sophistication defines the nature and proportion of waste being produced. Thus, waste are classified as either urban or rural waste, requently, domestic and commercial waste are known as urban waste, WHO (2006).

Literature suggests that technical factors influencing the system are related to lack of technical skill among personnel within the municialities and government authorities(Hazra and Goel, 2009), deficient infrastructure (Moghadam,Mohtarani, and Mohatarani, 2009), poor road and vehicle (Henry, Yongsheng and Jun, 2006), insufficient technologies and reliable data (Mrayyan and Hamdi, 2006).

Matete and Trois (2008) and (Asase, Yanful, Mensah, Stanford and Amponsah, 2009) respectively suggested that the factors affecting the enironmental aspect of the solid waste management in developing countries are lack of environmental central systems and evacuation of the real impacts. Ekere,Mugisha and Drake (2009). Proposed that the involvement of the population active environmental organization is necessary to have better systems. Similarly Abudulsalam (2010) looked at the health impact of solid waste management among residents around Mangwaneni dumpsites in Swaziland. He basically

focused only on population. The study was conducted among 78 households, found that 82% of the respondent seek landfills around them particularly because of odour.

Sharholy *et al.* (2008) indicated that the involvement of the private sector is a factor that could improve the efficiency of the system. Ukoje (2011) conducted analysis of the determinants and participation of stakeholders in Solid Waste Mangement in Zaria, Nigeria. She found out that social and economic contribution of stakeholders is a major additional to solid waste management and concluded that huge problem of sold waste management shows some level of failure on the part of institution , households, and stakeholders rather than lack of capacity to perform.

The operational efficiency of solid waste management depends upon the active participation of both the municipal agency and the citizens, therefore, socio-cultural aspect mentioned y some scolars include people participating in decision making (Sharholy *et al.,* 2008)

Management deficiencies are often observed in the municipalities. Some researchers that investigated the institutional factors that affect the system have come to the conclusion that local waste management authorities have a lack of organization capacities (leadership) and professional Knowledge. Besides, they concluded that information available is ery scanty from the pulic domain (Chung and Lo, 2008). The etremely limited information is not compltet or is scattered around various agencies concerned, therefore, it is extremely difficult to gain an insight into the complete problem of munici al solid waste management (Senge, Kaneko, Hirayama and Katayama- Hirayama 2010).

Sharholy *et al.,* (2008) further argued that because the capacity to handle all of the household waste generated is still weak, about 83% of the population drum refuse in either authorized or unauthorized sites in their neigbhourhood which creates unsanitary conditions. They added

that insufficient commercial facililties can lead to open defecation along bushes, drains and open spaces and the tendency for faecal material intermixed with household refuse.

In 2011 Amedu examined the spatial distribution of open air solid waste dumpsites and their effect on the people and their environment in Sabo Gari Local Government Area using remote sensing and geographic information system the researcher noted modernization and progress has had its share disadvantages and one of the main aspects of the concern is the pollution it is causing to the earth be it land, air or water. With increase in the global population and the rising demand for food and other essentials, there has been rise in the amount of waste being generated daily by each household. The wastes that are being genrated are indiscriminately dumped in available open spaces or in drainage channels. If at this stage the management and disposal of solid waste is improperly done, it can cause serious effect or health prolems to man and his surroungin environment. Waste that is not proerly managed , especially excreta and other liquid and solid waste from households and the community, are serious health hazard and lead to the spread of infectious diseases , also (Benedine, Robert & Abbas 2011). Analyzed the impact of the spatial distriution of solid waste dumpsites on infrasture facilities using Geographic Information System they found out these dumps were stituated on drainages, road networks, in and around school premises as well as adjacent to resdential buildings and adopted the Integrated Waste Mangement (IWM) approach which inoles reduce, reuse and recycles; education and sensitization of people and the estalishment of sanitation monitoring team to inspect the environment regularly and prosecute offenders.

Salam (2010) in his study environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini: Swaziland noted that residents living 200m away and those beyond 200m away from the dumpsites were affected. He also stated that the residents whose houses were within 200 meters of the dumpsite are victims of malaria, chest pains, cholera and diarrhea. However, residents whose houses were more than 200 meters were also

affected with the chest pain and bad smell from the dumpsite but with less severity. He concluded that dumpsites should be located at least 200 meters away from human settlements.

Zaidu (2008) in his study on the selection of final waste dumpsites in Kaduna metropolis adopted a distance of 500 meters as meeting the standard criteria for waste dumpsite location. Based on their findings, this study will consider buffers of 200 meters, 300 metres and 400 meters around dumpsites in the area but according to Kaduna Environmental Protection Agency (KEPA) standard a dumpsites should be sighted within the range of 400 meters from the residential areas. Also man has limitation on the way of solid wastes disposal as such dumpsites should not be more than 400 meters (KEPA 2014).

2.3.1Application of Remote Sensing and Geographic Information System in Waste management , Buffer Zone creation and Risks of dumpsite.

The use of Information Technology and availability of software programs like the GIS program have a great role to play in solid waste management, environmental monitoring and control, spatial data processing, storage, indexing, retrieval, analysis and communication of spatial information of the entire environmental data (Heywood and Cornellius, 2002). Mănoiu, Fontanine Costache, Prăvălie and Mitof (2013), researched on Waste Landfill Placement Suitability in Prahova, Romania Using GIS techniques as a methodology, the restrictive factors like distance from localities, forests, protected areas and water courses where buffered in accordance with the legislation in force, and overlaid with the reclassed natural factors e.g. slope, seismic and rainfall were analyzed, findings from the research shows that the suitability index for waste landfills (SIWL) in Prahova County, showed that

11% (516 km²) of the study area is favorable to waste landfill siting, but only 3.4% (160 km²) of the area is highly suitable.

Also Gouveia & Prado (2010) in their work, evaluated the association between people living close to solid waste landfill sites and occurrences of cancer and congenital malformations among populations in São Paulo. The researchers used Buffer zones of radius 2 km around the 15 sites and also Bayesian spatial models which showed thatthe highest values for the standardized mortality ratios were found in more central areas of the municipality, while the landfill sites were located in more peripheral areas, which had a greater risk of bladder and liver cancer, and death due to congenital malformation, but without statistical significance.

CHAPTER THREE : THE STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter describes the study area and methodology: the study area, location, climate, relief and drainage, geology, soils and vegetation, population and people, socio economic activities and ecological chanllenges while the methodology consists of types of data used, sources of data, data collection procedure and data analysis.

3.2 The Study Area

3.2.1 Location

Kaduna Metropolis is the capital city of the Kaduna state (Fig.3.1).It lies between Latitudes7^0 $22^{'}$ 40"E and $10^0$$34^{'}$ 40" N and Longitudes7^0 $27^{'}$ 50" E and 10^0 $29^{'}$ 50" East of Greenwich Meridian The state shares boundary with the following state; Zamfara, Katsina , kano in the North, Bauchi, Plateau in the Eastern part of the country on the western part lies to Niger state also occupies an area of about 260km^2; the distant between the Eastern and Westeren limits of the city is approximately 13.7 km. It is made up of two main Local Government Areas, the Kaduna North and Kaduna South, adjoining local government area that makes up the entire metropolis are Igabi and Chikun. Kaduna North is a Local government in Kaduna State, with headquarters in the town of Doka.

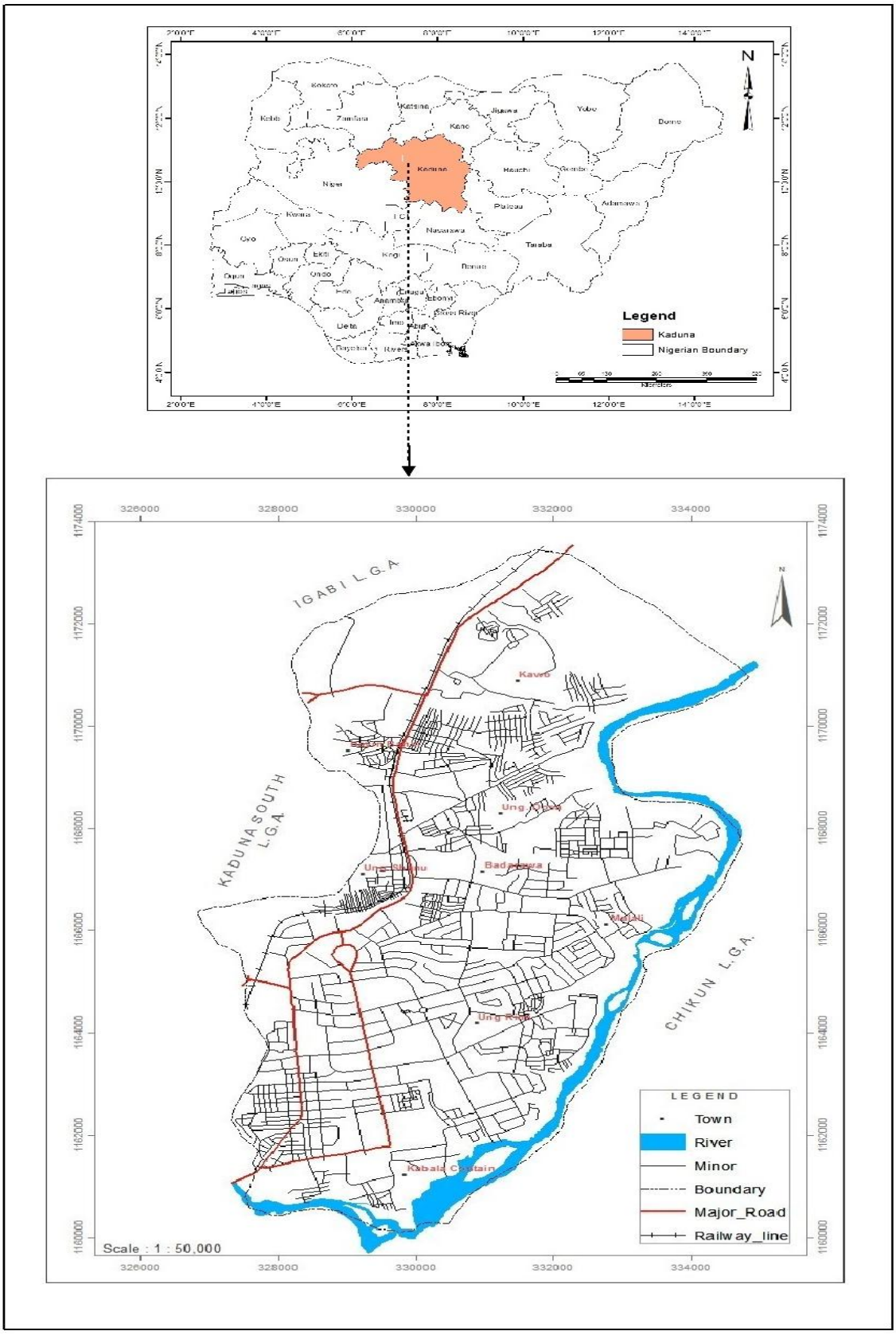


Figure 3.1:The Study Area Map
Source: Modified from the Administrative map of Kaduna (2014).

3.2.2 Climate

Kaduna experiences tropical continental climate (A_w), of koppen classification. The A_w climate is characterised by wet and dry season in a year.The wet season lasts for six months (May to October) and is dominated by convectional heavy falls with intensities of up to 120mm/hr. The mean annual rainfall is about 120cm. The rainfall peaks up in july/August.The monthly temperature is between 21^0C and 32^0C. An annual temperature range of 11 to 13^0C is typical (Coker, 2000).

3.2.3 Relief and Drainage

The morphology of the area on which Kaduna is built comprises of a gentle undulating terrain at about 600m extending up to 50km outward but more to the north and south-east where it terminates at the foot of Jos Plateau. It is drained by river Kaduna. The river takes its sources from the Kajama hills on the Jos Plateau and flows for about 210km before reaching kaduna town. It cuts across the city diving it into Kaduna North and South areas. Beyond Kaduna, the river flows for about 100km into Shiroro dam. From Shiroro, there is another 200km flow before it finally discharges into River Niger on its Northern shores at Pategi (Sulaiman, 2001).

3.2.4 Geology

The geology of Kaduna is made of out crops of hard resistant granitic rocks which are as a result of weathering through the ages of perniciously existing pre-Cambrian rocks that have been exposed to agents of erosion through the ages. The activities resulted in the outgrowth of rocks forming inselbergs and large rocky land mass like that of Tudun Wada, Tundu Nupawa and Malali (Sulaiman, 2001).

3.2.5 Soils and Vegatation.

The soil of the study area is mainly lithosols developed over the thoroughly weathered solid geology, the regolith is overlain by a thin layer of Aeolian drift (Buchanan and Pugh 1962, Udo 1978). Along Kaduna River and some of its tributaries are alluvial soils and swaps soils (Vertisol, locally called Fadama Soil). On the upland areas, lateritic iron stone form a capping and erosion has dissected it to form mesas and buttes with secondary detrital lateritic surfaces on the lower slopes.The highly weathered soils which are lateritised by loss of silical are considered to be a zonal soil (Coker, 2000). These soils are developed under the prevailing climatic condition with enough rainfall the soil aggregates are usually very small, particularly in wet conditions, the water holding capacity is good but this primary depends on the structural composition (Mallo, 1998).

The vegetation is charcterized with the tree stratum dominated by *Isoberlina doka*. It is a parkland savannah made up of tall grasses as the lower stratum wiithin the city, the natural vegetation has been replaced by exotic species, which are observable in the parks, garden and road sides, some of the tree found within the city includes Eucalyptus (*Eucalytus globules*), medium size tree with large red flower (*Jacaranda minosaefolia*), timber tree (*Gmelia arborea*), and Mango (*Mangeifera indica*) other includes Gold Mohur (*Delonix regia*), Guava *(Psidiumquajava)*, Margosa (*Azadirachata indica*), and so on. Food crops such as maize, sorghum, sugar cane and ground nut etc are also grown (Coker, 2000).

3.2.6 Population and People

The state has a total population of 6,066,526 (NPC,2006). The figure has changed now because of increase in population as Kaduna is an admiinistratie centre in the Northern part

of the country. The popuation of Doka and Gabasawa is 205,354 (The population was Projected). The major tribes in kaduna are mainly Hausa, Gwari and other migrated people of different languages.

3.2.7 Socio-Economic Activities.

The state has a total population of 6,066,526 (NPC,2006). The figure has changed now because of increase in population as Kaduna is an admiinistratie centre in the Northern part of the country. The popuation of Doka and Gabasawa is 205,354 (The population was Projected). The major tribes in kaduna are mainly Hausa, Gwari and other migrated people of different languages.

Tertiary services are undertaken by Government and privately owned companies, parastatals, finance houses, legal chambers, architects, estates manager, etc distributed all over Kaduna township. They offer various services that are in accordance with their areas of specialization. It is interesting to mention here therefore, that most of these services are located within the Central Business Districts (CBD) of the city.

3.2.8 Ecological Chanlleges

In Kaduna state the role of humanity and solid waste are both contributing to the causes and effects of ecological changes within the metropolis. These includes Climate change: Global warming, Global dimming, Fossil fuels, Greenhouse gas, Urban Heat Islands and Flooding. Roads and agriculture land uses cut across all category of slopes. However, agricultural land uses it least in the part of the metropolis because the area is designed for industries and its

associated road linkages. Gulling pose the greatest treat to the survival of buildings and currently the most active in the areas where ground as been severely scared (Mallo, 1998).

3.3. METHODOLOGY

3.3.1 Type of Data Used

Data that was manipulated to achieve the aim and objectives of this study includes:

(i) Base maps of Doka and Gabasawa Districts.

(ii) Inventory of the dumpsites.

(iii)Geographic Coordinates of both legal and illegal dumpsites.

(iv) Responses on health implication of dumpsites.

3.3.2 Sources of Data

The sources of data used for this study were classified into two, which are the primary and secondary sources. Data was sourced primarily from the location of the various dumpsites in the area. This was got through the GPS survey of the study area during the field survey.

Materials for literature review were got from relevant projects, conference proceedings, street guide of Kaduna Metropolis provided by Kaduna Environmental Protection Agency (KEPA), journal articles related to the study were also used to obtained data of interest to the researcher. A high resolution Google image was got from the Google Earth Pro.

3.3.3 Data Collection Procedure

Structured questionnaire was used to get information out on the characterized different methods of solid waste disposal in the study area and the potential risk posed by the impact of these dumpsites on the environment.The instrument used for the collection of coordinates at the study area was a hand held GPS receiver. The process involved collecting waypoints within the boundaries of the study area. Collecting Coordinates was done by calibrating the GPS and allowing it to acquire satellites on the satellite page, after which the locations were fixed and saved on the GPS. This process was repeated for all the dumpsites encountered along the roads and streets so as to have their coordinates. The reliability of the data depends on the proper utilization and accurate recording of information on the data sheets.

3.3.3.1 Sampling Technique

A systematic random sampling technique was used to select samples of households from the population of the study area.

Gabasawa and Doka have a total projected population of 205,354 as shown in Table.3.1. A total of 384 sample size was selected from the study area based on Krejcie and Morgan (1972) sample size selection table, where it is stated that given a population size above 99999, sample size of 384 is appropriate based on the formula.

To determine the proportion of the respondents to be administered in Doka and Gabasawa Districts, sampling method for determination of respondents will be used.

Proportion of the respondent=$\frac{nx384}{N}$

Where n = population of each selected settlements/localities in the LGA.

N = total population of selected settlements in the selected LGA.

Due to unavailability of present population data infered method of projection was used to obtained the preent population sample size required.

Method of Population Projection (Pn)

$Pn = Po^{ern}$

Pn= Expected population

Po= Base year population

e = Exponential sign

r =Growth rate

n =Number of years interval.

The statistics is given in Table 3.1

Table 3.1 Table Showing Sample Size.

DISTRICTS	1991 Population	2013 Projected Population.	Selected Localities.	Proportion of respondents sampled.
DOKA	52,266	101,047	Ungwar Shaba, Ungwar Lima, Maiburiji and Doka.	189
GABASAWA	53,911	104,307	Ungwar sarkin and Ungwar Rimi	195

Source : Compiled by authors from Census figures of (NPC, 1991).

3.3.3.2 Data Processing

A high resolution satellite image of the study area was captured using Google Earth Pro. The image was import in ArcGIS 10 environment, and then projected to geographical coordinate system using World Geodetic System (WGS 1984), georeference and subset. Various shapefiles were created in the same environment and latter digitize. Again, the coordinates of the dumpsite were then import on the maps to show the locations on the map for various analysis and the results were presented inform of tables, charts, map and ArcMap documents format.

3.3.3.3 Location Of Dumpsites and Map Production

First, a database was created in Microsoft Office Excel containing the waypoints and their locations (easting and northing obtained from the GPS survey). The base map which had already been digitized was activated. The coordinates were then imported from Microsoft Excel into the GIS environment (ArcGIS 9.3) and then overlaid with the base map. A point-in-polygon overlay was carried out to show the spatial distribution of open-air solid waste dumpsites in the area.

3.3.3.5 Buffering

Buffers are rings drawn around features at a specified distance from the features.Based on the analyzed dumpsites the study adopted buffers of 200meters, 300meters and 400meters. These various buffer were carried out to see how many of these dumpsites fall within the standard

recommended by Kaduna Environmental Protection Agency. This operation is an important spatial operation that is concerned with the determination of proximity of spatial feature.

3.4 DATA ANALYSIS

The data collected for this research was analyzed in a variety of ways which ranges from the application of geospatial techniques, questionnaires and descriptive statistics. In order characterize the different methods of solid waste disposal by the residents of the study area, these were done during the reconnaissance survey and the waste was characterized on the basis of their type. To map out the spatial distribution of legal and illegal dumpsites within the study area, GPS was used in collecting the coordinate location of the waste dumpsite, typed in Microsoft excel, and lather import in to the ArcGIS environment, various analytical tools such as query, selection by attributes and location were used to show the spatial distribution of the dumpsite in the study area. In order to ascertain the potential risk posed by the dumpsites to the surrounding, Structured questionnaire was used to collect data to aid captured the views of the respondents and characterized different methods of solid waste disposal in the study area and also determined the potential risk posed by the impact of these dumpsites on the environment. Simple percentage statistical technique was used to analysed the data form the questionnaire. To assess the dumpsites that violets KEPA regulation in the study area, buffering analysis of 200m, 300m and 400m was carried out in order to assess the areas that violets or that do not complained with the KEPA regulations for siting of waste dumpsite.

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CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter deals with the presentation of result of this study. A total of 384 respondents were interviewed out of which same number were retrieved and analyzed, giving a response rate of 100%.

4.2 SOCIAL DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

This section reveals interesting social, demographic and economic attributes of the respondents. This considered aspect of respondents help revealed adequately the basic concern of this study as well as some basic information regarding the objective of this study.

4.2.1 Occupation of respondents

Occupation of respondents within the study area is access and presented in table below.

Table 4.1 Distribution of Respondents by occupation.

Occupation	Frequency	Percentage
Public servant	105	27.3
Private sector employee	86	22.4
self-employed	113	29.4
Unemployed	80	21.7
Total	384	100.0

Source: Field Research (2014)

Result presented in table 4.1 above shows that, out of 100% sampled respondents, 29.4% who constitute the majority are self-employed where 27.3% respondents are public servant, 22.4 % are private sector employees while 20.8% are unemployed.However, having that, roughly

all respondents have means of income, it can therefore be assumed that waste generation could be high within the study area, this can be ascribe to the findings of (Begon *et al.*, 1990) who observed that type of occupation contribute to the type of waste generated.

4.2.2 Educational level of respondents

Examining the educational level helps reveal the level of environmentalawareness and consciousness in the study area and this also has implications on wastemanagement. Table below revealed the educational level of respondents.

Table 4.2 Level of Educational

Level of education	**Frequency**	**Percentage**
Qur'anic education	25	6.6
Primary school	52	13.5
Secondary school	110	28.6
Polytechnic	197	51.3
Total	384	100.0

Source: Field Research (2014)

Reporting the education level of respondents in table 4.2 above disclosed that, most of the respondents are educated having 51.3% who attended polytechnic as their highest level of education, 28.6% stopped at secondary level, 13.5% stoped at primary school while few respondents covering 6.5% obtained Quranic education. Thus, very few of the sampled respondents have low level of education where more than one third of them are highly educated. Therefore, respondents have understanding on the phenomenon waste management.

4.2.3 Household Survey

Human population is concentrated in both rural and urban areas. These two areas generate solid wastes from various sources like domestic, industrial, commercial and agriculture. Being that everyone generated some quantities of waste daily, it is of great importance if the

population by household size of the study area is considered. Table below shows population by household size.

Table 4.3 Number of persons in household

Number of people in household	Frequency	Percentage
1-4	166	43.1
5-9	166	43.1
10-14	42	11.0
15-19	2	0.2
20-24	6	1.1
25 and above	2	0.5
Total	384	100.0

Source: Field Research (2014)

It is observed that the household having 1-4 and 5-9 people are more in the study area this is covering 43.1% respondents each, 11.0% of the household contained 10-14 people, 1.1% household contains 20-24 people while 0.5 % of the household contains 15-19 also 25 and above people.This is in accordance with the national average family size of between 8 to 10 persons per household (National Population Commission, 2006). Thus, those households with more than 10 persons may be those household with low level of educational attainment with culture and religion. Given the differential family sizes, it is expected that the amount of waste generated in the study area will varies as well.

4.2.4 Monthly Income of Respondents

Cost of living which dependents on the income level of individual in a way determine the categories of people who would prefer to reside in an environment, this also results to

generation of more waste in that area. However, monthly income of respondnets is given in Table 4.4.

Table 4.4. Monthly Income of the Respondents.

Monthly Income	Frequency	Percentage
less than N20, 000	194	50.5
N20, 000- N50 , 000	90	23.5
N50 ,000 and above	100	26.0
Total	384	100.0

Source: Field Research (2014)

The monthly income shows that majority of the respondents covering 50.5% earned less than N20,000 every month, 23.4% of the respondents earn between N20,000 and N50,000 every month while few covering 26 % respondents earn N50,000 and above.Thus, from the high as well as the low income earners residents inthe study area, the rateof waste generation is significant, this can be ascribe to the findings of Zhu et al (2008) who discovered that income level, economic growth and lifestyle have strong influence on wastegeneration.

4.2.5 Categories of Waste Generated

In Kaduna metropolis the following types of wastes and trash are mostly generated. The biodegradable,which includes food and kitchen waste such as meat trimmings or vegetable peelings, yard or green waste and paper. These particular wastes are common in the residential areas. The recyclable materials include paper and stationeries materials and non-biodegradable items such as glass, plastic bottles, other plastics, chemical, pesticides, dye, refining, rubber goods industries, metals and aluminium cans, these categories are easily accessible and commonly seen along the Nnamidi Azikwe Express way where related

companies are located. These categorization buttresses the findings of Igbaonugo (2004), that municipal wastes consists of household waste, construction and demolition debris, sanitation residue, and waste from streets.

Waste can be classified based on composition, source as well as physico-chemical properties. The classes of solid waste based on source are: municipal (domestic, institutional and commercial), agricultural, mining and mineral, radioactive and industrial wastes. However, from the study area, the types of waste generated are examination and presented in table below.

Table 4.5: Categories of household waste generated

types of wastes generated in house	Category of waste generated				Total	
	Non-Biodegradable waste		Biodegradable waste			
	Freq	Percent	Freq	Percent	Freq	Percent
Food and fruit, remnants	0	0	90	40.5	90	23.4
Paper and cardboard	0	0	40	18.0	40	10.4
Textile materials	32	19.8	0	0	32	8.3
Plastic materials	20	12.3	0	0	20	5.2
Metal scrap	20	12.3	0	0	20	5.2
Bottle and Glass	30	18.5	0	0	30	7.8
Ash and dirt	0	0	30	13.5	30	7.8
Leaves and Woods	0	0	62	27.9	62	16.1
Polythene and Nylon	40	24.7	0	0	40	10.4
Tin cans	20	12.3	0	0	20	5.2
Total	162	100	222	100	384	100

Source: Field Work (2015)

Result reposted in table above shows that, food and fruit, remnants comprise the bulk waste from the study area as revealed by 40.5% respondents. This high concentration is expected because food and fruit are generally consumed by both the high as well as the low income earners. Leaves and woods comprise the second largest category of waste as indicated by 27.9% respondents which are also found among the high and low income earner as well, this types of waste could be generated from garden flowers, trees etc.

A close examination of Table above revealed that the type of waste generated can be ascribed to the standards of living in each area. For instance, conditions of life in the rural areas are poor hence, few manufactured products can be afforded compared to urban areas where standard and quality of life are high and a variety of modern confectionaries are produced in bottles, tin cans and polythene bags and are mostly consumed by urban dwellers. However, it is instructive to note that even in urban centres; there is a spatial-temporal variation in the types of wastes collected.

4.2.6 Characteristics rating of different methods of solid waste disposal.

Table 4.6: Methods of solid waste storage

Method	Frequency	Percentage
Drums	169	44.0
Plastic containers	125	32.5
Cartons	74	19.3
Others	16	4.2
Total	384	100.0

Source: Field Research (2014)

Table 4.5 gives the methods of solid waste storage in the study area.The widely used method is in drum.This is practiced by 44.0% inhabitants in the study area, 32.5% store theirs in plastic containers, 19.3% store theirs in cartons while few covering 4.2% use other methods which includes: polythene, baskets, bagco bags etc. This implies that the common method of solid waste storage is the drum.

4.2.7 Waste disposal

Having examined the method of waste storage in the study area, table below further revealed some fundamental method used for disposal.

Table 4.7: Method of waste disposal commonly used

Response	Frequency	Percentage
Burying waste in landfill pits	70	18.2
Burning/incineration waste	100	26.1
Composing	30	7.8
Recycling	20	5.2
Open dumping	144	37.5
Others	20	5.2
Total	384	100

Source: Field Work (2015)

From table above, this study revealed that the common method of waste disposal is open dumping as indicated by 37.5% respondents, the second most considered method is burning/incineration waste as revealed 26.1%. Other methods are burying waste in landfill pits, composing, recycling as well as other method. More so, in several African cities, dumping and burning are the common disposal methods (Isuwa, 2006). For instance, in Kigali and Rwanda, 84% of the solid waste generated is burnt openly (Aryeetey-Attoh, 2003).Furthermore the above listed methods are rated in table below where majority of the respondents indicated that the method used for waste disposal is unsatisfactory.

Table 4.8: Rating of waste disposal methods

Response	Frequency	Percentage
Very satisfactory	40	10.4
Satisfactory	90	23.4
Unsatisfactory	200	52.1
Don't know	54	14.1
Total	384	100

Source: Field Work (2015)

More so, 52.1% respondents indicated that the above mentioned method used for waste disposal is unsatisfactory, 23.4% are satisfy by the disposal method of solid waste in the study area, only 10.4% respondents are very satisfied with the method they use in waste disposal while 14.1% respondents don't know.

4.2.8 Risk sposed by unsafe dumpsites.

The major concern in this section is to identify the risk posed by unsafe solid waste disposal that affect the wellbeing as well as the health condition of people in Kaduna metropolis. From Ajibuah (2013), indiscriminate disposal of wastes along Kaduna Metropolis is the main factor influencing susceptibility of residents along Kaduna River to floods annually. However, some basic problems of unsafe dumpsite in the study area is reported in table below.

Table 4.9: Risks Posed by unsafe dumpsites.

Risks	Frequency	Percentage
Flooding	80	20.8
Bad odour	107	27.8
Fire outbreak	23	6.0
Water pollution	92	24.0
Proliferation of insects	74	19.3
Others	8	2.1
Total	384	100.0

Table 4.9 pointed out that, the frequent risk posedin the study area as a result of unsafe dumpsite is bad odour.This is revealed by 27.8% respondents, also 24.0% respondents revealed water pollution as another frequent risk pose on the study area. However, 20.8% pointed flooding, 19.3% revealed proliferation on insects, 6.0%indicated fire out break while few respondents covering 2.1% opted others risks. However, the frequency of the listed risks post on the study area as a result of illegal dumpsite is displayed in figure below.

4.2.9 Rate of occurrence of Dumpsite Risk

The rate of occurrence of the risk posed on the study area as a result of the unsafe dumpsite identified in figure 4.1 above is revealed in figure below.

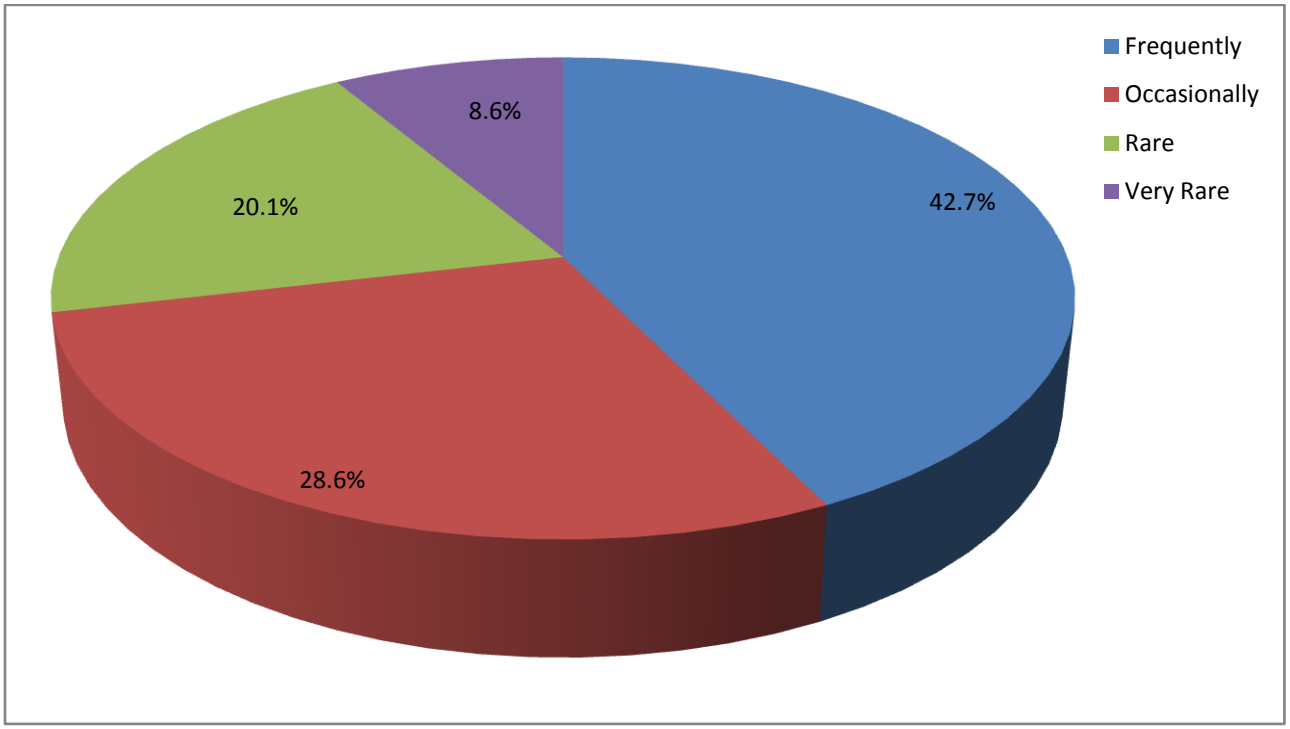


Figure 4.1: Rate of occurrence of Dumpsite Risk

The percentage distribution of respondents reported in pie chart above shows that, the said risk posed on the study area as a result of unsafe dumpsite is very high as indicated by 42.7% respondents, 28.6% pointed out that the risk is occasionally, 20.1% opted rare while just 8.6% revealed very rare. This study therefore indicated that, risk such as water pollution, bad odour and flood revealed in table 4.7 above occurs frequently.

4.3.1 Trend of occurrence across place of residence

The commonly practice of wastes deposition in the rural settlement of Kaduna metropolis which covers the slums, ghetto, and sprawl neighbourhoods of some residential areas is the open ranges, these are used as refuse dumpsites (Onwughara, et al., 2010). From a general point of view, the open ranges can be seen as the non-secured collection point covering the major routes, footpath and piece of undeveloped land or abandoned residential structure which no form of protection is given is mostly located within the rural settlement. However, this study examined and present result on the variation of risk posed by the said unsafe dumpsites across place of residence in table below.

Table 4.10: Rate of risk occurrence across place of residence

Rate of occurrence	Place of residence					
	Rural		Urban		Total	
Frequently	160	84.7	4	2.1	164	42.7
Occasionally	28	14.8	82	42.1	110	28.6
Rare	1	0.5	76	39.0	77	20.1
Very Rare	0	0.0	33	16.9	33	8.6
Total	189	100.0	195	100.0	384	100.0
X^2 = 2.809E2[a], df= 3, p-value = .000						

More so, this study revealed in table 4.8 above that, there is variation in occurrence of the risk posed by unsafe dumpsite across the place of residence having that, the occurrence is frequent in the rural settlement as recorded by 84.7% while is occasionally in the urban settlement as indicated by 42.1% respondent. However, the above presented is supported with a chi-square test conducted having p-value of .000 which is less than 0.05α level of significance. This is implying that, there is statistical variation in the occurrence of risk posed across place of residence in Kaduna metropolis.

Having examined occurrence of risk posed by unsafe dumpsite across place of residence, table below further revealed the category of people who are more vulnerable to the risk posed by unsafe dumpsite.

Table 4.11: Category of people more vulnerable to the frequency of the occurrence of risk posed in the study area

Rate of occurrence	Monthly Income						Total	
	less than N20, 000		N20, 000- N50 , 000		N50 ,000 and above			
Frequently	113	58.2	34	37.8	17	17.0	164	42.7
Occasionally	55	28.4	28	31.1	27	27.0	110	28.6
Rare	25	12.9	16	17.8	36	36.0	77	20.1
Very Rare	1	0.5	12	13.3	20	20.0	33	8.6
Total	194	100	90	100	100	100	384	100

Result reported in table above shows that, people earning less than N20,000 are experience frequent occurrence of the said risk posed, this is indicated by 58.2% respondents, those earning N20,000-N50,000 experience occasional occurrence of the risk posed on the study area where rare and very rare occurrence is experienced by amongst those earning N50,000 and above as indicated by 36.0% and 20.0% respondents respectively. Thus, this implies that, the occurrence of the said risk is more vulnerable amongst the low income earner.

4.3.2 Frequency of solid waste disposal

In waste management, irrespective of the types of collection point and wrong approach adopted for the collection, transportation and disposal could be seen as a problems in waste collection. (Nwude. 2006).The frequency of solid waste disosal by the residnence of the study area is given below in table 4.13**.**

Table 4.12: Frequency of solid waste disposal by the residence.

Frequency of waste disposal	Frequency	Percentage
Every day	95	24.7
2-3 times a week	116	30.3
Once a week	151	39.3
Others	22	5.7
Total	384	100.0

Table 4.12 shows that 39.3% of the respondents empty their waste once every week, also 30.2% of the respondents revealed that they empty their waste 2-3 times a week,while 24.7% revealed every day and while 5.7% opted others. This implies that respondents of the study area do not empty their waste frequently.

4.3.3 Location of waste disposal

Location of waste disposal in the study area is given in table 4.8 below.

Table 4.13: Location of waste disposal

Dumpsites	Frequency	Percentage
Approved depot	133	34.6
Open space	121	31.6
Burning	23	6.0
Gutters	95	24.7
Others	12	3.1
Total	384	100.0

Table 4.8 shows that, in the study area most of the respondents do not have positive attitude toward waste management, this is because 31.5% dump their waste in an open space, 6.0% respondent burn their waste, 24.7% dump their waste in gutters while 3.1 have others places where they dump their waste. However, only 34.6% respondents/people have positive attitude because they dump their waste in an approve depot.

4.3.4Solid Waste Services.

The level of satisfaction to solid waste services in the study area is shown below.

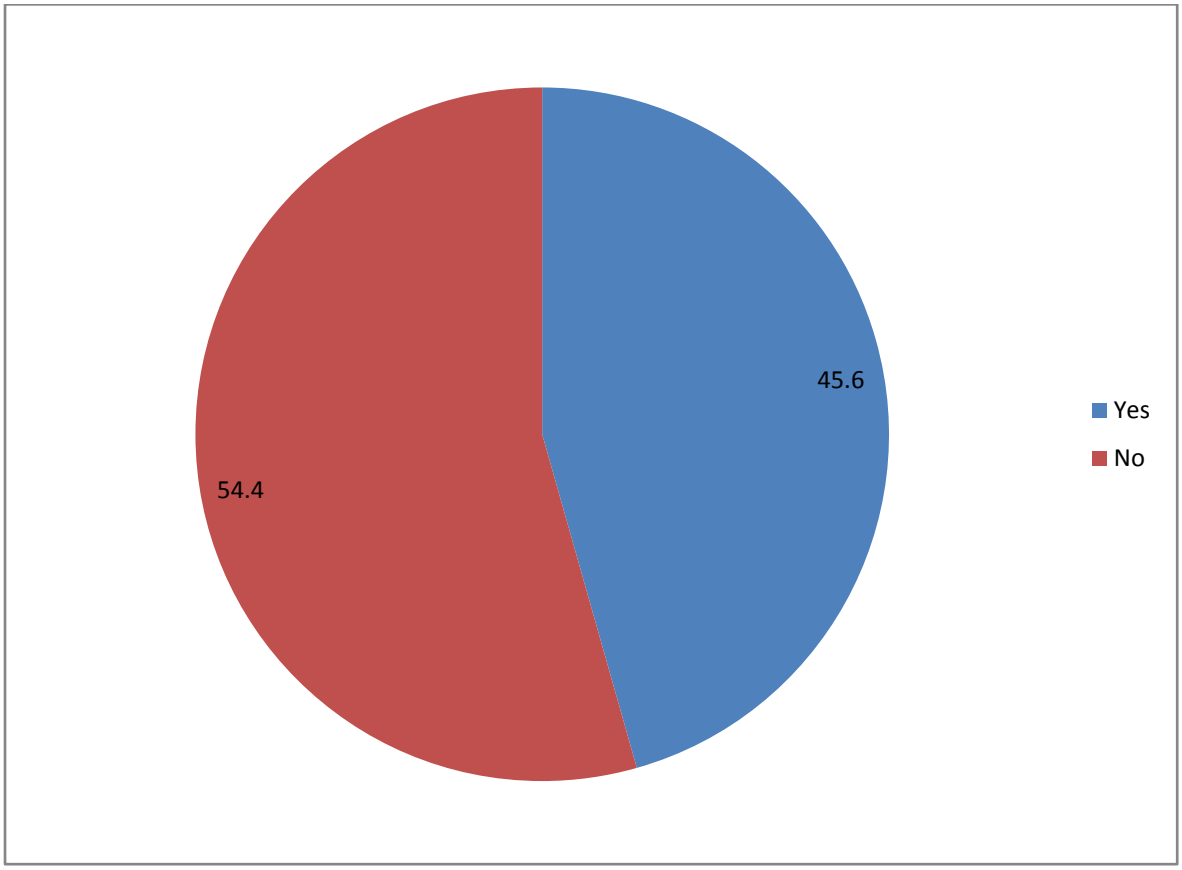


Figure 4.2: level of satisfaction to solid waste services

Figure 4.2 shows that majority of the respondents covering 209(54.4%) are not satisfied with the level of the solid waste services in Doka and Gabasawa District of Kaduna state while 175(45.6%) are satisfied. The majority are unsatisfied because the agency responsible for collection of waste over time have neglected there duty, residents even pay money for services and they are not render as such individual have resulted to disposal of the waste themselves.

Therefore, in order to maintain effective waste management services in Kaduna metropolis, this study gave relevant suggestion on how to better the services of waste management.

4.3.5 Suggestion to Improve the Services

The suggestion to improve the solid waste services is given in the table below.

Table 4.14 : Suggestion to improve the services

Suggestions	Frequency	Percentage
collecting waste in season and out of season	1	.3
Employ more staff to improve waste services	45	11.7
Government should provide situated site for deposition of waste	43	11.2
provide more facilities	25	6.5
Refuse collection points be develop	4	1.0
Sanitize the environment	15	3.9
No idea	251	65.4
Total	384	100.0

Table 4.14 revealed some suggestions on how to improve the services of the waste collection in the study area. Amongst the options suggested are: employment of more staff as revealed by 11.7% respondents, 11.2% pointed provision of situated site for deposition of waste, 6.5% revealed that more facilities be provided while 3.9% stated that the study area be sanitized. However, other options were stated as collecting waste in season and out of season and also refuse collection points be develop.

4.4 DISTRIBUTION OF DUMPSITES

4.4.1 Spatial Distribution of Legal and Illegal Dumpsites

The legal and illegal dumpsite with their coordinates is given below in in the Table 4.15 and figure 4.16.(See appendix)and their spatial distribution a total of 48 dumpsites were indenfied 16 illegal dumpsite and 32 Legal dumpsites.Figure 4.3 Show the Spatial distribution of the dumpsites both legal and illegal in the study area.

Table 4.15 Legal and Illegal Dumpsite

DUMPSITE	NUMBER	PERCENTAGE (%)
Legal	32	66.7
Illigal	16	33.3
Total	48	100

Source: Author's Analysis

The distribution spatial distribution of the dumpsite showed that 66.7% were legal and 33.3% were illegal as shown in figure 4.15. the dumpsite that were in conformity with the regulations for location with respects to KEPA were among others off collage roads in ungwan Dosa, Wurno road, off Liberian road, Zaria roads and Nupe roads among others. It also appears that location of dumpsite does not take into account the proper locations on the basis of KEPA regulations for the dumpsite in the study area and Specific examples of the illegal dumpsite include among others off Isa Kaita road In ungwan Sarki, central bank area, Degel road, Airforce base, constitutional road, Kabala etc. Based on the results, it was found that, the illegal dumpsite was mainly concentrated in the highly populated site in the study area and also closed to places that had highly human activities such as high residential areas and market places. The result shows that, the dumpsites were randomly distributed in the study area.



FIGURE 4.3: Location of legal and illegal dumpsites.
Source: Author's Analysis

4.1.2 Buffer Analysis

In order find dumpsite that is 2000m, 300m and 400m from the residential areas, the location of the dumpsites is geographically reference to the coordinate collected from the field, and way point method was carried out to superimpose the coordinate on the map as it is presented in figure 4.4.

By using the buffer tool, the dumpsite that was highlighted yellow was the one selected for the analysis. The analysis was carried out to show how powerful GIS is in selecting features that are within a specific range of buffer zone in order to know the dumpsites that were located or sited within a required standards or regulations set by KEPA for siting a location for dumpsites for any decision pertaining the environmental set up. This analysis was carried out to provide necessary information on the nearest dumpsites within a distance of 200m, 300m and 400m which will help KEPA with management information to know the various houses dumpsites that will be affected within the 200m, 300m and radius when assessing or sanitising the environment for proper development and management and supporting decisions about planning as supported by KEPA (2014). The results reveal that the 30% of the dumpsite fall within 200m buffer, 33% falls within 300m and 37% within 400m buffers. Also found that the areas that fall within the 200m buffers were of very high risk compares to the others.

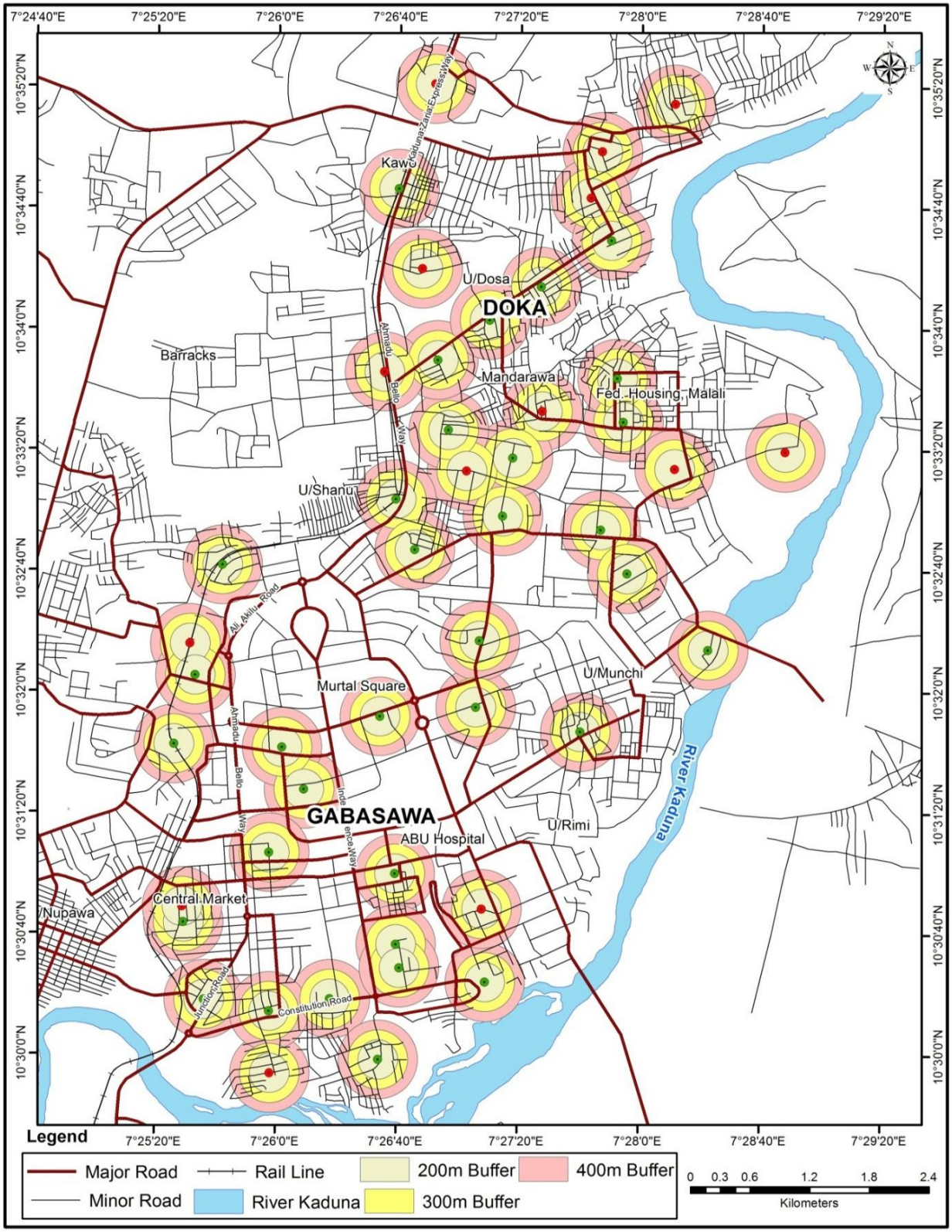


Figure 4.4: Map of the Study Area showing buffers around legal and illegal dumpsites
Source: Author's Analysis

Figure 4.4shows the proximity of the dumpsites to the residences. The results also show that 33.3% of the dumpsites which happened to be illegally sited fall within the residents as shown in figure 4.4. So therefore where we have interred joining polygon should have sighted dumpsites. It can therefore be said that the effect of dumpsites diminishes with increased distance away from the dumpsites. Based on the results obtained from the research, field work and literatures, it was also found out that most of the areas of the dumpsites that were located within the danger buffer zones of 200m, 300m and 400m have serious environmental dangers which in terms lead to health hazards which is also supported by Salam (2010) environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini had a nagative the residents whose houses were within 200 meters of the dumpsite and are victims of malaria, chest pains, cholera and diarrhea. Also, Zaidu (2008) opined that waste dumpsites should be sighted within the range of 400 meters from the residential areas for better environment. Man has limitation on the way of solid wastes disposal as such dumpsites should not be more than 400 meters as supported by KEPA (2014).

CHAPTER FIVE: SUMMARIES, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter the researcher indicate how the research aim and objective of the study were achieved. This chapter also focus on conclusion and recommendations that will intend to help the people of Kaduna metropolis in understanding the basic concept waste management.

5.2 SUMMARY

In summary this research work collates and analyzes data on "Spatial Distribution of dumpsites in Doka and Gabasawa Districts of Kaduna metropolis Nigeria".

The data were collected from a primary source which is administration of questionnaire, the process were followed as directed in the chapter three which gives the method of data collection and data analysis. However, result gotten answers the research questions and met the desired objectives of this research work. From the asked questions and desired objective, the socio-economic status of respondents is determined, types of waste generated according to zones. The spatial variation in the types of waste generated according to areas, education status etc, a chi-square test revealed that there is significant difference in the rate of occurrence of risk posed on the study area as a result of the unsafe dumpsites located also the environmental consequences of the unsafe dumpsite in the study area.

Chapter two of this research work reviews some relative literature by pointing the conceptual framework, etc. Chapter three presents the study area and methodology, chapter four carried out analysis and presented result on the collected data while chapter five summaries conclude and gave some relevant recommendations.

A larger population of the respondents annual income is less than N20,000 and majority of them are self also working as public servant. Within the respondents and their various main

sources of Income, self-employed constitute the largest proportion of the main source of income. Government should make deliberate effort to expand the economic base in Kaduna Metropolis so that people can find more employment opportunity.

Some of the major considered environmental problem includes; air pollution, inadequate sanitation (sewerage), water pollution, flooding, and proliferation of insect, fire outbreaks and unsafe dumpsite as well as unsafe waste disposal. The inadequacy of solid waste collection is very serious, this is applied to Nigerian as a whole (United Nations System in Nigeria, 2001).

The problem of unsafe solid waste disposal is considered very serious because wastes usually end up dumped illegally on streets, open spaces and waste land. This buttresses Ajibuah (2013) claims that indiscriminate disposal of wastes along Kaduna Metropolis is the main factor influencing susceptibility of residents along Kaduna River to floods annually. This study also revealed that the collection point in Kaduna metropolis is the non-secured collection point (Ajibuah Bolanle Joel., 2013). On average, the household size of resident in Kaduna metropolis is 4.28.

Result reposted that food and fruit, remnants comprise the bulk waste from the study area. This high concentration is expected because food and fruit are generally consumed by both the high as well as the low income earners. Leaves and woods comprise the second largest category of waste which are also found among the high and low income earner as well, this types of waste could be generated from garden flowers, trees etc.

5.3 CONCLUSION

Conclusively, the analysis on spatial distribution of dumpsitesin Kaduna metropolis has been carried out in this work. Although, the distribution identified legal dumpsite as having the highest record. Findings in the study further show that illegal dumpsite is situated in the study area as well. The categories of waste identified from these dumpsites are in form of polythene bag, plastic bottles, plastic food pack and polystyrene food pack are altogether generated at an average rate. The people of the study area are said to be face by several challenges that hinders them from developing (Moser, C.O.N.1993). From the result obtained, it is therefore said that: Despite environment agencies set up in Kaduna metropolis the deterioration of the urban environment remains a chanllenge to the communities especially the local government that are constitutionally responsble for managing the waste. However, with the situation in the study area, it is noted that government and development partners have not really mobilized and created awareness to beneficiaries on how solid waste should be managed.

Furthermore it is discovered that, there is no properly designed final solid waste disposal facility in Doka and Gabasawa. Most of the legal dumpsites are located within the Central Bussiness Districts and high income earners residential area within due consideration to the low income earner resdential area. In this low income earner areas both municipal and industrial wastes are disposed in an uncontrolled manner. To improve eisting strategy, a comprehensive assessment approach is essential to established performance of present strategy, to provide information to stakeholders and a platform for discourse that's why Geographic Information and Remote Sensing is employed in showing the spatial distribution of both legal and illegal dumpsites within the study area help planner in agaitation for better and efficient solid waste management in Kaduna metropolis.

5.4 RECOMMENDATION

From the result presented and findings made, concrete recommendations are giving by the researcher form the findings which if properly followed can help better the life of people residing in the study area. The recommendations are as follows:

For effective and efficient management of solid waste in Kaduna metropolis, the local governments should be charged with the responsibility of collection, transportation and disposal.

Policies should be formulated to raise awareness, promote knowledge andmotivate households with regards to environment and waste management practices in the areas.

The first recommendation is that there should be effective legislation and clear guidelines governing safe disposal of waste especially domestic waste.

The legislation of Kaduna Environmental Protection Agency (KEPA) regulating waste disposal and clarifying punishment for specific offences should be enforce.

The mandate given to KEPA to investigate the environment standards and prosecute offenders in specially create courts or triunal should be vigorously pursed for efficiency and effectiveness.

The public need to be educated and enlightened. Health insurance agency should let the populace realize the importance of rotecting the quality of the environment and make them accept the notion.

Sensitization of the general public on the dangers associated within indiscrimate refuse disposal.

For Kaduna metropolis to be clean waste management activities should be established extended to all areas not only the Central Bussiness District and high income earner residential areas.

REFERENCES

Abah S.O. and Ohimain E.I. (2010).Assessment of Dumpsite Rehabilitation Potential Using the Integrated Risk Based Approach: a Case Study of Eneka, Nigeria World Applied Sciences Journal *8(4) 436-442.*

Akpu,.B, Robert.T.A and Abbas.I.I (2011). The Impact of Spatial distribution of Solid Waste Dumps on Infrasture in Samaru, Zaria, Kaduna State, Nigeria Using Geographic Information System (GIS*). Research Journal of Technology* Vol.3.No.3.pp.133-117.

Abdullahi, J., Shaibu-Imodagbe, E. M., Mohammed, F., Sa'id, A., & Idris, U. D. (2009). Rural- urban migration of the Nigerian work populace and climate change effects on food supply: A case study of Kaduna city in Northern Nigeria. Paper presented at the Fifth Urban symposium.

Abdullahi, Y. A. (2011). Waste to Wealth: Agricultural Engineers Approach, A Presented at a public Lecture organized by Nigerian Institute of Agricultural Engineers (NIAE),Kaduna State Chapter. Mohammed Dikko Lecture Theatre, Kaduna Polytechnic, 10thNovember.

Abudulsalam,N.(2010). Environment and health Impact of Solid Waste Disposal a Mangwaneni Dumpsites in Manzini: Swaziland. Journal of Sustainable Development in Africa, Vol.12, No.7.pp: 64-78).

Achenyo,I (2009).Climate Change and Power Supply Solution. LFGE/MSWE Project Development in Nigeria. A white paper on Greenvative Chain.

Adedibu, A. A. (1985). *A comparative analysis of solid waste composition and generation in two cities of a developing nation. The Environ.,* Vol.5, No.2. pp. 123-127.

Adejuwon, J. O. (2006). Food crop production in Nigeria II. *Potential effects of climate change. Climate Research,* Vol.32, No.3.pp. 229-245.

Adewole, A. (2009). *Waste management towards sustainable development in Nigeria: A case study of Lagos state. International NGO Journal,* Vol.4,No.4.pp. 173-179.

Adewumi, I.K; Ogedengbe, M.O; Adepetu, JA.&Fabiyi, YL (2005). *Planning organic fertilizer industries for municipal solid wastes management. Journal of Applied Sciences Research,* Vol.1,No3. pp. 285-291.

Afon, A.& Okewole, A. (2007). *Estimating the quantity of solid waste generation in Oyo, Nigeria. Waste Management & Research,* Vol.25,No.4.pp. 371.

Afroz, R., Hanaki, K., Tuddin, R., & Ayup, K. (2010). *A survey of recycling behaviour in households in Dhaka, Bangladesh. Waste Management & Research,* Vol.28, No.6.pp. 552.

Agunwamba, J.C. (1998). Solid Waste Management in Nigeria: Problems and Issues. *Journal of Environmental Management* ,Vol. 22, No. 6.pp 12-32.

Al-Jarrah, O.& Abu-Qdais, H. (2006). *Municipal solid waste landfill siting using intelligent system. Waste Management*, Vol.26, No.3.pp.299-306.

Amar, M. D. (2008), Chandrasekhar B Pawar, Pratapsingh B Pardeshi and Dhanraj APatil, 2008.Municipal solid waste disposal in Pune city – *An analysis of air and groundwater pollution Current science*,95, 6,773777.

Ambulkar, A.R & sheldar, A.V, (2004). *Prospects of biomethanium technology in the india context: A programatic approach. Resources Conservation and Recycling* Vol.40, No.2.pp. 111- 128.

Ariko, J.D. (2009). An Analysis of the Impact of Solid Waste Disposal on the Environment in Tudun Wada Zaria. An Unpublished B.Sc. Research Project Submitted to the Department of Geography, Ahmadu Bello University Zaria.

Arthur, J. (2010). Waste Disposal Management: Three Methods for Waste Disposal Accessed from http://www.articlecell.com.14/06/15.

Aryeetey-Attoh, S. (2003).*Geography of Sub Saharan Africa* (2nd edition). USA. Prentice Hall Inc.

Asase M. Yanful, E.K, Mensah M, Stanford J, and Amponsah S. (2009). Comparison of the municpal Solid Waste Mangement System in Canada and Ghana: A case study of the cities of London, Ontario and Kumaji, Ghana . Journal of Waste Management Vol.29, 2779-2786.

Ayotamuno, J.& Gobo, A. (2004). Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects. *Management of Environmental Quality: An International Journal*,Vol.15, No.4.pp. 389-398.

Baron, J. (1995).An Introduction to Waste Management.The Chartered Institution of Water and Environmental Management.www.domain.gree@sunderland.ac.uk. 05/06/15.

Basagaoglu, H., (1997). Selection of Waste Disposal Sites using GIS.*Journal of the American Water Resources Association*, 33(2), 455–464.

Begon M., Harper J.L. and Townsend C.R. 1990.*Ecology, Individuals, Populations and Communities*. Blackwell, Cambridge.

Bernstein, J. (1999). Social Assessment of the Solid Waste Management Project: Diyarbakir, Sanliurfa, Mardin, and Siverek. Southeastern Anatolia, Turkey. The World Bank.

Boyla, C.A. (2000). Solid waste management in new Zealand. Waste management Vol.20, No.7.pp. 17-26.

Brunner, P. H. &Fellner, J. (2007).*Setting priorities for waste management strategies in developing countries. Waste Manage. Res.*,Vol. 25, No.3. pp. 234-240.

Buchana, K.M.& Pugb, J.C. (1962). Land and People in Nigeria: The Human geography on Nigeria and its background- Uniersity of London Press Ltd; pp 12-21

Cointreau-Levine, S.& Program, U. M. (1994). *Private sector participation in municipal solid waste services in developing countries*: Published for the Urban Management Programme by the World Bank.

Chris, Z.(2003). Solid Waste Management in Developing Countries; Adapted from the Solid Waste Management Text. www.sanicom.net. 05/03/15.

Chung S. & Lo, C. (2008). Local Waste Mangement Constraints and Waste Administrators in China. Journal of Waste Mangement Vol.28 pp. 272-281.

Dauda, M. & Osita, O. O. (2003). Solid waste management and re-use in Maiduguri, Nigeria. Towards the Millenium Development Goals. 29th WEDC International Conference, Abuja, Nigeria, pp. 20-23.

Dennison, G., Dodd, V., & Whelan, B. (1996). A socio-economic based survey of household waste characteristics in the city of Dublin, Ireland II. Waste quantities. Resources, Conservation and Recycling, Vol.17. No.3.pp. 245-257.

Ebreo, A. Hershey, J. & Vining, J. (1999). "Reducing solid waste: Linking recycling to environmentally responsible consumerism." Environment and Behavior, Vol. 31, No. 1. pp.107-135.

Ebreo, A. & Vining, J. (2001). "How similar are recycling and waste reduction? Future orientation and reasons for reducing waste as predictors of self-reported behavior." *Journal of Environment and Behavior*, Vol. 22, No. 3. pp. 424-448.

Egunjobi, L. (1992). Perception of Urban Environment Problems:A Pilot Study Centered on the City of Ibadan, Nigeria. Africa Union Vol.4, No. 1 & 2 pp 59-69.

Ekere W, Muguisha J, and Drake L. (2009). Factors influencing wastes seperation and utilization among households in the lake Victoria Cresent, Uganda. *Journal of waste management, Vol.29, pp 30-47.*

Elkan, W. (1988). Analysis of policy for small scale industry, *Journal of international development*, Vol. 2,pp. 34-47.

Global Waste Management Market Report (2007) In: Lawal, A.S.D. (2011). Composition and Spatial Distribution Solid Waste Collections' Points in Urban Katsina Northern Nigeria. Unpublished M.Sc Research Proposal, Department of Geography, Bayero University, Kano.

Golits, C. (2001). Sustainable Cities and Benefits Regional Policy and Deelopment Series 9., Mitshire Kingsley publishers London.

Gouveia N & Prado RR, (2010), Health risks in areas close to urban solid waste landfill sites RevSaúde Pública 2010; 44(5)

Hardoy J E, Mitlin D, Sattethwaite D, 2001Environmental Problems in an UrbanizingWorld (Earthscan, London)

Hamoda, M. F., Abu Qdais, H. A., & Newham, J. (1998). *Evaluation of municipal solid waste composting kinetics. Resources, Conservation and Recycling*, Vol.23, No.4.pp. 209-223.

Hayward, D.& Gaskin, S. (2005). *Sustainable waste management systems.* Paper presented at the 33rd Annual General Conference of CSCE, Toronto, Canada.

Heywood, I. & Cornellius, S. (2002). Introduction to Geographic Information Systems. Ibadan: Longman (Nig.) Plc.

Hazra T. & Goel. S. (2006). Municipal Solid waste mangement chanllenges in developing countries Kenya case study. *Journal of waste Mangement* Vol.29, pp 70-78.

Henry. R.k, Yongsheng Z and Jun. D. (2006). Municipal solid waste mangement challenges in developing countries kenyan case study. Journal of waste Management. Vol.26, 92-100.

Hussain, I. G. (2008). Interated waste management facility. Kaduna: Kaduna State Environmental Protection Authority.

Jones, A. Nesaratnam, S., & Porteous, A. (2008). Factors which influence household waste generation (Fact sheet No. 2). Milton Keynes: The open University.

Ifatimehin, O.O. (2007), The use of Computer Intelligent Tools by Environmental Scientists in Nigerian Universities, Savanna.

Igbaonugo. S. (2004), "Lagos: A city where filth stifles splendour", an article contributed to the Daily Independent lagos. pp. 29-30.

Imam, A. Mohammed, B. Wilson, D.C. and Cheeseman, C.R. (2007). *Solid waste management in Abuja, Nigeria. Waste Management* Vol.28, No.2. pp. 468-472.

Imran, I., Si, M., Wardhani, C., Fatimah, S., Barlinti, Y., Setiawan, B., . . . Rosadi, A. (2008). Institutionalization of Sustainable Waste Management: An Extension Program of Environmental Awareness in Jakarta and West Java.

Isuwa (2006).*Sustainability of Municipal Solid Waste Management in Kaduna metropolis.Research Journal of Environmental and Earth Sciences* 2(4): 56-94.

Jagadeesha, C.J. (2005). Water resources development and management. India space reseach organization, New Delhi, India.

Jenkins, R. R. (1993), The Economics of Solid Waste Reduction. The Impact of User Fees. Edward Elgar.

Kofoworola, O. (2007). Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria. Waste Management, Vol.27, No.9.pp 1139-1143.

Kontos, T. H. D, Komilis, D. P. and Halvadakis, C. P.(2003).Siting MSW Landfills in Lesvos Island with a GISbased methodology. *Waste Management and Research,* 21(3), 262–277.

Liu. Y, Ren. Y, Wang, A. and Zhou, H. (2008). Identifying the Location and Distribution of Open-Air Dumps of Solid Wastes Using Remote Technique. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. Vol. 38, Part B8. Beijing 2000.

Krejcie, R. & Morgan, D. (1970). Determinig sample size for research. *Educational and psychological measurement,30*, 607-610

Mallo, I.I.Y. (2000). Hydro geomorphological and Pedological implication of Dumping Linear Low density on the Land surface of Kaduna metropolis, Northern Nigeria.Z. Geomorph. N.F. verlin, Stuttgart.

Manyanhaire, I.O. Sigauke, E. and Munasirei, D. (2009) Analysis of Domestic Solid Waste Management System: *a Case of Sakubva, Zimbabwe, Journal of Sustainable Development in Africa Vol.11*, No.2, Clarion University of Pennsylvania, Clarion, Pennsylvania.Pp.126-131.

Matete N. & Trois C. (2008). Towards Zero Waste in emerging countries. A south Africa experience. *Journal of Waste management,* 80-92.

Mato, R. A. M. (1999): Environmental Implications Involving the establishment of sanitary landfills in municipalities in Tanzania: the case study of Tanga municipality. Resource, conservation and recycling. Pp. 25 1-16.

Mabogunje, A. (1988). The Debt to Posterity: Reflection on a National Policy on Environmental Management. In Sada, P.O. and Odrmerho (Eds) Environmental Issue and Management in Nigerian Development. Ibadan Evans Brothers (Nig. Publishers)

Mănoiu.V, Fontanine.I, Costache. R, Prăvălie. R, Mitof. I, using GIS techniques for assessing Waste landfill placement suitability. Case study: Prahova County, Romania, *Geographia Technica, Vol. 08, No. 2, 2013, pp 47 to 56*

Moghadam M.R.A, Mokhtarani N, and Mokhatarani (2009). Municipal solid waste mangement in Rasht city. *Iran Journal of waste Management Vol.29,pp.485-489*.

Moser, C.O.N.(1993)Gender Planning and Development: Theory, Practice and Training. Rout ledge London

Mustapha, A. R. (2003). Ethnic minority groups in Nigeria: Current situation and major problems Commission on human rights. Oxford: Working group on minorities.

Mwanthl, M. A., Nyabola, l. O. and Tenambergen, E. D. (1997) The Present and Future Status of Municipal Solid Waste Management in Nairobi. International Journal for Environmental Health Research,Vol. 7. pp.345-353.

Myers G A, 2005 Disposable Cities: Garbage, Governance and Sustainable Development in Urban Africa (Ashgate, Aldershot, Hants)

National Population Commission. (2006). *Population and Housing Census*: Class Size of Household. Abuja, Nigeria.

National Population Commission (NPC) (2009). Federal Republic of Nigeria Official Gazette; 2 (96), Abuja.

Navalgund, R. R. and Kasturirangan, K., (1983).*The remote sensing satellite – A programme overview*.Proc. Indian Acad. Sci. Engg. Sci. –Remote Sensing – III, 6, 313–336.

Nishanth, T.1., Prakash M.N and Vijith, H., (2010).Suitable site determination for urban solid waste disposal using GIS and Remote sensing techniques in Kottayam Municipality, India.*International Journal of Geomatics and Geosciences Volume* 1, No 2, 2010© Copyright 2010. All rights reserved Integrated Publishing service

Nwaka, G. (2005). The Urban Informal Sector in Nigeria: Towards Economic Development, Environmental Health, and Social Harmony. Global Urban Development Magazine,Vol.1,No.1.pp.1.

Nwankwo, C. (1994). Solid waste management, general reviews and a glance at the Nigerian Situation. *J. Mining Geol,* Vol.27.pp. 20-25.

Nwude, M.O. (2006). Sustainable Option For Solid Waste management In kaduna Metropolis. Unpublished Msc thesis submitted to Department of Urban & Regional Planning, ABU, Zaria.

Nwude U. (2006) *Solid Waste Management*: Issues and Challenges in Asia. Report of the APO Survey on Solid-Waste Management 2004–05

Nzeadibe, T. (2009). Development drivers of waste recycling in Nsukka urban area, southeastern Nigeria. *Theoretical and Empirical Researches in Urban Management*,Vol. 3,No.12.pp. 137–149.

Obirih-Opereh, N. & Post, J. (2002) *Quality aassessment of public and private Modes of Solid Waste Collection* in Accra, Ghana. Habitat International, Vol.26.pp. 95-112.

Ogbonna, D., Amangabara, G., & Ekere, T. (2007). Urban solid waste generation in Port Harcourt metropolis and its implications for waste management. *Management of Environmental Quality: An International Journal*, Vol.18,No.1.pp. 71-88.

Ogwueleka T. C. (2009). Municipal Solid Waste Characteristics and Management in Nigeria *Iran Journal of Environmental Health Science and Engineering* Vol. 6, No. 3, pp. 173-180.

Ogra,A.(2003). Logistic management and spatial planing for solid waste mamnegement system using geographic Information system. In: Map Asia 2003 India.

Ogu, V. (2000). Stakeholders' partnership approach to infrastructure provision and management in developing world cities: Habitat international,Vol.24.No.4. pp.517-533.

Ogunsote, O. O., & Ogunsote, B. P. (2002). Defining climatic zones for architectural design in Nigeria: *A systematic delineation. Journal of Environmental Technology*,Vol.1.No.2.pp. 1-14.

Onwughara, I. N., Nnorom, I. C. and Kanno, O. C. (2010).*Issues of roadside disposal habit of municipal solid waste*: Environmental impacts and implementation of sound management practices in developing country Nigeria. International Journal of .Environmental. Sci. Dev., 1(5): 409-418.

Osazuwa, I. B. and Abdullahi, N. K. (2008). Electrical Resistivity and Induced Polarization Investigation at an Open Solid Waste Dumpsite, Kaduna, Nigeria.Journal of Environmental Hydrology.The Electronic Journal of the International Association for Environmental Hydrology.*Volume 16 Paper 29.*

Oresanya, O. (2010). *Progress and challenges to effective waste management in Nigeria: The case Lagos state. Lagos Waste Management Authority(LAWMA).* Paper presented at Waste management conference/workshop, Oxford, UK

Otten, L. (1997), Integreted Solid waste Management paper in Cleaner production and Consumption. Harere, Zimbabwe. Accessed from : http://www.jsd-africa.com/jjsda/V11No2_Fal2009/PDF/AnaysisDomensticSolidWasteManagementSystem.pdf.On22/10/2012.

Poll, J. (2004). Greater London Authority Waste Composition Scoping Study. Produced for the Greater London Authority.

Radhakrishnan, K & Adiga, S (1996) "Enhanced GIS Application Using IRS-IC Data-Potential For urban Utility Mapping and Modelling current Science, 70(7)

Sandra, C. (1995). Private Sector Participation on Municipal Solid waste Serices in Developing Countries. *Journal of Environmental Sciences*,Vol.1.pp.12

Sanyanga, R. & Masundire, H. (1999). Waste Management in the Zambezi Valley: case studies from Botswana, Zambia and Zimbabwe in Yap, N.T.P. (1999) (eds) cleaner Production and consumption in eastern and Southern Africa; Challenges and opportunities. University of Guelph, Canada: Weaver Press Series.

Savage, G.M., Diaz, L. F. and Golueke, G.C., (1998). Guidance for Land Filling Waste in Economically Developing Countries. Washington DC, USA: *United States*

Environmental Protection Agency, National Risk Management Research Laboratory, Cincinnati, OH, EPA 600/ R98040.

Seng B; Kaneko H, Hirayama K; Katayama and Hirayama K. (2010). Municipal solid waste managent in Phnom Penh, capital city of Cambodia.Waste Management and Research Vol.29. pp 491-500.

Sha'Ato, R. Aboho, S.Y. Oketunde, F.O. Eneji, I.S. Unazi, G. Agwa, S. (2006). Survey of solid waste generation and composition in a rapidly growing urban area in central Nigeria. *Waste Management* Vol.27,No.3. pp. 352-358.

Simone, L., Ian B. and David, E., (2001).Assessing the demand of solid waste disposal in urban region Porto Alegre City, south of Brazil.Dynamics modelling in a GIS environment.*Resources, Conser_ation and Recycling* 33 (2001) 289–313.

Suchitra, M., (2007). Outside: *Burnt or buried, garbage needs land. Down to Earth,*15 March.22–24.

Sulaiman, M. A (2001). The effects of Industrial Waste Disposal on water Quality of Rier Kaduna. Unpublished B.Sc proect, dept of Geography, N.D.A. Kaduna.

Sundberg, C. & Johnson, H. (2008). Higher pH and faster decomposition in biowaste composting by increased aeration. Waste Management, Vol.28, No.3.pp.s 518-526.

Surreywaste.info.(2008) Waste Composition. Retrieved from: http://www.surreywaste.info/communities/action/composition on 12/01/2014.

Tchobanoglous, G., Theisen, H., Vigil, S. (1993). Integrated Solid Waste Management: Engineering Principles and Waste Management Issue. Boston, Irwin McGraw-Hill.

Ukoje, J.E (2011). Analysis of determinantnof participation of stakeholder in solid Waste management in Zaria. An Unpublished Ph.D Reserach project submitted to Department of Uran and Regional laning, Ahmadu Bello Uniersity, Zaria.

UDBN (Urban Deelopment Bank of Nigeria), 1998. Solid waste sector appraisal report.

UNHabitat,2009PlanningSustainableCities:GlobalReportonHumanSettlements2009(Earthscan, London)

United Nations Centre for Human Settlement (UNCHS) (2001). The state of the World's Cities 2001 Habitat, United Nations Centre for Human Settlement, Nairobi.

United State Environmental Proctection Agency USEPA (2005). Municipal Solid Waste Basic Facts,Retrieved Accessed Date: 23-3-2013 from http://www.epa.gov/epaosower/non-hw/mancipl/reduch.htm.

United Nation Statistic Division (2011) Demographic Year Book Washington Dc 51-53

Walling, E. W., A; Warren, E; Warsley, B; Wilhelm, E. (2004). Municipal Solid waste management in developing countries: Nigeria, a case study. Retrieved from http://www.dnr.cornell.edu/saw44/NTRES331%2014.

Wilson, D., Velis, C., & Cheeseman, C. (2006). *Role of informal sector recycling in waste management in developing countries.* Habitat International, Vol.30,No.4.pp. 797-808.

World Bank (1999). What a waste: *solid waste management in Asia*. *Urban Development Division, East Asia and Pacific Region.*

World Bank, (2003). World Development Report, Development and Environment, New York. Paper No 13.

Xi, J. Q, and Jiang, H.H. (2003). The Analyzing of Current State and Existing Problems of Household Garbage Treatment. *journal of Enironmental Monitoring in China*,Vol.19.

Zhu, et al, (2008),*Improving Municipal Solid Waste Management in India*, World Bank, Washington.

APPENDIX I

DEPARTMENT OF GEOGRAPHY
FACULTY OF SCIENCE
AHMADU BELLO UNIVERSITY,ZARIA.

HOUSEHOLD SURVEY QUESTIONAIRE

Dear sir/madam

I am a postgradute student of the department of geography A.B.U Zaria,writing on **Spatial Distribution of Dumpsites in Doka and Gbasawa Districts of Kaduna Metropolis, Nigeria** a purely acedemic exercise aimed at finding a lasting solution to the Solid Waste Management problems in Kaduna metrolpolis.

All information given will be treated with confidentiality. Your honest opinion on the questions will highly be appreciated.

Thank you.

1.Town :

Zone/District:

2. what is your occupation? Tick which is appilcable
(a) Public servant (b) Private sector employee
(c) Self employed (d) Unemployed.

3.Highest Level of Education:
(a) Quranic Education (b) Primary School
(c) Secondary School (d) Post secondary School.

4.Number of people in the house hold.( )

5.How much is your monthly income ?
(a) Less than N20,000.00 (b) 20,000-50,000
(c) N50,000.00 above

6.How do you store your solid waste
(a) Drums (b) Plastics containers
(c)Cartons (d) others

7.What are the risks pose by these dumpsites to your environment?

(a)Flooding (b)bad odour(c)Fire outbreak(d)Water pollution(e)Profileration of insects
(f) others .....

8.What is the distant covered to the dumpsites?
(a)50meters (b)100 meters
(d)200meters (d)specifys .....

9.How often do you dispose of your waste ?
(a) Every day (b) 2-3 times
(c) Once (d)others

10.Where do you normally empty your waste?
(a) Aproved depot (b) Open space
(d)Burning (d)Gutter (e) Others.

11.Do you pay for solid waste collection ?

(a) Yes (b) No
If yes How much ? N.....K

12.How much are you willing to pay for soild waste collection monthly?
(a) Less than N50.00 (b) N50-N100.00
(c) N100.00-N150.00 (d) More than N150.00

13. Are you satisfied with the existing solid waste services in your area?
(a) Yes (b) No

14.What do think need to be done to improve the service?
.....
.....
.....

APPENDIX II

Table 4.16 Location and Status of Dumpsite

Dumpsite	Latitude	Longitude	Status of Site	Address
1	10°35'20.77"N	7°26'51.79"E	Illegal	Daura Road, Hayin Banki
2	10°34'58.53"N	7°27'46.91"E	Illegal	Zango Road, Kawo
3	10°35'14.41"N	7°28'11.17"E	Illegal	Shanu Street, Kawo
4	10°34'46.04"N	7°26'39.78"E	Legal	Zaria Road
5	10°34'43.03"N	7°27'43.22"E	Illegal	Kudan Street
6	10°34'19.70"N	7°26'47.58"E	Illegal	College Road, Kawo
7	10°33'45.63"N	7°26'35.19"E	Illegal	Off Brracks Road
8	10°33'49.49"N	7°26'52.83"E	Legal	Off College Road, Ung. Dosa
9	10°34'2.81"N	7°27'9.93"E	Legal	College Road, Ung. Dosa
10	10°34'13.93"N	7°27'26.88"E	Legal	Ishaku Road, Ung. Dosa
11	10°34'29.19"N	7°27'50.08"E	Legal	College Road, Ung. Dosa
12	10°33'26.35"N	7°26'56.40"E	Legal	Wurno Road, Ung. Dosa
13	10°33'32.63"N	7°27'27.36"E	Illegal	Off Liberia Road
14	10°33'43.67"N	7°27'52.18"E	Legal	Conakry Road, Fed. Housing Scheme
15	10°33'29.27"N	7°27'54.25"E	Legal	Off Liberia Road
16	10°33'19.47"N	7°28'47.82"E	Illegal	Rabar Road
17	10°33'13.70"N	7°28'11.25"E	Illegal	Off Waziri Machido Road
18	10°33'17.28"N	7°27'17.74"E	Legal	Off Wurno Road
19	10°33'12.93"N	7°27'2.54"E	Illegal	Rabar Road
20	10°32'53.54"N	7°27'46.90"E	Legal	Off Isa Kaita Road
21	10°32'39.09"N	7°27'55.73"E	Legal	Off Inuwa Wada Road
22	10°32'58.00"N	7°27'14.48"E	Legal	Off Isa Marnono Road
23	10°33'3.50"N	7°26'39.13"E	Legal	Zaria Road, Ung. Sarki

24	10°32'41.62"N	7°25'42.02"E	Legal	Kagarko Road, Doka
25	10°32'15.67"N	7°25'31.28"E	Illegal	Off Bank Road, Doka
26	10°32'46.84"N	7°26'45.45"E	Illegal	Off Isa Kaita Road, Ung. Sarki
27	10°32'5.02"N	7°25'32.94"E	Legal	Bank Road, Doka
28	10°31'42.43"N	7°25'26.02"E	Legal	Off Polytechnique Road, Doka
29	10°31'41.48"N	7°26'1.83"E	Legal	Off Kanka Road, Doka
30	10°31'51.43"N	7°26'34.04"E	Legal	Mohammadu Buhari Way, Doka
31	10°32'16.73"N	7°27'6.96"E	Legal	Sultan Road, Ung. Rimi
32	10°32'13.90"N	7°28'22.56"E	Legal	Off Balareba Musa Close, Ung. Rimi
33	10°31'54.89"N	7°27'5.85"E	Legal	Kwato Road, Rimi
34	10°31'46.74"N	7°27'40.37"E	Legal	Shehu Laminu bAvenue, Ung. Munchi
35	10°31'27.60"N	7°26'9.12"E	Legal	Lafiya Road
36	10°31'6.60"N	7°25'57.71"E	Legal	Nupe Road
37	10°30'48.63"N	7°25'28.92"E	Illegal	Central Bank
38	10°30'43.56"N	7°25'29.42"E	Legal	Ogbomosho Road
39	10°30'59.65"N	7°26'39.18"E	Legal	Off Bori Road
40	10°30'48.13"N	7°27'8.03"E	Illegal	Degel Road
41	10°30'36.42"N	7°26'39.71"E	Illegal	Airforce Base
42	10°30'28.59"N	7°26'40.86"E	Legal	Airforce Base
43	10°30'14.21"N	7°25'57.86"E	Legal	Constitution Road
44	10°30'18.17"N	7°26'17.95"E	Legal	Constitution Road
45	10°29'53.68"N	7°25'58.05"E	Illegal	Kabala Costain
46	10°29'58.26"N	7°26'33.92"E	Legal	Kabala Costain
47	10°30'23.98"N	7°27'9.21"E	Legal	PolaORoad
48	10°30'17.91"N	7°25'36.26"E	Legal	Offa Road

APPENDIX III



Plate 1: The researcher at the scene of legal dumpsites in Gabasawa District area of kaduna Metropolis.

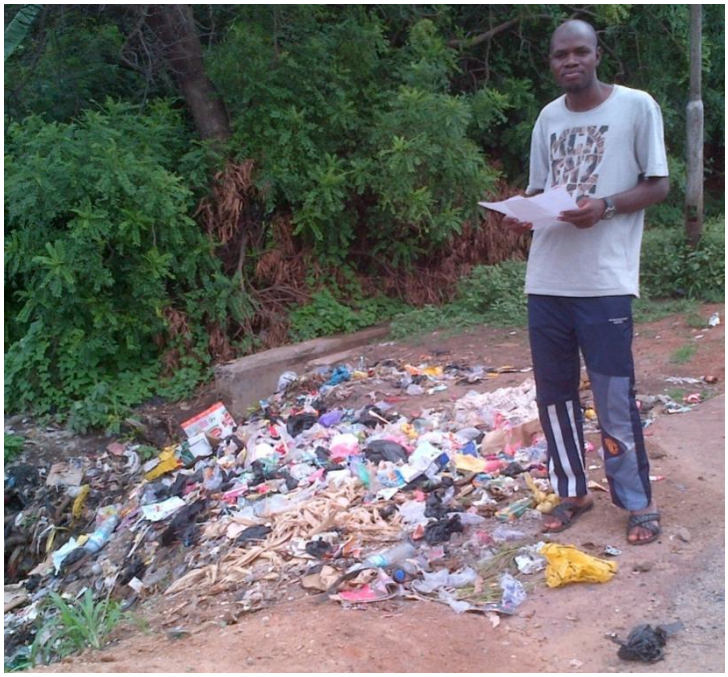


Plate II : The researcher at the scene of illegal dumpsites in Doka Districts of Kaduna Metropolis.