TUDY OF SOLID WASTE MANAGE MENT SYSTEMS IN NYANYA AREA OF THE FEDERAL CAPITAL TERRITORY, ABUJA, NIGERIA

BY

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DECLARATION

I hereby declare that this research was conducted by me in the Department of Geography under the supervision of Dr. P.S. Akinyeye. The information derived from the literature has been duly acknowledged in the text and list of references provided. No part of this thesis was previously presented for another degree or diploma of any university.

Name of Student	Signature	Date
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CERTIFICATION

Thesis titled: Study of Solid Waste Management Systems in Nyanya Area of the Federal capital Territory, ja, Nigeria by: Bello, Jafaru Awalu(M.Tech/SSSE/2005/1388) meets the regulations governing the award of egree of Masters of Technology (M.Tech) of the Federal University of Technology, Minna and is approved s contribution to scientific knowledge and literary presentation.

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ABSTRACT

Day to day management of solid wastes produced by the community is one of the fastest growing problems in developing countries like Nigeria. The study was carried out to come up with suitable solid waste management system in Nyanya area of the Federal Capital Territory, Abuja. This was done through a method of field investigation for data collection with the help of a GPS used to take co-ordinates of the different dump sites in Nyanya, also, questionnaire was used to get responses from respondents in the study area and a QUICKBIRD O.6m resolution satellite image was digitized to bring out the spatial information of base layers with an Arcview 3.2a GIS software. Different types of wastes are generated in the study area and are in large quantity all due to rapid urbanization. The spatial out result based on GIS analysis shows that dump sites are indiscriminately located in the study area with a few of them sited in sensitive points which thereby leaves some residents with little or no access to the dumpsites. A query is sent to map out good locations for the citing of refuse containers based on proximity and accessibility to both refuse vehicles and residents. All these are done by inculcating the use of GIS in finding solutions to solid waste management problems.It is recommended that stakeholders should be sent on refresher courses on how to use GIS for waste management and the release of fund also goes a long way in reducing the overall problem of waste management.

TABLE OF CONTENT

CHAPTER TWO

LITERATURE REVIEW

CHAPTER THREE

MATERIALS AND METHODS

CHAPTER FOUR

RESULTS

CHAPTER FIVE

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

FCT:	Federal Capital Territory
FEPA:	Federal Environmental Protection Agency
GIS:	Geographic Information System.
NSWAI:	National Solid Waste Association of India
SWM:	Solid Waste Management
UNDP:	United Nation Development Programme
WHO:	World Health Organization.

GLOSSARIES

ArcGIS – ArcGIS is the name of a group of geographic information system software product lines produced by ESRI.

ArcView – ArcView is the entry level licensing level of ArcGIS Desktop, a geographic information system software product produced by ESRI

Climate – Climate is weather in an area averaged over some long period of time.

GIS – Geographic Information System integrates hardware, software, and data for capturing, managing, analyzing and displaying all forms of geographically referenced information.

Weather – Weather is a set of all the phenomenon occurring in a given atmosphere at a given time.

Location – Location is a position or point in physical space that something occupies on Earth's surface.

Land Use – Land use is the human modification of natural environment or wilderness into built environment such as fields, pastures and settlement.

Physiography – This is the study of the physical features

QuickBird – QuickBird is a high-resolution commercial earth observation satellite owned by Digital Globe and launched in 2001.

Soil – Soil is the naturally occurring, unconsolidated, loose covering on the earth's surface.

Solid Waste – These are non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex, and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes and mining residues.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

From ancient times, human and animals have used the resources of the earth to support life. In the primitive society, disposal of human and other wastes did not pose significant problems, for the population was very small and the amount of land available for the assimilation of wastes was large. But these days the burgeoning problem of solid waste is being given serious consideration everywhere. Rapid population growth and uncontrolled industrial development are seriously degrading the urban and sub-urban environment in many developing countries, placing enormous strain on natural resources, and undermining efficient and sustainable development (WHO, 1984).

The purpose of the Solid Waste Management (SWM)exercise is to help improve the poor management practices prevailing in many low income countries where this subject has received scanty attention compared to other aspects of infrastructure such as water supply and transport (Upasna, 2002). It is a multi-disciplinary field embracing waste collection, transfer, haulage and disposal and its impacts are wide. It is important therefore to take a broad view and not to consider disposal options within the narrow confines of a particular technology. This work is drawn from the available literature and lays particular emphasis on the principle of building on existing capacity of waste managing authorities.

An effort is made to study and improve solid waste management practice of Nyanya whose waste generation resembles a typical urban community so that the

proposed strategies could be replicated in large communities and townships. Optimal solid waste management strategies of many kinds of waste is proposed by incorporating spatial analysis tools, (Geographical Information System) constituting a framework for efficient planning. Suggestions endeavouring source segregation, designing collection systems, usage of organic wastes for production of biogas and fertilizer, hazardous waste management, safe disposal options etc. is evolved.

1.2 STATEMENT OF RESEARCH PROBLEM

"Nyanya is an accident that is not supposed to have happened", (Mabogunje, 2001). The collection and disposal of solid waste has been a major public health issue and a vital factor affecting the quality of Nyanya environment. No doubt the problem of solid waste disposal in Nyanya has become one of the most intractable environmental problems facing the environs of the study area. Nyanya, being a labour camp, is serving as a last resort for people with accommodation problem ranging from shortage of houses or rent as well as government owned residents to high cost of renting a house in the city of Abuja. This has pioneered the movement of people to Nyanya, which has led to overcrowding of the study area, thereby increasing the volume and range of solid waste being generated in the study area.

The commonly observed problems in the area are as follow:

- The garbage is not lifted at regular intervals.
- The waste bins are most of the time in a pitiful condition lying full of garbage without being cleaned and also bins are either uncovered or not lying upright.
- The citizens do not throw the waste inside the bins, so it often lies outside and around the bins, making the area around the bin look dirty.

1.3 AIM AND OBJECTIVES

Abuja was supposed to be a perfectly planned city, a city planned after the city of Washington D.C. but today the aim of the plan is gradually being defeated. Some parts of Abuja are characterized by the presence of solid waste. The aim of the study is to come up with suitable solid waste management system in Nyanya area of the Federal Capital Territory. The stated aim shall be achieved through the following objectives:

(a) Examine the type and characteristics of waste generated in the study area.

(b) Determine the volume of waste generated.

(c) To integrate spatial analysis tools to arrive at the best Solid Waste Management (SWM) sites.

1.4 SCOPE AND LIMITATION

The scope of the research work is centred on solid waste management in Nyanya area of the Federal Capital Territory, Abuja. The limitations encounter were financial constrain, weather problem (rain) while on the filed and lastly, difficulties in getting information required from individuals/organizations

1.5 JUSTIFICATION

Day to day management of solid waste in the study area (Nyanya) is one of the fastest growing problems in Municipal Area Council of the F.C.T. Prevailing management strategies are insufficient, because of their complexity, cost and lack of technology, which ignore solid waste management's socio-economic and ecological characteristics. Improper management of these wastes lead to public health hazards,

unaesthetic appearance, pollution of water bodies such as lakes, groundwater sources etc, hence the reason for the study.

1.6 STRUCTURE OF THE PROJECT

The project looks basically solid waste management in Nyanya which is the study area. It deals with studying of the different waste management strategies with GIS based management system as the main centre of focus.

STUDY AREA

1.7 LOCATION

Abuja, the Federal Capital Territory of Nigeria is located in the Guinea Savannah region of the middle half of Nigeria with a land area of 8000sq.km. It lies between Latitude $8^0$25' and $9^0$20' North of the equator and Longitude $60^0$45' and $7^0$31' East of the Greenwich Meridian.(udo,1992)

The Federal Capital Territory (F.C.T) is bounded by four of the thirty-six (36) state of the Federation. To the North of the F.C.T is Kaduna State, Nassarawa State to the South-East, Kogi State to the South-West and Niger to the West.(Udo,1992).

1.8 PHYSIOGRAPHY

Nyanya is located on Lat. $6^0$40'60N and Long. $8^0$58'0E of the Equator. It is located in a valley with hills forming a fence-like structure around it and Karu.

1.9 CLIMATE/WEATHER

The Federal Capital Territory (Abuja) has Nyanya in one of it's Area Councils (Municipal Area Council); it has it's highest temperature of about 30^0c-32^0c during the dry season months which are generally cloudless.

During the dry season, in the month of February/March, towns in the North-Eastern part of Abuja (Nyanya) experience temperature that could be as high as 32^0c. During the rainy season, temperature drops drastically to 21^0c, this is due to dense cloud cover and this is between July and August. (Udo, 1992)

Abuja, the capital city experience major atmospheric weather variation twice a year. There are two seasons, the rainy season which begins from Mid-March and runs through October, while the dry season is characterized by bright sunshine that most times last for 10-11 hours daily. During this period of dryness, the temperature is always on the high.

The harmattan with occasional dust haze occurs in November and last till March. During the harmattan period, the weather is usually cold at night and early hours which sees temperature dropping to as low as 21^0c. (Udo, 1992).

1.10 SOIL

The study area is covered predominantly with a combination of the three (3) types of soils – namely, sandy soil, loamy soil and clay soil. These different soil types are scattered in different parts of the study area in proportionate quantity, thus making the study area eligible for any kind of land use activity.

1.11 LAND USE

Though Nyanya is comprised of the three (3) different soil types, but it is mainly used for residential purpose and also commercial purposes where there are a lot of build-up areas which serve as housing accommodation for its environs as well as shops for commercial purposes. There are rarely land for farming or rearing of animals and livestocks. So, land use activities in the study area are mainly buildings for housing as well as commercial purposes.

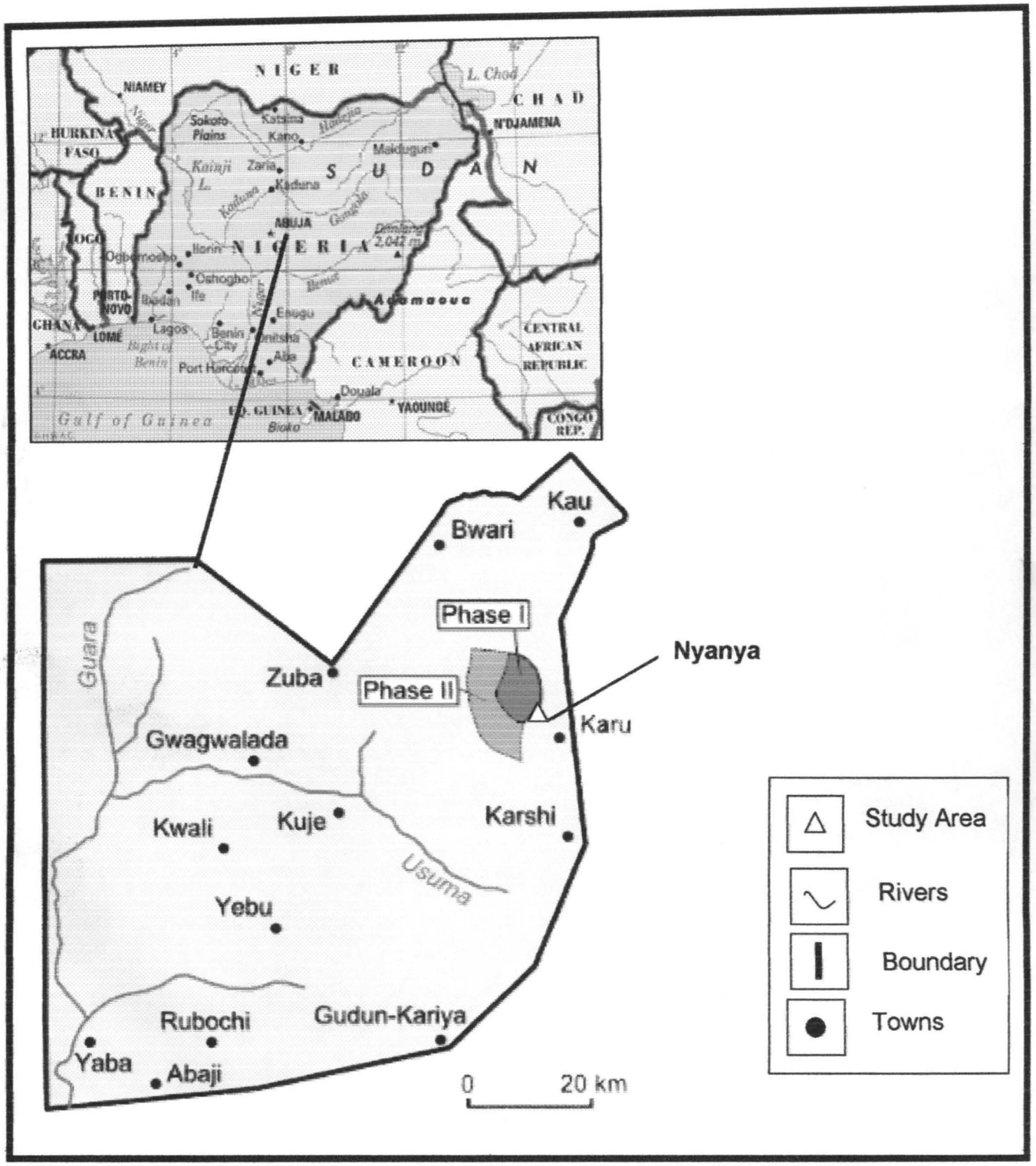

Fig.2.1 **MAP SHOWING THE STUDY AREA**
Source: **www.abujagis.com**

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews some literature on solid waste generation as well as its management.

It is a bit complex to summarize the total meaning of the term solid waste in a single definition. In a wider term waste can be said to be the items which are no more in use and not expected to be used in future. The only solution to these items is to destroy them. There are also some technical descriptions to the term solid waste which are; "solid waste is the term used to describe non-liquid waste materials arising from domestic, trade, commercial, agricultural, industrial activities and from public services". (Palniktar, 2002). "The Municipal Solid Waste" includes commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous waste, but including treated bio-medical wastes." (MOEF, 2000). Though the definition of the term will remain same in all times, but it changes it's features in different times. There is a large variation in solid waste from country to country. The type of waste depends on the commodity usage and lifestyle of the people.

Gosh, et al., 2005 defined household waste as the non-gaseous non-liquid waste that result from various domestic or household activities. In other words, solid waste are the non essential remnants of daily household consumable items. Another definition describes solid waste as useless, unwanted or discarded materials that arise from man's activities in the home and are not free flowing. (W.H.O. 1984).

2.2 GLOBALLY REVIEWED LITERATURE

Regardless of specific concern of most researchers, they agree on the domain of refuse generation, which may be residential block, a manufacturing unit or other particular buildings where various functions are performed. No matter what other functions a residential building performs and where it might be located, one common characteristics of all residential buildings is that they generate solid waste in varying quantities and qualities. In one of many works on environmental quality, Berry (1974) opined that "all types of land-use, whether residential, recreational or industrial, by-products of his affluent society will be found". The question is how each of what units arises and under what circumstances.

The environment is heading towards a potential risk due to unsustainable waste disposal. It is a sensitive issue which concerns about serious environmental problems in today's world. The present situation of direct dumping of the waste without proper inspection and separation leaves a serious impact of environmental pollution causing a tremendous growth in health related problems. "Domestic, industrial and other wastes, whether they are of low or medium level wastes, they are causing environmental pollution and have become perennial problems for mankind". (Ramasamy, et al., 2003). If this situation is not handled in a proper manner within time then it would lead to worse consequences on a global level.

There has been awareness regarding waste management amongst many countries. There has been development of new technologies for improving the waste management systems. GIS is one of the new technologies which has contributed a lot in very less time span to the waste management society. The Geographical Information System (GIS) helps to manipulate data in the computer to stimulate alternatives and to take the most effective decisions (Naravan., 1999).

2.3 REGIONALLY REVIEWED LITERATURE

In a recent work on waste management on some parts of Nigeria and, Sridhastal, (1985-1993) wrote that no efforts were made by people either to recycle or dispose their waste in a more hygienic way, he went further to say that several attempts by them to encourage rural and semi-urban communities to make composts out of their wastes were short lived because they did not commit themselves fully to the project.

Akintola, (1974) emphasized that the urban system is overloaded to capacity and therefore, malfunctions and Mabogunje, (2001) in a seminar held in Abuja titled, "Good Urban Governance", said that "Nyanya is an accident that is not suppose to have happened". He attributed this to the drastic rise in the population of Nyanya inhabitants and the unplanned nature of the area. The over-load can be said of the situation of essential services in some parts of Abuja such as Karimo, Gwagwa, and Karu. The rapid growth of population within these core areas of Abuja has constantly been creating problems because the available facilities cannot sufficiently serve the people. The rate at which solid wastes are generated is faster or higher than what the available disposal service can cope with.

Akintola,(1974) also went further to emphasize that, "adjustment within the system without corresponding expansion of physical facilities constitute major further cause of environmental administrative incompetence".

2.4 CONTRIBUTIONS OF GIS IN SOLID WASTE MANAGEMENT

There are several phases in solid waste management, right from the stage where it is generated till it reaches its final destination or at a stage where it is no more a threat to the environment. It is observed that solid waste management can be bifurcated into mainly two phases. One is the waste management in the area where it is generated and second is the management of waste at dumping grounds. This paper will cover the first phase which deals with the municipal waste management within the city limits. This includes the issues related to the waste generation, their storage, collection and removal from the collection points.

Waste is generated in all areas, but there is large variation in its type and quantity. According to Garg., (2002), the quantity and nature of the waste generated vary with the activities and with the level of technological development in a country. "The issue of waste is not only because of the increasing quantities, but also largely because of an inadequate management system". Tinmaz, et.al.,2005. The analysis of this variation would give the information which could make it easy to understand the area's waste generation nature and trend. This trend can help to propose a proper waste management system that could recognize this variation. The suggestions made after considering these variations would maintain a balance in this variation by considering the area which generate more or a different category of waste. Also there is some generation categorization in the waste generation which also helps to analyze the waste generation trends. These trends are useful while planning waste management. An analysis done in this systematic way can bring out the appropriate remedies for the solid waste management applications. GIS could help in dealing with several factors simultaneously which needs to be considered while planning waste management. "GIS is a system of computer hardware and software, designed to all

users to collect, manage, analyze and retrieval of large volume of spatially referenced data and associate attribute data collected from a variety of sources". Upasna, et. al, (2003).

There are also lots of planning aspects in waste management. A good planning would support proper management policies. There are several problems which need to be treated with decisions taken considering all the related factors. Often the order and the amount of preferences given to these factors, decides the decision's credibility. Manual methods adopted for analysis of many factors would be a lengthy and tedious work. Also there are possibility of errors while merging the spatial and non-spatial data. But in GIS, as the work is carried in layers, there are least chances of confusion or error and the system is capable enough to coordinate between spatial and non-spatial data. The spatial is normally performed in conjunction with GIS functionality found in most GIS software". (Lunkapis, 2004).

GIS is a good decision support tool for planning waste management. There was a research conducted for landfill site selection in Malaysia and it was mentioned in the report (Lunkapis, 2004) that the purpose of the research was to use Geographic Information System (GIS) as a tool to aid the decision-making process and to test its effectiveness using some established government guidelines. Due to the multifunctional texture of the geographic information systems, the information can be related spatially with a very good flexibility to exchange, compare, analyse and process it "by assessing the location of something and then combing it with what's around it, you're able to make a decision you were never able to make before", said (Sexman) a GIS manager for San Francisco. (Wired News Publication Website).

Obasanjo, (1992) in a paper on "Constitutional Role of Local Government in Waste Management in Nigeria" with the focal point "knowing and doing it right"

broadened the scope of the fast growing source of waste in Abuja Metropolis in particular and Nigeria at large. He further expressed that, "though poverty is a key factor in the inability to effectively manage waste in the country, profligacy characteristics of other facets of our national life, degrees of plantlessness appear to be the main draw-back in the approach to waste management".

A manifestation of such lack of resourcefulness could be in the nationwide monthly environmental sanitation exercise which he believed would have to be reviewed again for a benefit analysis in order to determine the extent to which the laws of productivity of these three has gone in indicating the habit of sanitation discipline and cleaners. Obasanjo (1992) further noted the potential sources of waste by calling attention to the massive importation of used vehicles and parts that already have limited life span from Europe. He then suggested that there's need to start planning ahead now for the tones of scrap that will emanate from this body of Nigeria's Economy down town in view of the absence of scrap recycling technology in the country.

Famuyibo, (1992) noted that in the next four years, an estimated 60% of the world population will live in the cities because of rapid rate of urbanization. This urbanization, posited is more pronounced in poor countries". He also lamented that urban areas were becoming larger with high rate of both domestic and industrial generated wastes, while many inhabitants suffer from poor living and indecent environmental conditions. Apart from adequate and efficient facilities, he contends that those that exist are poorly maintained and function in epileptic manner.

No matter the weight, seasonality or the characteristics of solid waste generated in some locations, the most important thing is how they efficiently get rid of the problems they might constitute to the society and individuals in such a society.

2.5 CITY WASTE MANAGEMENT BACKGROUND

This system is designated for the conditions of Nyanya town of the FCT. It is based on the practical observations regarding the functions and the time wise needs of the town. The town conditions are such that the inhabitants face a lot of problems due to improper management of solid wastes. This is not because the municipality is not doing their work properly or due to work negligence, but is due to the old conventional working methods which need to be upgraded with the advanced system like GIS and a better management system.

"Municipal bodies are unable to prove a 100% efficient system and even are not able to reach the efficiency of 60%" (Ogra, 2003). The maintenance and the management of data is an important thing

which was found missing in the system due to which it was quite difficult to know about the systems functioning. The data should be managed in an integrated way to reduce the complexity of different issues related to the function of the work involved in the waste management system.

2.6 PROBLEMS DUE TO SOLID WASTE MANAGEMENT

The situation now is such that there are several drawbacks of this garbage accumulation and even worse were its consequences, some of them are;

- The biggest threat to a locality is the waste could be a breeding ground for flies, insects, bacteria, fungus and many such micro-organisms. This could spread diseases and it would become worse during rainy season and the contamination might end up in an epidemic like cholera, malaria etc.

- Bad odour is created around the garbage area, making an unbearable environment.
- Poor waste pickers pose a serious threat to public health.
- Animals like cats, dogs, goats and cows come to the garbage in search of food and end up in spreading the garbage and the bins.
- The economic factor is also affected, the market value of a particular area decreases if there is a badly maintained waste area near by as it poses a bad aesthetics.
- It overall leaves a bad impression and poses a threat to the environment.

The town's condition is such that the inhabitants face a lot of problems due to improper management of solid wastes. This is not because the municipality is not doing their work properly or work negligence, but it is due to the old conventional working methods. Municipal bodies are unable to prove a 100% efficient system and even are not able to reach the efficiency of 60%" (Ogra, 2003). There are several areas where the municipal bodies are striving hard to provide best of their services for the betterment of the city. They even follow their methods promptly and perform their duties in a way that could run this system perfectly. In this kind of situations, there has to be a better and a refined system which is developed with the consideration of all the facts and figures of the situation. This can be achieved with the help of GIS which can handle different data forms like spatial as well as attribute data simultaneously. The system seems to fall short in terms of its approaches to maintain a clean environment and it needs to be upgraded and refined. Solid waste management is one of the most important areas where problems arise from time to time. "One of the simple ways to bring innovations in any system is to document and study the

existing factors and bring possible reforms by adopting appropriate measures of various levels through the introduction of innovative and cost effective solutions" (Ogra, 2003).

The type of dataset which is required is the information about the areas where most waste is generated, the data related to the employees involved in the waste management programme. A systematic map with sufficient information related to the waste generated in different areas and even along the roads and junctions.

To provide a waste management service which can be acceptable on existing financial constrains. This action plan proposed two elements of the plan, first the creation of an efficient Management

Information System (MIS) and Geographic Information System (GIS) and the second, the provision of planning and management such that there are possibilities of improvement in financial and institutional support. Due to the financial constrains it was suggested to incorporate those options which can promote the improvement in the system without a major capital investment. So it was proposed to create the MIS and GIS information.

According to Ogra, 2003, through continuous planning and dynamic management these systems can be designed to have capacity that meet demand on a continuous basis. The process of planning cannot be stopped and suggested as ideal for the system as the town's situations of waste generation and the service requirements change in due course of time so the planning also have to be upgraded and reconsidered. GIS can make the analysis of the situation and a future trend can be predicted which will help in planning for a long time.

Charks, (1981) examined, "waste management as an integral part of environmental planning and health sanitation services". According to him, waste

management is a necessary science which aims at averting the hazards posed by undisposed liquid, solid and gaseous waste. Such hazards include the unsightliness, nuisance and obnoxious odours of waste, contamination of water supply from physical, chemical and bacteriological agents, destruction of fish, shell fish and other aquatic lives, imp-ailment of beneficial uses of natural wastes for recreation, commerce and industrial purposes and spread diseases from crops grown on sewage irrigation or sludge disposal.

In summary, Charks, (1981) identified the lack of adequate institutional arrangement, low financial and technical sustainability of existing system as the main factors behind seemingly intractable solid waste management problem in Nigeria such problems include the inadequate coverage of the population to be served, operation efficiency and municipal solid waste service limited utilization of the informal and formal private sector in recycling activities and lack of effective monitoring system.

CHAPTER THREE

MATERIALS AND METHODS

3.1 DATA COLLECTION

GIS links spatial information location with descriptive information (attributes) and creates a map (layer). The spatial information can be XY – coordinates (e.g. latitude and longitude) or they can be more hidden like the Assessors Parcel Numbers (APNs) or physical addresses. The descriptive information can be anything that the user might find useful and that is tied to the specific location or area. The layers created by the GIS should be specific to one type of features like roads or transfer stations.

In GIS you can overlay an endless number of layers to create specific maps for any point on these maps all information stored as attribute in the selected layers is available.

Global Positioning System (GPS)

The most accurate way to obtain the position of a spatial data is to use the Global Positioning System:

Satellites constantly send signals to the earth. With a GPS receiver one can calculate the position of a feature according to the satellite signals. The accuracy of the position of a feature depends on the type of receiver and the quality of the signals received.

During the field investigation of this work, a GPS was used to take coordinates as well as readings of the different dumpsites and road boundaries located or noticeable in the different zones of the study area, this was done through ground trotting. The GPS was carried along from one waste dumpsite to another, as each dumpsite is approached, the X and Y coordinates of the dumpsite is taken and the exact position of the site read and recorded.

QUICKBIRD 0.6m RESOLUTION SATELLITE IMAGE

QuickBird is a high resolution satellite. QuickBird collects image data to 0.6m pixel resolution degree of detail. This satellite is an excellent source of environmental data

useful for analyses of changes in land usage, agriculture and forest climates. QuickBird's imaging capabilities can be applied to a host of industries.

A QuickBird 0.6m resolution satellite image which gives a clearer visual of features on the ground was used in the course of this research work. This satellite image (QuickBird 0.6m resolution) was digitized and geo-referenced to arrive at and bring out the spatial information of base layers (boundary, road network, distribution of buildings and dumpsites). This was done with the aid of an Arcview 3.2a software which was used to process the data or information gotten from the field and also the QuickBird 0.6m resolution of the study area to finished product.

ARCGIS DESKTOP

ArcGIS Desktop is a collection of software products that runs on standard desktop computers. It is used to create, import, edit, query, map, analyze and publish geographic information. There are four products in the ArcGIS desktop collection; each adds a higher level of functionality. One of these products (ArcGIS) is the ArcView GIS software.

ARCVIEW 3.2a GIS SOFTWARE

An Arcview 3.22 GIS software was also used in the course of the research work, this software was used in the data analysis stage of the work. This software (ArcView 3.2a) was used to create base layers boundaries etc after which a query was sent with the help of the Arcview software for sites that are suitable dumpsites to be made visible and the positions pin-pointed on the satellite image.

VISUAL INVESTIGATION

Visual investigations where also carried out to ascertain the types of waste noticeable in the study area and also to take account of the total number of dumpsites in the different zones of the study area. During this process, a total number of 18 dumpsites where counted, but out of the total number of dumpsites noticeable, a good number where wrongly sited i.e. they where not sited in areas that could give easy access to consumers as well as collection vehicles.

CHAPTER FOUR

RESULTS

This part is divided into two sections, which deal with the analysis of data collected during field work. The first section deals with the examination of the socio-economic characteristics of respondents. The socio-economic characteristics examined include educational background, age and occupation of respondents. The second section covers waste disposal system/management using a spatial analysis tools (GIS).

SECTION ONE

4.1 PERSONAL INFORMATION OF RESPONDENTS.

TABLE 4.1: AGE OF RESPONDENTS IN HOUSEHOLDS OF STUDY AREA.

AGE DISTRIBUTION	S/NO.	PERCENTAGE (%) OF HOUSEHOLD
15 – 30 Yrs.	45	45
31 – 45 Yrs.	26	26
46 – 60 Yrs.	19	19
61 – Above	10	10
TOTAL	**100**	**100**

SOURCE: Field Work, 2008.

TABLE 4.2: EDUCATION BACKGROUND OF RESPONDENTS.

EDUCATIONAL BACKGROUND	S/NO.	PERCENTAGE (%) OF RESPONDENTS
Primary Education	5	5
Secondary Education	40	40
Tertiary Education	30	30
Adult Education	20	20
Illiterates	5	5
TOTAL	**100**	**100**

SOURCE: Field Work, 2008.

TABLE 4.3: OCCUPATION OF RESPONDENTS.

OCCUPATION OF RESPONDENTS	S/NO.	PERCENTAGE (%) OF RESPONDENTS
Trading	20	20
Civil Servants	47	47
Self Employed	13	13
Unemployed	8	18
Retired	12	12
TOTAL	**100**	**100**

SOURCE: Field Work, 2008.

4.2 WASTE DISPOSAL MANAGEMENT.

This section of the work looks at the different types of waste generated by the inhabitants of the study area, the volume generated and the management of the waste through the use of Geographic Information System (GIS) as a spatial analysis tool.

4.3 TYPES OF WASTE GENERATED BY HOUSEHOLDS IN THE STUDY AREA

Collected field data shows that waste generation types vary slightly from one area to another in the study area with respect to its nature, composition and functions in the study area. There are four different types of wastes generated in the study area, and they are shown on table 4.4.

TABLE 4.4. WASTE GENERATED BY HOUSEHOLDS IN STUDY AREA

TYPES OF WASTE	S/NO.	PERCENTAGE (%) OF RESPONDENTS
Domestic Waste	54	54
Agricultural Waste	16	16
Market Waste	22	22
Other forms of Waste	8	8
TOTAL	**100**	**100**

SOURCE: Field Work 2008.

4.4 VOLUME OF WASTE GENERATED PER DAY

The volume of waste generated per day in the study area is also examined.

Table 4.5 shows the volume of waste generated daily in the study area.

TABLE 4.5. VOLUME OF GENERATED WASTE IN (KG) BY RESPONDENTS

VOLUME OF WASTE GENERATED	S/NO.	PERCENTAGE (%) OF RESPONDENTS
3Kg	25	25
2Kg	49	49
1Kg	21	21
Less than 1kg	10	10
TOTAL	**100**	**100**

SOURCE: Field Work 2008.

TABLE 4.6 – SPATIAL DISTRIBUTION OF FEATURES IN THE STUDY AREA.

	ZONES	NO. OF BUILDINGS	AVERAGE HOUSEHOLD	POPULATION	TOTAL NUMBER OF CONTAINERS PER ZONE (USEFUL POINTS)	INDISCRIMINATE DUMPSITES	DUMPSITES USEFUL AS COLLECTION POINTS
1	A	334	17	5678	6	7	1
2	B	216	17	3672	4	2	1
3	C	433	17	7361	7	3	2
4	D	276	17	4692	5	6	4
5	E	350	17	5950	6	0	0
TOTAL	5	1609		27,353	28	18	8

SOURCE: Field Work 2008.4.5

BUILDING SPATIAL DATA

Integrating spatial analysis tool with management issues is a vital part of this study. Geographical Information Systems (GIS) software Arcview 3.2a was used to create various vector layers from a QUICK BIRD 0.6m resolution satellite image of Nyanya area. Digitized vector layers include:

- Boundary
- Road network
- Building distribution (built up areas)
- Dump sites (present)
- Assumed collection points.

The spatial information of base layers (boundary, road network, distribution of building and dump sites) is generated using QUICK BIRD 0.6m resolution satellite image of the study area as well as field data collection with the aid of a GPS. The vector layers of boundary, road network, buildings and dumpsites were overlaid for further analysis.

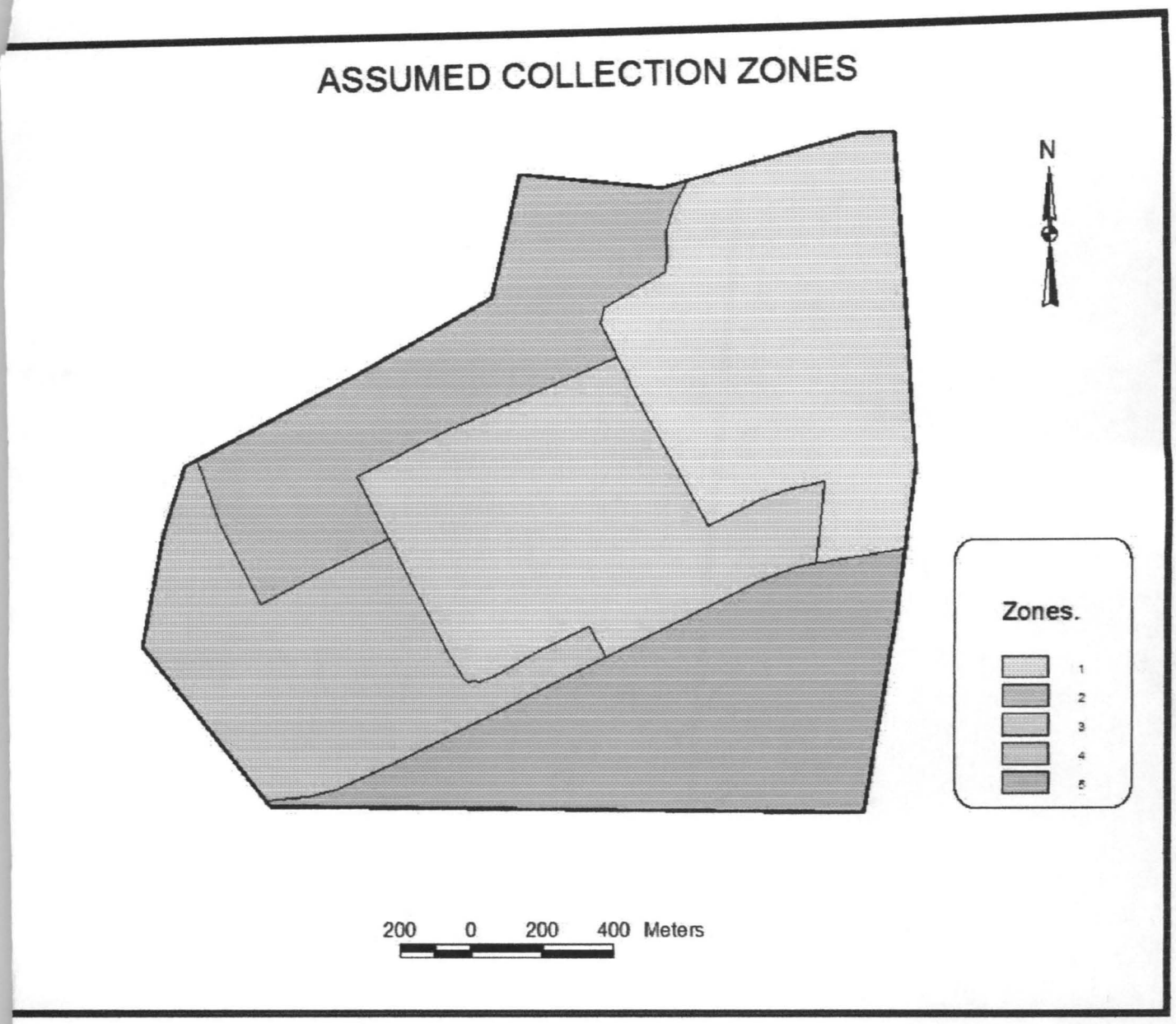

Fig.4.1 ASSUMED COLLECTION ZONES
Source: **Field Work/Digitized Satellite Image (2008).**

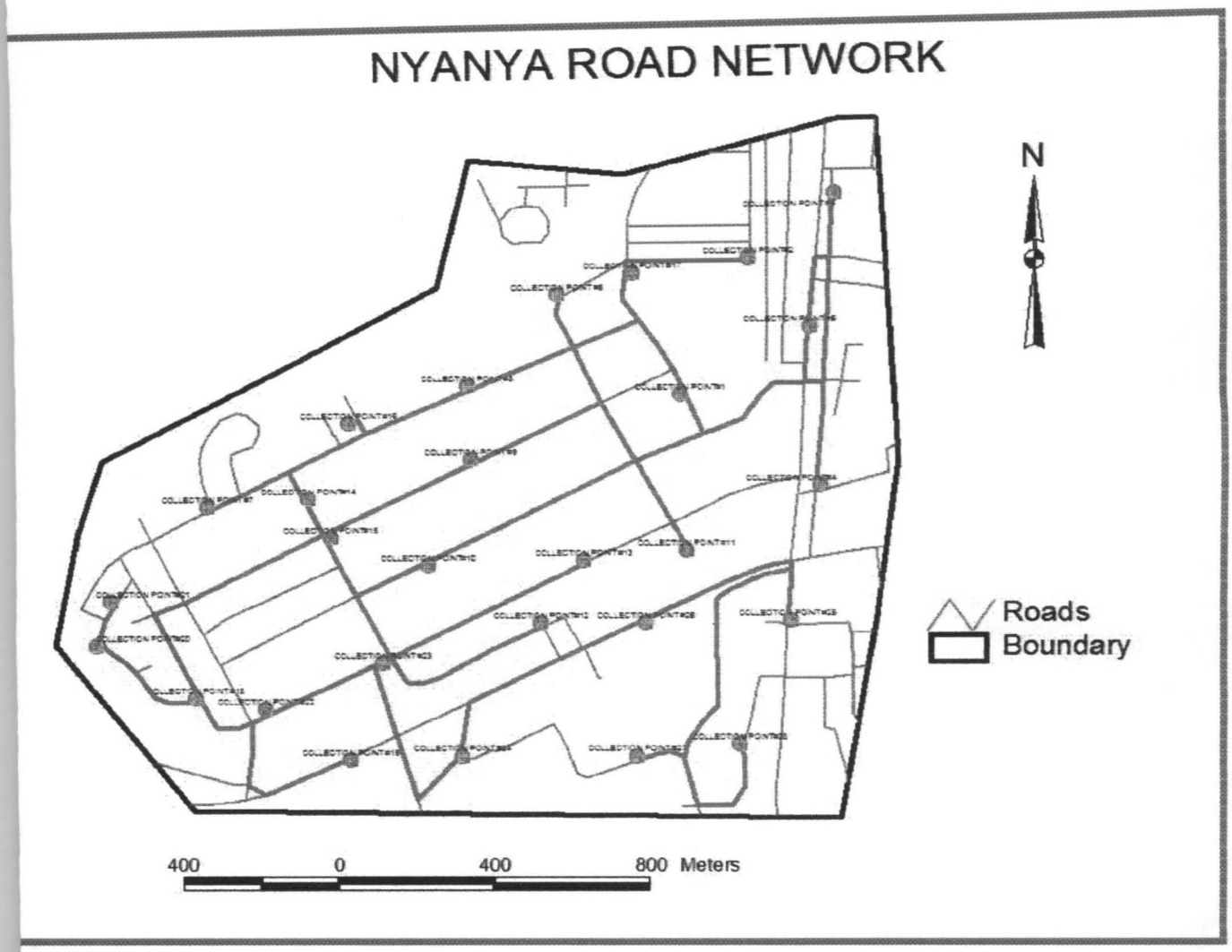

Fig.4.2 NYANYA ROAD NETWORK

Source: **Field Work/Digitized Satellite Image: 2008**

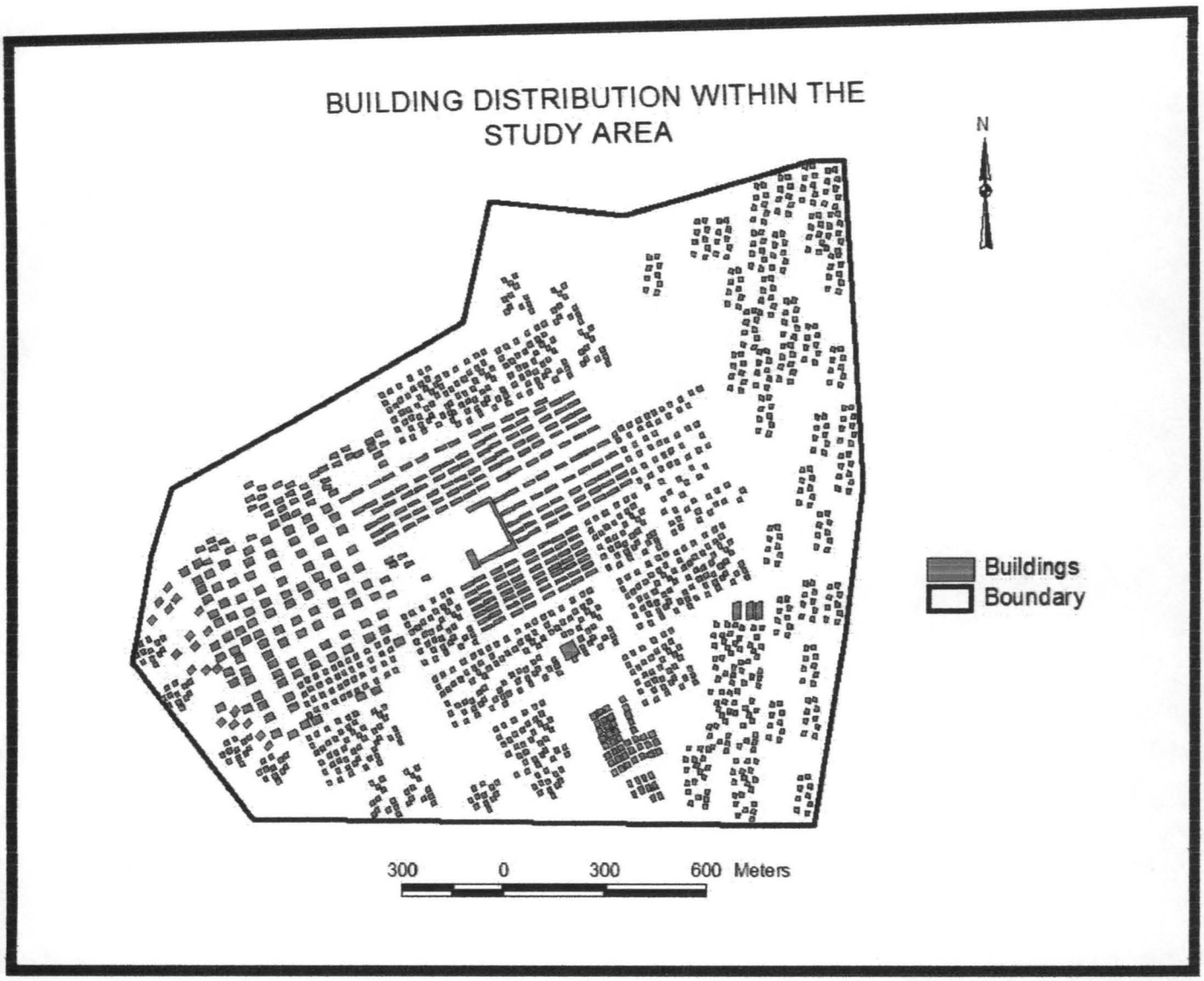

Fig.4.3 **BUILDING DISTRIBUTION WITHIN THE STUDY AREA**

Source: **Field Work/Digitized Satellite Image: 2008**

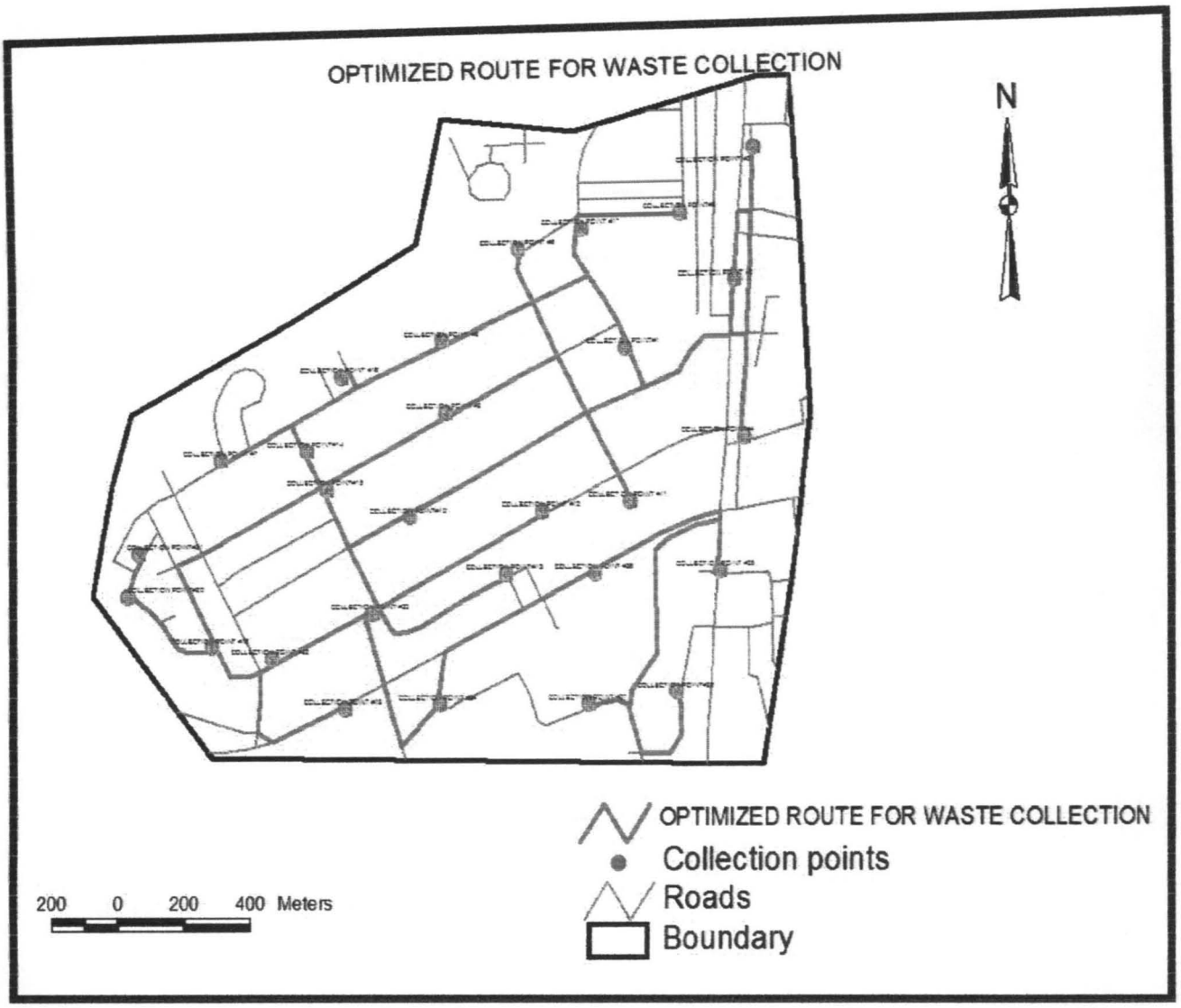

Fig.4.4 **OPTIMIZED ROUTE FOR WASTE COLLECTION**

Source: **Field Work/Digitized Satellite Image: 2008**

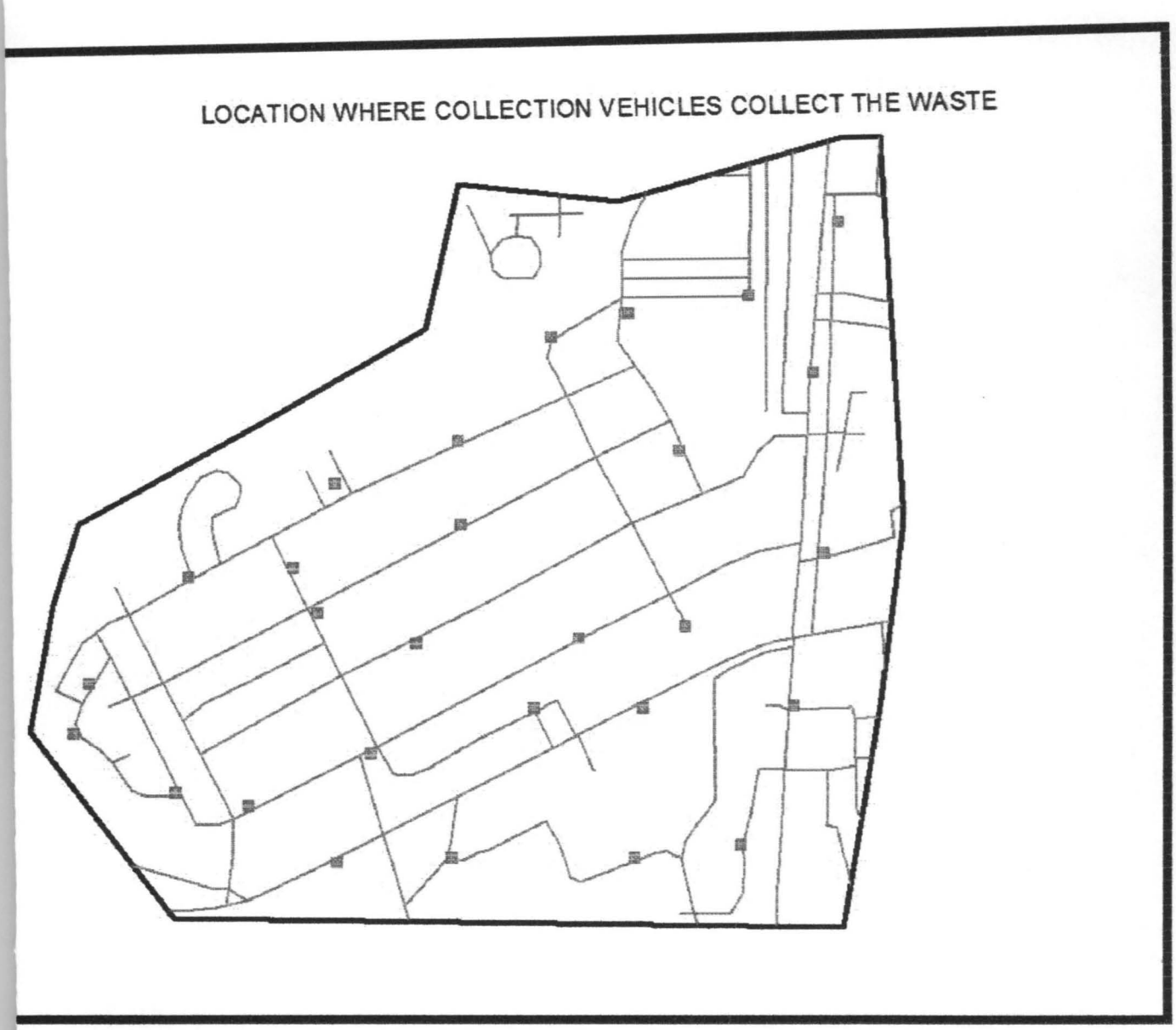

Fig.4.5 **LOCATION WHERE COLLECTION VEHICLES COLLECT THE WASTE**

Source: **Field Work/Digitized Satellite Image: 2008**

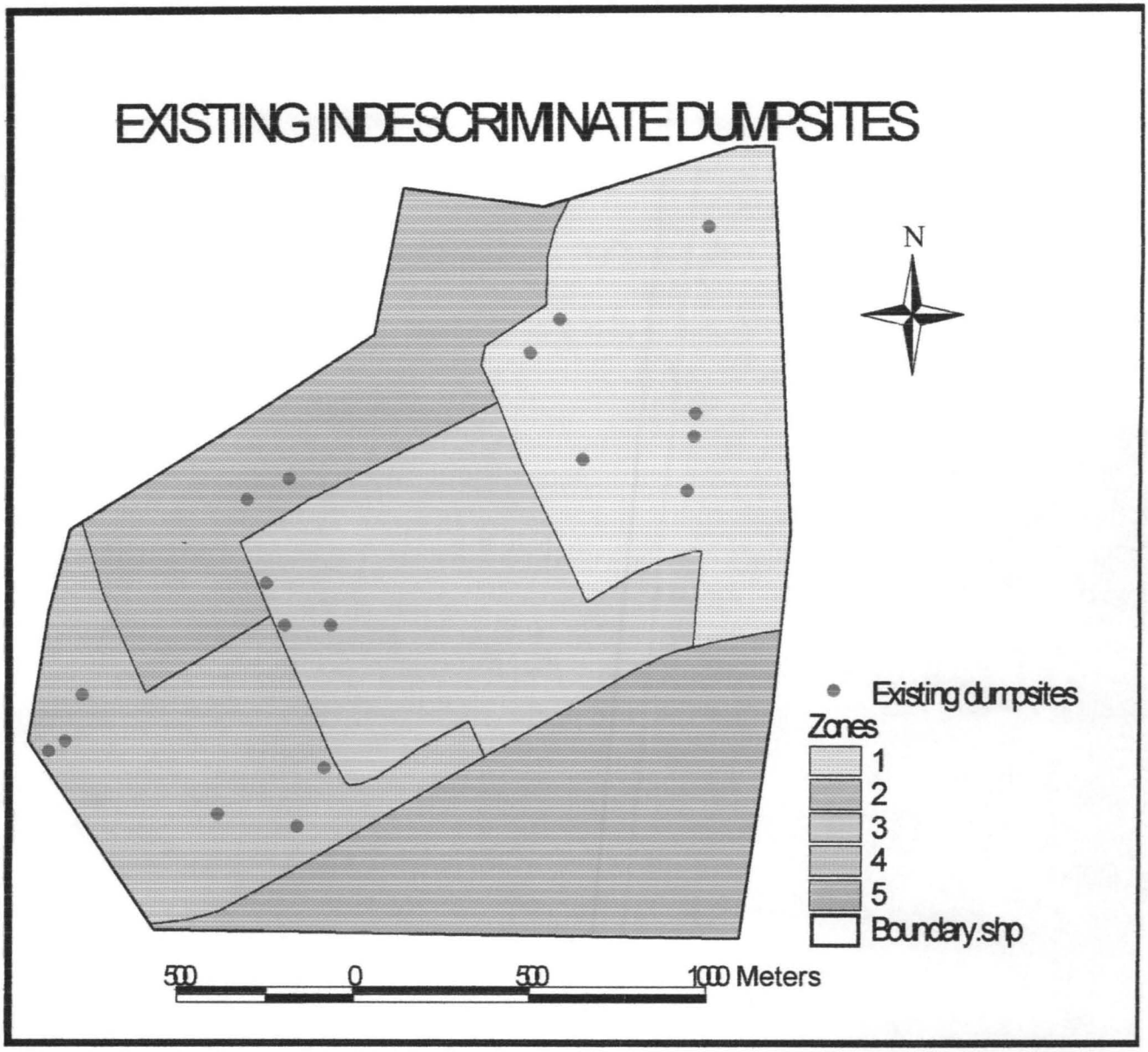

Fig. 4.6. **EXISTING INDISCRIMINATE DUMPSITES**
Source: **Field Work/Digitized Satellite Image: 2008**

1

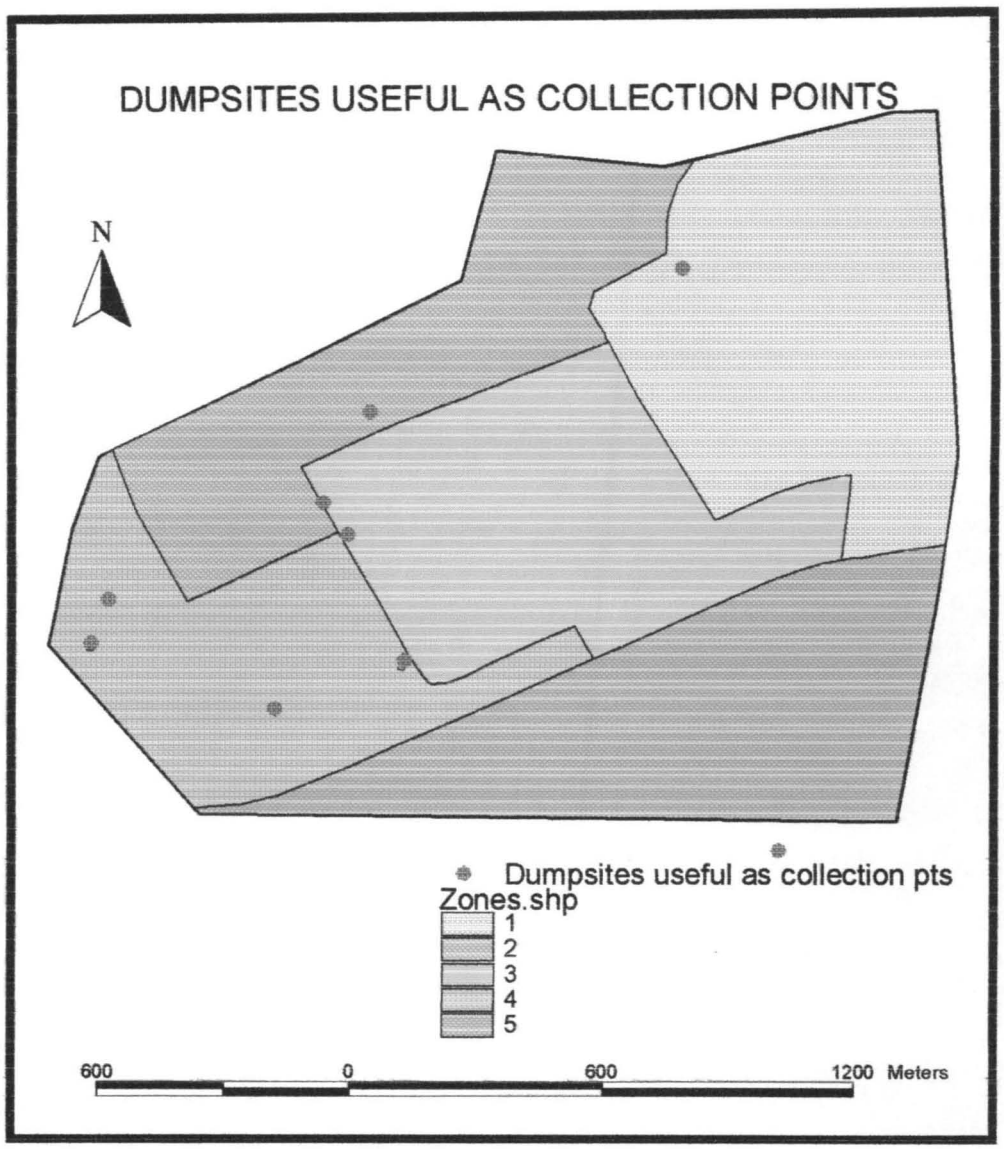

Fig.4.7. **DUMPSITES USEFUL AS COLLECTION POINTS.**
Source: **Field Work/Digitized Satellite Image: 2008**

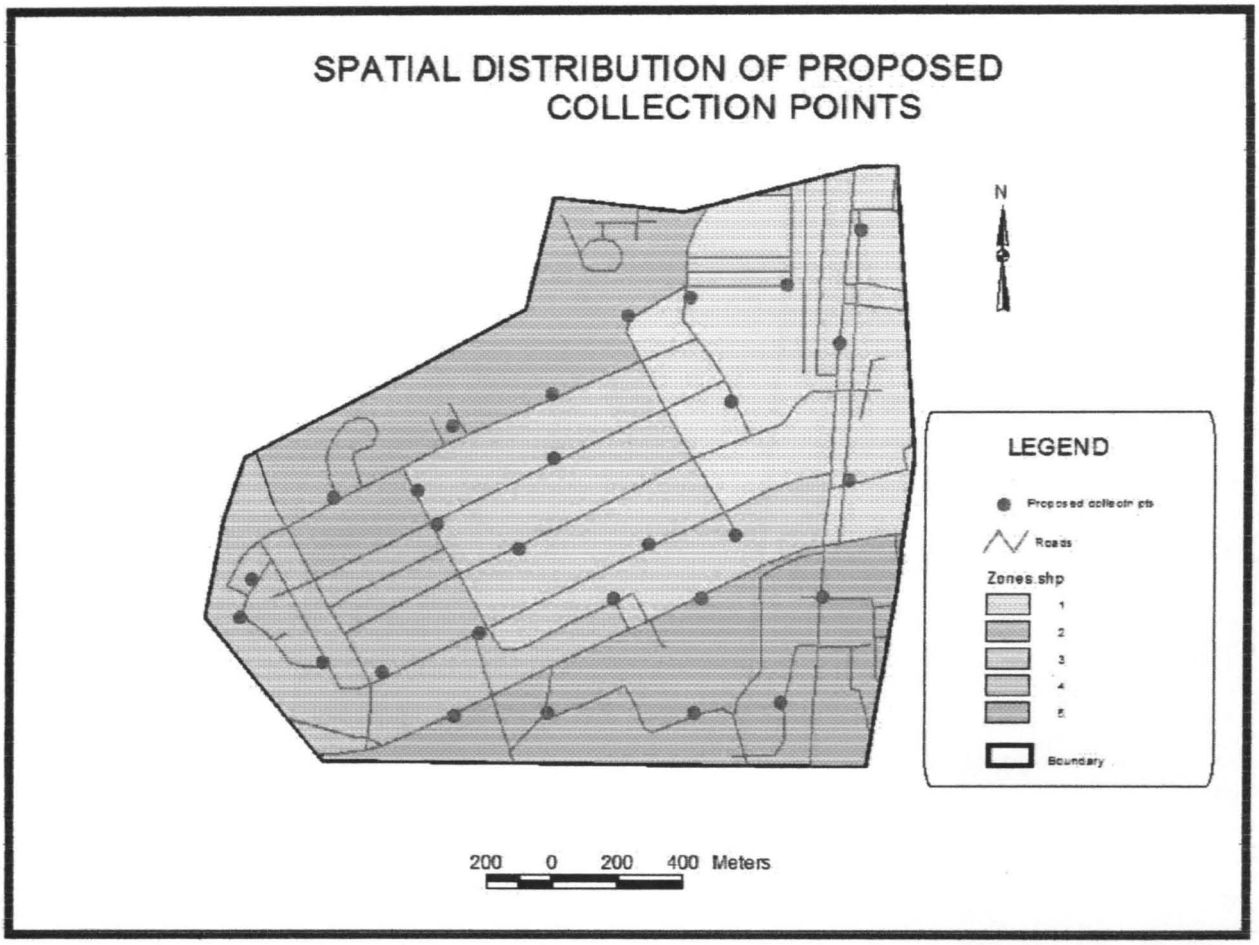

Fig.4.8 **SPATIAL DISTRIBUTION OF PROPOSED COLLECTION POINTS**

Source: **Field Work/Digitized Satellite Image: 2008**

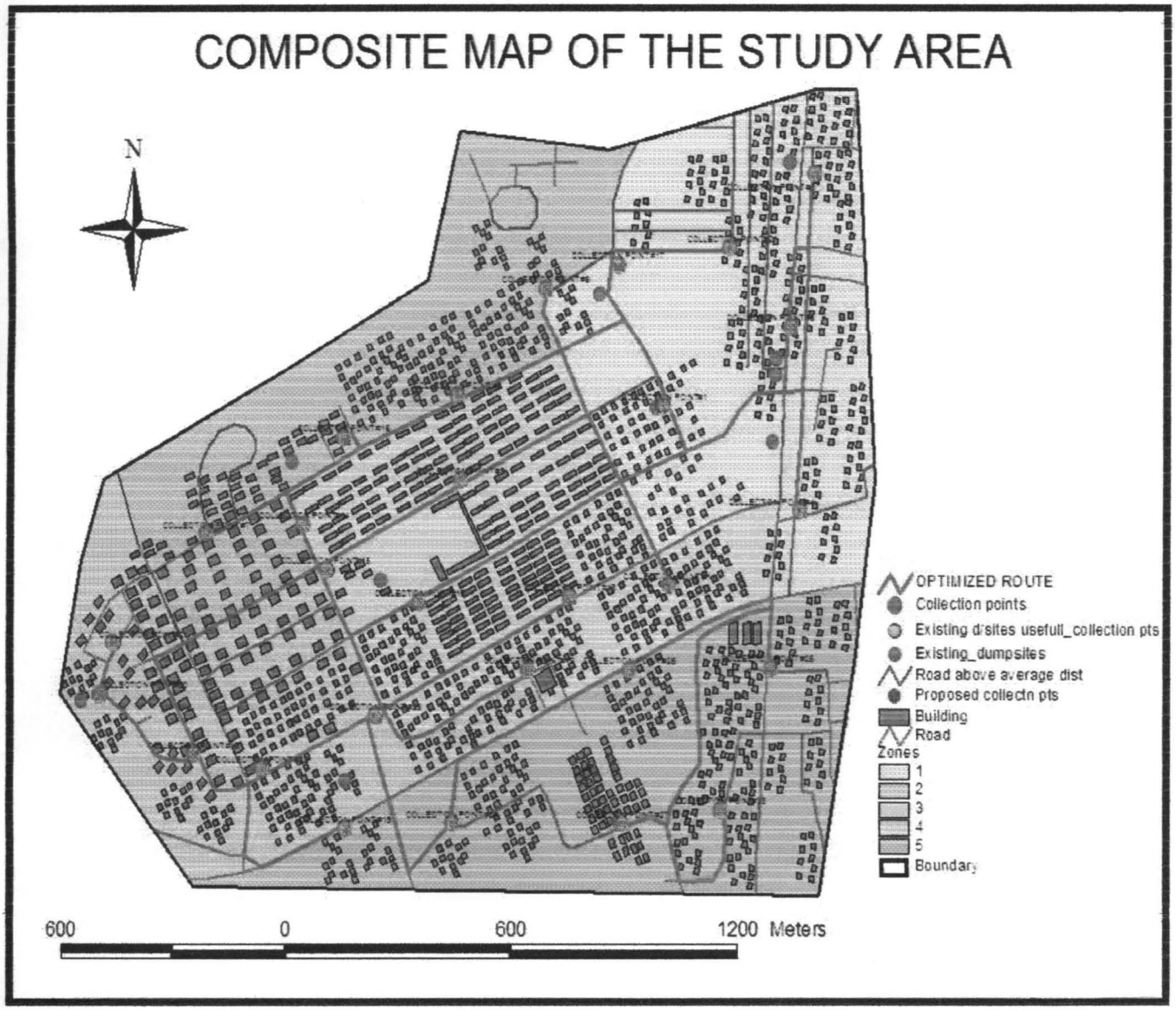

Fig.4.9. **COMPOSITE MAP OF THE STUDY AREA**

Source: **Field Work/Digitized Satellite Image: 2008**

CHAPTER FIVE

DISCUSSION, SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 DISCUSSION OF TABLES

From table 4.1 it can be deduced that the number of respondents sampled in the study area was 100. Ages 15-30 and 31-45 had the highest response of 45% and 26% respectively which accounts for 71% of the total respondents. The remaining 29 responses was shared between ages 46-60 and 60-above.

Table 4.2 indicates that both Primary education and illiterate had 5% responses each, while those respondents that went beyond primary school account for 70% of the responses for secondary and tertiary education with 40% and 30% respectively. The 20% respondents left attended adult education.

Table 4.3 shows that, out of the 100 sampled respondents in the study area, 47% of them are working, 25 civil servants. The remaining 53% of the respondents have 33% attesting to the fact that they are not on the pay-roll of any government parastatals and this group covers the traders and the self-employed. While the 20% respondents that are left are without any job to do and comprise the unemployed and retired.

Out of the 100 sampled respondents shown on table 4.4, a total of 54% respondents claimed to generate domestic waste. This was followed by market waste with 22% respondents. Agricultural waste and other forms of waste had 16% and 8% responses respectively.

The two types of wastes with high responses totaling 76 are domestic wastes and market waste.

From table 4.5. it shows that 74% of the respondents sampled generated wastes that weigh 2kg to 3kg, while those that generate daily waste of 1kg to less than 1 kg volume of waste make up the remaining 26% of the respondents.

SPATIAL OUTPUT DISCUSSION

Figure 4.1 shows the different zones in the study area which are assumed to be the zones for generation and collection of wastes. The zones were aligned with the help of the different road boundaries in the study area and the zones which are recorded as zones A,B,C,D,E, are represented with figures in that order.

The road network in the study area is shown in Figure 4.2 and the total road length of the road network in the study area is put at 27.161m from the beginning of Zone A to the end of Zone E.

Figure 4.3 shows the distribution of buildings in the study area. Based on record gotten from the digitized satellite image (a Quick Bird 0.6m resolution), it is deduced that the total number of buildings in the study area is put at 1,609 and they are evenly distributed within the different zones.

Figure 4.4 shows an optimized route for waste collection. In this figure, a clear and distinct route that could or should be taken. For easy and convenient access to the different waste collection points and this could help to make waste management much easier and faster. The red lines show the different routes.

The different locations where collection vehicles collect waste make up figure 4.5. This figure shows the different points where the collection vehicles could collect the waste generated in the study area and these locations are marked with the green boxes.

Figure 4.6 shows a picture of the different dumpsites taken or recorded at the study area with the help of a GPS. These are dumpsites that are not planned and had some of it not sited in convenient sites. The dumpsites are represented by the blue dots.

The picture (figure 4.7) shows dumpsites that are useful as collection points. The dumpsites shown above are part of the total number of dumpsites recorded in the study area, but that are sited in convenient site that can be accessed easily and that are also conveniently located. The dumpsites are represented by the green dots.

Figure 4.8 shows the spatial distribution of proposed collection points in the study area. This picture shows the different collection points that are proposed as good and convenient collection points for collection vehicles. This is arrived at after a query was sent with the use of the Arcview GIS software for convenient collection points to be spotted based on accessibility and proximity to road and settlements. These points are spotted in blue dots.

Figure 4.9 shows a complete map of Nyanya where all the vital features are present and visible. This picture shows the different road networks, collection points, dumpsites, (optimized / indiscriminate) buildings etc. These different features are shown on the legend of the map.

5.2 SUMMARY OF FINDINGS

(a) From the study carried out, it was found out that four different kinds of wastes are generated in the study area with domestic waste being the most generated waste of all the four. This is made possible because the study area is more of a residential area. Next comes market waste which is due to the presence of market/traders and trading shops around. The last two waste found in the study area according to their level of

generation are agricultural waste and other types of waste comprising metal scraps, saw dust etc.

(b) The study carried out in this respect also revealed that more waste are generated in the study area because households that generated two kg and three kg of waste account for more than 60% of the total number of sampled respondents. Respondents with generated waste of 1kg and less account for less than 40% of the total respondents.

SPATIAL OUTPUT RESULT

- The analysis of results shows that the study area is divided into zones and they are numbered five (5) i.e. Zones A,B,C,D,E respectively. This zones are mostly residential houses, a market, business centres etc.
- The road network of the study area is fashioned in a way that it gives easy access to the residential places, markets, churches, business centres etc.
- The building distribution of the study area is such that the buildings are evenly distributed within the area and to a great extent, the building structures are planned and in a linear format. Also, the total number of buildings in the study area is put at 1,609, these buildings are distributed in the different zones with Zone A having 334, B=216, C=433, D=276, E=350 and the average household put at 17 person per house based on an estimated population of 7,000.

(Table 4.6) and a shared population amongst the different

Zones put at A=5678, B=3672, C=7361, D=4692, E=5950.

- An obtained result also shows existing dumpsites of the study area taken with the aid of a GPS numbering 18 with dumpsites that are useful for waste collection put at 8. (Table 4.6). These dumpsites are chosen to be useful based on their proximity to roads and residences and easy accessibility. So, with just 8 dumpsites adjudged as being useful (convenient) out of a total of 18 dumpsites, thus puts the displaced dumpsites at 10. These useful dumpsites (8) are not evenly and conveniently distributed within the different zone i.e. Zone A=1, B=1, C=2, D=4, E=0 (Table 4.6).
- Based on the result finding after a query is sent using an Arcview 3.2a for the system to pick good sites for the location of containers in the study area based on the proximity of these container to roads and also easy accessibility of these containers by the collection vehicles, a result was given with a total of 28 containers placed in sensitive sites for convenient waste collection. (Fig4.8).
- These containers were distributed according to the population of the different zones based on the fact that a container is attached to 1000 persons (Table 4.6).

GIS has been used to identify how much an area is covered by a bin of certain walking distance. Some locations of the waste bins are selected and they show the service areas of those of a given distance that is walkable. Coverage of service areas were produced where the individual service areas of waste bins are not overlapping each other and can cover the entire Nyanya area. In otherwords, it can be mentioned as optimum distribution of the waste bins at a distance factor. GIS gives me an opportunity to produce different coverage with different service area

covers at different distance factors and compare how many waste bins are needed in different cases.

In summary, Geographic Information System (GIS) is practiced for solid waste management elsewhere in the world including some developing countries, but not in Nigeria. It was found out that, Nyanya has no guidelines for locating waste collection bins in an area. They do not even have any proper instrument to analyze how the waste bins serve the people around. In these circumstances,GIS was used to analyze the existing service area of the waste bins in Nyanya and then select some suitable locations of the waste bins in the area.

The actors (households) view that, they need to have waste bins nearby or walking distance. Then the need for something that could be used to analyze the spatial and service coverage of the existing waste bins. With the GIS interpretation, It could easily be analyzed that the existing bins are too few and are not located well to get a good service area. In addition, the service areas of the existing dumpsites/bins are overlapping one another to big extent. GIS interpretation also shows that most of the Nyanya area is not covered by the existing waste bins within acceptable distances.

5.3 CONCLUSION

The solution, which comes out of GIS interpretation, might not work if the social, cultural and other malpractice will not be overcome. The actors need to have, as they are supposed to, in a country like Nigeria the systematic and well behaved actors may be expected in a remote future. So, any solution should be worked out within the frame out of the existing actors environment. Though the modern technology like GIS cannot have direct benefit for implementation work, but, it has

fruitful utilization in other way when the authority needs to seat with different stakeholders to resolve the conflict among each other. However, the findings of the study broaden the opportunity for further study. As this study reveals that GIS can be used for solid waste management, then further study can be done about how the authority like Abuja Environmental Protection Board (A.E.P.B) can be equipped with GIS.

Moreover, concerned people can think about if there is any possibility to include social factors in conventional GIS programs. By understanding how the rational actions use a GIS to transform information and the changes in the decision environment due to the introduction of the technology one would be able to improve GIS design, which in turn will lead to better decision making, the ultimate objective for having the technology in the first place.

5.4 RECOMMENDATIONS

Since the different zones in the study area are mostly occupied by building sited or built for residential purpose and also market as well as business, they contribute considerable quantity of recyclable materials like paper, paper envelopes and plastics (polyethylene) which has good market values if they are properly segregated from the waste stream. Separate dustbins can be provided to sort out recyclable materials at source itself in these zones to accomplish source reduction and also recycling.

- In the current practice of collection, the vehicle collects wastes generated in Nyanya not frequently. It is necessary to arrive at better collection strategies for better utilization of waste materials generated in Nyanya. In this regard, a transfer station is proposed to handle the waste collected

from the other zones before final disposal. This station enhances further separation of bioresource and recycling products and reduces the volume of waste going to the final disposal site.

- As for the current practice, which prevails in developing and developed countries for final disposal facilities such as incineration, sanitary landfill, gasification etc., it has its own advantages and disadvantages and if final disposal relies on a single disposal method, it won't be effective. The current practice of waste disposal is a non-engineered one, (**Mansoor Ali et al, 1999**) Nyanya waste is dumped (open dumping ground) in corporation disposal site. The proposed **(FEPA, 1991)** integrated approach (i.e. combination of aspects like source reduction, recycling, incineration and landfill) allows only inert materials to final disposal which cause almost no environmental degradation.
- Finally, the most crucial issue in waste management in general is that of funding. The Federal Government should try as much as possible to fund projects aimed at alleviating the issues faced with waste management. Also, stakeholders should be sent on refresher courses to update their knowledge on the most recent as well as easy ways to help check issues of solid waste.

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