Solid Waste Management in Westlands Suburb of Nairobi: A comparison between private and City Council garbage management services

By

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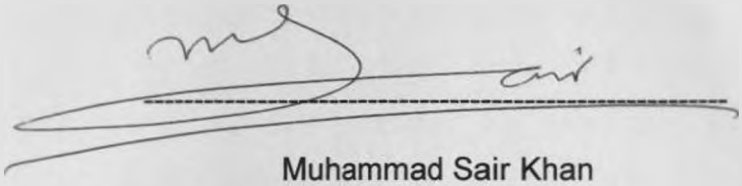
A research project presented in partial fulfilment of the degree of Master of Arts in Environmental Planning and Management in the Department of Geography, University of Nairobi (Kenya)

14 August 2003.

Declaration

This dissertation is my original work and has not been presented for a degree in any other university.



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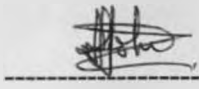
This dissertation has been submitted for examination with our approval as University Supervisors.



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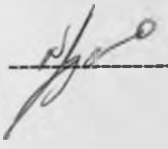

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Dedication

This work is affectionately dedicated to my late great father Mr. Adam Khan and my mother; and also to my brothers Haji Sher Rehman, Mr. M. Quresh Khan, sisters and my dedicated wife.

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Abstract

This study focused on Solid Waste Management in the Westlands suburb of Nairobi and more specifically on the generation of both commercial and domestic waste in Westlands and the interval of collection by both private companies and the City Council. The main objective of this study was to investigate the frequency of collection and accumulation of solid waste in the Westlands suburb of Nairobi City in order to assess the environmental impact of solid waste in the area. The general hypothesis for this study was that solid waste collection process did not vary between private firms and Nairobi City Council.

To solve the research problem and achieve the objectives of the study, there was a need to design a suitable investigation method. The research method had the following components: Data type; Data sources; Data sampling design; Data collection; Data Analysis. In this study, both secondary and primary data were used in an attempt to solve the stated research problem although primary data predominated. The primary data required for this study were on the following elements relevant to solid waste management: location of waste bins in the CBD and in four residential areas; waste generation represented by weight (Kg) from the units or bins; type of waste per unit or bin; waste management body; demographic information; spatial information in terms of the City of Nairobi administrative and road map and; public perception on municipal solid waste management by survey. The collected data were analysed using various analysis techniques or methods. Each variable score was first tabulated in the field notebooks and the resulting records were then subjected to the descriptive and spatial analysis methods in order to provide answers to the research problems and to meet the objectives of this study.

The results of the data analyses indicated that private companies are more efficient in waste collection than the City Council in the Westlands. The residents of Westlands were generally satisfied with the handling of solid waste in the area by private collection companies but were unhappy with the performance of the City Council regarding garbage collection and sanitation. Most of the waste generated in the study area was largely organic which could easily be composted.

The recommendations of the study are that Dandora dumpsite needs to be relocated; cleaner production should be encouraged to reduce the waste at source as a primary option and improvement of recycling and reusing should be patronized as a secondary option for waste minimization. Environmental Impact Assessment and ISO 14000 for the protection of environment should be enforced aggressively. Public awareness and motivation should be the key for waste reduction and its effective management. Public awareness about waste minimization must be propagated in comprehensible language and viable way. Privatisation of municipal solid waste management both wholly or in partnership with City Council should be encouraged and expedited. The use of traditional and indigenous material, which is easily biodegradable or durable for use, should be encouraged. Waste should be managed as a resource.

Abbreviations

APELL	Awareness Preparedness for Emergencies at Local Level
APO	Asian Productivity Organization
BOD	Biochemical Oxygen Demand (BOD)
CBD	Central Business District
CBO	Community Based Organizations
CBS	Central Bureau of Statistics
CMSW	Commercial Municipal Solid Waste
CMSWS	Commercial Municipal Solid Waste Stream
CO2	Carbon dioxide
COD	Chemical Oxygen Demand
CPC	Cleaner Production Centre
CPRF	Cleaner Production Revival Fund
DCC	Dare-es-Salaam City Council (DCC)
DMSW	Domestic Municipal Solid Waste
DMSWS	Domestic Municipal Solid Waste Stream
EA	Enumeration Areas
EA	Environmental Audit
EIA	Environmental Impact Assessment
EIRs	Environmental Impact Assessment Reports
EM	Effective Micro-organisms
EPZ	Export Processing Zone
ERA	Environmental Risk Assessment
EST	Environmental Sound Technology
GEF	Global Environment Facility
GEO	Global Environment Outlook
GIS	Geographic Information System
GPS	Global Positioning System
HDPE	High Density Polyethylene
IETC	International Environmental Technology Centre
Kgs	Kilograms
Ksh	Kenyan Shelling (Currency)-Current currency exchange rate US$ 1= 75 Ksh)
M.A. (EPM)	Master of Arts (Environmental Planning Management)
MHS	Metropolitan Household Survey (MHS)
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NCC	Nairobi City Council

NGOs	Non-governmental Organizations
PCB	Polychlorinated Biphenyl
PET	Polyethylene Terephthalate
pH	Hydrogen Ion Concentration
POPs	Persistent Organic Pollutants
RCCs	Refuse Collection Charges
SPREP	South Pacific Regional Environment Programme
SWRM	Sustainable Waste Resource Management
UNEP	United Nation Environment Programme
UNIDO	United Nations Industrial Development Organization
UON	University of Nairobi
WSSD	World Summit on Sustainable Development

Chapter One

1.0. INTRODUCTION

About half of the world's population (47%) now lives in urban areas, compared to little more than one-third in 1972. The accumulation of people, their consumption patterns, travel behaviour and their urban economic activities impact the environment in terms of resource consumption and waste discharges. Some 70 per cent of the world's urban population live in Africa, Asia or Latin America. The urban population is expected to grow by 2 per cent per year during 2000-15, and to reach an overall 65 per cent by 2050. Between one-third and one-half of the solid wastes generated within most cities in low and middle income countries are not collected (UNEP, GEO-3, 2002).

The implications of rapid urban growth include increasing unemployment and poverty, inadequate urban services, overburdening of existing infrastructure, lack of access to land, finance and adequate shelter, and environmental degradation. Managing the urban environment in a sustainable way will therefore become one of the major challenges for he future. Poverty is among the major drivers of urban environmental degradation. The urban poor, who are unable to compete for scarce resources or protect themselves from harmful environmental conditions, are most affected by the negative impacts of urbanization. It is estimated that one-quarter of the urban population lives below the poverty line and that female-headed households are disproportionately affected.

A common term used for waste collected and disposed of by or on behalf of a local authority is called Municipal Solid Waste (MSW). In general the

waste consists of mainly household and commercial waste. It may also include waste derived from civic amenity waste collection/disposal sites by the general public, street sweepings, gully emptying wastes and construction and demolition waste from local authority sources (Williams, P.T., P-53-57, 1998).

Inadequate waste collection and waste management systems are the cause of serious urban pollution and health hazards, especially in cities in developing countries. Cities in industrialized countries also face the consequences of past environmentally damaging production techniques and inadequate waste disposal. Well-planned, densely populated settlements can reduce the need for land conversion, provide opportunities for energy savings and make recycling more cost-effective. (UNEP, GEO-3, 2002)

Disposal of solid waste is a worldwide problem and if inadequately managed, waste disposal has the potential to affect the health of the people, damage the environment and be a barrier to economic development. The problem of waste management is also experienced in Kenya, particularly in its capital city of Nairobi. Westlands suburb of Nairobi has a "Central Business District" (CBD) with fast food outlets, shopping malls and some three star hotels. It has also a considerable number of residential blocks. It is against this background that a considerable amount of solid waste is generated in the area. Despite the fact that a proper waste management is an essential part of the City Council, there seems to be a problem in terms of the rate of collection per week of the solid waste. Many residents in the suburb have engaged the services of private companies to collect their solid waste both domestic and commercial. This study was undertaken in order to compare the efficiency of both municipal and private companies in collection of solid waste in Westland. In this research, Geographic Information System

(GIS) was used to capture the spatial data so as to attain optimum accuracy in the analysis and comparison of performance between City Council and Private Companies. Application of geocoding enables environmental engineers to identify potential impacts of storage facilities for hazardous/solid waste or materials in populated areas by matching the site addresses to a theme containing census data. The use of research and technological tools, such as GIS and satellite imagery, will make it easier to create appropriate collection points/zones of solid waste and regulations for effective and efficient guidelines. There is no doubt that the field of municipal solid waste management is multi-faceted but at the same time under-researched. As the sources and patterns of municipal waste, are keeping changing with pace of technological development and consumption style of the people. Therefore, it calls for constant monitoring, updated and efficient management planning. It is not claimed that the "total" solution for any given problem of SWM found herein. However, this research of Nairobi-Westlands Suburb area will lead planners and managers to many other possibilities and approaches as a guidelines in future.

1.1. Background of the problem:

The rate of influx and population growth in Nairobi City has been quite high and has been commensurate with solid waste generation. The efficiency of Nairobi City Council dealing with garbage collection has been put to test due to inadequate financial resources and vehicles to collect solid waste along the streets lying uncollected for long periods and becoming both eyesore and environmental hazards. This study was conceived after it was observed that solid waste management in the Westlands suburb has been a big problem (See Photograph-1).

Photograph 1: Illegal dumping site in Westlands.

1.2. Statement of the problem

The study investigated the generation of both commercial and domestic waste in Westlands and the interval of collection by both private companies and the City Council. The study also attempted to establish the residents' perception of the efficiency of both private companies and the City Council on solid waste collection from their premises as well as the environmental protection perception. The concept of waste as a resource rather than hazard in the environment formed a pertinent element in the analysis of waste management problems in Westlands and Nairobi. More specifically, the study addressed the following research questions:

i) What were the sources, types and amount of waste both in commercial and residential areas of Westlands, Nairobi?

ii) What was the public perception on private companies waste collection services and Nairobi City Council waste collection services?

iii) Was waste considered a resource or as a hazard in Westlands and Nairobi environment?

iv) What indigenous strategy and mechanism should be employed for efficient solid waste disposal in terms of both public health risk and environmental hazard?

1.3. Objectives of the study:

The main objective of this study was to investigate the frequency of collection and accumulation of solid waste in the Westlands suburb of Nairobi City in order to assess the environmental impact of solid waste in the area.

1.3.1. Specific objectives of the study are:

(a) To assess the frequency of solid waste collection by both private companies and City Council in Westlands.

(b) To establish the daily generation of solid waste per household/business premise.

(c) To gather information from residents on their satisfaction with solid waste collection and their views on environmental protection

(d) To create a spatial information system on solid waste management problem in Westlands using Geographic Information Systems (GIS) technology.

(e) To devise improved strategy and mechanism for efficient solid waste disposal of the area to mitigate both public health risk and environmental hazard.

1.4. Research Hypotheses

The general hypothesis for this study was that solid waste collection process did not vary between private firms and Nairobi City Council. Specifically the following hypotheses were used to guide the study:

i. The rate of solid waste generation is of no consequence in Westlands environment and therefore does not require special attention
ii. There is no difference in efficiency of solid waste collection between Nairobi City Council waste collection department and Private refuse collection Companies
iii. The residents of Westlands are satisfied with the handling of solid waste in the area by the Nairobi City Council
iv. Awareness on solid waste as a sustainable resource is not of value in Westlands

1.5. Scope and Limitations of the Study

1.5.1 Scope of the study:

This study did not consider the Commercial Waste generation separately due to uncertainty of the source of solid waste found in the sampled bins. The sorted wastes were only recorded from the Kijabe street dumpsite and it was not easy to differentiate solid waste from Westlands and the other parts of Nairobi or even from other adjacent towns. The quantity and intensity of hazardous solid waste needs to be identified and assessed. Special wastes are dangerous to people or have harmful effects on the environment. For example they could be toxic, flammable or explosive. Consequently special wastes require particular care in handling and disposal. Therefore special waste are not suitable for

ordinary landfilling and may not be fit for indigenous way of recycling as mentioned in the study, which needs to be investigated. Further thorough study for the whole of Nairobi city waste generation and management is required, as the present study confined to Westlands suburb, and the data samples were taken from that specific study areas. Lifecycle analysis of recycled products is also required.

1.5.2. Limitations of the study:

This study dealt with solid waste situation in Westlands suburb of Nairobi, which was taken to be a representative sample. Owing to shortage of time and funds to conduct a more detailed study, samples taken within the suburb were also limited. It was also difficult to obtain appropriate data about sorted waste and the researcher had to do it, which was time consuming. The Global Environment Outlook-2000 published by UNEP identified both data availability and data quality as issues that limit environmental reporting and assessment worldwide. Not having any relevant data is obviously a problem, but having poor quality data may sometimes cause more problems than having no data at all. Quality control, therefore, should be an essential part of the data collection strategy.

1.6. The Study Area

1.6.1. Introduction

The study area is specific Westlands suburb of Nairobi city, which has been projected to the whole of Nairobi city. The Nairobi city is a capital of Kenya and has experienced rapid growth, both in terms of population and physical expansion. In 1895, a depot for caravan trade was established at the present Ngara area, and when the Uganda railway reached Nairobi the settlement became the

railway's headquarters. In 1905 the colonial government established its capital in the same place, and 14 years later launched the Nairobi Municipal Council. The physical areas of Nairobi expanded from 3.84 sq. km in 1910 to 25 sq. km in 1919. By 1948 the city boundary covered an area of 83 sq. km. In 1963, the boundary was extended to 680 sq. km, which is still the current official size of the city. The new boundaries included Karen, Nairobi National Park, and Embakasi Airport area, Dandora, Kahawa, Garden Estate, Ruaraka, Njiru and Githurai. As the boundaries were expanded, the population increased from 8,000 in 1901 to 118,976 by 1948. At the time of independence in 1963 the population had grown to 350,000. From then the number rapidly increased at a rate of 7-9% per annum, reaching 835,000 people by 1979. However, the present population has been halted by adoption of contraceptive and since 1979 to 1999 the population of Nairobi City increased at an average rate of 6% per annum reaching the number of population to 2143254 by 1999 (Population Housing Census of 1979,1989 and 1999 by Central Bureau of Statistics of Kenya). While the growth of household raised at an average rate of 7.9% since 1979 to 1999 from 200474 to 649426.

Of significance is the fact that, in 1950 Nairobi became a city by a royal charter of incorporation. Nairobi is by far the smallest administrative province in Kenya. Besides being the capital city, it is the largest urban centre in East and Central Africa. The city centre is located at longitude 36° 59'E and latitude1°19'S with the spurs of the tilted plateau (Kikuyu plateau) lying between 1905 and 1675 meters above sea level and the west merging into the flat lava plains which lie at 680 and 1500 meters above sea level.

1.6.2. Westlands Area:

Westlands is a constituency of the Nairobi City Council consists of two wards, that is, Kilimani Ward and Parklands Ward. Its population increased at an average rate of 19.3% per annum since 1979 to 1999 from 23965 to 207610. While its households increased from 5461 to 61258 at the same period at an average rate of 23.43% per annum.(Population Housing Census of 1979, 1989 and 1999 by Central Bureau of Statistics, Kenya). The reason of such a rapid increased of both population and households in the Westlands is safety, security, and accessibility to Central Business District and employment opportunities. With increase of income, every one is striving to have a place or house in the posh area like Westlands.

1.6.3. Economy

Over the past 25 years, Nairobi City has experienced the construction of high-rise commercial buildings in the central business area and additional government offices on Nairobi Hill. The industrial area has expanded and new industrial zones have been developed in Ruaraka and Dandora. New residential areas have also come up during this period, mainly in the eastern and southern parts of the city.

As the city has grown, however, the provision of adequate low-income housing has not been able to keep pace with demand. Immigration into the city, lack of sufficient employment opportunities for the majority as well as inadequate housing has resulted in the unabated growth of spontaneous squatter settlements. Neither the public nor private sectors have been able to provide adequate services and infrastructure. During the Urban Housing Survey of 1983 it was estimated that over 20% of Nairobi residents were living in substandard housing in slums and squatter settlements.

In the decade before 1980, there were fluctuations in the growth of wage employment in Nairobi. During the 1980-84 period, wage employment greatly improved, with an average growth rate of 18% per annum.

In the same period, recorded self-employment grew by an average rate of 27.7%, in spite of the constraints and harassment that prevailed in the informal sector, and this accounted for about 15% of total employment. Current government estimates now put the figure at between 40-60% (Development Plan 1989/93).

The unemployment rate in Nairobi for the period 1980-84 was in the range of 20-25%, which is above government estimates of the average national urban unemployment rate of 16.5%. This was during the period that Kenya's economy experienced a high inflation rate of up to 22.3% and the prolonged drought in 1982-83. Earnings per employee during the 1980-81 period grew by a high rate of 17%, then declined to 6.9% in 1981-82 and to a further low of 3.7% during 1982-83. On the whole, however, average real earnings increased only nominally due to inflationary pressures. The sectors with the highest average wage earnings per employee were, in order of importance; finance, insurance, real estate and business services; transport and communications; wholesale trade, retail trade, restaurants and hotels; and manufacturing.

The distribution of wage employment by income groups shows that the majority of Nairobi's employees are low-income earners (65.6% in 1984 and 74% in 1987). The proportion in the middle-income bracket has been increasing over the past years.

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Wage employment in major towns between 1982 and 1988 for the six dominant industries shows that since 1982, 103,000 new jobs were generated by these activities in the urban areas. Nairobi had 41,500 (40.3%) and Mombassa had 12,600 (12.2%) of the new jobs. In 1986 and 1987 Nairobi generated only 3500 new jobs – about a 1% increase.

The inflation rate, as measured by Nairobi Consumer Price Indices, has gradually moderated over the years, reaching a peak of 23.3% in 1982 and a record low of 5.7% in 1986. It rose to 7.1% in 1987, 10.7% in 1988 and 11.0% by March, 1989.

In Nairobi between 1986 and 1987, the food index increased by 6.7% while rents went up by about 8%. During 1988, the food index increased by 7.6%, 9.0% and 7.3% for the lower, middle and upper income groups, respectively. These increases are partly attributed to the policy decision to decontrol prices of some items in May 1988 (Economic Survey, 1989).

In general, average earnings recorded high growth rates between 1982 and 1987, with the highest rate being in community, social and personal service activities in the private sector, which recorded a growth rate of 78.2%. The corresponding figures for 1986/87 also reflect an upward trend, with the highest average earnings being recorded in the construction industry, which registered a growth rate of 19.9%. Trade, restaurant and hotel activities recorded the lowest growth rates of 8.5% within the private sector, whose overall growth in average earnings during 1986/87 was 11%.

In the public sector, nominal average earnings for the period 1982/87 grew in virtually all areas. A remarkable growth of 93.2% was realized in electricity and water activities.

Real average wage earnings in the private sector increased by 3.8%, while in the public sector they decreased by 3%. All activities in the private sector recorded increases, with the construction industry registering 12% and trade, restaurant and hotel industry registering 1.4%. In the public sector, construction, transport and communications, finance, insurance, real estate and business services, and community/social and personal services activities recorded negative growth rates of 2.3%, 1.3%, 3% and 5.7%, respectively.

1.6.4. Future Development

The Nairobi Metropolitan Growth Strategy Report of 1973 projected a population figure for Nairobi between 3 and 4 million by the year 2000. However, the government estimated and predicted a figure of 2.2 million by turn of the century. It was to be achieved by the present urbanization policy of the government, which aims to curb migration to large urban centres by slowing down the growth rates of large cities and promoting the growth of smaller towns and rural development. It was estimated that the population of Nairobi was to be grown at an annual rate of 5% up to the turn of the century (Nairobi City Commission Development Plan, 1984/88). The government prediction proved to be accurate, as by the end of 2000 the population of Nairobi was 2143254 on the basis of Housing Population Census, 1999, published by the Central Bureau of Statistics, Kenya. Thus the annual growth rate of population was 6% since 1989 to 1999.

Being a capital city, Nairobi continued to influence the country, especially its immediate catchments areas and districts. Most of the peri-urban areas, which lied outside the city boundaries, such as Githurai, Athi River, Ongata Rongai, Ngong and Ruiru, are today functionally part of Nairobi and consequently there was a need to take into account these areas as well for planning purposes.

1.6.12. Socio-economic characteristics of Nairobi

The following sections of this chapter are based largely on data from the Metropolitan Household Survey (MHS) carried out in selected residential areas of Nairobi in 1989.

The MHS evaluated the provision of shelter, water, sanitation and education for the urban poor and studied how consumption and supply could be improved. The main objective of the survey was to document the socio-economic status of poor households living in some of the slums and squatter settlements of Nairobi with a view to determining their levels of consumption of these basic needs. To evaluate how the government's structural adjustment policies and programmes will affect the consumption and supply of basic needs, the study was extended to some low and middle income housing areas such as Umoja II, Kayole, Jerusalem and Shauri Moyo where some of the adjustment policies have been implemented.

According to the Urban Housing Survey of 1983, Nairobi's average household size then was 3.45. Holins' 1987 survey of rents in six low-income areas in Nairobi shows that these neighbourhoods have a substantial number of relatively small households of one to three persons.

In the latest survey, the MHS of 1989, the average household size is 3.59 persons, with a range of 2 to 4 persons per household.

Economic Survey, 2002 prepared by Central Bureau of Statistics, Ministry of Finance and Planning, Republic of Kenya reveals the following latest facts about Nairobi: -

On the basis of recent economic survey, the overall inflation rate, estimated using the Nairobi Consumer Price Indices, decreased from 6.2 per cent in 2000 to 0.8 percent in 2001. Tight fiscal and monetary polices, stable world petroleum prices and exchange rates and; low food prices in the year 2001 contributed to the low inflation rate. The fall in inflation was more pronounced in the lower income group, which declined from 5.9 percent in 2000 to minus 0.2 per cent in 2001, while inflation rate for middle-income group fell from 7.1 percent in 2000 to 3.4 percent in 2001. However, inflation rate for upper income group edged up from 7.7 per cent in 2000 to 8.4 percent in 2001.

Wage employment in major urban centres by six selected dominant industries (Manufacturing, Construction, Wholesale and Retail Trade, Restaurants and Hotels, Transport and Communications, fiancé, Insurance, Real Estate and Business Services, Community, Social and Personal Services) is represented. Over the five-year period, there was a growth of 10.9 per cent in urban wage employment in these industries from 833,900 in 1996 to 925000 in 2001. Nairobi city had the highest total wage employment of the six main urban areas of 401, 300, representing 43.4 per cent of the total urban workforce.

In the informal sector, Nairobi province continued to have the largest proportion of persons engaged in the sector at 1.1 million persons, constituting 24.1 per cent.

Employment in the manufacturing sector remained depressed in 2001 as a result of retrenchment and closure of factories mainly in the public owned manufacturing industries. Overall, employment is estimated to have reduced further from 218,000 persons in 2000 to 216000 persons in 2001. However, employment at the Export Processing Zones (EPZ) more than doubled from 6,620 persons in 2000 to 13, 758 persons in 2001 mainly due to opening up of new factories.

The value of building plans approved by NCC maintained a downward trend from Ksh. 6.6 billion to Ksh. 4.3 billion in the years 2000 and 2001 respectively, representing a drop of 34.8 per cent.

The urban areas have higher labour force participation rate of 86.4 per cent compared to rural ones with participation rate of 73.6 per cent. Nairobi province had the highest participation rate 86.3 per cent followed by Ester, North-eastern, and Central Provinces respectively.

According to the new Consumer Prices Indices, the income groups are defined as: (1) the lower income group comprises households with monthly earnings below Ksh: 10,000 in October, 1997; (2) the middle/upper income group comprises households with monthly earnings above Ksh, 10,000 in October, 1997. The proportion of those who never attained any education is highest in North Eastern province (54.0 per cent) and lowest in Nairobi (5.3 percent).

1.6.13. Trends and patterns of urbanization

Nairobi district whish is a metropolitan area is the only one that reported all of its population as urban. Thus the highest growth rate of urbanization between 1989-1999 was recorded in Nairobi and Coast Provinces.

Provincial analysis showed that Nairobi, Central and Western provinces had the highest access (above 80 per cent) to descent sanitary facilities. Despite high levels of access in Nairobi Province, sanitary conditions in slums/informal settlement in the province are in pathetic state and are compounded by overcrowding in slums/informal settlements.

1.6.14. Topography of Nairobi/Westlands

Generally, Nairobi lies at an altitude of between 1475 meters and 1540 meters above sea level. The western boundary lies at approximately 6400 ft, which drops to 5600 ft in Westlands. The city centre is generally in a relatively flat area with an altitudinal variation of 200 ft between Westland 5600 ft and 5400 ft at Eastleigh. The Northern area, Eastlands and industrial area in the far east of the central business district in an almost flatland which lies at an altitude of 5200 ft and 500 ft to the Far East. The eastern boundary lies at 4900 ft above sea level. **This can be seen clearly on Fig. 1.**

1.6.15. Climate of Nairobi

The Nairobi area receives annual rainfall of about 800mm. This is usually concentrated during the rainy seasons. Nairobi has an equable climate with the following characteristics features:

(i) Very small seasonal changes in temperature

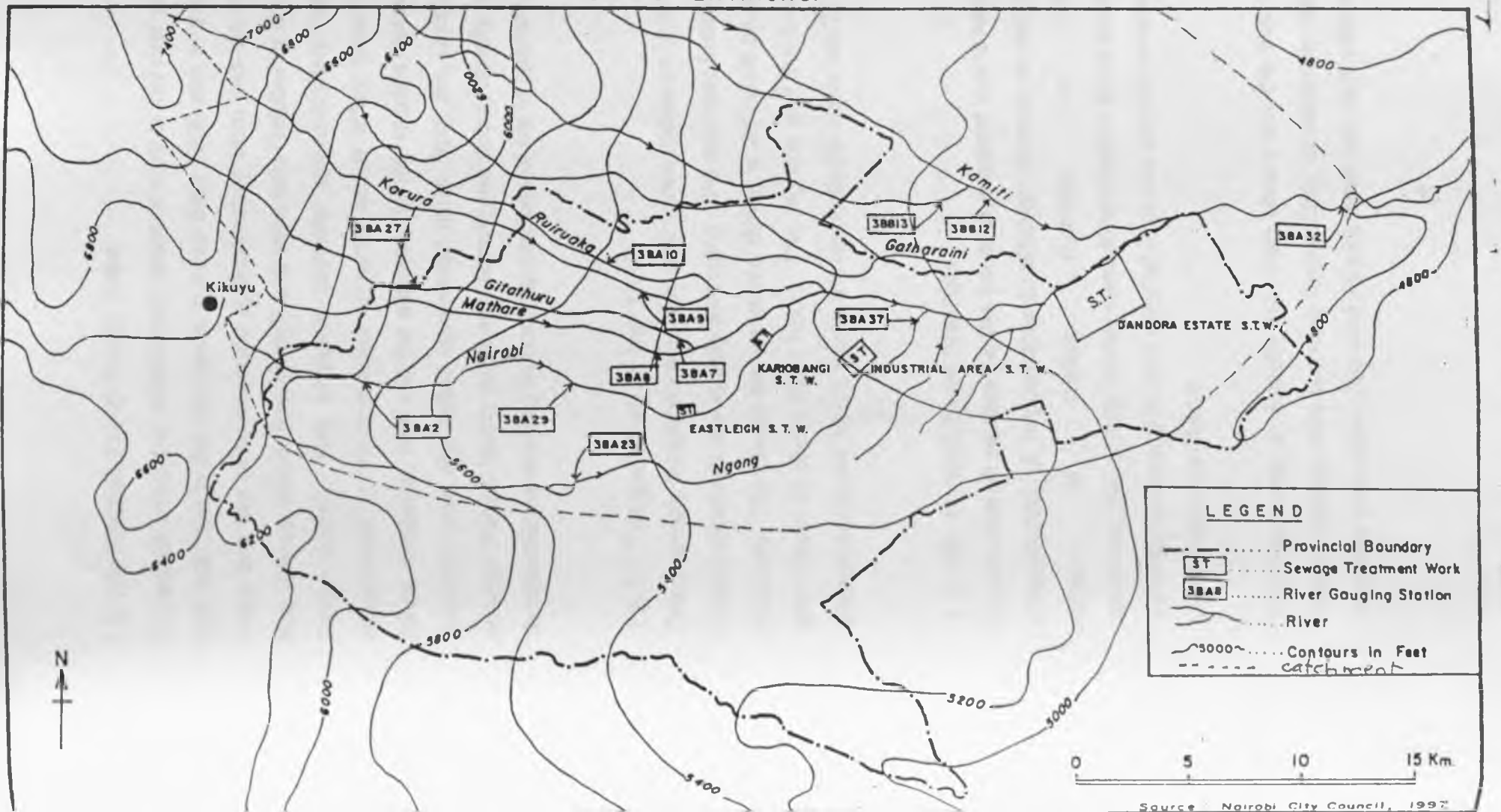
(ii) Considerable daily changes in temperature

(iii) Existence of definite wet and dry seasons

(iv) Marked daily changes or relative humidity

Figure –1

TOPOGRAPHICAL MAP OF NAIROBI AND ITS ENVIRONS.



1.6.16. Rainfall in the Study Area

The actual amount of rainfall may however vary in any one year, ranging from 500 mm in the dry years to more than 1500 mm in the wet years. There are two rainy seasons approximately from mid-March to end of May (the so called "long rains") and from mid-October to Mid-December ("short rains"). The seasons coincide approximately with time of changeover of the monsoon currents, which affect most of the East Africa. However, rain can be expected in the months between the two seasons, what are called continental rains, from the Congo basin and western Kenya. Heavy rains may sometimes occur, usually as a result of thunderstorms resulting to flooding and loss of life to riparian settlement.

1.6.17.Temperature of the study

The average temperature in the day varies between (6.8-29.4)°c. The diurnal variations are largely averaging 10°c and may increase to 15°c in February. The lowest temperatures during a 24 hours period occur first after dawn at about 0630 hours. The highest and the lowest recorded temperatures are 32.8°c and 3.9°c respectively in the last 25 years.

1.6.18. Humidity of Nairobi

Nairobi doesn't experience the rather unpleasant humid heat, which is so characteristic of tropical towns, although there is a very marked daily range of relative humidity. In the early mornings, the air is at or very close to saturation, but in the afternoon, the humidity is about 50% and may fall to as low as 10% on clear sunny days in February and March.

Early mornings in Nairobi are often cloudy but the sun nearly always breaks through mid morning hours. Only occasionally during the rainy seasons or in June, July and August there are days with no sunshine at

all. However, even in the cloudiest month of August, there is an average of hour's sunshine per day. The average solar radiation in Nairobi (Dagoretti) is 452 cal/cm2.

The wind direction is predominantly easterly varying between Northeast and East from October to April and between east and southeast from May to September. The strongest winds occur during the dry season just prior to long rains when speeds of 30-40 km/hr are uncommon, from midmorning to early afternoon. On the other times of the year, wind speeds are usually 16-24 km/hr.

The wind speed coupled with temperatures given above result to a potential evaporation of 1900 mm per year, from a free water surface.

1.6.19. Geology of Nairobi

The geology of Nairobi area has resulted predominantly from metamorphism, faulting and folding of the basement system. The geological system of Nairobi area was subjected to period of volcanic activity and erosion lasting for more than 400 years whereby a thick succession of phonolitic lava, tuffs and trachytic pyroclatics were formed old erosional surfaces lie comfortably below the younger phonolites.

The Nairobi trachyte overlies the Nairobi phonolite and is separated from the latter by a thin layer of agglomeratic tuff. It outcrops in the stream courses in the vicinity of the city centre and extends eastwards from Dagoretti-Karen area to city centre and to northwards to Kiambu. The trachytes resemble phonolitic rocks but they lack nepheline crystals.

The Kirichwa valley tuffs overlie trachytes and in Nairobi central business district the thickness is between 10-20 metres. It outcrops visibly in the Nairobi River valley. The tuffs represent three flows of upper tuff which is

generally greyish-brown, middle tuffs which are greenish-blue (the Nairobi building stone) and the lower tuff, is greyish-black overlaying the grey-green agglomeratic tuffs which separates the Nairobi trachyte and resembling the Athi tuffs and lake bed series.

1.6.20. Soils and drainage of Nairobi

The soils occurring from the central business district to the eastern boundary are imperfectly drained deep dark greyish brown mottled fine clay, abruptly underlying thick topsoil of friable silty clay loam. These soils together with highly weathered tuffs constitute a shallow aquifer of low transmissibility and low aquifer hydrolysed conductivity. When water is pumped out of these shallow aquifers or dries through evaporation and underground flow, the water level drops rapidly because water cannot easily flow through the clay aquifer to replenish the water table.

The water transmissibility of the aquifer ranges between 1-12 m2/day. This low transmissivity values obviously indicate low storage co-efficient values about 0.001 for most of the aquifer in Nairobi area.

The shallow water table that is a characteristic of most of Nairobi area, (CBD) lie at 1.1 and 4.5 meters below ground level facilitates quick recharge of the shallow perched aquifer. The deep water tables are at 15-90 meters below ground level and occur in Eastlands and Industrial area plains respectively. Rainfall run-off infiltrates into the ground to feed the aquifer and discharge to Nairobi River as subsurface flow.

1.6.21. The Nairobi River and its Hydrology

The Nairobi River has its source at Ondiri Swamp in Kikuyu at an altitude of 2000m above sea level. The first 4 kms of its flow have an average slope of about 1 in 20 and its altitude drops to about 1800m above sea level. It then has an almost uniform slope of about 1 to 110, flowing on its way through Dagoretti and the City Centre and then passing in residential areas, where it gets some of its waters from Kariobangi and Eastleigh sewage treatment works.

After Kariobangi, the river runs through barren sites and quarry sites where the Gitathuru and Ruaraka rivers join in. Above 7 kms downstream Kariobangi, Ngong River flows into Nairobi river. From 3kms upstream, Ngong River and until Dandora Estate, the river flows through a fertile valley with vegetation (Riverine).

Ngong River gets its waters from Ngong Hills and has a reservoir (Nairobi Dam) just below Kibera slums. After Nairobi dam, the river flows though a narrow deep valley, passing through industrial area of the city.

The river then drains into Nairobi River at a slope of about 1 to 170. Ngong River is small and in fact during the dry season, it gets almost of its water from liquid wastes and treated or semi-treated discharge coming from industries situated near or have drainage network connecting them to the river.

Nairobi River also gets water from other minor rivers and artificial drainage networks. A minor river is Gatathuru, which flows from Limuru (2100 meters above sea level).

Generally, Nairobi River is highly polluted and environmentally degraded. The permanent flow of the river is replenished by seepage from shallow underground aquifers in the weathered tuffs and wastewater from defective sewers and storm water drains. The riverbed of Nairobi River and its tributaries lie on the hard grey welded truffs in the upper reaches and, on top of the weathered phonolite are the lower reaches. The wide floodplains with thick vegetation consist of imperfectly drained dark grey to black firm calcareous boundary cracking clay soil. Dredging to mainstream some average depth to improve flood control can level the bed of the river.

The nature and morphological set-up of various volcanic lava flows and the configuration of the basement rock system control the hydrogeology of Nairobi city and its environs. The river drainage system and indeed the groundwater table gradient closely follow the easterly direction of the lava flows. The main streams and rivers draining the Kikuyu highlands towards the Nairobi area are perennial but are fed by springs that issue within the contacts of the Kirichawa valley tuffs and the trachyfic lava.

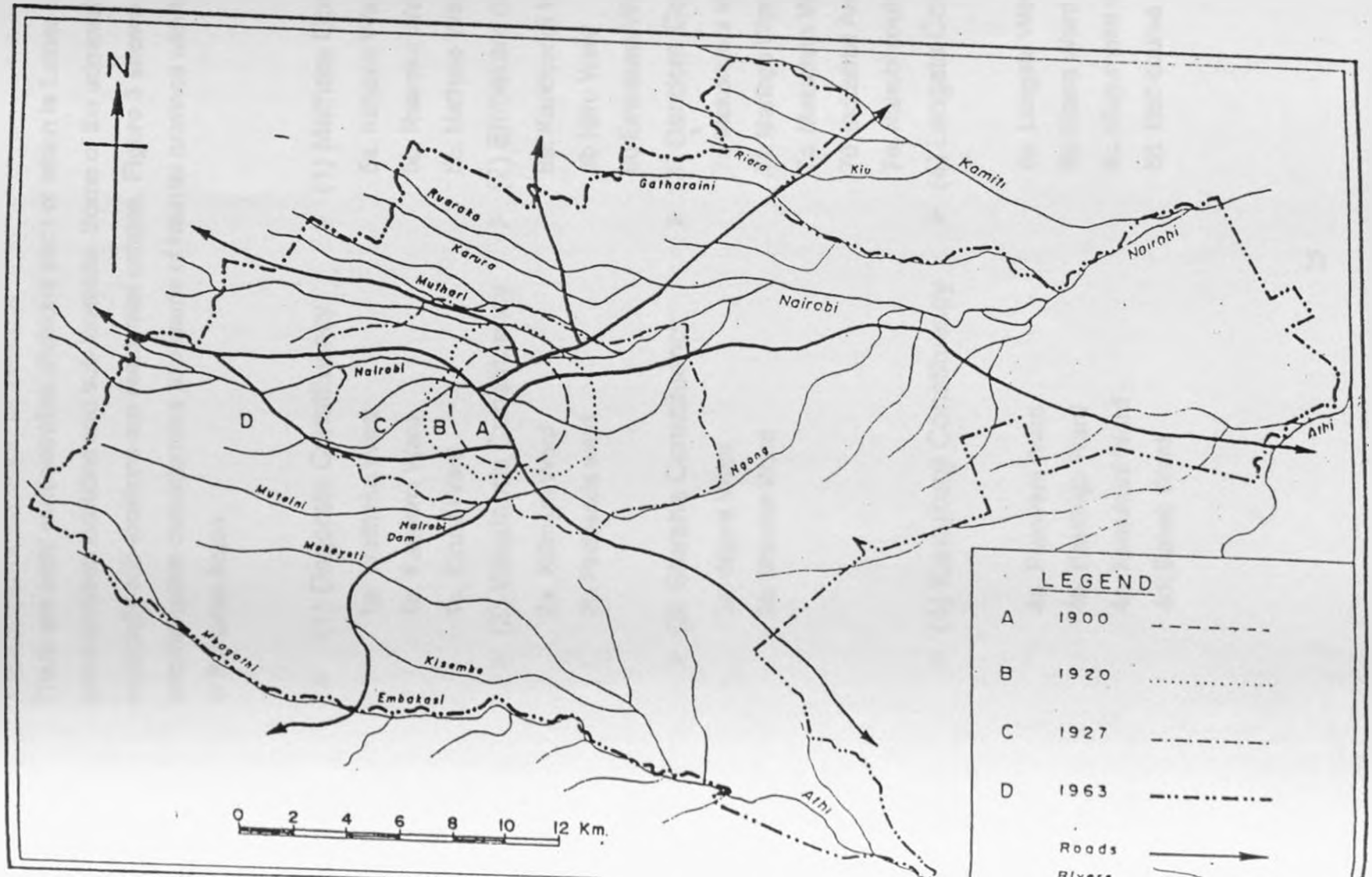
The Kirichwa valley tuffs between Westlands and Buruburu are so porous and pervious that the contact between them and the underlying impermeable Nairobi phonolite is a good aquifer. Thus, a number of buried channels containing groundwater occur beneath the Nairobi city Centre. The channels represent the old river courses of the Nairobi River and its tributaries and are encountered during geo-technical drilling and dining the digging of deep foundations for multi-storey buildings. **The drainage of Nairobi River can be seen in Figure 2.**

1.6.22. Geomorphological Hazards

As described earlier on, the Nairobi river valley is at times prone to flooding which may lead to loss of property and at times loss of life. This is usually in the rainy seasons especially during the heavy downpours.

Major storms in Nairobi occur between November and May the long rains begin in mid-march and continue to end of May while the short rains occur between October and December. The highest rainfall intensity that has been measured in the city of Nairobi was 45 mm/hr that fell on 23/4/1970. (Krhoda, G.O. 1992). Most of the rain falls in the evenings (1200-2400 Hrs) and nearly 50% of the total rainfall occurs in 10-15% of the total duration. 90% of the total rainfall occurs in 30-35% of the total duration. This, coupled with high runoff caused by concrete surface of building in residential areas, central business district and tarmac roads and paved ways result to high velocity runoff to Nairobi River, resulting to floods. Nairobi lies within a seismic-intensity zone of 6 – 7 on the Reactor scale. Hazards associated with landslides and expansive soil movement may be significant in Nairobi area especially in realm land next to rivers and streams and valleys e.g. Nairobi river Valley. They may be caused by river action, weathering, rock blistering (especially in the quarry sites on the eastern side of the city), accumulation of solid waste dumps and loading of buildings and other structures.

Figure-2

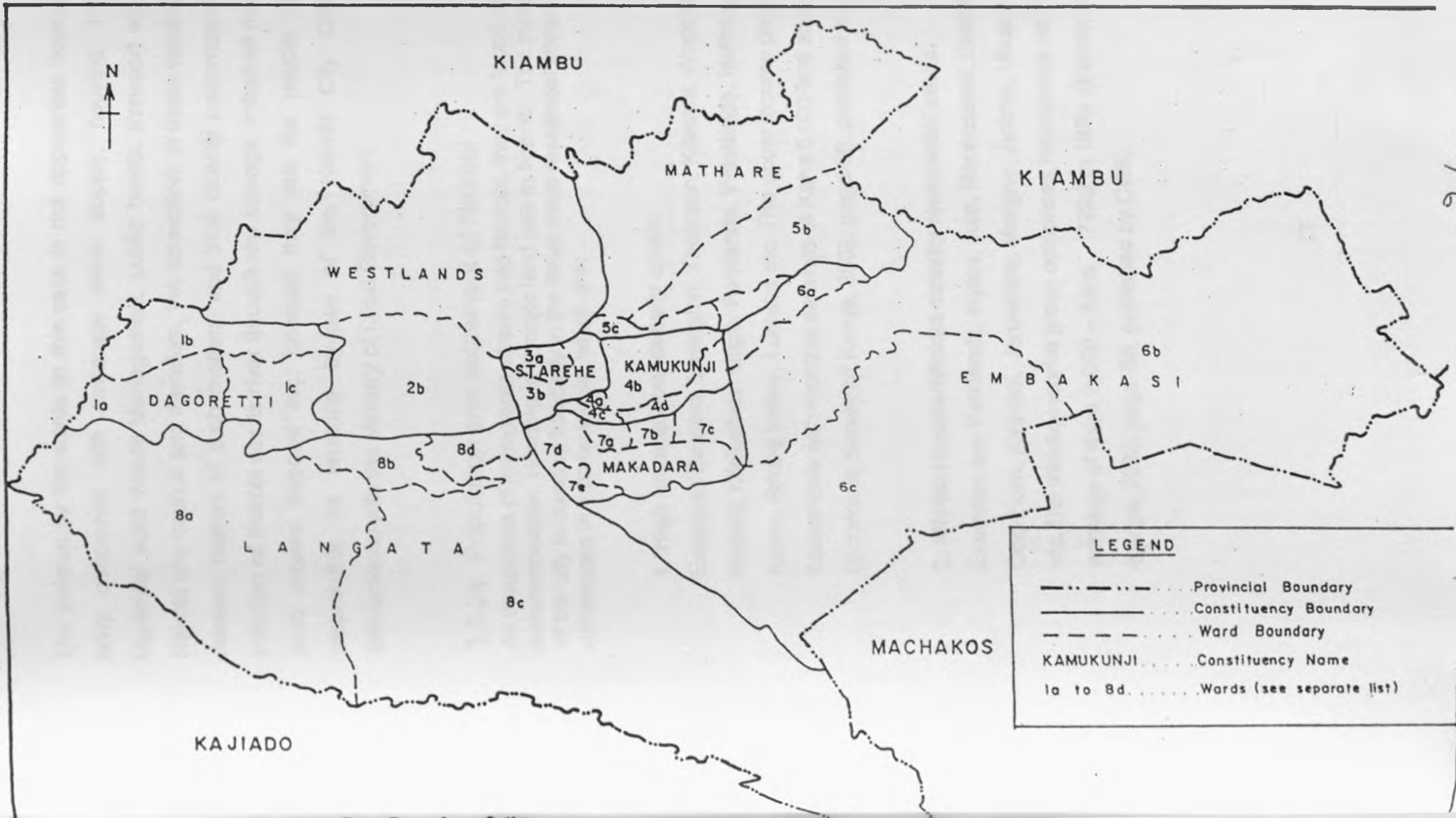

N
Riera
Kiu
Kamiti
Gatharaini
Ruaraka
Kanura
Mutharl
Nairobi
Nairobi
Nairobi
D
C
B
A
Athi
Ngong
Mutaini
Nairobi Dam
Mokoyeti
Mbagathi
Kisembe
Embakasi
Athi
0 2 4 6 8 10 12 Km.
LEGEND
A 1900
B 1920
C 1927
D 1963
Roads

1.6.23. Administration of Nairobi

There are eight administrative divisions each of which is further sub-divided into administration locations and sub-locations. Some of the administrative units especially sub-locations are residential estates. **Figure 3 shows** the administrative consistencies and wards of Nairobi province with their key shown in the table below.

- (1) Dagoretti Constituency
  - 1a. Waithaka Ward
  - 1b. Kangemi Ward
  - 1c. Riruta Ward
- (2) Westlands Constituency
  - 2a. Kilimani Ward
  - 2b Parklands ward
- (3) Starehe Constituency
  - 3a. Ngara Ward
  - 3b Starehe Ward
- (4) Kamukunji Constituency
  - 4a. Pumwani Ward
  - 4b. Eastleigh Ward
  - 4c. Kamukuni Ward
  - 4d. Bahati Ward
- (1) Mathare Constituency
  - 5a. Kahawa Ward
  - 5b. Ruaraka Ward
  - 5c. Mathare Ward
- (2) Embakasi constituency
  - 6a. Kariobangi Ward
  - 6b Njiru Ward
  - 6c Embakasi Ward
- (3) Dandora Constituency
  - 7a Makongeni Ward
  - 7b Maringo Ward
  - 7c. Makadara Ward
  - 7d. Industrial Area Ward
  - 7e. Nairobi south Ward
- (4) Langata Constituency
  - 8a. Langata Ward
  - 8b Kibera Ward
  - 8c. Mugumoini ward
  - 8d. Golf-course /Kenyatta Ward

Figure-3


N
KIAMBU
MATHARE
KIAMBU
WESTLANDS
5b
6a
5c
1b
3a
STAREHE
KAMUKUNJI
4b
6b
EMBAKASI
1a
DAGORETTI
1c
2b
3b
4a
4c
4d
7a
7b
7c
8b
8d
7d
MAKADARA
7e
6c
8a
LANGATA
8c
MACHAKOS
KAJIADO
LEGEND
Provincial Boundary
Constituency Boundary
Ward Boundary
KAMUKUNJI ..... Constituency Name
1a to 8d ..... Wards (see separate list)

The division by the wards in this case is not appropriate because, the body concerned with sewerage water supply, housing, transport, Municipal solid Waste Management, public health, transport etc. is the Nairobi city council and therefore, the councillors in these wards are the decision makers of such matters, and thus directly instrumental in the pollution of Nairobi city its river through raw sewage, industrial discharge, solid wastes disposal etc. because they are the people who are responsible for enacting by-laws of the Nairobi City Council in concurrence with the Ministry of Local Government.

1.6.24. Population and settlement of Nairobi

As thousands of immigrants stream into Nairobi, they are faced with lack of accommodation. Housing is a major land use in Nairobi. The current population of the city is dwelling basically in the three main residential zones based on differences in income levels, which are:

1. High Income/Low density areas:

Examples Bernard, Lavington, Thomson, Kilimani, Woodley, Upperhill Nairobi, Kileleshwa, Upper Parklands, Westlands, Muthaiga, Langata, Karen, Spring Valley, Loresho etc. The upper income group comprises households with monthly earnings of Kshs 8,000 and above in 1986. (Economic Survey of Kenya, 2002, page-68, published by CBS).

2. Middle Income/Middle density residential areas.

Examples are Parklands, Ngara, Juja, Racecourse, Eastleigh North, Doonholm, Kaloleni, Jerusalem, Marigno, Jericho, Uhuru, Nairobi West, etc.The middle-income group comprises households with monthly earnings of Kshs 2,000 – Kshs 7999 in 1986. (Economic Survey of Kenya, 2002, page-68, published by CBS).

3. Lower income/high-density residential areas.

The lower income group comprises households with monthly earnings below Kshs 2,000 in 1986 (Economic Survey of Kenya, 2002, page-68, published by CBS). Examples: Mathare, Muthurua, Jericho, Makadara, Kibera, Eastleigh Sout etc.

Housing shortage in Nairobi has been disserved in the last 3 decades. The acute and ever increasing shortage of housing units has been caused by the city's high population growth rates as well as the migration of people from rural areas to the urban housing units needed to settle the ever increasing populations resulting to overcrowding in private and public rental units and the mushrooming of uncontrolled informal settlements. According to the Urban Housing Survey of 1983, Nairobi's average household size then was 3.45 persons. Holins' 1987 survey of rents in six low-income areas in Nairobi shows that these neighbourhoods have a substantial number of relatively small households of one to three people. While at present in Westlands average household size is 3.38 and in Nairobi average household size is 3.3 persons.(Housing & Population Census, 1999 of Kenya published by CBS) The same shows that the household size has been decreased from 4.5% as compare to 3.45% of 1987. The 1983 Urban Housing Survey in Kenya shows that in Nairobi, 66% of households were renters, while 29% were owner-occupiers. This implied that most of Kenya's urban dwellers do not own the housing they live in. On the basis of Housing Survey of 1989, it disclosed that out of 1440 households only 15.8% claim to be owners of their dwelling units while 84.2% were tenants.

This makes the population to spread into slums and squatter settlement. These areas often lack adequate sewerage, water supply, electricity and sanitation, waste collection and other services. This leads to generation of waste and sewerage which finds its way to Nairobi River thereby

polluting it and posing public health risk and threatening environmental degradation. This has been as a result of increase of incidence of urban poverty, inadequate access to housing and basic services leading to urban environmental degradation and particularly more important; water, sewerage and drainage and sanitation problems (Obudho and Owuor, 1994). More dangerous is the accumulation of heaps of garbage which is generated rapidly and excessively but left uncollected, thereby thrown in the ravines and rivers and quarries and roadside where it is breeding diseases causing publics health sever injuries in the shape of diseases spreading by mosquitoes. (**See Photograph- 2**). Ironically these settlements are next on in the river valleys such as Kibera, Mathare, Korogocho, Mukuru etc. leading to river pollution **as shown in figure 4 of population distribution patterns and figure 5 of land use patterns.**

Photograph -2: Waste openly/illegally dumped by the roadside in Westlands

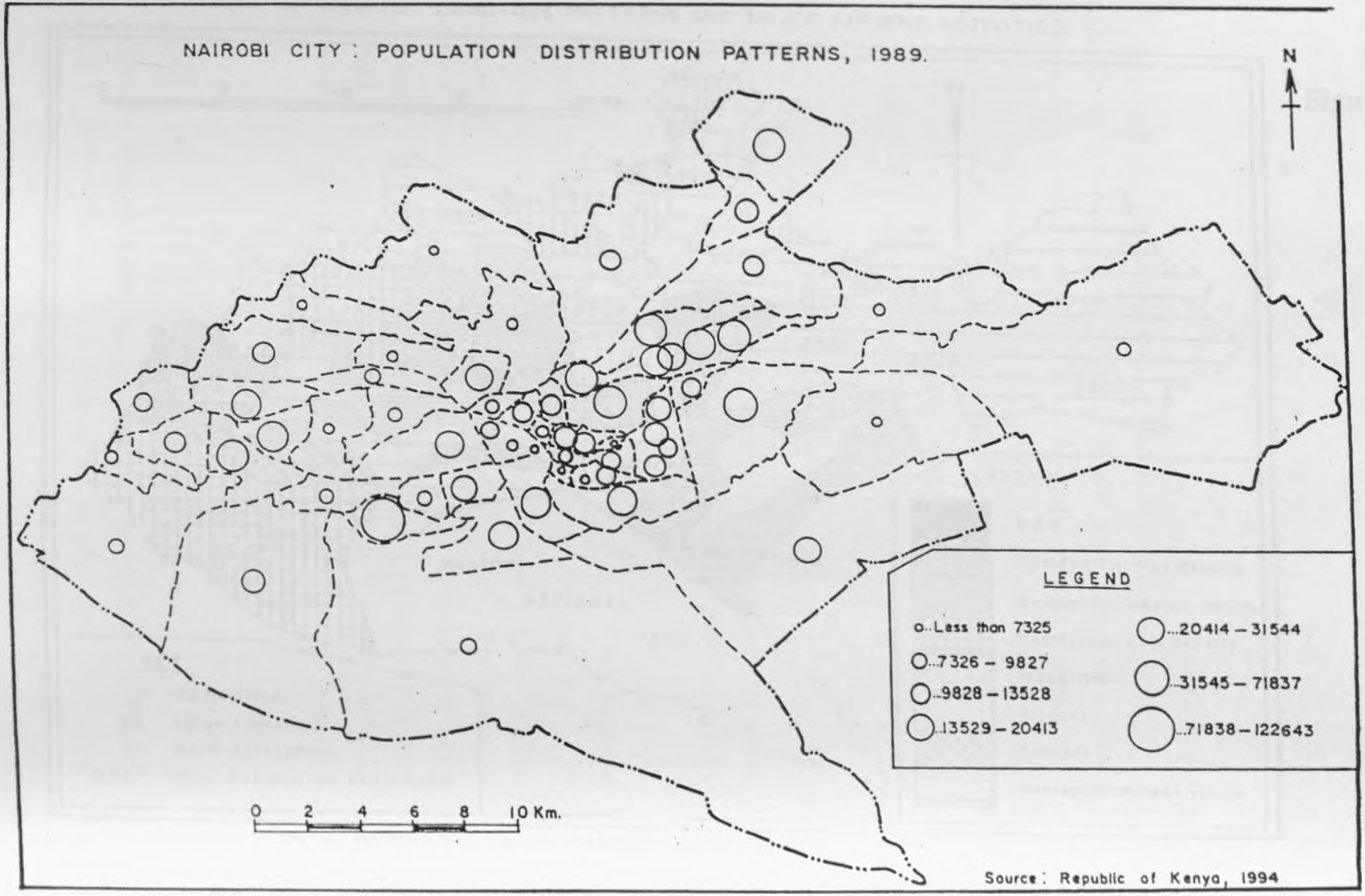
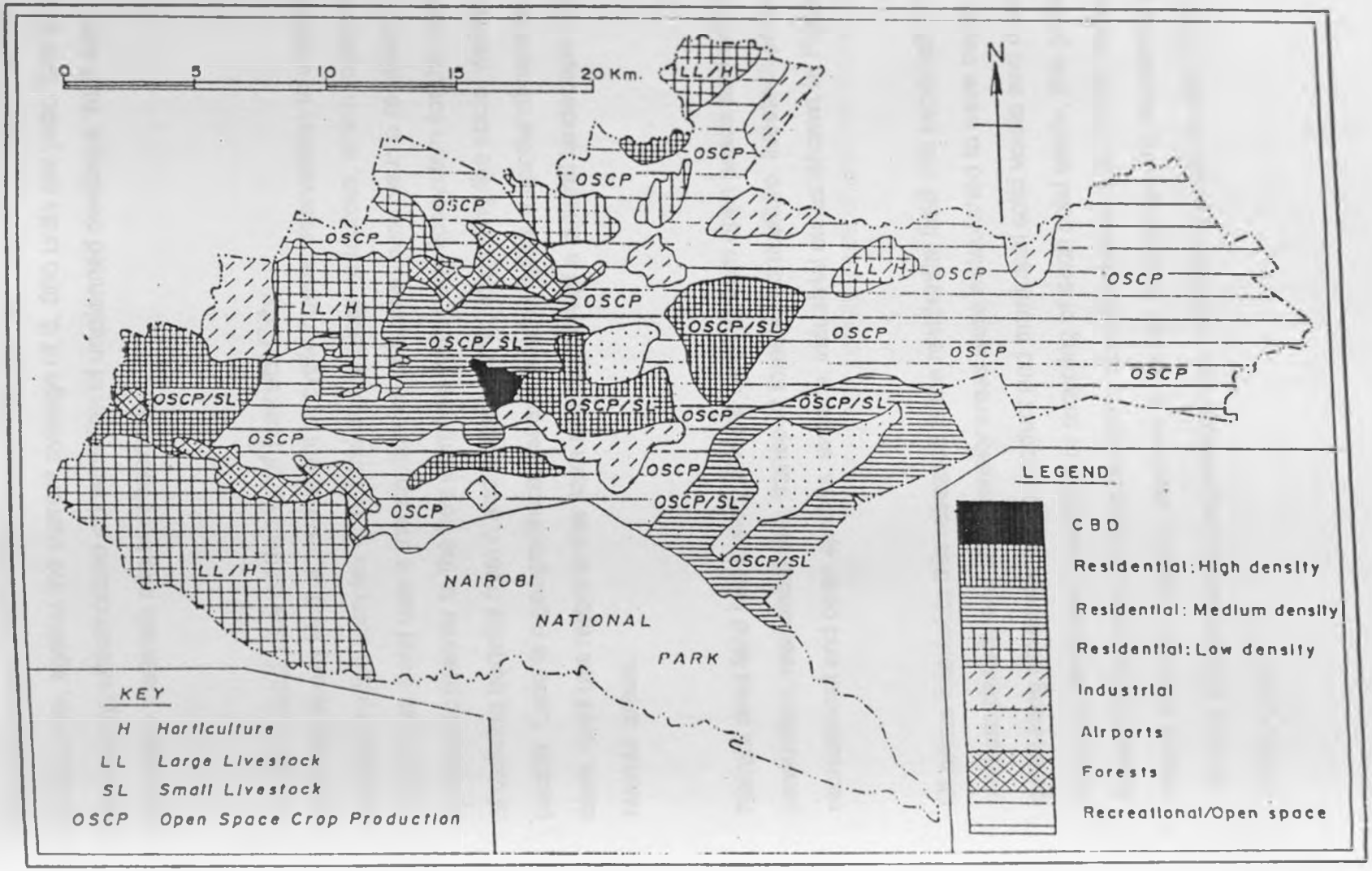

NAIROBI CITY : POPULATION DISTRIBUTION PATTERNS, 1989.
N
LEGEND
Less than 7325
7326 – 9827
9828 – 13528
13529 – 20413
20414 – 31544
31545 – 71837
71838 – 122643
0 2 4 6 8 10 Km.
Source : Republic of Kenya, 1994

Figure-4

CITY OF NAIROBI: LAND-USE PATTERNS AND MAJOR FARMING ACTIVITIES.



Source Modified from Obudho (1995) and Ogonda (1976)

Figure-5

The projection of 1987- 2000 reveal that, the city require an annual growth of 25,000 units, against the current average of 5, 000 units per year. Due to such inadequacy, unauthorized construction of unplanned dwellings, built with unsuitable materials can be observed.

1.6.25. Land use patterns of Nairobi City.

Land use is any kind of permanent or cyclic human intervention to supply human needs from the complex of natural and artificial resources, which together are called land. Land use is the application of human controls in a relatively systematic manner to the key elements within any ecosystem for the purposes of deriving benefits from it and consequently, improving the social welfare of the people. Land is a geographical aspect, which implies a spatial dimension. In this case, land use refers to the form and function of a cultural landscape in the Nairobi areas.

Nairobi area land use is very diverse ranging from open space agricultural production, residential use, transport forests, horticulture, livestock production, recreational and open spaces, airports, industrial etc as **shown in Figure 5.**

Of prime interest to this research is the residential land use especially in the medium density and high density areas were established to have been generating sewerage waste product and municipal solid waste and due to lack of proper treatment, collection or recycling of such solid waste, the garbage finds its way to the rivers, or leftover at the open dumpsite or scattered across the streets or roads, quarries, ravines and even heaped around residential areas causing environmental degradation and threatening public health (See photograph 3).

Photograph-3: Waste scattered by the roadside in Westlands of Nairobi

Photograph 3: Waste Scattered by the roadside in Westlands of Nairobi

Open space crop production is another form of land use whereby, there are quite a number of agricultural chemicals like fertilisers (Inorganic), pesticides etc. which are washed down to the aquifer or which dissolve in water and enter into the river surface run-off, thereby interfering with the ecological balance of the riverine ecosystem. Also, these sites are areas of soil erosion which find its way into the river thereby causing sedimentation which reduce the volume of river channel and may result of flooding during storms. Livestock production, where there is overstocking and overgrazing may also be a potential source of threat to soil, which is eroded in the rainy season and finds its way into Nairobi rivers.

The industries may also produce solid waste and effluent and discharge it into rivers or open land and then after the rains, the water that infiltrates into the underground aquifer will be polluted and when it flows through base flow and into the river, the river may be polluted.

Many more new industries within and around the Nairobi city (Dandora and Ruaraka) have been set up which produce air pollution and huge waste generations. Despite the existence of many policies adopted by the Nairobi City Council, Local Government, Ministry of Industries, like National Environmental Management Act (NEMA), pollution control, they have not yet been implemented in spirit and letter. Moreover, the existence services and resources of the Nairobi City Council cannot cope with the demands and requirements of rapidly increasing population especially the provision of water, sewerage, drainage and sanitation, garbage collection and its proper disposal, which resulting to environmental degradation.

Improper waste dumpsite is also converting a major part of land into landfill, contaminating water aquifers by leachate, pollute environment, spreading diseases like Dandora Dumpsite of Nairobi. (See Photo-4).

Photo-4: Dandora dumpsite of Nairobi-Kenya.

Photo 4: Dandora dump site of Nairobi, Kenya

The Dandora garbage dump in Nairobi provides a livelihood for many scavengers. In 1992 Father Alex Zanoteteli started the Mukuru Recycling Centre, helping the scavengers work together to collect difference types of

garbages more efficiently and sell to middlemen for better prices. The project now has 140 members and with the help of Habitat' Settlements, Infrastructure and Environment Programme has organized itself into a cooperative, with several different projects. One buys waste from individual scavengers, sorts it and sells it to recycling industries – in addition to running a dairy project. Another gathers waste from commercial buildings in the city; it earns small fees for cleaning up to commercial buildings and income from selling the waste to paper and other recycling industries. A third manufactures fuel briquettes from paper and other waste such as sawdust and coffee husks. A fourth manufactures compost from organic waste. The centre is about to establish a facility for recycling plastic (Source:Panos,2001).

CHAPTER TWO

2.0. LITERATURE REVIEW

Most African cities share the same problem of how to dispose of solid waste. The majority of solid waste produced in cities is due to rapid urbanization. This is compounded by an equally rapid rise in "standard of living/high consumption level expectation, which relate an increased demand for canned, plastic-wrapped and bottle goods (UNEP, 1977).

Living and working conditions within most cities and towns in East Africa have been deteriorating over the last decade or so. This is manifested in the growing numbers of urban residents living in sub-standard housing within informal settlements and slums with little or no basic services. Within most cities and towns, manifestations of this deterioration include excessively pot-holed roads, poor storm drainage, mounting garbage heaps and unreliable electricity and water supplies. A wide range of factors accounts for this state of affairs. Firstly, the revenue bases of most urban local authorities in the sub-region are inadequate to cater for their rapidly expanding populations. Secondly, existing revenue collection mechanisms are generally ineffective and what little is collected tends, in some cases, to be mismanaged. Thirdly, because the municipalities are generally financially weak, they have to rely on substantial assistance from the central governments, which often undermines their independent decision-making and operational autonomy. Fourthly, physical maintenance of the limited urban infrastructure that is available has been seriously neglected. Further exacerbating the problem of access (HABITAT, 1998).

The picture painted in the HABITAT (1998) report suggests a serious institutional vacuum. From the report therefore, it is obvious that the challenge facing governments and urban local authorities today is the reorientation of policies, strategies and instruments of municipal management in order to improve efficiency and social equity in the delivery of services. Meeting this challenge partly entails the institutionalisation of an enabling framework that will permit community-based Organizations (CBOs), non-governmental organizations (NGOs), individual households and the private sector (both formal and informal) to contribute towards the provision and maintenance of urban services. This also entails strengthening the public sector's capacity to safeguard standards and protects the public from the negative consequences of private provision of infrastructure and services.

By the year 2000 there were twenty mega cities with over 11 million citizens, the great majority of these in the developing world. More than 50% of all mankind will live in urban environments. African cities are currently growing at a rate of 10% annually. While the challenges of tomorrow's mega cities are social, economic and political, improved and more efficient technologies will be important in addressing the needs of managing the growing urban environments in a humane and sustainable way.

The challenge is for cities to reconcile the competing demands of economic growth and environmental destruction. For cities in developing countries, that means reducing their excessive consumption of natural resources: A resident in a city such as New York consumes approximately three times more water and generates eighth times more garbage than a resident of Bombay or Karachi. For many cities, the most urgent challenge is to provide for the basic needs of the urban poor and thereby alleviate a major cause for degrading urban environments.

Meeting this challenge will entail activities ranging from providing fundamental urban services, such as water, sanitation and garbage collection. Much is to be gained from encouraging income-generating activities, for example waste recycling, that similarly improve livelihoods and the local environment. Urban areas affect the environment through three major routes: the conversion of land use, the extraction and depletion of natural resources, and the disposal of urban waste.

In the face of growing responsibilities and limited funds, cities must make strategic choices, set priorities by assessing the impact of growth and development, including the resulting environmental costs, and identify solutions – technological, indigenous or otherwise – appropriate to the local environment. Particular attention must be paid to sustainable environmental management, cost-effective technologies, greater economic efficiency and cost recovery (UNEP, 1997).

2.1. Privatisation of municipal services in Eastern Africa

Privatisation is a process of expanding the sphere of the market through a host of regulations that create an enabling environment for free market enterprise to operate as a strategy for sustainable economic development (HABITAT, 1998). An analysis of the experiences of privatisation of municipal wastes in the East African Region shows that there still exists some conceptual confusion of ambivalence about what privatisation actually involves. Some understand it as contracting or leasing out tasks and responsibilities to private sector firms, while the local (municipal) government retains overall supervisory and regulatory control; some understand it as commercialisation of services by municipal departments or parastatals, and some understand it as total and complete transfer of responsibilities for providing the service to private sector firms who set their own prices, *et cetera*. This ambiguity is reflected, for example, in a

report on the process in Dar-es-Salaam which concludes that, so far, success has been limited despite the engagement of five private contractors to collect waste in the city and that 'the most important issues for the establishment of sustainable solid waste management in Dar-es-Salaam City is to strengthen the capacity of the Dar-es-Salaam City Council (DCC) with priority going to the reinforcement of operational capacity by the improvement of equipment and facilities and development of human resources and the establishment of financial resources by the DCC increasing its revenue generation efforts. This would seem a contradiction, as it implies giving back responsibility for solid waste management to the city council. It, however, reflects the ambiguity with which privatisation is perceived.

A review of case studies in East Africa identifies the following modes of privatisation of municipal services:

2.1.1. Privatisation of Solid Waste Management (SWM)

Solid waste management (collection and disposal), is the municipal service in which greatest attempts at privatisation has been made. The experiences of these attempts in Kenya and the United Republic of Tanzania are reviewed below.

2.1.1.1. Nairobi, Kenya

The management of solid waste in Nairobi has proved to be a good case study of the decline in the delivery of urban public services and private sector involvement in search of a sustainable solution.

The earliest attempts at privatising solid waste management services (SWM) in the city of Nairobi were in 1906 when a private company was contracted to sweep and clean city streets, collect garbage and private street lighting. This company did not succeed in effectively executing

these duties and the role had to revert back to the city council (Mbui: 1995), which initially performed this role relatively satisfactorily.

However, recent urban growth and increases waste generation have outstripped the city's capacity to provide an adequate and efficient waste management service resulting in gross urban decay and an increased involvement by city residents and actors other than the city council in Solid Waste Management activities.

In 1998, this also attracted organized commercial private sector companies such as Bins (Nairobi) Services Limited and Domestic Refuse Disposal Services Limited (DRDSL) who registered to manage, collect and dispose solid waste (at the Dandora land-fill site) from industries, institutions, commercial establishments, and high income residential areas, at a time when Nairobi city Council (NCC) performance was only 21.54% leaving about 28, 700 tons of solid waste uncollected. By 1996 the combined daily collection capacity of the two private companies (Bins and DSRDL) was 400 tones while NCC's was 100 tons only. And in 1997, following a research effort by NCC with support from the Japanese government, NCC opted to privatise garbage collection and street sweeping as a pilot scheme in Nairobi's Central Business District (CBD) on a management contract basis. Kenya Refuse Handlers Ltd. (Handlers) as the lowest bidder was awarded the contract to sweep the street, roads, lanes, pavements and markets daily as well as remove and then dispose all garbage at Dandora landfill site every day, for an agreed sum of 1.3125 million KES (US 20, 275) per month. The cost implications to the Council were that it has been able to re-deploy 525 workers and vehicles to other areas, saving 2.625 million KES p.m. Exclusive of fuel and vehicle maintenance costs. Such privatisations have seemed to improve the Council's performance efficiency and effectiveness from 40% to 90%.

Delays in payments to Handlers, however, are interfering with their operations.

Other than the officially contracted SWM Company Kenya Refuse Handlers, NCC does not license all other entrepreneurs as private waste collection companies but rather registered as business establishments. It is however estimated that there are over 30 small private solid waste entrepreneurs operating within the city. These are small ventures owned and run mostly by households. There are not more than five large-scale private waste collection firms and all private companies currently operate in open competition. Most of this private sector entrepreneurship however, remains unguided, taking place without any institutional and legal regulation.

2.1.1.1.1. Magnitude of the solid waste problem in Nairobi

A recent survey, (Esho, 1997) found that 36% of the respondents saw the problem of garbage collection as very serious in their areas while 36% and 28% perceived it as moderate or non-existent respectively. Ratings were found to be influenced by several factors such as area, activity type, level of education, etc. For instance, in residential areas, 41% of the households tended to view the solid waste problem as being very serious compared to 28% of commercial enterprises. However, the majority of those who thought the frequency of collections was adequate were either currently being served by private companies, or were themselves actively involved in disposing of their garbage. It is important to observe that the majority of those served by NCC expressed dissatisfaction with the frequency of the waste collection service, with 63% of them suggesting privatisations preferably in partnership with NCC. Overall, 78% of the respondents generally felt that the involvement of the private sector would ensure efficient waste collection and management services. Factors influencing response were found to include respondents' employment

area, income level and the extent to which they had already incorporated the private sector in solid waste collection and disposal e.g. owners of industry genuinely preferred any initiative that would incorporate the private sector in SWM.

2.1.1.1.2. Cost of Privatised Services in Nairobi

While the charges currently levied by private companies, and those that respondents were willing to pay tended to vary, an interesting finding of this research is that most people are generally willing to pay substantially more than they are currently paying. For example, while 53% of those paying below Ksh. 100 did not want to pay more, 47% indicated that they were willing to pay more than Ksh 200 per month. The same applied to those paying between Ksh. 100 to 200. Similarly, 50% of those paying between KSh 300 and 400 indicated a willingness to pay up to Ksh: 800 per month. This rather strange phenomenon is probably the result of the publicity that privatisations of the service have received in recent years. It could also reflect the level of frustration that city residents have had due to poor services currently being offered.

In residential areas, regarding the seriousness of the solid waste menace, the majority (41%) thought the problem was very serious while 27% and 33% saw the problem as moderate or non-existent respectively. Majority (63%) of respondents in residential areas had their garbage collected once a week while 21% and only 6% had their waste collected twice and thrice a week respectively. Although 86% of households were satisfied with the frequency of collection, 77% of these respondents went on to suggest that SWM services should be privatised either in a pure form or in partnership with NCC, or with community based organizations. 64% of the residential respondents were found to pay below 200 Ksh per month while those who do not receive privatised services indicated a willingness to pay the same amount. Below presents an area-based analysis of the extent of private solid waste entrepreneurship.

High-income residential areas reported private firm waste collection to be efficient. As a result, 79% of them thought that the best way to deal with the inadequacies that face the SWM in Nairobi was to privatise. All preferred dealing directly with the private company. On the other hand, among the institutions interviewed comprising of educational institutions, hospitals, charges etc., while 21% and 31% of them have their waste collected by NCC and private firms respectively, 47% take responsibility for SWM in their establishments mainly through burning (45%) and selling to scavengers (55%).

With industries it was found that half the respondents depended on the private sector while the other half managed their own wastes through recycling (60%), open dumping and selling to scavengers. However, all agreed that the best way to deal with the inadequacies was to privatise. This was the same view held in 1991 when 85% of the industries indicated that the city might be better off with privatised waste collection service (See Fadamulla, 1991). Similarly, in the CBD, while a few depend on the private sector and NCC, 67% of the respondents handle their own solid waste mainly by selling to scavengers.

2.1.1.1.3. Status of Private Solid Waste Entrepreneurship

Other than the officially contracted SWM Company Kenya Refuse Handlers, NCC does not license all other entrepreneurs as private waste collection companies but are rather registered as business establishments. It is, therefore, not possible to ascertain the exact number of private solid waste entrepreneurs operating within the city. They however, estimate that there are over 30 such firms. Field survey indicated that the bulk of these are small ventures owned and run mostly by households. There are not more than five large-scale private waste collection firms and all private companies currently operate in open

competition. Most of this private sector entrepreneurship, however, remain unguided, taking place without any institutional and legal regulation.

In terms of size of vehicle fleets, 60% of small firms interviewed do not use their own equipment and instead hire vehicles in the open market. They either use pick-up trucks of below two tones or for purposes of efficient resource use, hire large capacity vehicles of about 7 tones or more. However, none of the equipment was purchased or even designed for refuse collection. They are either old dilapidated vehicles with little other use, or small family pick-up trucks used for other purposes as well. Whether hired or privately owned, all the small firms use an average of one vehicle.

It could be said that while privatisation and contracting out of solid waste management has to some extent improved waste management in Nairobi, many areas still remain inadequately served or not served at all. The Nairobi City Council operates some waste management service and still has responsibility for ensuring this service citywide. The privatisation or contracting out has not been done in total.

2.1.1.2. Dar-es-Salaam, United Republic of Tanzania

Solid waste management in Dar es Salaam is the responsibility of the Cleansing Service Division in the Preventive Services Section of the city's Health Department, which also undertakes street cleaning and drain clearance.

It is estimated that a total of 1,929 tones of waste is generated daily from domestic, commercial, institutions and market centres. Before the decision to privatise solid waste collection and disposal, the city council, was only able to manage between 2-4% of the waste generated daily.

There was a particularly serious crisis in the city centre area and at markets sites.

In view of the poor waste management facing Dar es Salaam City, the DCC decided to embark on the privatisation of waste collection option as one of the initiative of the Solid Disposal Project (SDP).

2.1.1.2.1. Phase I of the privatisation programme Dar-es-Salaam City Council:

The first phase for privatised sold waste collection started after a meeting between the DCC and the PMO who sought to find a permanent solution after the success of the emergency clean up campaign of 1992. It was in this meeting that the idea of privatisation was re-introduced. This time the idea was supported and means to implement were identified. It was agreed that private individuals and contractors interested in this business avail themselves to be assessed and the winner to be given the tender. Then the tender was advertised for applications. The only contractor who availed for scrutiny was M/S Multinet Africa Company Limited and thus, it was granted a tender.

Ten city centre wards namely Kivukoni, Kisutu, Mchafukoge, Upanga East, Upanga West, Jangwani, Kariakoo, Gerezani, Mchikichini and Ilala were selected for this first phase. M/S Multinet Africa Co. Ltd. Was assigned to clean these wards. Besides collecting the wastes from these areas, the contractor was also empowered to collect refuse collection charges directly from customers. It was agreed that for commercial premises the Refuse Collection charges (RCCs) will be linked to the issuing of trade licenses to facilitate collection on an annual basis and the residential RCCs will be collected on a three monthly basis. Other phases were to be effected on the condition that the first phase was successful.

Then followed the preparation of the Dar-es-Salaam City (Collection and Disposal of Refuse) By-laws. This was prepared by the City Solicitor's office and was passed by the council under the Urban Authorities Act of 1992. The Prime Minister approved the By-laws on 7th August 1993, to take effect from 1st September 1994. Later on a contract based on the above-mentioned By-Laws was prepared by the two parties (DCC and Multinet).

M/S Multinet Africa Company (Ltd.) started operation in September 1994. For the first six months from November, 1994 the operation showed good results. Many streets in contract areas were clean and data from Vingunguti disposal site showed that large volumes of waste were disposed off. On the other hand the revenue collection refuse, as collection charges was promising while RCCs payers paid immediately.

By May 1995, there was an increase in waste collection from 2% before privatisation to 75% of the generated waste in the privatised areas. However, the amount of waste collected dropped due to some implementation and contractual problems, which seriously affected revenue collection and actual collection of wastes from the designated areas of privatisation. This resulted in a situation in which privatisation could not be extended to other areas. The private contractors area was therefore reduced to 5 wards instead of 10. It was clear in the contract that, in order to enable the contractor to perform as required, DCC was required to enforce the By-Laws, relevant legislation and regulations.

A working group on privatisation, which comprised experts from different stakeholders including the contractor discusses and deliberates on issues relevant to the process and functioning of the DCC and contractor on what further actions and alterations are required. This group works out plans for implementation so as to achieve the objective of the private

sector involvement in the provision of solid waste collection services. The RCC tariffs were set after a detailed study by a working group on privatisation of Solid Waste Management (SWM) of the Solid Disposal Project (SDP) and approved by the Council.

2.1.1.2.2. Phase I achievements

The major achievements realized during the first phase of privatisation included:

i) Establishment of partnership in solid waste management through the advice of a multi-disciplinary working group, which comprised of almost all stakeholders in solid waste management.

ii) At the beginning, solid waste collection improved in terms of the percentage of waste collected (70%). This rate started to decline six months after the engagement of the private contractor due to the problems outlined in the following section.

iii) Contracting of our SWM increased the efficiency in service provision and revenue collection. Households were slowly getting to understand that they have to pay for the service of refuse collection. There is evidence that privatisation has increased the amount of waste collected from 30-60 tones collected by the DCC throughout the city, to 100-120 tones collected by the private contractors in the city centre alone. There is also a more efficient use of human resources, in the sense that, compared to 800 DCC workers who collected 30-60 tons the 318 workers under the private contractors collect 100 tons of refuse per day.

iv) Through the privatisation process, a number of jobs were created. A total of 318 workers employed by the contractor were created in event when privatisation of solid waste collection was effected.

v) The working group managed to re-draft the first contract (Multinet Contract) and prepared plans for the second phase of privatisation.

2.1.1.2.3. Constraints in Phase-I

i) Non-fulfilment of obligations from all parties – For example, under the contract, the contractor was supposed to pay to the DCC the monthly costs of renting trucks, a leased depot and refuse disposal charges at the "dump" of Vingunguti. On the other hand the DCC was obliged to pay revenue collection charges for the services provided by the contractor at DCC owned premises like schools, hospitals, offices, etc. Unfortunately no party had paid to the other, a situation that made the DCC to withdraw its facilities in September 1995. Similarly, the DCC was responsible for the public campaigns of raising awareness among residents of the privatised area for solid waste collection and also prosecuting the defaulters of RCCs, the same was not done thereby limiting the contractor in effectively collecting revenue from the waste producers.

ii) Lack of competition – A single Contractor could not create the competitive situation needed in order to increase efficiency (a principle of market led economy). Unfamiliar with the idea and practice – Since privatisation of services in the United Republic of Tanzania is a new system there is not much experience to date. Staff of both the DCC and the Contractor was never familiar with

privatisation of solid waste collection and disposal leading to poor monitoring of the process.

iii) Lack of well functioning Management Information System (MIS) – Required specific data/information on households, which were to pay for the RCC, were not yet built up.

iv) Problems within the contract agreement – Some of the items within the contract were not well elaborated. For example, there was no clear indication on the period when refuse collection charges would be reviewed, how to deal with complaints by the refuse producers, how to monitor the daily operation of the contractors and methods of arbitration.

2.1.1.2.3. Phase II of privatisation from one contractor to five

The second phase of "privatisation" started in September 1996 after a process of open tendering whereby four other firms out of 14 bidders who applied in May 1996 were given the contract to provide solid waste collection services to a total thirteen wards. The new contractors and their wards in brackets are as listed below.

- The 1994 Environmental Protection (MAZINGIRA) Ltd. (Msasani Kawe, Kinodoni, Mwananyamala, Manzese and Tandale;
- Allyson's Traders (Magomeni, Mzimuni and Ndugumbi);
- Kamp Entgerprises (Majurumla and Ubungo);
- Kimangele Enterprises (Keko & Temeke **14).**

2.1.1.2.4. Performance in Phase II

The daily solid waste collection increased in the newly contracted wards and there were signs of reduction in solid waste heaps especially in open spaces and market places.

The four new contractors faced the similar constraints as those experienced by Multinet in Phase 1. These included:

- Inadequate payment of Refuse Collection Charges (RCCs) to the Contractors. One of the reasons for this failure was the fact that there have been insufficient preparations to involve and raise awareness of the people on the new strategies to clean the city and the responsibilities of each stakeholder and individuals. Inadequate revenue collection affected the performance of Contractors who could not reach their targets.
- The Companies, which were given the tenders, did not have enough equipment and facilities to enable them to conduct their business adequately despite the fact that they promised to purchase the same.
- Records show that the DCC role of providing the enabling environment to the contractors, e.g., the adequate information of residents liable for payment of RCCs and awareness creation among them has been inadequate. The contractors have to be very closely supervised, monitored and supported with information (data) for planning, technical advice and more importantly with financial assistance.
- All households were treated as equal, something not true within the specified operational Wards.

2.2. Prospects and limitations of privatising solid waste management

Among the problems that process of privatisation of SWM has faced are the absence of public awareness at the local or national level and creation of mechanisms to facilitate such participation; Constraints in the implementation of policy reform measures are found in the managerial deficiencies and weaknesses within the local authorities; a lack of specialised administrative capacity to administer and manage the

privatisation process which calls for experienced and competent personnel. Municipal councils who opt to privatise or commercialise their services on the other hand, find that they need to upgrade all their staff in accounting, auditing, information management, policy development and management to gain the required operational expertise for efficient and effective performance.

Given the sub-additive nature of garbage collection as a public utility, a classic economic problem with privatised SWM arises with areas served. Although private solid waste entrepreneurs are spread all over the city, most of their activity is concentrated in residential neighbourhoods and biased towards the middle and higher income areas. There is absolutely no private sector solid waste collection activity in low-income areas. This was found to be due less to the inaccessibility of these areas and more to lack of effective demand.

There is also not indication that private firms have extended services to previously un-served groups, who primarily reside in low-income settlements. There is, of course, no economic reason why profit-seeking private enterprises would be interested in serving poor communities.

In all cases studied in which urban waste collection services have been privatised, the target groups were invariably middle and high-income neighbourhoods.

In a recent survey (Esho, 1997) 70% of the small firms interviewed mainly serve middle-income areas and some lower-middle income areas. They generally find it difficult to penetrate high-income areas, which are mostly reserved for the larger firms. The operations of most small firms seldom go beyond one residential neighbourhood. However, few may occasionally collect refuse from institutions, commercial and industrial establishments. On average each of these small firms serves about 500

clients. Unlike small firms, medium and large sized firms may serve more than one residential area, and a variety of the other waste generating activities. Informal private sector waste entrepreneurs or "scavengers" on the other hand, operate anywhere they wish.

Another argument put forth by the proponents of privatisation is that the private sector's higher efficiency comes from their better-maintained refuse collection vehicles. The relevant evidence from Nairobi, however, suggests that this proposition does not always stand. When contracts do not provide incentives for the private firms to invest in appropriate equipment, most firms will lease second-hand dump trucks that are frequently inoperable.

2.3. Summary of Literature on privatisation of Municipal Services

The process of decentralization and privatisation of municipal services is under process in Kenya, Tanzania and Uganda. In other countries the processes are just in the planning stages or on pilot/trial basis. None of the countries has yet completely privatised its municipal services. Only solid waste management and water supply are experimented by privatisation and decentralization.

Privatisation of municipal services, i.e. solid waste management has mostly been materialized in affluent areas where rich people can afford the private services while the poor are deprived of the same services for want of money to pay for services. So the solid waste management problem of a major segment of population remains unresolved public policy issue.

The overall assessment of the privatisation of collection and disposal of waste in the East African sub-region indicates that it is more efficient than city council, but does not cover the whole city.

There is no clear policies or legislation on privatisation of municipal services both central and local. The efficiency of privatised municipal services is hampered in the sub-region by the following factors: -

- Limited organizational capacities; and
- Financial inadequacy resulting in inability to mobilize the required capital inputs (equipment, technologies and supplies) to sustain their privatisation operation.
- Inadequate professional/technical staff trained to monitor and supervise the operation of the various privatised services, i.e., collection of solid waste etc.

There still exists some conceptual confusion or ambivalence about what privatisation actually involves. Some understand it as contracting or leasing out tasks and responsibilities to private sector firms, while the local (municipal) government retains overall supervisory and regulatory control; some understand it as commercialisation of services by municipal departments or parastatals, and some understand it as total and complete transfer of responsibilities for providing the service to private sector firms who set their own prices, etc.

Considering the differing perceptions of the concept and application of privatisation of municipal services as a process and strategy and considering its relatively recent and limited adoption and application in the countries of the East African sub-region, as well as the public policy issues of equity it raises, it is not yet possible to render a definitive verdict

on the efficacy and effectiveness of its performance in municipal services provision and management.

Chapter Three

3.0 Research Methods

This study was focused on the problem of municipal solid waste management (MSWM) in the Westlands suburb area of Nairobi. To solve the research problem, there was need to design a suitable investigation method. The research method had the following components:

- Data Type
- Data sources
- Data sampling design
- Data collection
- Data Analysis

3.1. Data Type

In this study, both secondary and primary data were used in an attempt to solve the stated research problem although primary data predominated. The secondary data were mainly used to verify the field data as well as to assist in generalization of the solid waste management problem in Westlands suburb. The primary data required for this study were on the following elements relevant to solid waste management:

- Location of waste bins (private and City council) in the CBD and in four residential (domestic) areas selected randomly from the population census enumeration units
- Waste generation represented by weight (Kg) from the units or bins
- Type of waste per unit or bin
- Waste Management body (private & city council)
- Demographic information Spatial information in terms of the City of Nairobi administrative and road map

- Public perception on municipal solid waste management by survey

3.2. Data sources

The primary data were collected through fieldwork using various techniques including the use of field questionnaires, field research assistants, individual interviews, field observations, and photographic approach, solid waste field managers from City council and private sectors and personal consultation. The secondary data were sourced from government of Kenya data stores (mainly from the Central Bureau of Statistics (CBS) especially on household information in the study area), Nairobi City council databases and from the waste management private companies records.

3.3. Data sampling design and collection methods

For the primary data, the map of Westlands division constituted the sampling frame. The division was then sampled randomly using the census enumeration areas (EAs) as the sampling point. This resulted in five sampling areas, which were then classified as Central Business District, Suburb I, Suburb II, Suburb III and Parklands (See Map-1). In each sampling area (zone), the waste collection points in the form of bins or residential unit were identified and selected randomly to represent waste generation points. The waste generation points then formed the sampling points from which the waste data were collected (See Map-2).

To get the waste data, each sampling point (bin) was regularly monitored and when filled up, was weighed and checked for waste type to identify waste generation stream. The waste type was deemed important in this study because they were to assist in sorting out the recyclable and non-recyclable components of the MSW. Moreover the waste stream identification help in determination of type of waste generated by both

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domestic and commercial. The field activity also recorded the frequency of waste collection, which was used to estimate waste generation and stream. Further, the disposal points of the wastes collected were determined through field observation and interviews **(See Photgraph-5).**

Photograph-5: Researcher taking sample of waste stream by weighing in Westland

Photograph-6: Researcher taking sample in the CBD of Westlands, Nairobi

Photograph 6: Researcher taking sample in the CBD of Westlands, Nairobi

3.4. Data Analysis

The collected data were analysed using various analysis techniques or methods. Each variable score was first tabulated in the field notebooks and the resulting records were then subjected to the following descriptive and spatial analysis methods in order to provide answers to the research problems and to meet the objectives of this study:

3.4.1. Descriptive Analysis of public perception data on Municipal Solid Waste Management (MSWM)

The perception data was collected on the basis of the following indicators:

- Collection agency
- Frequency of collection
- Designated collection points
- Satisfaction with the waste collection services
- Problems in waste collection
- Suggestion on improvement in municipal solid waste collection

The above data was subjected to descriptive statistical tools in the form of tables and graphical representation. The objective was to give the general indication on the public perception of MSWM. The pie charts, bar charts and tables were used to represent frequency scores in order to provide distribution tendency in the data distribution. The distribution tendencies were used to make tendency statements on public perceptions on MSWM. No inferential statement was implied in the use of descriptive graphical techniques but strong visual impression on public perception as defined by the above variables was captured.

3.4.2. Descriptive analysis of Municipal Solid Waste Managemen Data

To make general statement on the municipal solid waste management data, both measures of central tendency and dispersion were used. The central tendency measure used was the mean for waste stream generation and waste generation (See Map-3). To compute the mean for waste stream, the waste stream was first computed as follows:

- Waste collection point or bin were identified and inspected for the type of waste
- The type of waste constituted the waste stream. The study identified metal (See Map-4), glass and ceramics (See Map-5), vinyl and plastic (See Map-6), paper (See Map-7), wood (See Map-8), organic materials (See Map-9), medical materials (See Map-10) and others (toxic materials). This assisted in differentiating types of wastes generated by domestic and commercial activities
- The different types of wastes were then weighed using a weighing machine at scale and the resulting values for each type constituted the waste stream in this study

- The waste streams were collected each time the collection activities were due or on going. This was usually twice a week for domestic sector and once a day for the commercial sector. This in itself indicated rate of waste generation. The waste stream values were then summed up for each waste type and divided by the number observations to give the mean, which in this study represented the expected waste streams in Westlands suburb of Nairobi. The means were recorded in kilograms but this was converted to percentage values as a measure of variation in waste stream generation The resulting mean values and variations were then plotted as pie charts, bar charts and tabulation to give tendency in the waste generation data in Westlands suburb. The same was then projected and predicted to the whole of Nairobi.

3.4.3. Geographic Information Systems (GIS) Analysis

3.4.3.1.Spatial Analysis Municipal Solid Waste Management using Geographic Information Systems (GIS)

The spatial data in this study was deemed necessary in order to provide a data integration platform for the Municipal Solid Waste Management study and to assist in answering the following questions:

- What is the municipal solid waste management situation in Westlands suburb
- What is the emerging conditions (patterns) of municipal solid waste management in Westlands suburb
- What the situation could be given the total number of households in Westlands suburb

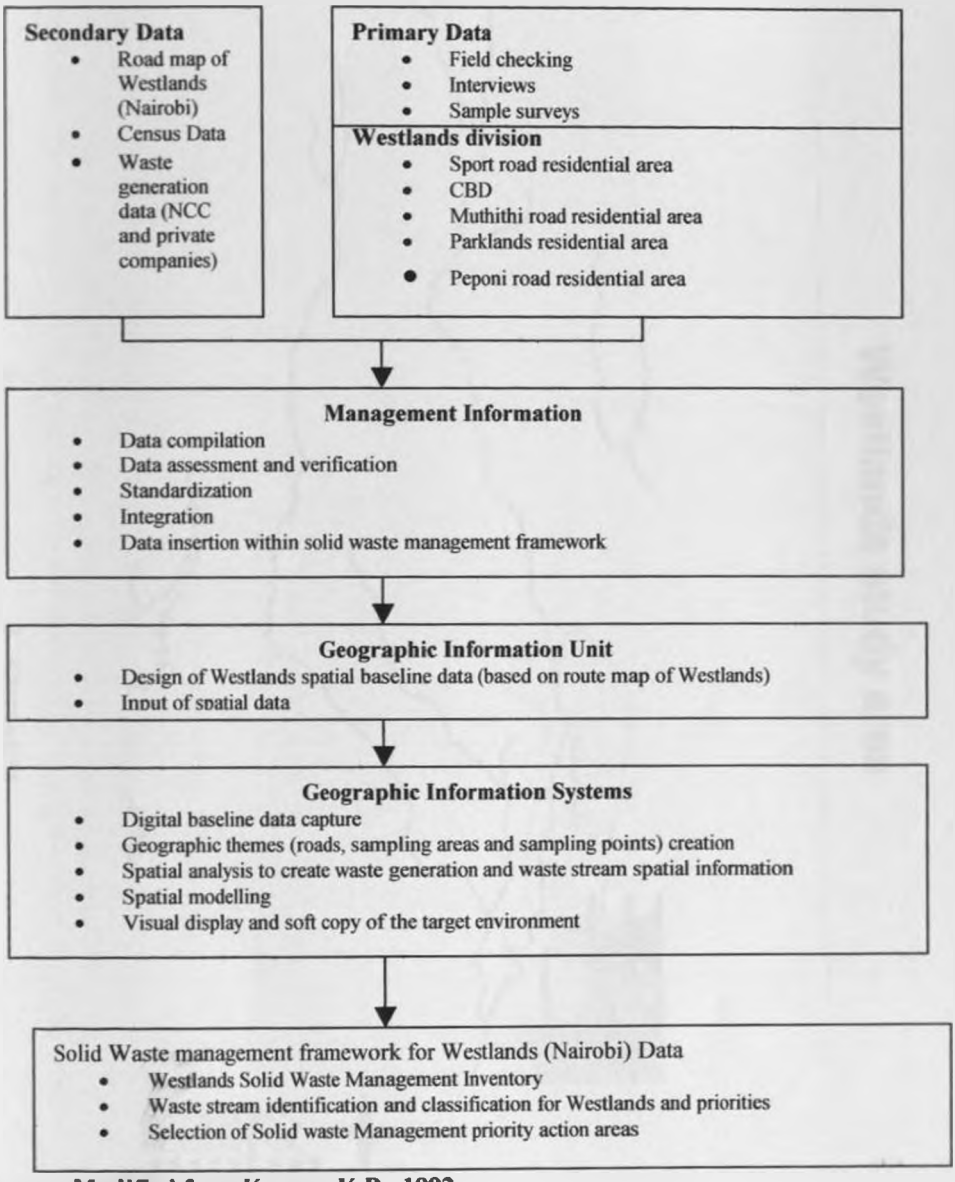
The source of spatial data of Westlands was the road map and administrative map of Nairobi. The spatial data was projected using the ***Casini Soldner*** method. The meridian of origin was 33°E and the latitude of origin was the

equator. The ***Casini Soldner projection*** is very useful in creating large-scale representation of surfaces especially on physical planning elements.

The geographic features or objects of Westlands captured were treated as themes in solid waste management and each theme represented a spatial layer. The resulting layers were roads and sampling zones. The road layer was useful in delimiting the sampling zones based on Waste collection agencies. The sampling zone layer was then tiled into five sub zones of CBD, Suburb I, Suburb II, Suburb III and Parklands. The CBD layer was defined by the bounds of Chiromo Road/ Waiyaki Way, Mpaka road, Peponi Road and Parkland road. The Suburb I was defined by the Chiromo road, Museum hill road, Ojijo road, Parklands road and Mpaka Road. Suburb II was defined by Chiromo road, Riverside drive, Waiyaki road and James Gichuru road. Suburb III layer was defined by Lower Kabete road, Peponi Road and Parklands road. Finally the Parklands layer was defined by Ojijo road, Parklands road, Peponi road, Limuru road and Forest road.

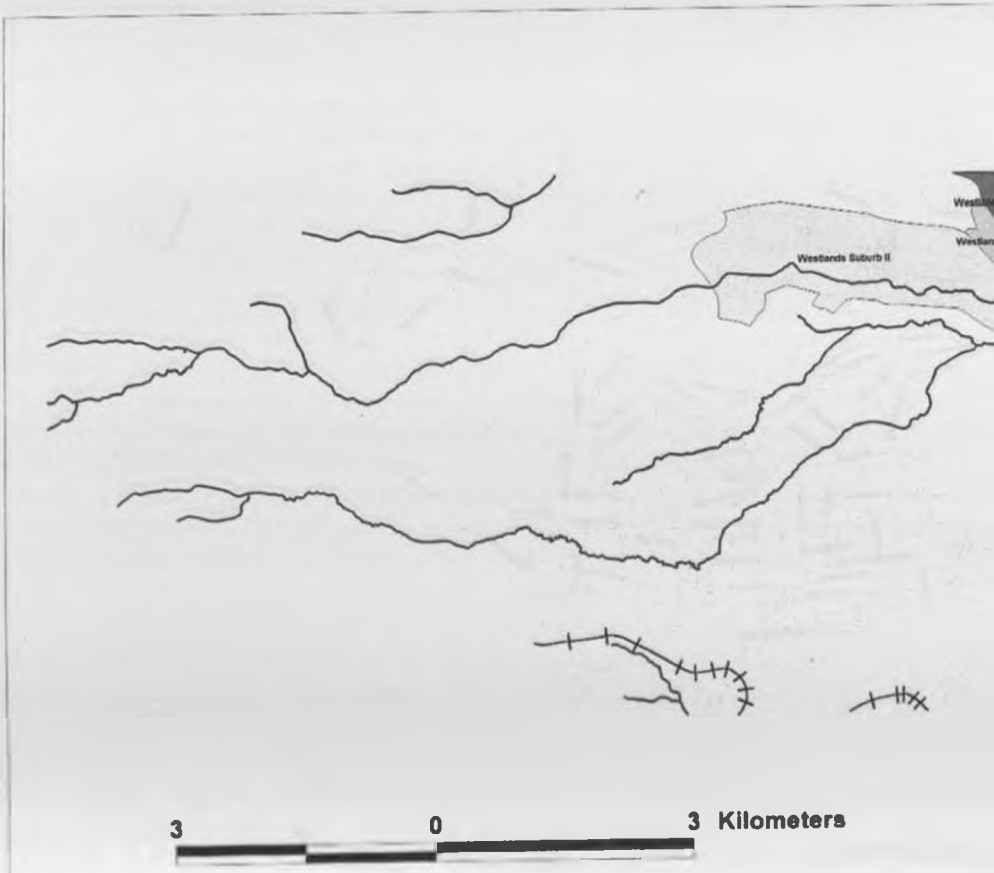
The spatial data objects were then assigned characteristics values based on Municipal solid waste data (including waste streams), demographic data, road names, and zones names. The solid waste data constituted the spatial analysis baseline data and the names attributes were used to delimit the sampling zones. Each waste stream was used to represent waste generation in the sampling zones. Note that the waste information originated from points but were used to represent areas (polygons) and not individual households. The results were therefore general tendencies rather than specific household or commercial unit information.

Figure-6:Integrated Model of spatial data analysis



Source:Modified from Kucera, K.P., 1992

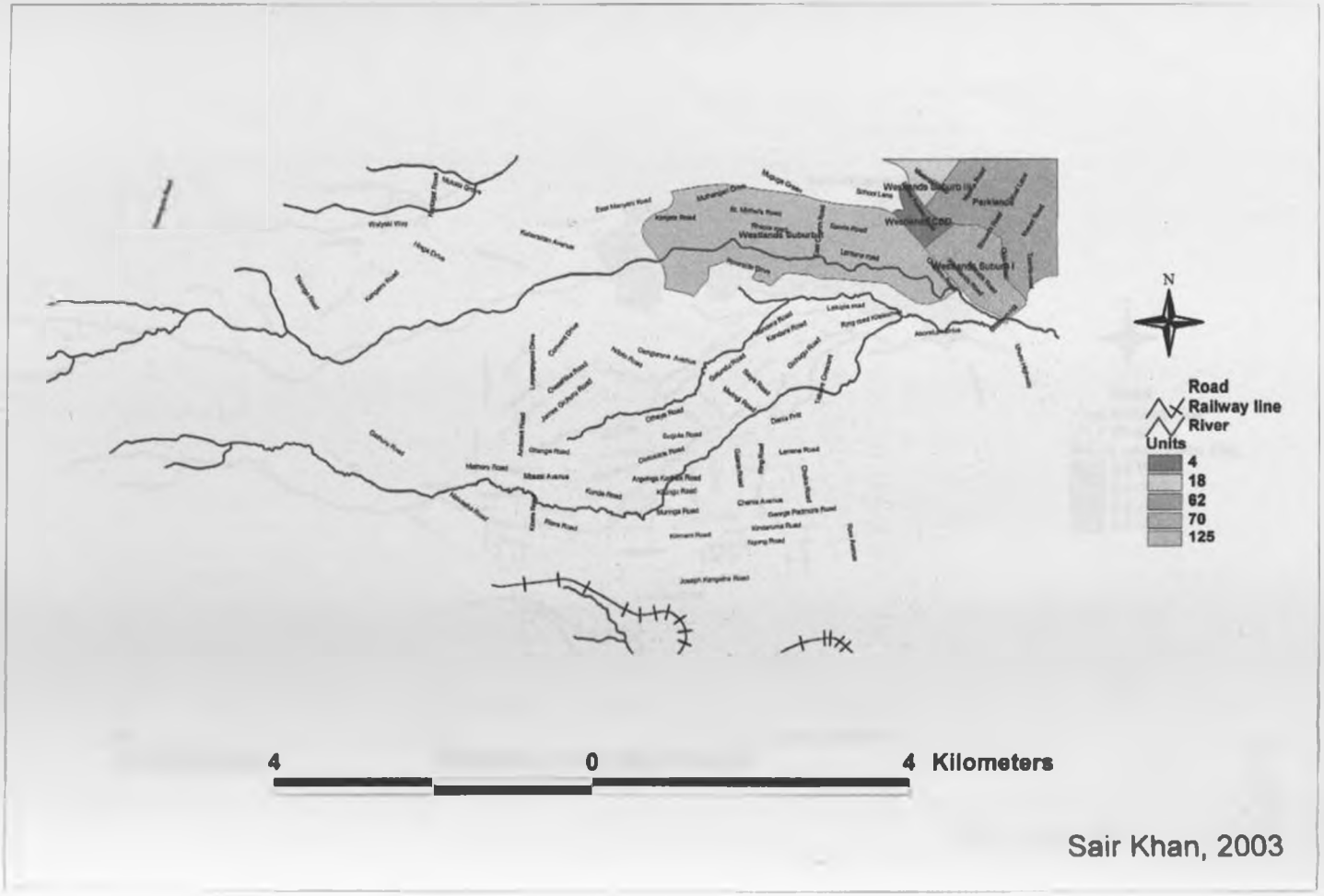
Westlands study area



MAP-1

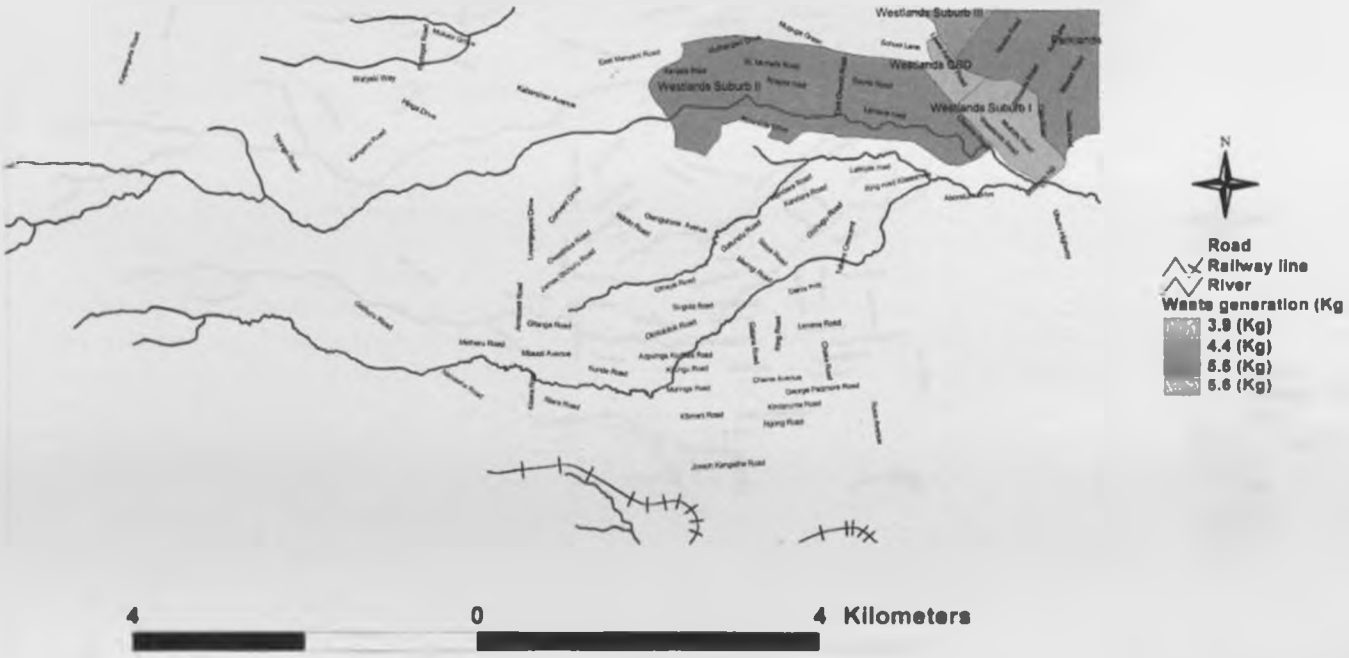
Sair Khan. 2003

Westlands: Units included in the sample per study area



MAP-2

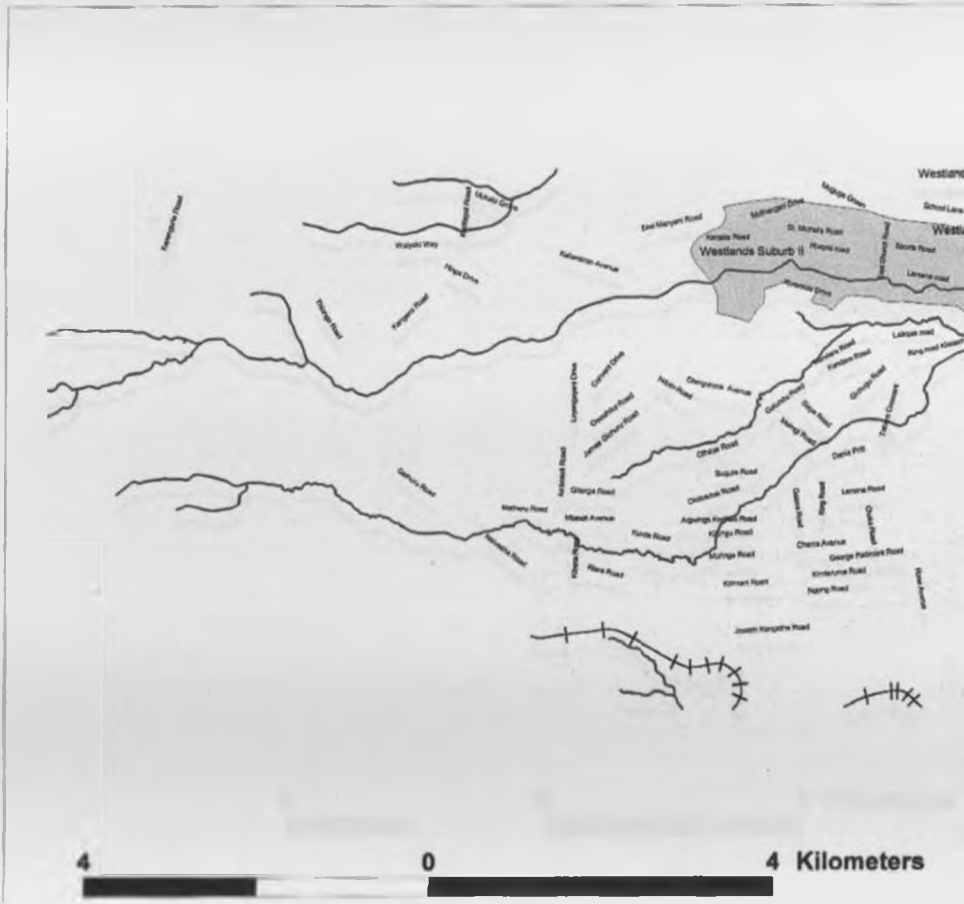
Mean Waste generation per day per unit/bin (Kg) in the Westlands suburb area of Nairobi



Sair, Khan, 2003

MAP-3

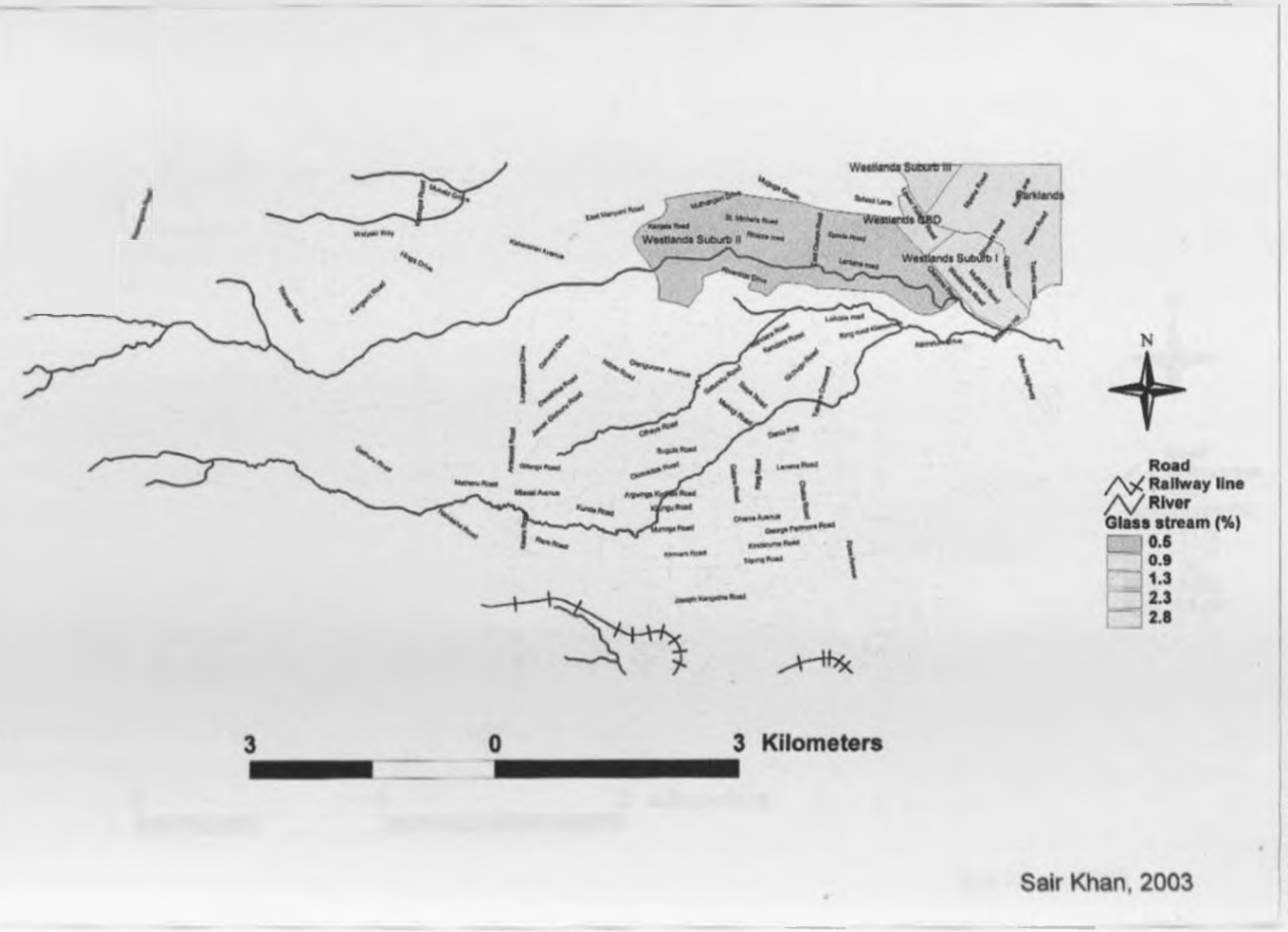
Waste metal stream per day per unit/bin (%) in the Westlands suburb area of Nairobi



MAP-4

Sair Khan, 2003

Waste Glass stream per day per unit/bin (%)
in the Westlands suburb area of Nairobi



Sair Khan, 2003

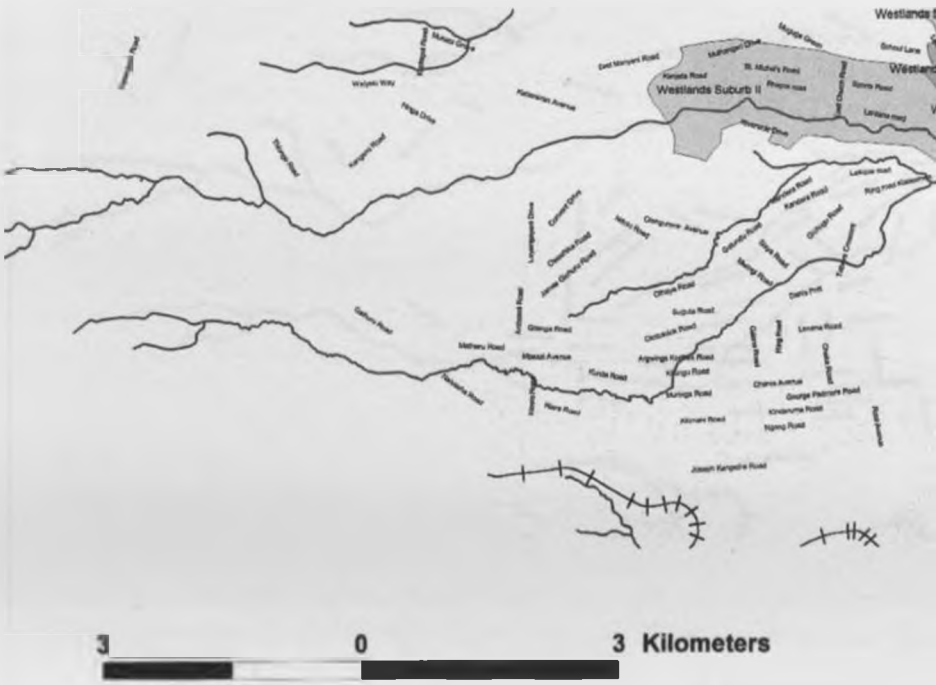
MAP-5

Waste Vanyl stream per day per unit/bin (%) in the Westlands suburb area of Nairobi

Sair Khan, 2003

MAP-6

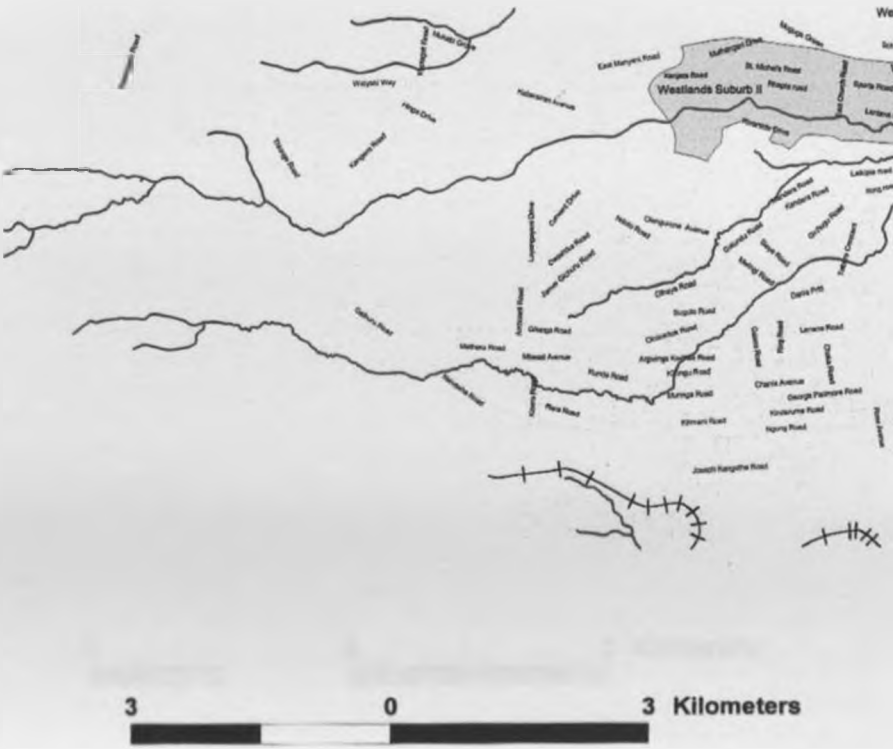
Waste paper stream per day per unit/bin (%) in the Westlands suburb area of Nairobi



Sair Khan, 2003

MAP-7

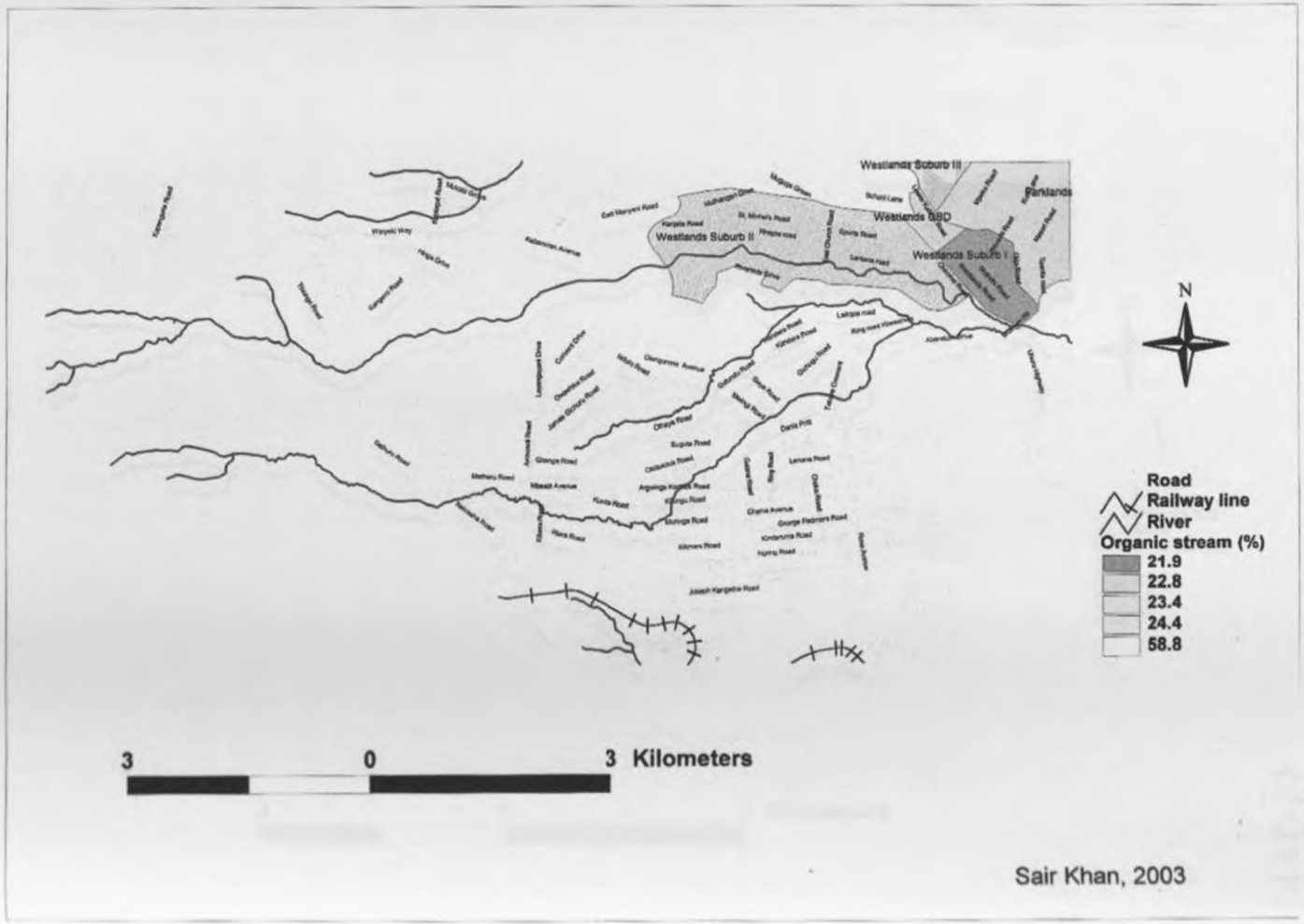
Waste wood stream per day per unit/bin (%) in the Westlands suburb area of Nairobi



MAP-8

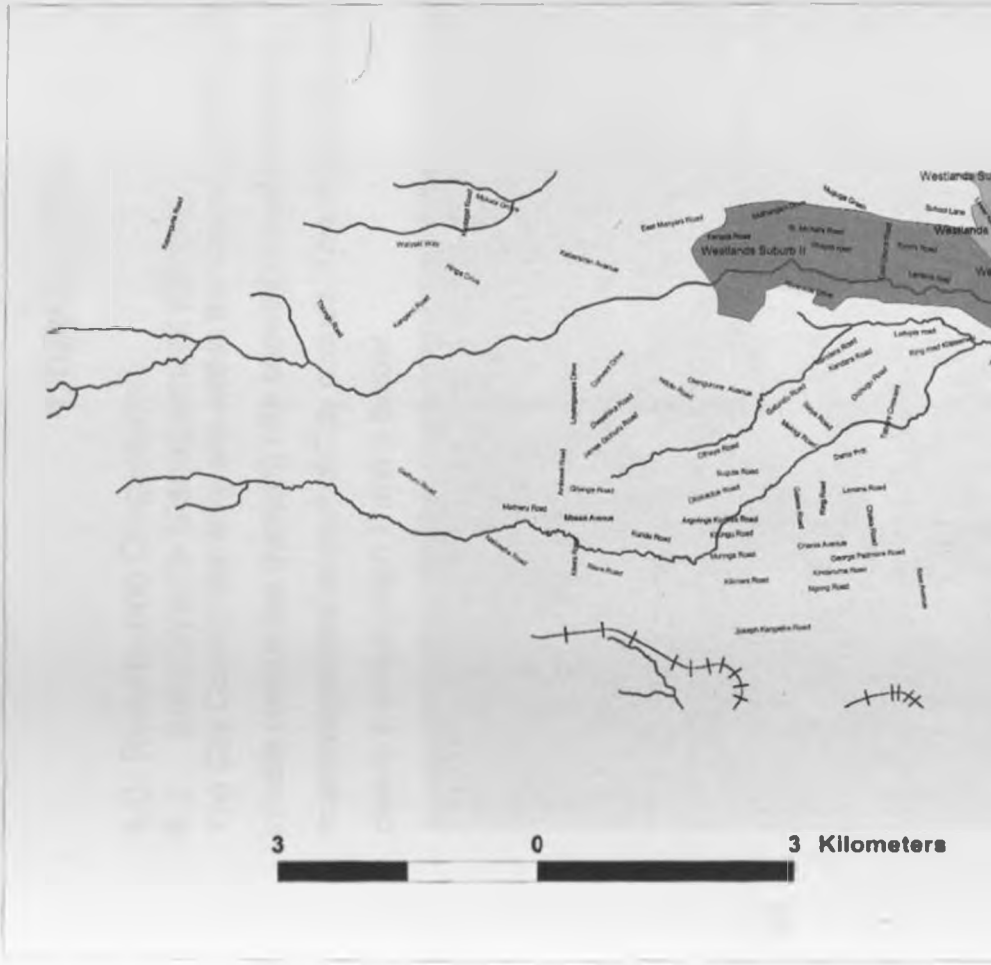
Sair Khan, 2003

Waste organic materials per day per unit/bin (%) in the Westlands suburb area of Nairobi



MAP-9

Waste medical materials per day per unit/bin (%) in the Westlands suburb area of Nairobi



MAP-10

Sair Khan, 2003

Chapter Four

4.0. Results and Discussions:

4.1 Solid Waste Management (SWM)

The City Council dumping site within the City when compared to private companies dumping site showed remarkable state of mismanagement on part of City council. This difference demonstrated clearly in photograph 7 and 8 below.

Photograph-7: The Nairobi City Council open dumping site in Westlands.

Photograph-8: The main dumping site of the private company in Westlands.

From the problems identified and shown, the researcher attempted to find out reasons for the difference in SWM in Westlands by investigating the performances of Private Companies and City council and public perception.

4.2 Solid Waste streams

Table 1: shows the results of a comparative analysis of solid waste streams from domestic sources and commercial sources in Westlands suburb area of Nairobi. The results are in stream or type of solid waste per day per residential unit and Commercial Municipal Solid Waste Stream (CMSWS) per bin.

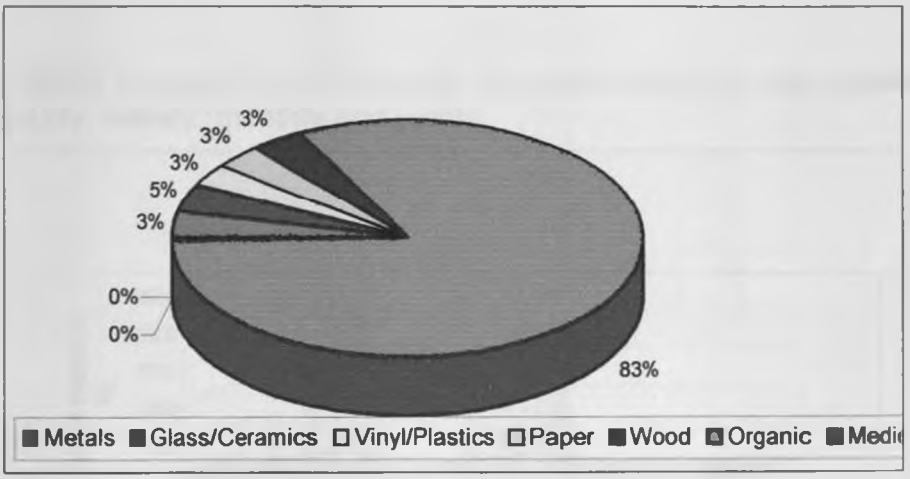
Table 1: Comparison between Domestic Municipal Solid Waste Stream (DMSWS) per day per residential unit and Commercial Municipal Solid Waste Stream (CMSWS) per bin.

	DMSW Generation		CMSW Generation		DMSWS weekly	CMSWS weekly	DMSWS Monthly	CMSWS Monthly	DMSWS Yearly	CMSWS yearly
Component	Value in Kg Per day	Value in %	Value in Kg per day	Value in %	Value in Kg	Value in Kg	Value in Kg	Value in Kg	Value in Kg	Value in Kg
Metals	0.17	3.4907598	0.25	4.504505	1.19	1.75	5.1	7.5	62.05	91.2
Glass/Ceramics	0.19	3.9014374	0.16	2.882883	1.33	1.12	5.7	4.8	69.35	58.4
Vinyl/Plastic	0.16	3.2854209	0.61	10.99099	1.12	4.27	4.8	18.3	58.4	222.6
Paper	0.16	3.2854209	0.88	15.85586	1.12	6.16	4.8	26.4	58.4	321.
Wood	0.17	3.4907598	0.05	0.900901	1.19	0.35	5.1	1.5	62.05	18.2
Organic (Veg)	4	82.135524	3.6	64.86486	28	25.2	120	108	1460	131
Medical (Drugs)	0.02	0.4106776	0	0	0.14	0	0.6	0	7.3	
Others	0	0	0	0	0	0	0	0	0	
Total	4.87	100	5.55	100	34.09	38.85	146.1	166.5	1777.6	2025.7

Source: Field data

Figure 7 shows the composition of Domestic Municipal Solid Waste stream generation per residential unit in Westlands Suburb of Nairobi.

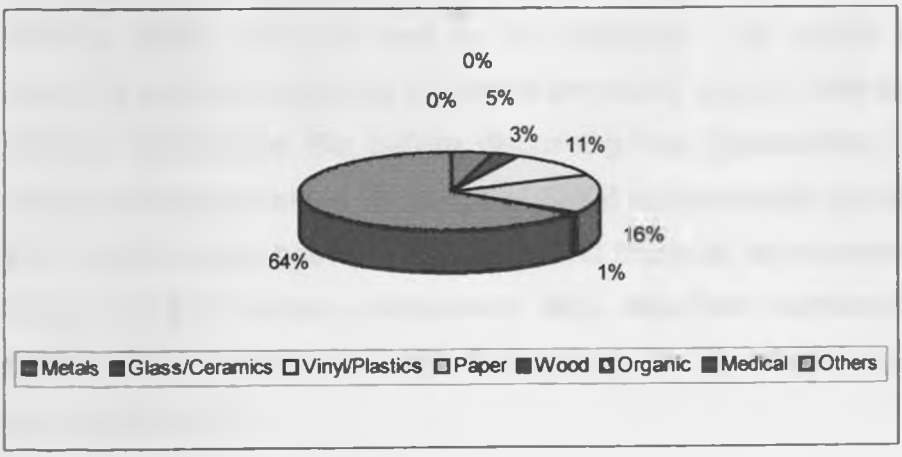
Figure 7: Percentage DMSW stream per unit (4.87 kg) in Westlands suburb of Nairobi



Source: Field Research

Figure 8 explains the composition of Commercial Municipal Solid Waste stream generation per bin of a total 5.55 Kg per bin daily in the Central Business District of Westlands suburb of Nairobi.

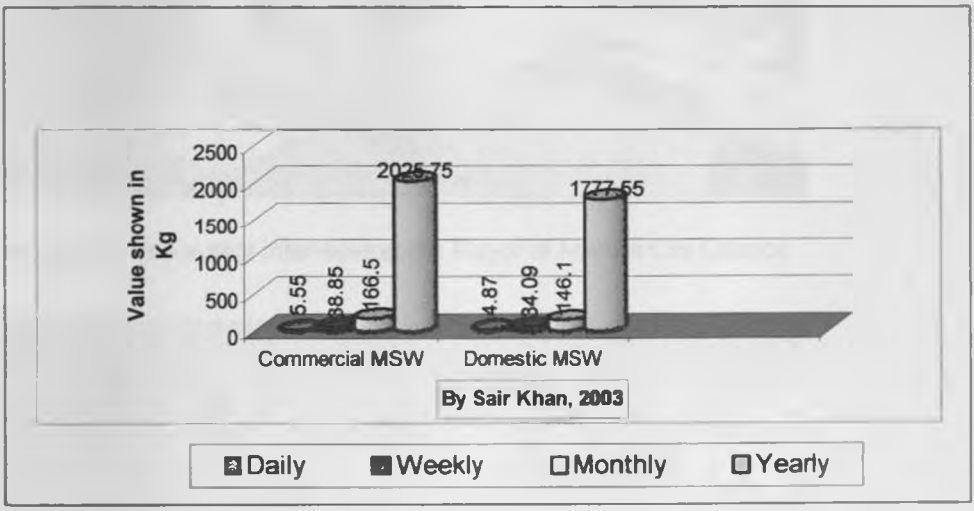
Figure 8: Percentage of CMSW stream generation per bin per day of total 5.55 kg in the CBD of Westlands suburb of Nairobi



Source: Field Research

After data analysis of both domestic and commercial solid waste, per resident for domestic and per bin for commercial, then solid waste generation for both was defined, daily, weekly, monthly and yearly. **(See Figure-9)**

Figure 9: MSW generation both domestic (per residential unit) and commercial (per bin) daily, weekly, monthly and yearly



Source: Field Research

The analysis used required that the project had to integrate several approaches in order to test the formulated hypotheses. For this to be achieved, Public Perception, on waste management, the Solid Waste Stream (SWS) and GIS had to be combined. The results from the sampling procedure indicate that there are many opportunities to improve SWM in Westlands. But before discussing the opportunities, the NCC which administratively is in charge of SWM in Westlands acknowledged their shortcomings both administrative and financial as expressed by the Mayor and the Director, environment, NCC after their interviews with the author **(See Photo- 9 & 10) & (Table 2 & 3)**, which explains the incapability of NCC.

Photograph-9: The author interviewing the Mayor of Nairobi City Council.

Photograph-10: The author interviewing the Director (Environment), Nairobi City Council.

Table 2:Expenditure on public health by Nairobi City Council, 1997-2002

	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002
Cleaning & Administration	32,610.00	36,700.00	39430	75734	83,166.00	57,810.10
Cleaning-General	134,998.00	139,514.00	139,714.00	163,344.00	164,196.00	139,137.00
Refuse Removal	50,248.00	25,124.00	28,744.00	70,112.00	74,304.00	60,955.00
Conservancy	318.00	322.00	322	494	496.00	147.60
Total	218,174.00	201,660.00	208,210.00	309,684.00	322,162.00	258,049.70

Source: Nairobi City Council (Provisional) and Economic Survey, 2001 and 2002 published by Central Bureau of Statistics, Kenya.

Table 3: Comparison between allocated and required budget, % shortfall

Area		Daily	Monthly	yearly budget for (2001/02)	% shortfall per annum
Westlands	(Available Funds)	66687.19	2000615.8	24340826	
	(Required Funds)	1249214	37476412	455963012.5	1773.243794
Nairobi	(Available Funds)	706983	21209490	258049000	
	(Required Funds)	9705390	291161704	3542467401	1272.788657
Per Resident	(Available Funds)	0.644	19.32	235.06	
	(Required Funds)	12	360	4380	1763.354037
Westlands (P/P)	(Available Funds)	0.2	6	73	
	(Required Funds)	3.8	114	1387	1800
Nairobi (P/P)	(Available Funds)	0.279	8.37	101.835	
	(Required Funds)	3.83	114.9	1397.9	1272.710758

Source: Economic Survey of Kenya,2002 published by CBS & Field Research.

The study found out that there are many alternatives to improve means of SWM in Westlands and Nairobi as a whole. This is demonstrated by the following findings from fieldwork results. **(See Table 4)**, which indicates the total waste generated per resident per day in Westlands and then projected to the whole city of Nairobi and, sorted waste (4.26%) to be recycled for economic value and waste reduction and management.

Table .4:Waste stream per day generation, sorted, unsorted, % of sorted waste and total amount (K.sh) of sorted waste of Westlands and Nairobi per day

Component	Total waste Per Res. Per day in (Kg)	Total waste Per Person Per day in (Kg)	% Waste gen. Per Person Per day	Total Per day waste gen. in Nairobi in (Kg)	Sorted Per day waste in Nairobi (Kg)	Un sorted Per day waste in Nairobi (Kg)	Total Per day waste gen. in Westlands (Kg)	Sorted Per day waste in Westlands (Kg)	Un sorted Per day waste in Westlands (Kg)	Total % of Sorted waste	Total Per day amount (K sh) of sorted waste in Nairobi	Total Per day amount (K sh) of sorted waste in Westlands
Metals	0.17	0.054	3.49076	136487.8	15000	121488	17725.28	1948.007	15777	10.99	52500	6818.024
Glass	0.19	0.0603	3.90144	152545.2	NIL	NIL	19810.61	NIL	NIL	NIL	NIL	NIL
Vinyl/Plastic	0.16	0.0508	3.28542	128459.1	40000	88459.1	16682.62	5194.685	11488	31.138	60000	7792.027
Paper	0.16	0.0508	3.28542	128459.1	100000	28459.1	16682.62	12986.71	3695.9	77.846	250000	32466.78
Wood	0.17	0.054	3.49076	136487.8	NIL	NIL	17725.28	NIL	NIL	NIL	NIL	NIL
Organic	4	1.2698	82.1355	3211479	11571	3199908	417065.9	1502.673	415563	0.3603	128565	1113.891
Medical	0.02	0.0063	0.41068	16057.39	NIL	NIL	2085.327	NIL	NIL	NIL	NIL	NIL
Others	0	0	0	0	0	0	0	0	0	0	0	0
Total	4.87	1.546	100	3909975	166571	3438314	507777.2	21632.08	446524	4.2627	536065	49616.92

* Source: Field research.

Table 5 indicates clearly that most of the solid waste in Westlands is collected by Private companies irrespective of whether domestic or commercial.

Table 5: Domestic waste generation (per day), ratio of collection and non-collection

Area	Total waste generation per day in (Kg)	Sorted waste for recycling in (Kg) per day	% of sorted waste for recycling	Collected waste by Private Co. & NCC in (Kg) per day	% of collected waste by Private Co. & NCC Per day	Uncollected waste in (Kg) per day	% of Uncoll-ected waste
Westlands	507777.237	21632.076	4.26	486145.16	95.74	00(Nil)	00(Nil)
Nairobi	3909975.39	166570.9	4.26	2150486.46	55	1592918.03	40.74

Source: Field Research and NCC and Private Companies records

In the Westlands residential area about 95% wastes is collected by the Private companies, scavengers sort the remaining. In the Commercial Business District (CBD) of Westlands 77% is collected by Private companies while 17% is collected by NCC and the remaining 6% is either collected by scavengers or left uncollected. In the Nairobi City, 30%

waste is collected by the private companies, mostly in the affluent areas, while 25% is collected by the NCC (Source: field research & NCC record from Dandora Dumpsite), about 4% is collected and sold by scavengers to recycling industries.

At present in the Westlands suburb most of the domestic solid waste (95%) is collected by private companies, and thereby the collection is satisfactory, **See Figure 10.**

Figure-10 shows Westlands suburb present daily domestic collected, sorted and left over Waste.

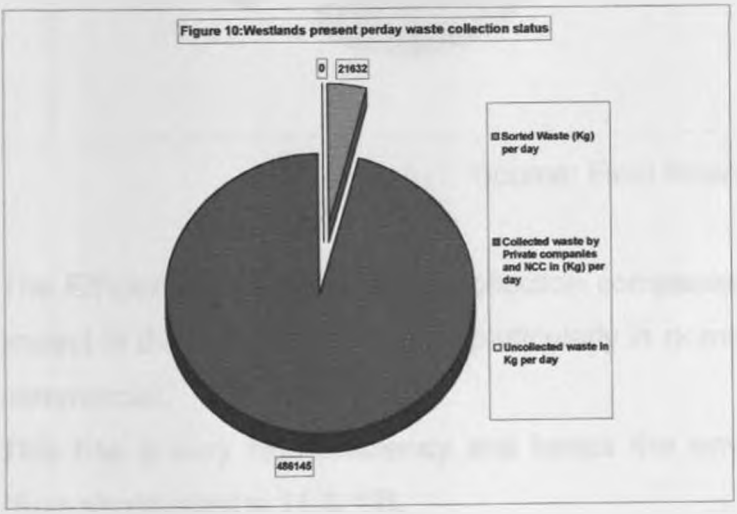


Figure 10: Westlands' present per day waste collection status

Source: Field Research

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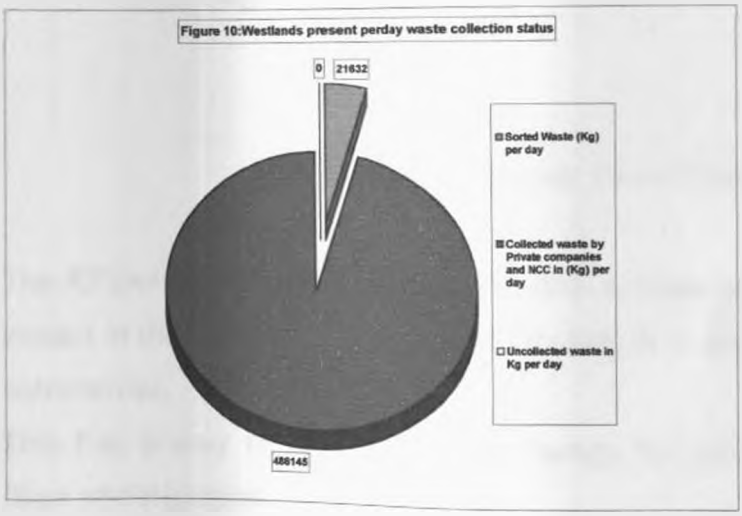
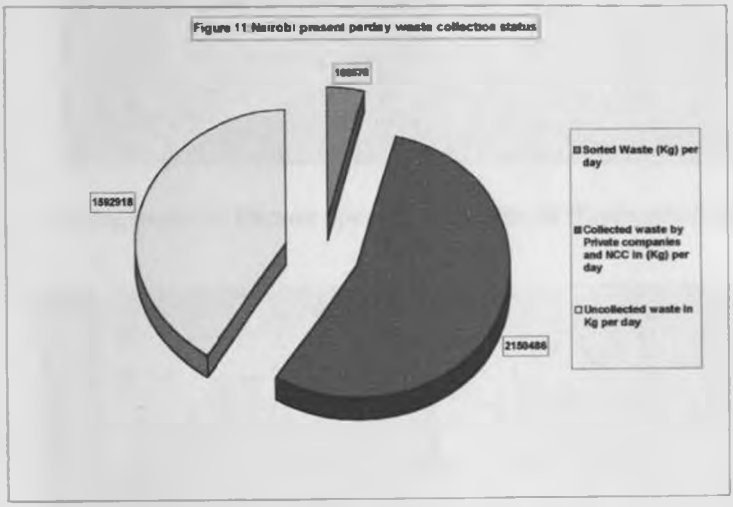


Figure 10: Westlands' present per day waste collection status
Source: Field Research

However, in the whole of Nairobi city 55% waste is collected and about 40% is left uncollected, which has serious environmental and public health impacts. **See Figure 11.**

Figure-11 demonstrates Nairobi current daily collected, sorted, and uncollected waste

Figure 11: Nairobi present per day waste collection status



Source: Field Research

The Efficiency of private refuse collection companies has a very positive impact in the surrounding areas, particularly in domestic and generally in commercial.

This has a very high efficiency and keeps the environment very clean **(See photographs 11 & 12).**

Photograph-11: **Former open dumping site in Westlands (CBD).**

Photograph –12: **Private Company collection point for residential area on in Westlands.**

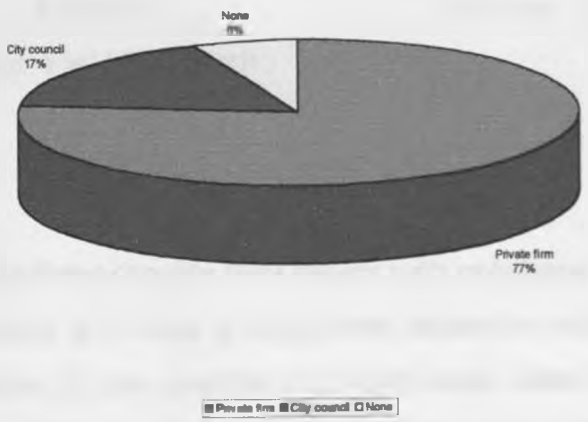
The study also identified the major problems encountered in SWM for Westlands by interviewing the residents for both Commercial and Domestic consumers and obtained the following results.

Solid waste continue to present a major management challenges to the municipal authorities of many urban areas around the world. The capital of Kenya, Nairobi city is not an exception to the same challenges.

The Nairobi City Council, the concerned authority responsible for MSW collection, has not been successful in managing the enormous amounts of waste generated within the city. However, the responsibilities of MSW collection has been effectively fulfilled by the private companies after privatisation of MSW collection services by the Nairobi City Council (NCC). About 70 private companies are operating in the jurisdiction of NCC, e.g., City Bin Ltd., Blue Bin Street Bins etcetera.

At present, private firms collect a great volume of both domestic and commercial waste. For example, according to the survey, private firms collect 77% of the commercial waste from Westlands suburbs, while the City Council is collecting only 17% of the waste **(See Figure 12 below).**

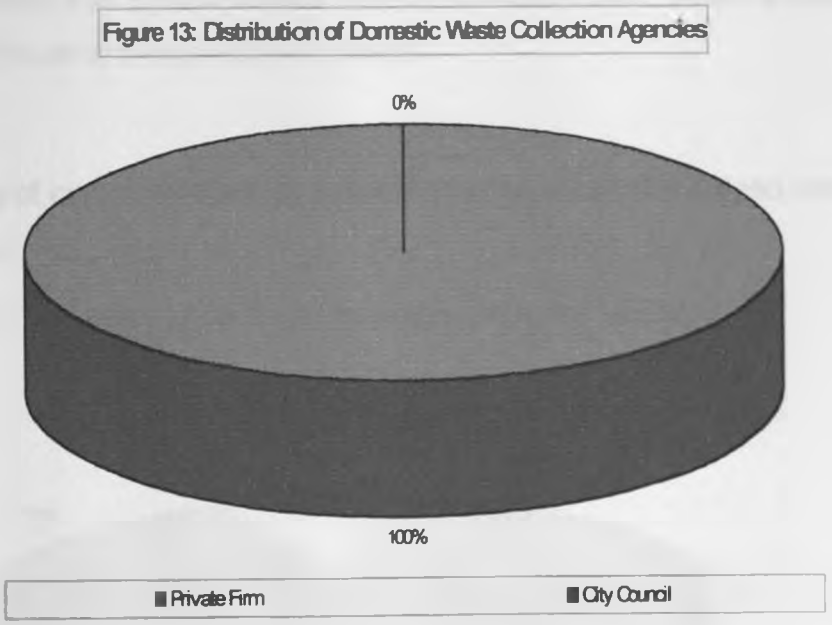
Figure 12: distribution of commercial waste collection agencies



Source: Field Research

For domestic solid waste, the situation is completely different since private firms collect almost 100% of the waste that is generated by the same area **(See Figure 13 below)**.

Figure 13: Distribution of domestic waste collection agencies



Source: Field Research

The waste collection firms provide their clients with polythene bags for the safe disposal of waste and have a designated collection point where the clients place the bags on the specified collection days. Most of the clients (95%)are satisfied with the services offered by the private MSW collection

firms. The few (5%) who are not satisfied cite late collection, infrequent collection and inadequate number of collection bags provided by the collecting agency as some of the major problems.

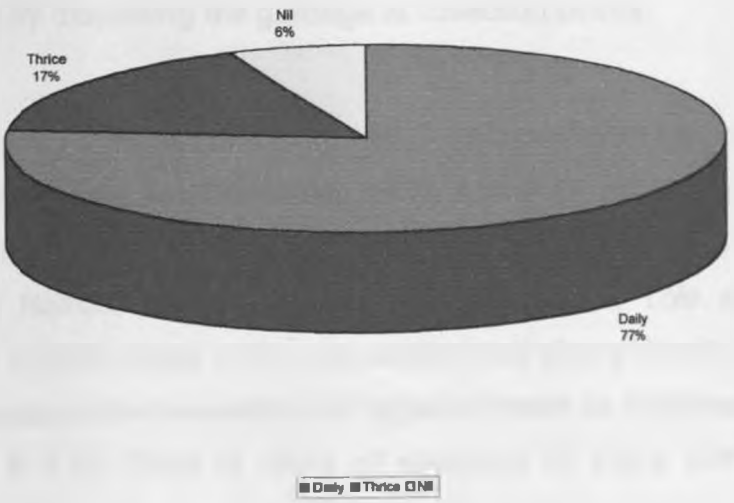
The survey further revealed that 47% residents are of the view that waste is collected once in a week. While 53% residents stated that the waste is collected twice a week. In the commercial area (CBD), 77% business-owners expressed their views that the garbage is collected daily while

Source: Field Research

17% shopkeepers say the MSW is collected thrice a week. It can be safely argued that private refuse collection firms collect waste effective but do not cover the whole city of Nairobi.

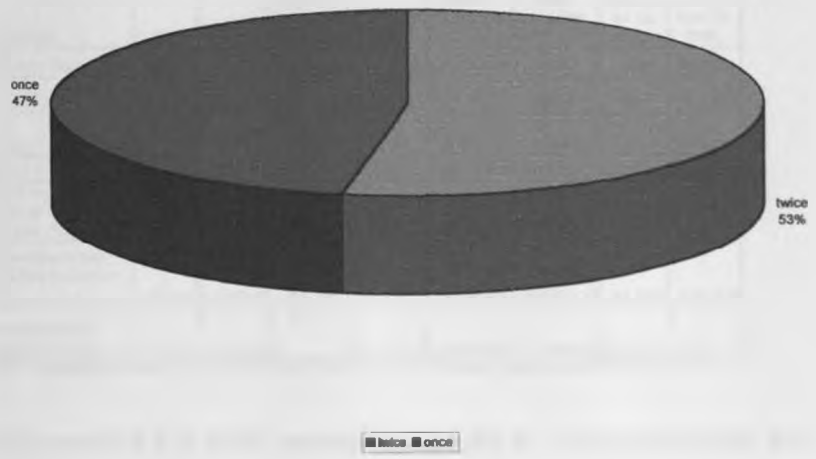
Frequency of commercial waste collection per week can be judged from **Figure 14.**

Figure 14: Frequency of commercial waste collection-weekly



Weekly domestic waste collection frequency in Westlands is demonstrated by **Figure 15**.

Figure 15: Frequency of domestic waste collection-weekly



However, some of the residents pointed out several flaws in collection of garbage. In this regard, problems are encountered when neighbours fail to pay for collection services or when they pile their garbage and especially so when there is delay in collection. Pets and scavengers are also known to create havoc and complicate the problem of MSW collection by dispersing the garbage at collection points.

The study revealed that the NCC expenditure on solid waste management has been declining while the city's population has been growing steadily in the last 23 years. This means that most of the solid waste in Nairobi is not collected (40.74%) at all. This explains the amounts of solid waste in the city estates and also within the city centre posing serious environmental and hygienic threat as explained in Tables 1.3, 1.4 & 1.5). SWM in terms of allocation of funds and population growth in the city were compared. The study revealed that NCC

expenditure was declining while the city population and waste generation have been growing steadily in the last 23 years. (See Table .6).

Table .6: Solid Waste generation in relation to Population increase of both Westlands suburb and Nairobi since 1979 to 2002.

Component	1979	1989	%per annum increase in the 1st decade	1999	%per annum increase in 2nd decade	2002 Projected population	%per annum in the 3rd decade	%Total increase from 79-2002
Westlands Population	22866	69411	12.06248	207418	19.810246	223420	10.2	1270.404
Nairobi Population	827775	1324670	6.00167	2143254	6.180762	2620020	6.0	286.6226
Westlands Households	6461	20877	27.31202	61262	20.062326	102624	22.00000	1786.722
Nairobi Households	200474	227102	[illegible]	640420	0.0022600	204314.1	7.06	281.2062
Total per day waste generation in Westland (Kg)	12250.7	40262.23	12.06248	140470.2	27.120060	607777.284	70.20	2662.162
Total per day waste generation in Nairobi (Kg)	420110	702260.4	6.00167	1643142.0	10.020462	2000076.22	61.1262	714.0024
Mean per person waste generation in Kg	0.62	0.62	1	0.72	2.4127021	1.644002	20.24222	166.6672

Source: Population Housing Census of 1979, [illegible] Kenya.

It shows that most of the solid waste in Nairobi is not collected at all. This explains the volume of solid waste in the city estates and also within the city centre. Despite the fact that about 70 private companies (small and large) including City council are collecting solid waste from the city, but still the whole waste is not collected. This is because the private companies collect waste from the affluent areas only and not from the whole of Nairobi City. The reason for this is that only the affluent people can afford the private services. To improve the MSWM, the NCC is actively considering to either privatise the whole MSWM or in partnership with them. They have already formulated a policy on Private Sector Involvement in Solid Waste Management (**See Appendix-I**). The City Council has also started a campaign of public awareness and involvement for making Nairobi environmentally clean and beautiful (**See Appendix-II**).

If the whole city garbage collection services are to be provided by the private companies, an annual amount of Ksh. 3542.4 million for Nairobi while Ksh. 455.9 million for Westlands is required which is beyond the

Council's present allocated budget of an amount of 258 million for the year (2001/02).

The following figures 16, 17, and 18 explain the integrated waste management plan, although the same may be difficult to implement for the developing countries because of huge financial involvement and costly technological requirements:

Figure 16: Integrated Waste Management

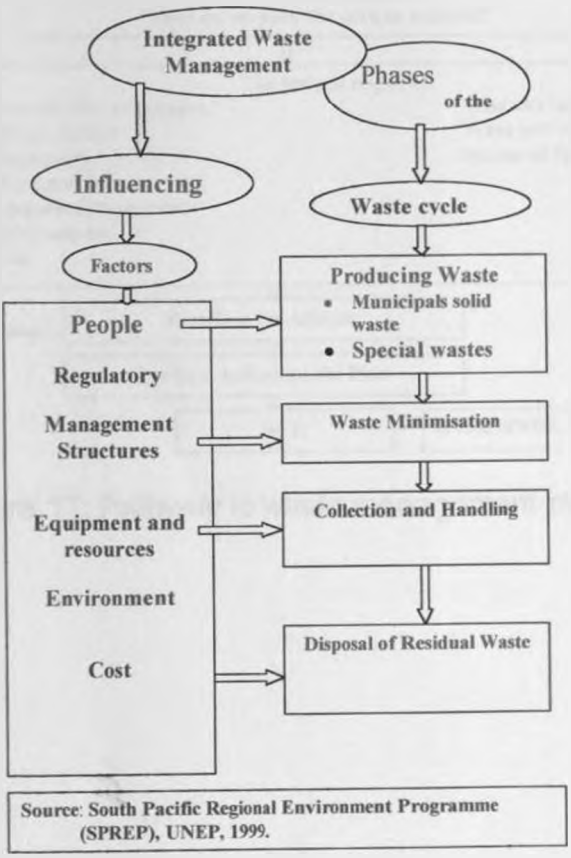


Figure 16: Integrated Waste management plan

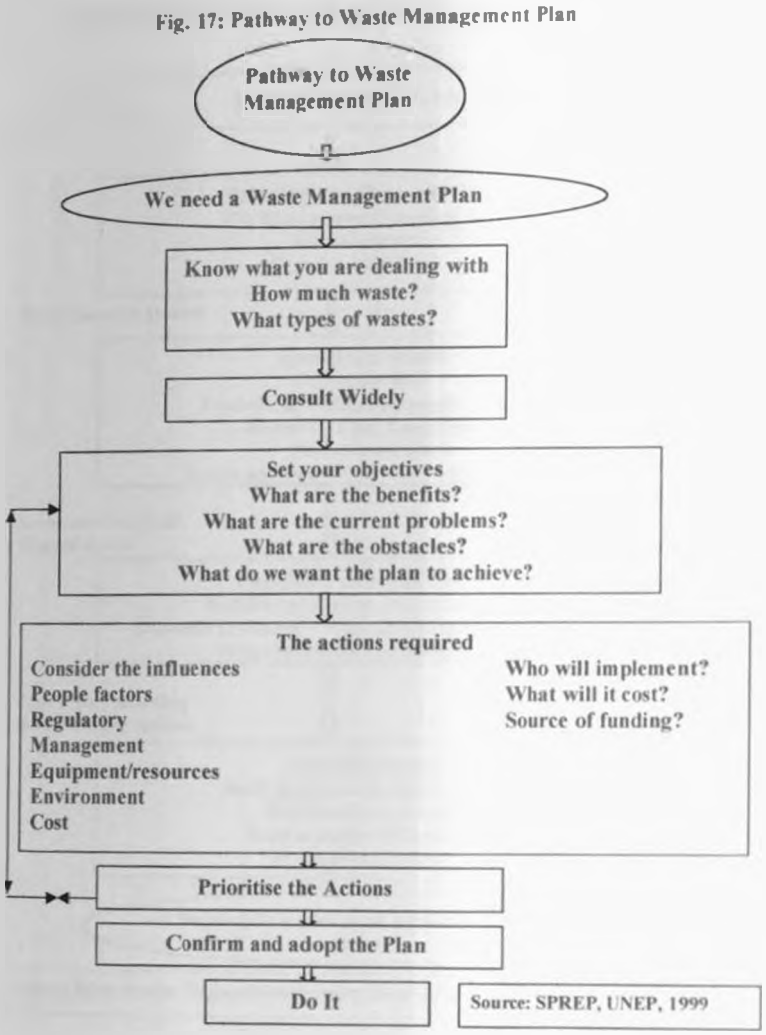


Figure 17: Pathway to waste management plan

Figure 18: The Waste Minimisation Audit Procedure

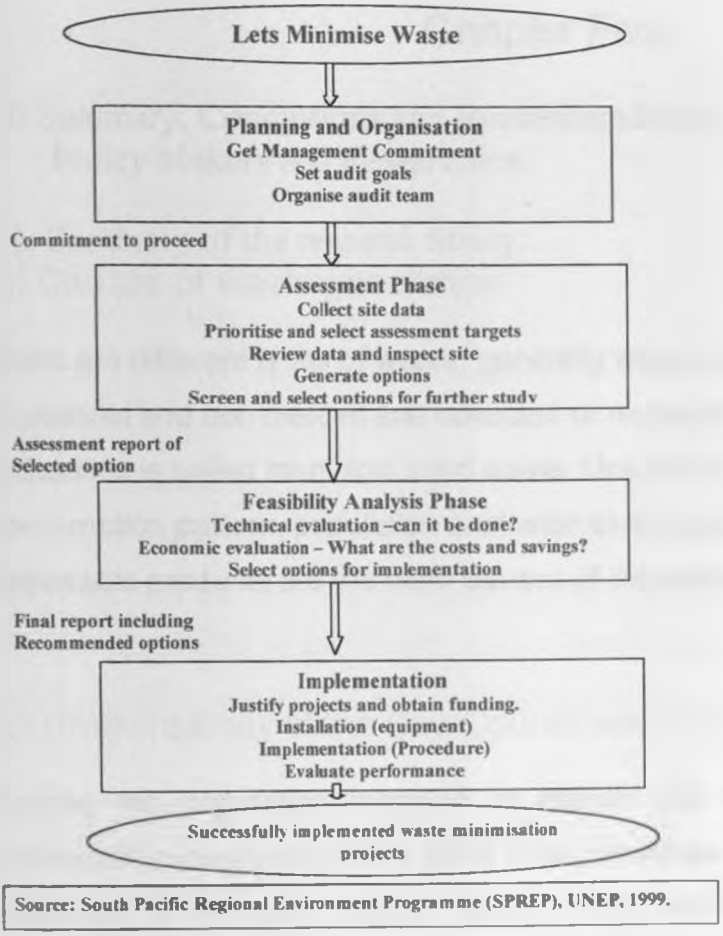


Figure 18: Waste minimisation Audit procedure

Chapter Five

5.0 Summary, Conclusions and Recommendations and Way forward for Policy Makers and Researchers

5.1. Summary of the research Study:

(a) Causes of waste generation:

There are different types of waste, generally waste consists of mainly household and commercial and collected or on behalf of the local authorities is called municipal solid waste. Unscrupulous production and consumption pattern, population explosion and excessive use of disposable products are the main causes of the waste generation.

(b) Responsibility of the City Council and its failure

Despite the population increase of Nairobi city and their exorbitant consumption producing about 3909 tones of waste per day, the meagre resources of the city council cannot cope with the pace of waste generation. Insufficient equipment is also contributing to the inefficiency of the council. The present council allocated budget for MSWM is Ksh: 258 million per annum, while the required budget is Ksh: 3542 million per annum. The shortfall of financial resources is 1773% and 1272% for Westlands and Nairobi respectively. Only an amount of Ksh: 365 million per annum is required for hiring truck to collect the waste. Owing to the paucity of financial resources and equipment, the Council is completely ineffective to manage the solid waste of the city.

C) Comparison of NCC and private Refuse Collection Companies:

There are 70 private companies operating in the city, mostly in the affluent areas. In some of the affluent areas the private companies collect almost form 95-100% waste, and the total share of the waste they collect only 30% in the city. Contrary to this, the Nairobi City Council collects only 25% of the total waste. The performance of the private refuse collection companies is better but they do not cover the whole of the city. The slums and the poor cannot afford private garbage collection services, ranging from Ksh: 150 to 600 per month. The Council has only 6 trucks for waste collection, while 3 of them are defective and only 3 are operating. For the effective collection of the total generated waste of the city, a fleet of 163 to 244 trucks is required. Moreover, the trucks of the Private companies are better than that of the council. **(See Photograph-13 & 14).**

The MSWM should either be privatised wholly or should be done in partnerships with NCC.

Photograph-13: Private Waste Collection Company's truck.

Photograph-14: The Nairobi City Council Waste Collection Truck.

(D) Impact of waste:

The impact of the waste on the environment, public health and economy is beyond imagination, if the waste could not be reduced at source, controlled at disposal and managed by recycling, reusing or retaking, it will destroy the social fabric and stature of the community by infinite diseases and environmental destruction. In term of economic loss it will jeopardize both human resource and natural resource base.

(E) Strategies to manage Municipal Solid Waste Management.

There are multifarious strategies for the management of solid waste but they are suitable in different circumstances to different countries. The developed countries can manage their waste by adopting Environmental Sound Technologies (EST), cleaner production and green packaging etc. On the other hand, these are difficult for the developing countries to adopt due to the lack of financial resources and technologies. However, the reduction of waste at source is, undoubtedly, the best option for waste management. Recycling, reusing and retaking are the secondary options for waste minimization. Using environmentally preferable material or recyclable products is equally important in the waste minimization strategies. Therefore, the poor and developing countries must either develop their capacity or devise indigenous technique and measures to manage their solid waste sustainably. As the waste is becoming a catastrophic for the poor and developing countries to manage, they must make strategy like awareness, preparedness for emergencies at local

level (APELL). Inviting foreign investors and donors for partnership is another option for effective Municipal Solid Waste Management.

5.2. Conclusion:

Excess of every thing is bad; therefore, nature works and interacts with all ecosystems in moderation and balance. There is no waste in the nature. The waste of one organism is the raw material of another. The cycle of nature is well balanced and durable. In the quest for short term financial gain, the human being without sensing the adverse impact of rapid economic gain through intensive industrialization, put such a heavy burden on the nature, which distorted its capacity to sustain or absorb it. Resultantly, the environment has been damaged, on which our very survival is dependent. Infinite Municipal Solid waste generation is also the result of the excessive human activities, such as rapid population growth, urbanization, urban slums (Kibara) poverty, unscrupulous economic activities, intensive industrialization, careless and unsustainable production and consumption pattern. In addition to the environmental destruction, MSW is also putting extra burden of expenditure on the financial budget of the concern authorities, and particularly of the urban areas. This burden is more gigantic on the developing and poor countries like Africa and South Asia, and Nairobi City is the glaring example of this. The pressure of MSWM is not limited to financial burden, but it also give birth to many other problems like disease, which either disabled the human resource of the area or adding salt to the injuries of the poor nation, where they require more money for health care. And destruction to the environment is beyond comprehension. The developed countries generating more solid waste because of their affluent production and consumption style, but they have the capability and capacity (financial and technological) to manage it properly. The developing countries like Kenya (Nairobi) are unable to control environmental destruction caused by the MSW generation. They need to build their capacity and develop

their capability to control the MSW or reduce it at source (CP). Therefore, the developing countries need to take the MSW at war footing, and devise such an affordable indigenous technique to turn the waste into a resource. They should be motivated through propagation that Solid Waste is not meant for dumpsite, but it can be utilized as a useful and lucrative resource. It needs governmental recognition and encouragement. The South Africa has the gold and Kenya has the waste, if efforts have been made, this waste can be turn into gold. And certainly, it will be a dawn of new era for Kenya and other developing countries, if they sustainably manage the waste as a resource. It will also open new avenues of productive and decent working for the community.

Urbanization will continue to play a major role in the economy, environment and people's lives. The challenge is to learn how to live with urbanization while using its benefits and guiding undesirable and negative impacts in manageable directions.

5.3. Recommendations for Policy Makers and Researchers

The immediate relocation of Nairobi major dumpsite of Dandora to the new proposed dumpsite of Ruai is required. The new proposed dumpsite should be professionally constructed and should be secured and accessible. To implement provision of Kariobangi Transfer Station on the way to the new proposed Ruai dumpsite for sorting recyclable waste, particularly by the indigenous technique, e.g., making Organic Pack, Briquettes, organic manure etc. The performance and efficiency of the NCC is required to be improved considerably in terms of MSWM and environmental protection. Privatisation of MSWM (wholly or in partnership with NCC) should be prioritised. The NCC should develop Financial and human resources along with professionally suitable equipment. The major slums should be either rehabilitated or upgraded. Secured dumpsites within the city should be provided by the NCC Dustbins to the public both in commercial

and residential areas should be provided particularly compartmentalized bin or different colour of bags (Green, Yellow, Red etc.) for different types of solid waste so that the people have the facility of sorting the waste at source.

Appreciation and recognition of indigenous knowledge and skill of recycling waste should be intensified. Motivating the people to treat the waste as a useful resource and turn it into an economic value and thereby manage it properly. Public awareness should be propagated by educating them to avoid waste burning which pollutes the atmosphere and is a destruction of a useful resource. EIA and ISO 14000 (Environmental Management System) should be enforced forcefully. Infrastructure of the Nairobi City, particularly, roads, sewage and sanitation, public health, and MSWM should be improved efficiently. The proposed Cleaner Production Revival Fund (CPRF) among the East African countries, i.e., Kenya, Tanzania and Uganda should be finalized for achieving sustainable development in the region. Cleaner production by adopting Environmental Sound Technologies should be encouraged and adopted as primary option for sustainable production while the recycling should be considered as secondary option.

Constant monitoring, review and updating of the production patterns and technologies should be in place. Environmental protection institutions should be strengthened and environmental protection laws and regulations must be enforced effectively.

5.4. Way Forward:

5.4.1. Integrated Waste Management

The treatment and disposal of waste has developed from its early beginnings of mere dumping to a sophisticated range of options including re-use, recycling, incineration with energy recovery, advanced landfill design and engineering, and a range of alternative technologies, including pyrolysis, gasification, composting and anaerobic digestion. The further development of the industry is towards integration of the various

options to produce and environmentally and economically sustainable waste management system.

Integrated waste management has been defined as the integration of waste streams, collection and treatment methods, environmental benefit, economic optimising and societal acceptability into a practical system for any region (Warmer Bulletin 49, 1996). Integrated waste management implies the use of a range of different treatment and disposal options, **including the indigenous ways and means mentioned in this research study**, i.e., waste reduction, re-use and recycling, landfill, incineration, and alternative options such as pyrolysis, gasification, composting and anaerobic digestion. However, integration also implies that no one option of treatment and disposal is better than another, and each option has a role to play, but that the overall waste management system chosen should be the best environmentally and economically sustainable one for a particular region.

Environmental sustainability means that the options, and the integration of those options, should produce a waste management system that reduces the overall environmental impacts of waste management, including energy consumption, pollution of land, air and water and loss of amenity (White et al 1995; Warmer Bulletin 49, 1996). Economic sustainability means that the overall costs of the waste management system should operate at a cost-level acceptable to all areas of the community, including householders, business, institutions and government (White et al 1995; Warmer Bulletin 49, 1996). In assessing the most environmentally and economically sustainable system, the local existing waste management infrastructure such as availability of landfill sites, existing incinerators, the types of waste to be managed, waste tonnages generated etc. should all be considered.

5.4.2. Main challenges in implementation of Sustainable production and consumption

- Raising awareness on the benefits of cleaner production, which is almost ignored by the various stakeholders. Effective tools such, as reporting, indicators, benchmarking and awards need to be promoted to increase transparency. Means and mechanisms for disseminating information on the benefits need to be explored and implemented; in particular to small and medium size enterprises.
- Building capacities for wide adoption of cleaner production, especially in developing countries.
- Engaging small and medium size enterprises in adopting sustainable production patterns.
- Integrating cleaner production and sustainable development into formal education systems and vocational training.
- Changing consumer behaviour and consumption patterns, including by stressing the positive health and other social aspects of sustainable consumption and production.
- Improving product design, which has decisive impacts on production and consumption patterns.
- Strengthening cooperation at national, regional and international levels for policy implementation and integration.
- Obtaining political commitment and financial means.
- Mainstreaming sustainable consumption and production by bring the issue of sustainable development, including sustainable consumption and production, to the highest level of governments, international organizations, the private sector and civil society to ensure proper decision making.

- Promoting stakeholder involvement and partnerships through active involvement of stakeholders in all relevant international fora, and partnerships at all levels.
- Disseminating information and practical tools, capacity building and education through harmonizing methodologies and tools by providing guidelines, manuals, databases etc; by developing and disseminating practical tools for decision-making, such as environmental management accounting and life-cycle analysis; by pursuing efforts to integrate the social dimension into accounting.
- Creation of cleaner production centres (CPC) with support from UNEP, UNIDO and donors.

For the effective management of solid waste, the developed countries have the capacity and capability to deal with it properly. Although they produce and consume more than the developing countries, yet they have technologies, e.g., Environmental Sound Technologies, recycling, cleaner production, proper scientifically constructed landfill, incinerators etc. The developing countries on the other hand despite their explosive population produce and consume lesser than the developed and affluent countries. But they don't have the capacity and capability (Technological and Financial) to properly manage their MSW. That is why either they need to develop their technological capability or financial resources to deal with MSW effectively. The best ways to reduce the waste at source by cleaner production, green packaging (biological degradable packaging) and recycling etc. However these options are too costly to be afforded by the developing countries like Kenya. The researcher has, therefore, strived to identify such an indigenous knowledge of the local people, which does not require much financial resources and expensive technologies (**See Photographs-15 & 16**).

Photograph 15: Researcher inspecting indigenously manufactured technology

Photograph 16: Researcher look on the organic pack used for plantation

To indigenously recycle the waste into organic manure, organic packing, briquettes etc., the waste of the whole city would be proved a useful resource, and instead of spending money on its collection and disposal, it would be sold for recycling to earn money. If that indigenous knowledge and technology has been adopted and the people have been motivated, the waste of the Nairobi City would be turn into a useful resource for its inhabitants. (See Table 7 and 8).

Table 7: Available funds of current financial year (2001/2002) for MSWM of NCC for private collection services

Area	Per Person per day			Per Resident per day			Total fund of the area per day			
	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection services	Expected earning by Waste Recycling	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	Net profit (Ksh)
Westlands	0.2	3.8	9.76	1	12	30.9	66687.19	1249215.7	3219307	1970093
Nairobi	0.27	3.83	9.76	1	12	30.9	706583	9705398	[illegible]	[illegible]
Source: Field research.										

It has been observed and experienced if the waste is sustainably managed as a resource, it can be turn into a profit instead of an environmental and public health hazard, on which money is spent for its collection and disposal; and land degraded by constructing landfill. It will produce profit as shown in these tables.

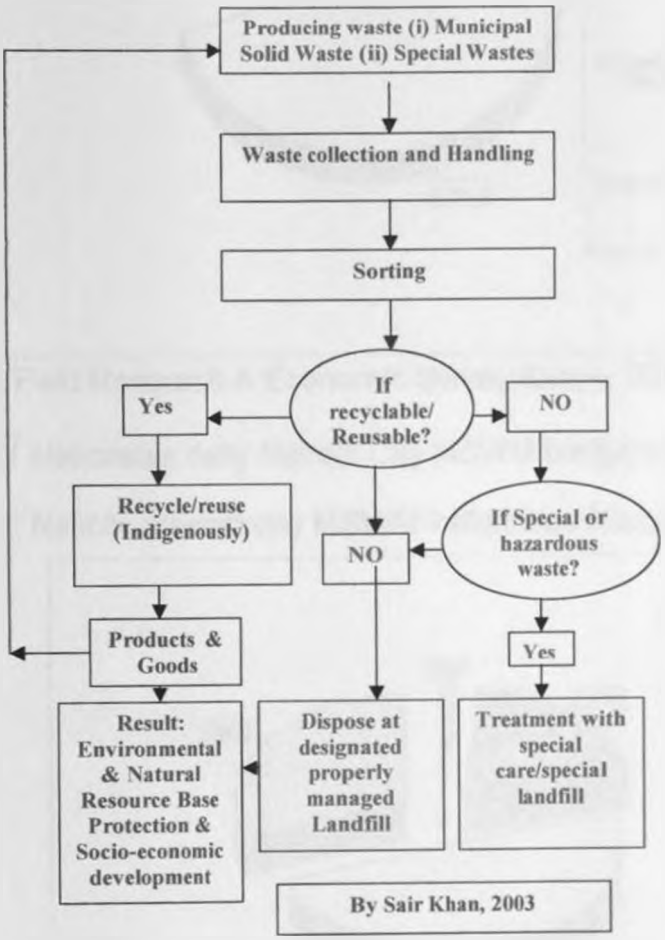
Table 8: Available/required funds and expected earnings(2001/2002) for MSWM of NCC

	Per Person annualy			Per Resident annualy			Total fund of the area annually			
Area	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	Available (Fund)	Required (Fund)	Expected earning by Recycling	Available (Fund)	Required (Fund)	Expected earning by Recycling	Net profit (Ksh)
Westlands	73	1387	3562.4	365	4380	11278.5	24340826	455963013	1175047055	719084042
Nairobi	98.5	1397.9	3562.4	365	4380	11278.5	258049000	3542467401	9048072965	5505605564
Source: Economic Survey Report, 2001/2002 published by Central Bureau of Statistics,(CBS) Kenya & field research										

To clarify further the concept of Solid Waste Resource Management, See Figure 19.

Figure 19: Conceptual framework of indigenous sustainable waste resource management by motivating the people to use waste as a resource

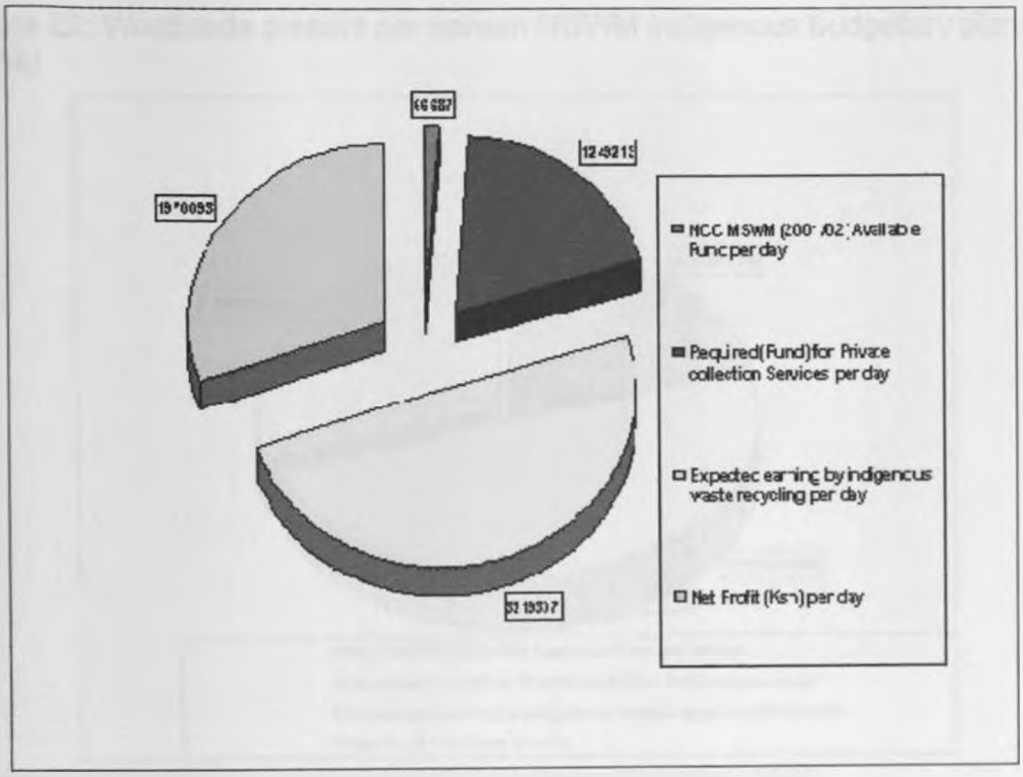
Figure-19: Conceptual Framework of Indigenous Sustainable Waste Resource Management by Motivating the people to use waste as resource



Source: Field Research, Observation and lesson learnt from expertise of the people practising Indigenous knowledge and practices of Sustainable MSW Resource Management in Nairobi.

Figure 20 demonstrates the daily Westlands MSWM budgetary plan.

Figure 20:Westlands per day MSWM indigenous budgetary plan (Kshs)



Source: Field Research & Economic Survey Kenya, 2002.

Figure 21 elaborates daily Nairobi City MSWM budgetary plan.

Figure 21: Nairobi present day MSWM indigenous budgetary plan (Kshs)

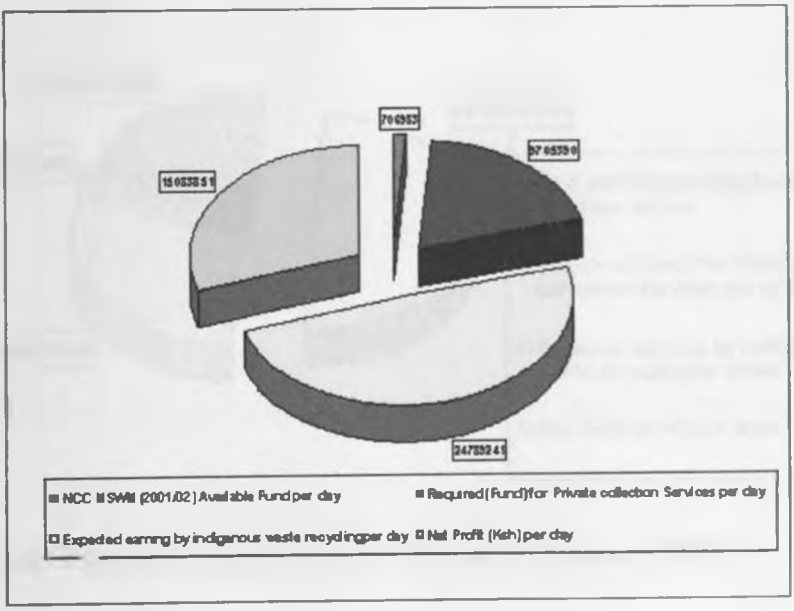
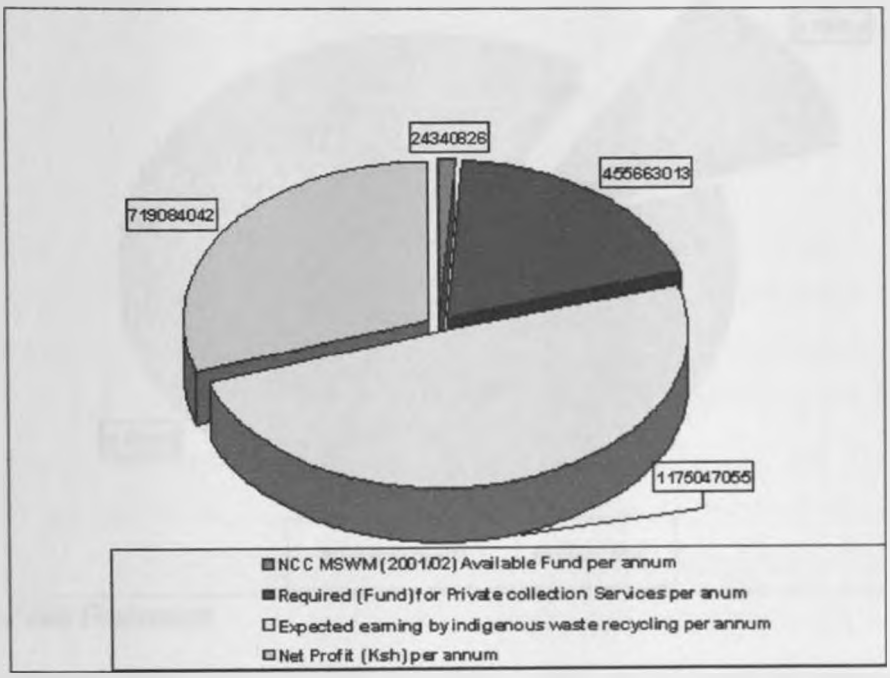


Figure 22 explains Westlands annual MSWM budgetary plan.

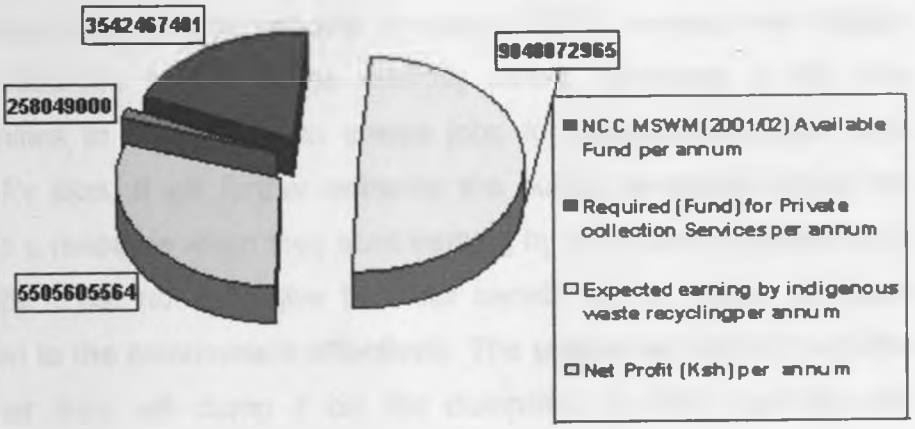
Figure 22: Westlands present per annum MSWM indigenous budgetary plan (Kshs)



Source: Field Research & Economic Survey of Kenya, 2002.

Figure 23 enumerates Nairobi annual MSWM budgetary plan.

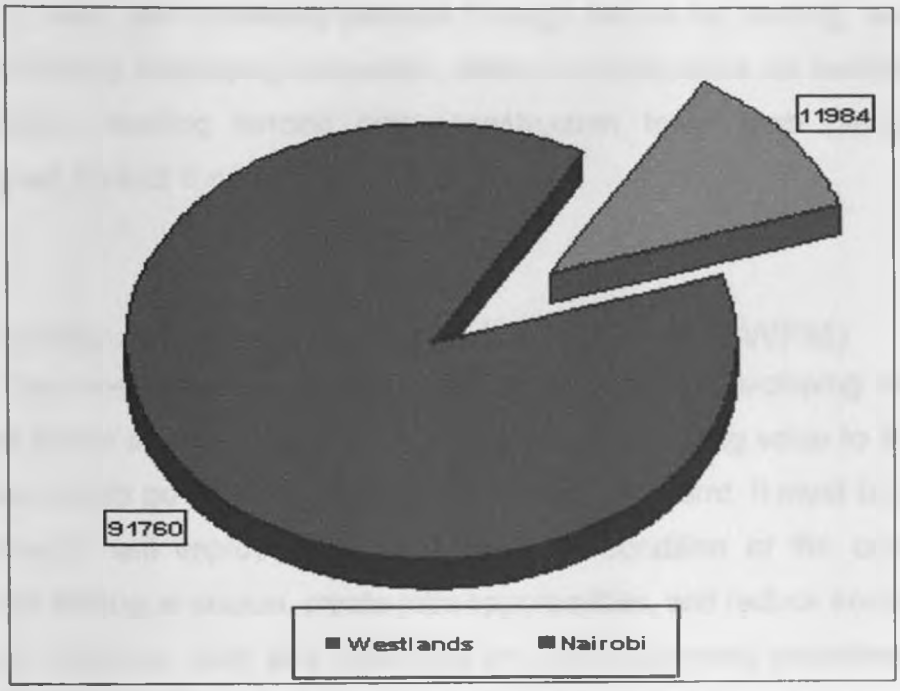
Figure 23: Nairobi present per annum MSWM indigenous budgetary plan



Source: Field Research and Economic Survey of Kenya, 2002.

Figure 24 demonstrates opportunities of jobs through SMSWRM.

Figure 24: Indigenous sustainable MSWRM and number of jobs to be created



Source: Field Research

If the above plan of indigenous sustainable waste resource management has been implemented through dissemination of information, imparting of technical indigenous knowledge, and motivation to earn livelihood from waste as a resource. It would ultimately create approximately jobs for 11984 persons on monthly salary of Ksh: 5000/- per person from Wastelands Waste resources and for about 91760 persons from Nairobi waste resources for the same monthly salary. Moreover, it will give opportunities to the people to create jobs for themselves rather than looking for jobs. It will further enhance the public perception about the waste as a resource when they start earning by its proper utilization, and resultantly it will not only give financial benefit to the people but also protection to the environment effectively. The people will neither burn the waste nor they will dump it on the dumpsite. As both burning and dumping of waste is destructive for the environment, dumping contaminate the soil by toxicant, ground water level, threatening public

health of the surroundings areas by spreading diseases and reducing the land by occupying it as a landfill. Burning on the other hand, pollute the air; soil by ash, and spreading toxicant through the air by burning, and most importantly destroying recourses, which could be used for benefit. For instance, making fencing pole, construction tower from plastic recycling will protect the trees, forests.

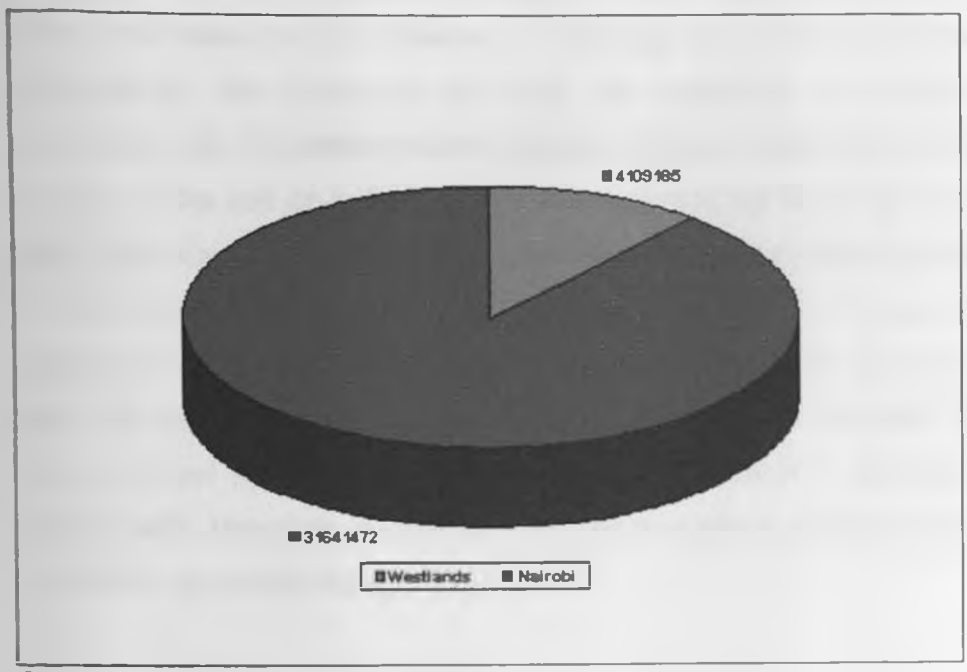
5.4.3. Sustainable Waste Resource Management (SWRM)

This is the most effective strategy and option for the developing and poor countries to use the waste as a resource by recycling adding value to it. Neither the waste should go to the dumpsites nor it should be burnt. It must be used as a resource. It will improve the socio-economic condition of the community; encourage sorting at source, create jobs opportunities, and reduce social crimes like street children, theft and robberies etc. And the most important aim of environmental protection will thus be achieved and the dream of sustainable development will be translated into reality.

5.4.4. Composting of Organic Waste

If the people of Nairobi are motivated to know how the waste can be utilized as resource, and they just compost the organic waste into organic manure of the city which is major portion of both domestic (83%) and commercial (64.8%) solid waste generated by the Westlands as well as by the Nairobi city. Westlands and Nairobi will generate an amount of Ksh: 4109185 (4.1 million) and 31641472 (31.6 million) per day respectively. The organic manure is sold at rate of Ksh: 15/- per Kg. **(See Figure.25 & Photograph-17).**

Figure 25: Per day earning by organic waste composting (Kshs)



Source: Field Research.

Composting is the most viable way for food security, waste reduction and environmental protection.

5.4.5. E.M. Effective Micro-organisms

EM is a new technology introduced by Japan (Dr. Teruo Higa, Inventor of EM Technology, University of Ryukyus, Okinawa, Japan as quoted in pamphlet published ACEF.). This technology is very useful for environmental management, e.g., composting, recycling solid waste, agriculture, recycling polluted water and animal husbandry.

EM is a combination of various beneficial, naturally occurring micro-organisms mostly used for or found in foods. It contains beneficial organisms from 3 main genera: phototropic bacteria, lactic acid bacteria and yeast. These effective micro-organisms secrete beneficial substances such as vitamins, organic acids, chelated minerals and

antioxidants when in contact with organic matter. They change soil micro flora and fauna so that disease – including soil becomes disease – suppressing, soil which in turn has the capability to develop into zymogene soil. The anti-oxidation effects of these micro-organisms pass directly to the soil or indirectly to plants maintaining their NPK and CN ratio. This process increases the humus content of the soil and is capable of sustaining high quality food production. Prof. Dr. Teruo (2002) developed effective micro-organisms over many years in liquid form. At first, EM was considered an alternative for agricultural chemicals. But its use has now spread to applications in environmental, industrial and health fields. However, it must be stressed that EM is neither a synthetic chemical nor a medicine.

5.4.6. EM for recycling solid waste (city waste, kitchen garbage)

Solid waste and kitchen garbage can be recycled into **fertilizer** with EM. The method is the same as that for EM Compost. Odour from the waste can be quickly removed. Generally, EM converts waste into harmless and useful products. Waste includes all kind from sewage waste to toxic waste. Normally, decomposition of waste takes several months; with **EM it takes only 4 to 6 weeks.**

5.4.7. Ecosystems; The Micro-organisms

Looking back at the developments made in the last century, one significant phenomenon: the thrust of increase in food production. Which was done successfully, by all means, but all the rest was ignored and forgotten and that became the root to all problems. (Burning of fossil fuels, mining and smelting of metalliferous ores, salinity, fertilizers and pesticides; poses a major environmental and human health problem.). The humans, in their endeavours to increase food production by all means, forgot and ignored the vital link in all ecosystems – the Micro-organisms.

5.4.8. EM technology is based on 5 principles of Kyusei Nature farming

a) It must produce safe and nutritious food to enhance human health.

b) It must be economically and spiritually beneficial to both producer and consumer.

c) It must be sustainable and easily practice.

d) It must be environmental friendly.

e) It must produce sufficient food of high quality for an expanding world population.

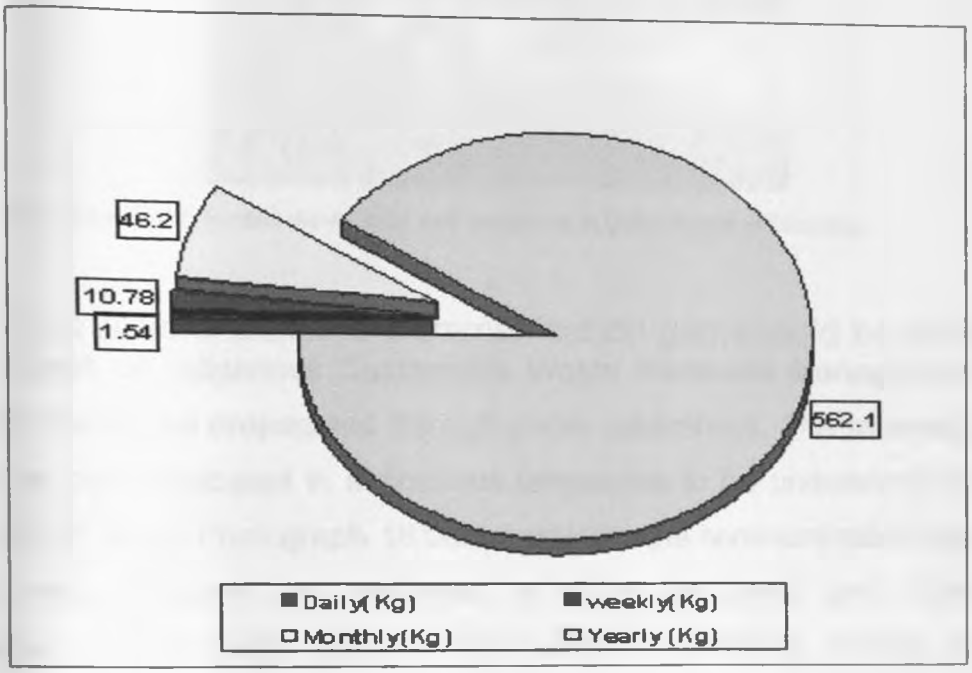
5.4.9. EM in environmental Management

- Suppresses bad odour from toilets, pit latrines, sewage systems, garbage dumpsites, etc.
- Inhibits proliferation of harmful vectors such as flies, mosquitoes and cockroaches.
- Unblocks sinks and sewage systems.
- Sterilizes the whole system (toilet bowls and sewage pipes)
- Suppresses harmful germs like E-coli that causes cholera and typhoid.
- It lowers BOD and COD to acceptable level within a short period of time.
- Treats water (drinking water and swimming pool)
- Cleans up the environment (oil spills and general waste spillage)

Photograph-17: Researcher inspecting City Garbage Recyclers' composting in Nairobi

Figure 26 explains the average per person daily, weekly, monthly and yearly, waste generation in Westlands, Nairobi.

Figure 26:Waste generation per person in Nairobi



5.4.10. Encouragement of sorting and indigenous technique of recycling:

It has been observed that there are about 500 individuals around Kijabe Street who do the business of buying of waste papers, waste plastic, etc for onwards selling to recycling industries. They should be encouraged to organize their business more effectively, the individuals/street boys should also be encouraged to earn their livelihood from sorting and on the other hand play an important role in the beautification and waste minimization of the city. **(See Photo-18)**

Photograph-18: Sorted waste sold and bought in Kijabe Street of Nairobi.

5.5. Public Awareness and Communication gap should be abridged.

The concept of indigenous Sustainable Waste Resource Management (SWRM) should be propagated through public awareness. The message should be communicated in indigenous languages to be understood by the public at large. Photograph 16 below explains the communication gap clearly, where people are expected to throw the used and clean recyclable plastic bags used in the Uchumi Shopping Centre of Westlands, while people throw all kind of waste in the same due to the lack of understanding and making them mix which cannot be recycled or reused because of making them mix with none recyclable waste. Some of the people even throw burning cigarettes in it. **(See Photograph-19)**

Photograph 19: A communication gap, the meaning of which most of the people do not understand very clearly

5.6. Comparison of products made of recycled material versus products made of virgin materials

Appendix-III demonstrates the fieldwork activities of the research study. It is important to analyse and assess production made of recycled material versus production made of virgin material in waste management. **(See Appendix-IV, V, VI, VII and VIII). Appendix-IX, X, XI, XII, XIII, XIV, XV and XVI demonstrate analysis of the research study.**

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Appendix-I

.0 POLICY ON PRIVATE SECTOR INVOLVEMENT IN SOLID WASTE MANAGEMENT

.1 Policy Statement

The Nairobi City council shall allow Private Sector involvement in the management of solid wastes within its areas of jurisdiction.

1.2 Policy Guidelines

The following policy guidelines shall apply:-

1.2.1 These policy guidelines shall be administered by the Town Clerk or on his behalf by the Director of Environment.

1.2.2 In case of any radioactive waste, the generation, handling and disposal shall be authorized and supervised by the Radiation authority in the Ministry of Health in liaison with Nairobi City Council.

1.2.3 In case of toxic waste, the necessary pre-treatment shall be done by the producer or by the licensed private collector before disposal into the designated disposal or transfer site.

1.2.4 For clinical and pathological waste, handling and transporting shall be done by specialized companies and disposal shall be by incineration, or by buying in designed and constructed undergrounds pits, approved by the Ministry of Health in liaison with N.C.C.

1.2.5 Disposal of waste shall only be done in designated disposal sites or as directed by the Town Clerk or on his behalf by the director of Environment.

1.2.6 All private operators in solid waste management shall be licensed in accordance with stipulated regulations.

1.2.7 All private operators shall appoint qualified operations Managers as approved by the Director of Environment.

1.2.8 The council shall be the overall supervising authority in handling, transporting and disposal of all generated waste within its area of jurisdiction.

1.2.9 All transfer stations and disposal sites shall be subjected to an Environment Impact Assessment in accordance with the Environment Management and co-ordination Act, 1999.

2.0 Licensing Policy and Regulations

All companies shall pay license fees to the council in accordance with their classification and category as advised by the Director of environment.

2.1 Categorization of wastes collectors.

2.1.1 Specialized Company – category "A"

Means any company specialized in clinical or toxic waste collection, transportation and disposal. Such company shall engage qualified staff and

appropriate equipment in the handling, transportation and disposal of the said waste. Such company shall also be qualified to handle other general wastes.

2.1.2 General Waste collectors – Category "B"

Means any company qualified to handle non-toxic, industrial commercial and domestic waste.

2.1.3 Small waste collectors – Category "C""

Means small scale solid waste collectors with small equipment like pick-ups, handcarts etc. These shall only qualify to collect and transport domestic and commercial waste. These categories of operators will only operate in **specified areas** as approved or directed by the Director of Environment.

2.1.4 All companies contracted by Nairobi city council to collect and transport solid waste for disposal shall be deemed to belong to category "A" for purposes of licensing.

2.1.5 Individual Refuse Generators

Means individual refuse generators who handle and transport their generated waste to designated disposal sites for disposal.

These include individuals, companies and institutions. The category of the license will be determined by the Director of environment based on quantity and classification of waste.

3.0 Regulations

3.1 The Private Waste Operator shall be legally registered.

3.2 The operator shall supply the city council with a copy of certificate of registration.

3.3 Toxic and hospital wastes shall be handled by specialized companies, which shall have qualified staff. The operator shall apply specific ways and means in collecting, handling, transporting, pre-treating and disposing of waste. Vehicles carrying such waste shall be distinctively marked "Hazardous Waste".

3.4 All waste transportation vehicles shall be suitably covered to avoid spilling on the street during collection and transportation.

3.5 The vehicles, equipment and other related machinery used by the operator shall be inspected and approved by the Director of Environment.

3.6 The operator shall keep a register indicating waste collected and areas covered including evidence of proper disposal of the same inspection by the director of Environment.

3.7 The vehicles and equipment used by the operator for the purpose hereof shall have an identification number allocated by the Director of Environment and the same shall be clearly and conspicuously inscribed on the body of the vehicle.

3.8 Containers and waste handling facilities used shall have the company logo clearly and boldly inscribed.

3.9 The driver shall have a clean driving license and the vehicle shall be licensed by the registrar of Motor vehicles.

3.10 The vehicles shall be maintained in a clean state at all time.

3.11 Staff engaged in solid waste management services shall have appropriate protective clothing while on duty.

3.12 The operators shall pay to the Council tipping charges based on the quantity and classification of waste.

3.13 The operator shall dispose of wastes at designated sites only or at points approved by the Director of Environment.

3.14 No waste shall be transported or disposed of between 6.00 p.m. and 6.00 a.m.

3.15 The operator shall ensure that no littering takes place during collection and transportation.

3.16 Any spillage not cleared or collected by the operator shall be cleared by the council at the operator's cost.

3.17 The operator's clients or members of the public shall have free access to the Director of environment in case of complaints about refuse operators. All waste operators shall be expected to respond promptly to complaints raised by their clients and / or members of the public.

3.18 The Director of Environment shall have the right to inspect the various contracts between operators and their clients.

3.19 All operations in solid waste management shall be carried out under the guidance of the director of environment.

3.20 Each operator shall sign an agreement to adhere to all requirements, specifications and standards as may be directed by the Director of Environment.

3.21 Each operator shall obtain a license or licenses and / or permit or permits as required by law and statutory regulations.

3.22 Violation of the above regulations may lead to prosecution or revocation of the operator's license permit.

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ANNEX 1: NCC GUIDELINES TO PRIVATE SECTOR INVOLVEMENT ON SOLID WASTE MANAGEMENT

1. PERSONNEL

Solid waste management managers shall posses the following qualifications or discipline:

- Environment/public health sciences
- Environment sciences/minimum diploma certificate
- Solid waste management – minimum certificate course

In addition they should have business administrative background. Companies must also engage a health work-force/staff.

2. VEHICLES/EQUIPMENT

Besides the manufacturer's standard specifications, the following specifications shall also apply:

- The vehicle/equipment shall be complete with all fittings and fully operational in every aspect with the requirements of the Traffic Act and any other law in order to run on public highways.
- The vehicle/equipment shall be complete with a set of standard tools and equipment required for all routine maintenance and operations.
- The container mounting carrying the waste shall be uniformly distributed along the whole vehicle chassis and securely separated from the driver's cabin and engine system. It must be of robust material.
- The exhaust system must be strategically positioned and directed.
- The internal coating of the container must with stand corrosion by use of appropriate non-toxic protective paints e.g. bituminous paints. Accessories including the body finish and workmanship are subject to the D.O.E's approval.
- The capacity recommended for the vehicle (tippers, flat-beds, side-loaders) should be 3 ton, 7 ton and 9-10 ton in order to standardize the weight units commensurate with the type of vehicle sizes available in the market. The tipping system of the vehicle shall be of hydraulic power taken off the vehicle engine.
- The vehicle body and cabin should bear a clear label of the company's name and logo.

3. CLOTHING

All the staff/personnel engaged in solid waste management shall put on appropriate protective clothing that includes, hand-gloves, over-coats, aprons, overall-head helmets, facemasks and gumboots.

4. COLLECTION FREQUENCY

Shall be:

(i) At least once a week in house holds
(ii) Once a day in markets and restaurants
(iii) Hospitals and industrial hazardous shall be collected depending on generation while commercial and industrial general waste depends on volumes.

5. CHARGES

(i) Household shall be charged between Kshs. 100/- to Kshs 600/- per month.
(ii) Charges for hospitals/clinics waste depend on their toxicity, pretreatment, disposal and persistence in the environment, while general industrial charges depend on the quantity, frequency of collection and transport.
(iii) Commercial waste shall be charged according to their volumes.
(iv) Restaurant waste charges shall conform to household charges and minimum of Kshs. 10/- for every 100L container or its equivalent collected.

6. CLEANSING

Shall be done in sanitary hygienic manner with no litter, refuse or garbage left about and must be to the satisfaction of the Director of Environment or the designated supervisor.

7. FINANCIAL QUALIFICATIONS

- No record bankruptcy
- Reputable balance sheet and record of the satisfaction of the relevant authority
- Value of business handled at any one time should not fall below Kshs. 500,000/-
- List of tools and equipment to be submitted
- City councils license
- Name of bankers
- PIN No.

- VAT registration number

ANNEX-II: AWARENESS FLYER ON SOLID WASTE MANAGEMENT

"keep Nairobi city Clean and Green"
"It is a duty to all of us: you and me"

City Council Tips	The Public
-Educate the public	- don't throw litter any-howly
-Provide waste receptacles	- clean up your neighborhood
-Collect, transport and disposal of water	- educate your next door neighbor care for the environment
-Involve the private sector	- abide by all environmental laws
-Enforce legislation of environment	- don't foul places
- Assist network and coordinate partnership	- pay your dues promptly
- Promote recycling and composting	-avoid excess packaging when shopping
- Beautify and landscape the city	- separate and reduce waste at source
	- practice composting

Nairobi City (you and me) generates, 1,110 Kg of waste every minute!

Source of separation of waste.

"Easy to do at home or premise"

- Waste generated should be separated at source of generation (where they come from)
- Place each type of waste (paper, plastic, metal, glass or food) in different receptacles, bags or containers.
- Clean and market the recyclable ones.
- Practice composting of food, organic and garden waste.

Appendix-II

The City Council has started initiative towards the environmental protection of the City.

7/4/2003

CITY COUNCIL OF NAIROBI

TOWARDS MAKING NAIROBI ENVIRONMENTALLY CLEAN AND BEAUTIFUL

Every body would wish to live in a beautiful and environmentally clean Nairobi City.

City Council of Nairobi is committed to this cause and its on going efforts are receiving commendations. More concerted effort however need to be done by all stakeholders in order to fulfill this dream in the earliest.

All well-wishers whether individually, corporate organizations, NGOs, UN Agencies are therefore invited to participate in the beautification programme.

Any innovative programmes involving but not limited to planting flowers, trees along the main roads, public open spaces, roundabouts, monuments, street furniture is hereby invited.

More equally important, property owners are requested to paint their buildings and repair the frontage pavements before 30th April 2003.

Industries especially those polluting the air and rivers are required to start initiatives that will reverse environmental degradation. Those who do not comply are liable to prosecution.

Interested stakeholders and those proud to be associated with a healthy clean city may contact: -

Mr. Mwangi Kuria,
Development Control,
City Hall Annex, 2nd Floor
Tel: 0722204666
Or 224282 Ex. 2765/2352
NAIROBI

J. M. MBUGUA
TOWN CLERK

Appendix-III

A Pictorial overview of the field activities of the study.

Photograph-: Researcher taking note of the sample from CBD of Westlands, Nairobi

Photograph-: Researcher discussing the open dumpsite with his supervisors and Operation Manager of Street Bins Ltd, operating in the CBD of Westlands.

Photograph: The Street Bins Co. collects the waste effectively but they dispose it off improperly.

Photograph: Researcher discussing with his supervisors the impact of improper waste disposal and its burning by the Roadside in Westlands.

Photograph: The Street Bins Co. collects the waste effectively but they dispose it off improperly.

Photograph: Researcher discussing with his supervisors the impact of improper waste disposal and its burning by the Roadside in Westlands.

Photograph: Improper disposal of the waste in open/illegal dumpsite of Westlands of Nairobi.

Photograph: Dandora dumpsite posing a serious health risk to the residents.

Photograph: Waste collection truck of a private company.

Photograph: Dandora dumpsite surrounding the residents- public health destruction, where standing for one minute is impossible.

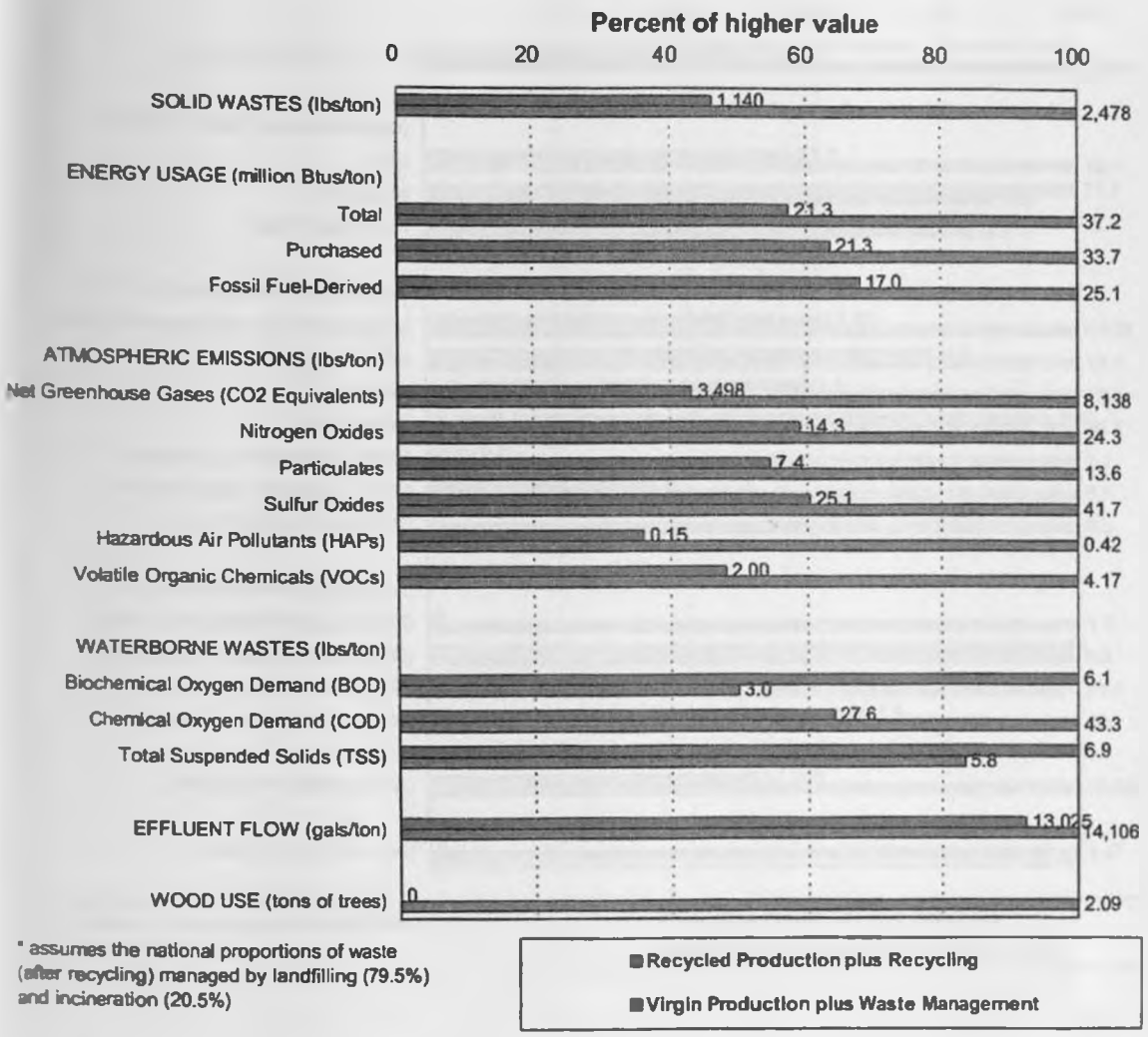
Photograph: Dandora dumpsite, a serious environmental destruction.

Photograph: Organic manure, made indigenously from Organic Waste by composting, which has been approved by the Kenya Standard of Bureau.

APPENDIX-IV

Newsprint

Average Energy Use and Environmental Releases for Managing Newsprint by Recycled Production + Recycling vs. Virgin Production + Waste Management (Landfilling and Incineration)*

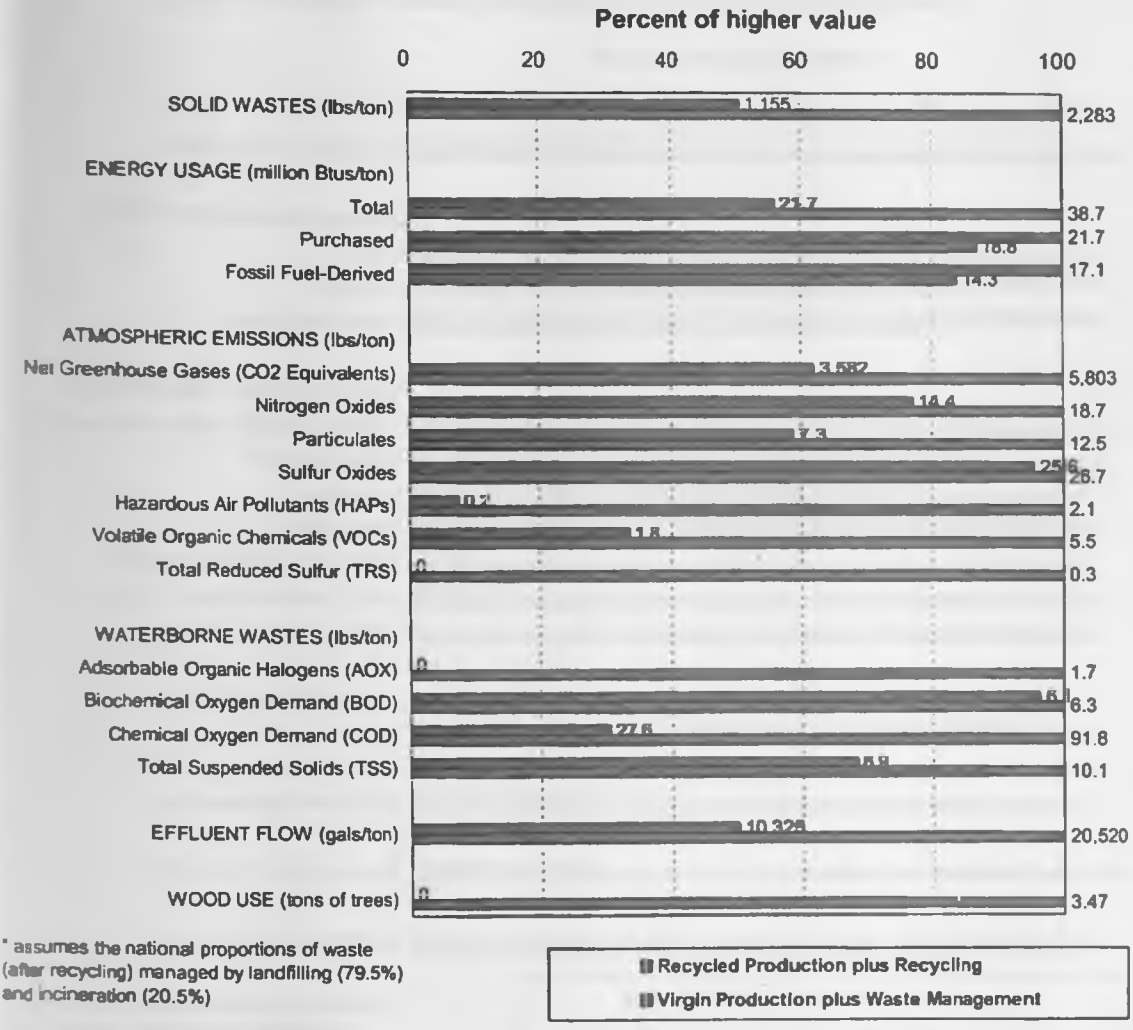


* assumes the national proportions of waste (after recycling) managed by landfilling (79.5%) and incineration (20.5%)

APPENDIX-V

Office Paper

Average Energy Use and Environmental Releases for Managing Office Paper
by Recycled Production + Recycling vs.
Virgin Production + Waste Management (Landfilling and Incineration)*

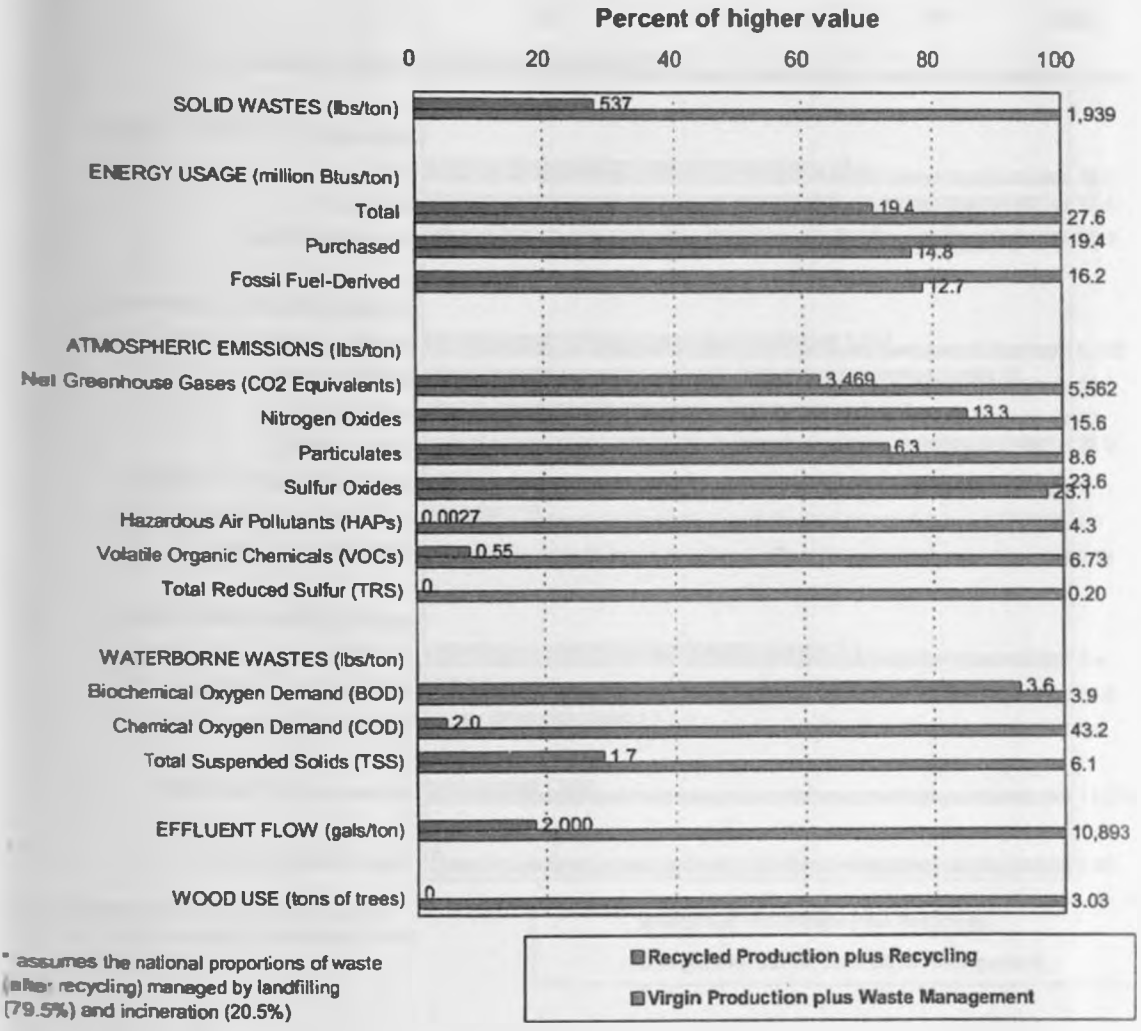


* assumes the national proportions of waste (after recycling) managed by landfilling (79.5%) and incineration (20.5%)

APPENDIX-VI

Corrugated

Average Energy Use and Environmental Releases for Managing Corrugated by Recycled Production + Recycling vs. Virgin Production + Waste Management (Landfilling and Incineration)*

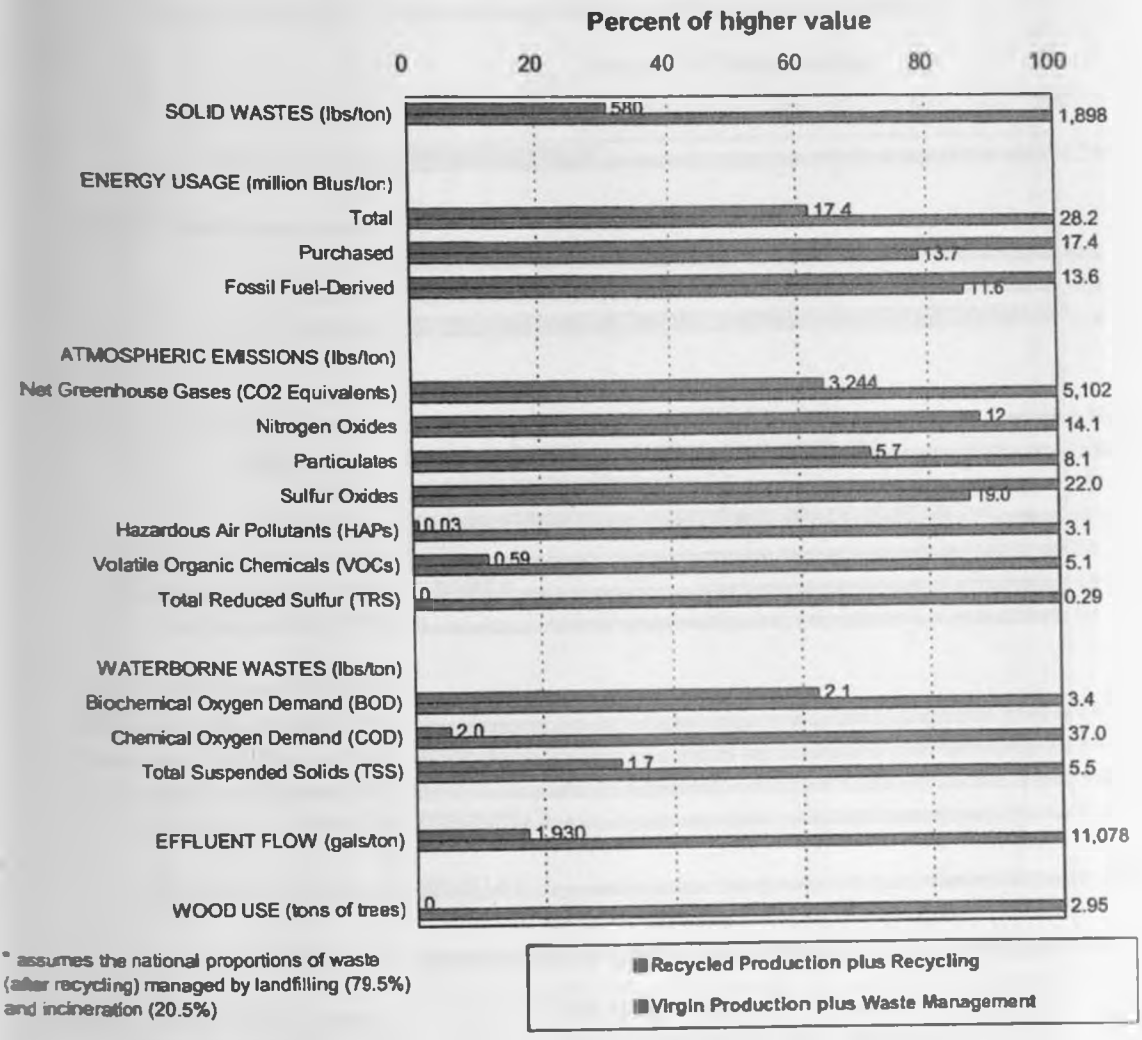


* assumes the national proportions of waste (after recycling) managed by landfilling (79.5%) and incineration (20.5%)

APPENDIX-VII

CUK Paperboard

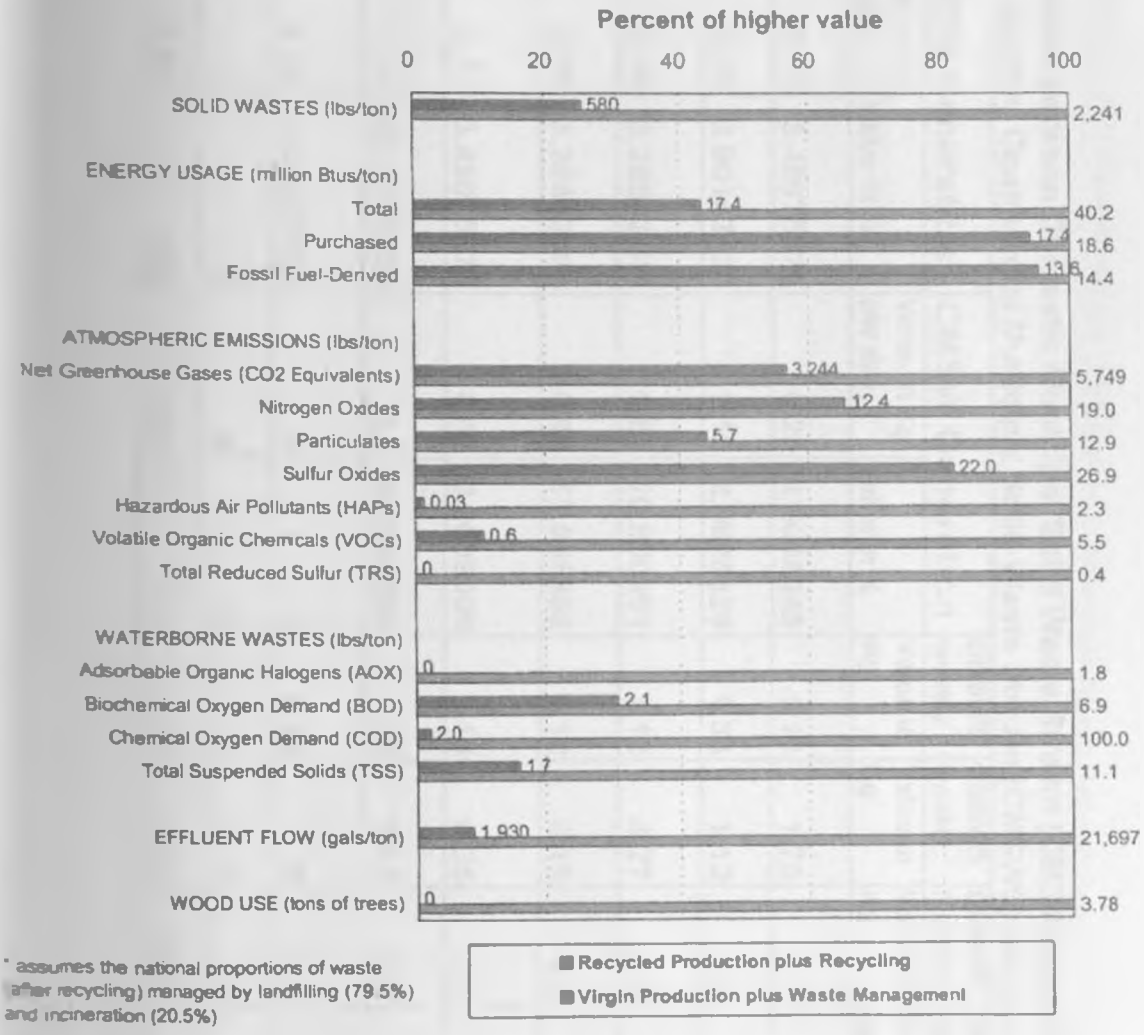
Average Energy Use and Environmental Releases for Managing Paperboard by Recycled Production + Recycling vs. Virgin Production + Waste Management (Landfilling and Incineration)*



* assumes the national proportions of waste (after recycling) managed by landfilling (79.5%) and incineration (20.5%)

APPENDIX-VIII

SBS Paperboard
Average Energy Use and Environmental Releases for Managing Paperboard
by Recycled Production + Recycling vs.
Virgin Production + Waste Management (Landfilling and Incineration)*



* assumes the national proportions of waste after recycling) managed by landfilling (79.5%) and incineration (20.5%)

Table 1: Comparison between Domestic Municipal Solid Waste Stream (DMSWS) per day per residential unit and Commercial Municipal Solid Waste Stream (CMSWS) per bin.

	DMSW Generation		CMSW Generation		DMSWS weekly	CMSWS weekly	DMSWS Monthly	CMSWS Monthly	DMSWS Yearly	CMSWS yearly
Component	Value in Kg Per day	Value in %	Value in Kg per day	Value in %	Value in Kg	Value in Kg	Value in Kg	Value in Kg	Value in Kg	Value in Kg
Metals	0.17	3.49075975	0.25	4.5045045	1.19	1.75	5.1	7.5	62.05	91.25
Glass/Ceramics	0.19	3.90143737	0.16	2.8828829	1.33	1.12	5.7	4.8	69.35	58.4
Vinyl/Plastic	0.16	3.28542094	0.61	10.990991	1.12	4.27	4.8	18.3	58.4	222.65
Paper	0.16	3.28542094	0.88	15.855856	1.12	6.16	4.8	26.4	58.4	321.2
Wood	0.17	3.49075975	0.05	0.9009009	1.19	0.35	5.1	1.5	62.05	18.25
Organic (Veg)	4	82.1355236	3.6	64.864865	28	25.2	120	108	1460	1314
Medical (Drugs)	0.02	0.41067762	0	0	0.14	0	0.6	0	7.3	0
Others	0	0	0	0	0	0	0	0	0	0
Total	4.87	100	5.55	100	34.09	38.85	146.1	166.5	1777.55	2025.75

Source: Field data.

Table 2 Expenditure on Public Health By Nairobi City Council, 1996/97 - 2001/02 (Ksh' 000)

	1996/97	1997/98	1998/99	1999/2000	2000/2001	2001/2002
Cleaning & Administration	32,610.00	36,700.00	39430	75734	83,166.00	57,810.10
Cleaning-General	134,998.00	139,514.00	139,714.00	163,344.00	164,196.00	139,137.00
Refuse Removal	50,248.00	25,124.00	28,744.00	70,112.00	74,304.00	60,955.00
Conservancy	318.00	322.00	322	494	496.00	147.60
Total	218,174.00	201,660.00	208,210.00	309,684.00	322,162.00	258,049.70

Source: Nairobi City Council (Provisional) and Economic Survey, 2001 and 2002 published by Central Bureau of Statistics, Kenya.

Table 3: Comparison between the allocated and required budget, % shortfall based on the research.(Amount in KSH)

Area		Daily	Monthly	yearly budget for (2001/02)	% shortfall per annum
Westlands	(Available Funds)	66687.19	2000615.8	24340826	
	(Required Funds)	1249213.7	37476412	455963012.5	1773.243794
Nairobi	(Available Funds)	706983	21209490	258049000	
	(Required Funds)	9705390.1	291161704	3542467401	1272.788657
Per Resident	(Available Funds)	0.644	19.32	235.06	
	(Required Funds)	12	360	4380	1763.354037
Westlands (P/P)	(Available Funds)	0.2	.6	73	
	(Required Funds)	3.8	114	1387	1800
Nairobi (P/P)	(Available Funds)	0.279	8.37	101.835	
	(Required Funds)	3.83	114.9	1397.9	1272.710758

Source: Economic Survey of Kenya,2002 published by CBS & Field Research.

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Source: Economic Survey of Kenya,2002 published by CBS & Field Research.

Table 4:Waste stream per day(type) generation , sorted, unsorted, % of sorted waste and total amount (Ksh) of sorted waste of Westlands and Nairobi per day.

Component	Total Waste Per Res. Per day in (Kg)	Total waste Per Person Per day in (Kg)	% Waste gen. Per Person Per day	Total Per day waste gen. in Nairobi in (Kg)	Sorted Per day waste in Nairobi (Kg)	Unsorted Per day waste in Nairobi (Kg)	Total Per day waste gen. in Westlands (Kg)	Sorted Per day waste in Westlands (Kg)	Unsort-ed Per day waste in Westlan ds (Kg)	Total % of Sorted waste	Total Per day amount (Ksh) of sorted waste in Nairobi	Total Per day amount (Ksh) of sorted waste In W lands
Metals	0.17	0.054	3.49076	136487.8	15000	121488	17725.28	1948.007	15777	10.99	52500	6818.024
Glass	0.19	0.0603	3.90144	152545.2	NIL	NIL	19810.61	NIL	NIL	NIL	NIL	NIL
Vinyl/Plastic	0.16	0.0508	3.28542	128459.1	40000	88459.1	16682.62	5194.685	11488	31.138	60000	7792.027
Paper	0.16	0.0508	3.28542	128459.1	100000	28459.1	16682.62	12986.71	3695.9	77.846	250000	32466.78
Wood	0.17	0.054	3.49076	136487.8	NIL	NIL	17725.28	NIL	NIL	NIL	NIL	NIL
Organic	4	1.2698	82.1355	3211479	11571	3199908	417065.5	1502.673	415563	0.3603	128565	1113.091
Medical	0.02	0.0063	0.41068	16057.39	NIL	NIL	2085.327	NIL	NIL	NIL	NIL	NIL
Othoers	0	0	0	0	0	0	0	0	0	0	0	0
Total	4.87	1.546	100	3909975	166571	3438314	507777.2	21632.08	446524	4.2627	536063	69616.92

* Source: Field research.

Table 5: Present areawise breakup of domestic waste generation (Per day) its ratio of collection and uncollection.

Area	Total waste generation per day in (Kg)	Sorted waste for recycling in (Kg) per day	% of sorted waste for recycling	Collected waste by Private Co. & NCC in (Kg) per day	% of collected waste by Private Co. & NCC Per day	Uncollected waste in (Kg) per day	% of Uncoll-ected waste
Westlands	507777.237	21632.076	4.26	486145.16	95.74	00(Nil)	00(Nil)
Nairobi	3909975.39	166570.9	4.26	2150486.46	55	1592918.03	40.74

Source: Field Research and NCC and Private Companies records.

Table 6: Analysis of Solid Waste generation in relaltion to Population increase of both Westalands suburb and Nairobi since 1979 to 2002.

Component	1979	1989	% per annum increase in the 1st decade	1999	% per annum increase in 2nd decade	2002 Projected population	% per annum in the 3rd decade	%Total increase from 79-2002.
Wastlands Population	23965	69411	18.96349	207610	19.910245	328439	19.3	1270.494
Nairobi Population	827775	1324570	6.00157	2143254	6.180753	2529039	5.9	205.5225
Westlands Households	5461	20377	27.31368	61258	20.062325	103526	22.99999	1795.733
Nairobi Households	200474	382863	9.097888	649426	6.9623599	804314.1	7.95	301.2062
Total per day waste generation in Wasteland (Kg)	13899.7	40258.38	18.96349	149479.2	27.129959	507777.204	79.89	3553.152
Total per day waste generation in Nairobi (Kg)	480110	768250.6	6.00157	1543142.9	10.086452	3909975.22	51.1258	714.3924
Mean per person waste generation in Kg	0.58	0.58	0	0.72	2.4137931	1.546032	38.24222	166.5572

Source: Population Housing Census of 1979,1989, 1999 published by Central Bureau of Statistics of Kenya.

Table 7: Available funds for the financial year (2001/2002) for MSWM of NCC; required fund for Private collection services based on field research; expected earning and net profit if waste is sustainably recycled by adopting indegenous knowledge/technique.(KSH)

Area	Per Person per day			Per Resident per day			Total fund of the area per day			
	NCC MSWM (2001/02)Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection services	Expected earning by Waste Recycling	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	Net profit (Ksh)
Westlands	0.2	3.8	9.76	1	12	30.9	66687.19	1249213.7	3219307	1970093
Nairobi	0.27	3.83	9.76	1	12	30.9	706983	9705390	24789241	15083851

Source: Field rsearch.

Table 8: Available funds for the financial year (2001/2002) for MSWM of NCC; required annual fund for Private collection services based on field research; expected annual earning and net profit if waste is sustainable recycled by adopting indegenous knowledge/technique.(KSH).

	Per Person annualy			Per Resident annualy			Total fund of the area annually			
Area	NCC MSWM (2001/02) Available (Fund)	Required (Fund) for Private collection Services	Expected earning by Waste Recycling	Available (Fund)	Required (Fund)	Expected earning by Recycling	Available (Fund)	Required (Fund)	Expected earning by Recycling	Net profit (Ksh)
Westlands	73	1387	3562.4	365	4380	11278.5	24340826	455963012.5	1175047055	719084042
Nairobi	98.5	1397.9	3562.4	365	4380	11278.5	258049000	3542467401	9048072965	5505605564

Source: Economic Survey Report, 2001/2002 published by Central Bureau of Statistics,(CBS) Kenya & field research.