

**AN APPRAISAL OF SOLID WASTE MANAGEMENT IN
SMALL TOWNS IN KENYA: A CASE STUDY OF
OTHAYA TOWN, NYERI DISTRICT //**

BY

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**A thesis submitted in partial fulfillment for the degree
of Master of Environmental Studies in the Department
of Environmental Science, Kenyatta University.**

August, 1998

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*An Appraisal of solid
waste management in*



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DECLARATION

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

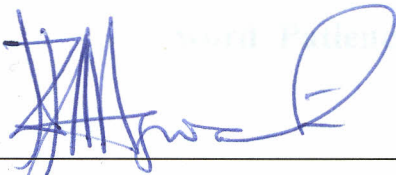


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DEDICATION

**This work is dedicated to my Parents, Brothers
and Sister for I believe they fully understand
and appreciate the real meaning of the
word Patience.**

ACKNOWLEDGEMENTS

This work would not have been successful without the guidance, support and co-operation of a number of people. It is my great pleasure to express my sincere thanks and gratitude to them.

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*Underdeveloped
writing*

To all my friends such as Kiarie, T., Medrine, W., E. Nyoike, Muthoni E., and Abishai J. of Loreto Limuru, I am really thankful for the time you spared, more so when times were hard. It was wonderful having you around. Space does not allow me to mention all persons but I remain truly grateful to all for their esteemed contribution.

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LIST OF ABBREVIATIONS

G.K	Government of Kenya
M.L.G	Ministry of Local Government
G.T.Z	German Technical Cooperation
U.N	United Nations
W.H.O	World Health Organization
U.N.E.P	United Nations Environment Programme
F.A.O	Food and Agriculture Organization
L.A.D.P	Local Authority Development Plan
W.M	Wastes management
C.B.D	Central Business District
S.T.D.P	Small Towns Development Project
C.B.S	Central Bureau of Statistics
W.Q.I	Water Quality International
U.O.N	University of Nairobi

ABSTRACT

The purpose of the study was to investigate the management of solid waste in Othaya town, Nyeri District. The study focused on the nature and quantities of wastes, the existing management capability, pollution and community participation in waste management in the town. It was based on the existing solid waste management system and how the system can be improved for effective waste management in the town.

A multiplist methodology was used as the research strategy and the one specifically chosen for this study was a modified Participatory Rapid Appraisal (PRA). The technique was chosen as it produces similar or comparable results as other methods. Analysis of data was done using descriptive statistics, which included calculation of means, ranges and percentages. Correlation coefficients were also calculated to show relationship between various waste management variables.

The findings show a picture of a town in transition in relation to provision of waste management services. The Council, however, has made a good attempt, but the situation is still wanting with most affected areas being the collection, disposal of wastes and community participation.

Conclusions of this study call for re- examination of the current waste management system to make it more effective. It is recommended that the entire waste management system be re-organized particularly with regard to waste storage and collection. The Council should also indicate clearly the role of the community in waste management.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

In recent years the subject of environmental degradation has attracted attention as a result of the increasing amounts of wastes emanating from domestic, industrial, agricultural and other sources. The problems arising from waste management are increasingly becoming critical and difficult to solve due to rising human population and urbanization.

A United Nations statistical report on human settlement in 1980 showed the total cities of both the developing and developed world with more than four million inhabitants to be 22 and 16 respectively and, projected that the urban population could double by the turn of the century. This growth is taking place against a background of low income and has out-stripped the national capability of most countries to provide accommodation and basic services like health, sanitation, transport and water to the people. In most urban areas in the developing countries for instance, people lack safe water and waste disposal facilities especially in the squatter settlements.

Developing countries have tended to look to the developed countries for a lead in developing and adapting pollution control and waste management technologies. These technologies are not suitable in most cases due to differences in climates, nature of waste streams, and the pattern of urban settlements and prevailing wage rates.

Most developing countries, for example, lie in the equatorial regions where temperatures are often intense and as a result, municipal wastes tend to be wetter and petrify faster than those generated in the developed countries. It is therefore not surprising that attempts to transfer waste management technologies to developing countries have failed due to the nature of the waste streams in these countries.

In solid waste management, there exist various operations, which are inter-dependent. Disposal methods for example, influence collection methods while collection methods exert strong influence on disposal practices. To minimize the cost of solid waste collection and disposal, these interdependencies should be considered as ignoring them makes the cost of waste collection and disposal prohibitive. When properly done, solid waste management planning requires an assessment of many complex interactions such as transport systems, land use patterns, urban growth and development and public health considerations.

1.2 Statement of the problem

The problem of waste increases with density of human agglomeration and its welfare (that is, income levels, product availability and economy). In this context small towns are of specific importance since on one hand they show a rapid growth caused by high natural growth rates and migration from the rural areas and on the other they are not as far developed as bigger towns in terms of services provision. Concerning waste evacuation, equipment and infrastructure the situation is wanting and in most cases they

cannot cope with demand caused by rapid population increase and per head generation of solid wastes. Though much progress has been made in this field only a minority of local communities are using the proper administrative and technical approaches that have with time proved most satisfactory.

The focus of this study was to critically evaluate and examine solid waste management in Othaya town. The purpose was to establish the causes of the numerous problems in the waste management processes with special regard to facilities, disposal options, administrative structure and the role of community participation in waste management in the town.

1.3 Basic research questions

The following questions were used to guide the study.

- a) What is the nature and quantity of wastes produced from the commercial and the domestic sectors in the town?
- b) How is solid waste managed in Othaya town ?
- c) What observable environmental impacts do poorly managed wastes in the town pose?
- d) To what extent has the community been involved in solid waste management in Othaya town?

1.4 Research objectives

The main aim of the study was to appraise solid waste management in Othaya town and analyse the major issues associated with the numerous processes in waste management in the town. The specific objectives that guided the study were to:

- a) examine the nature and determine the quantities of solid waste produced from the domestic and commercial sectors in the town,
- b) examine the existing methods of managing solid wastes in the town,
- c) identify pollution problems posed by uncollected and poorly managed wastes, and
- d) assess and suggest the scope for community participation for more efficient and cost effective waste management in the town.

1.5 Basic research assumptions

The research was done based on the assumptions that:

- a) different waste types and amounts are generated in the town and the management process is entirely the responsibility of Othaya municipal council,
- b) various methods are used to manage wastes in the town,
- c) solid wastes in the town pose various identifiable pollution problems; and
- d) the community has not fully been incorporated in solid waste management in the town.

1.6 Research scope and limitations

Geographically the study was limited to the area directly under the jurisdiction of Othaya Municipal council. The limitations of the study included the fact that:

- a) the research was confined to one local town meaning that the results of the study would be applicable to that town only, and
- b) only the household and commercial solid wastes were considered.

1.7 Justification of the study

Councils of various small towns in Kenya such as Othaya have developed Local Authority Development Plans (L.A.D.P), which stipulate the needs of these towns as a matter of priority. The problem of solid waste management comes out as one area that requires immediate attention.

The Othaya town council is faced with solid waste management problems and has undertaken an improvement programme targeting collection, safe disposal and management issues connected with disposal services. Although the Town Council has made good progress in solid waste management, waste is collected from only a small area of the town and even for this not all waste is collected. The wastes are also deposited only about 400 metres from the town centre. The local community has also not been fully involved in the processes of waste management in the town.

1.8 Significance of the study

It is hoped that the results from the study form a base for decision-makers in formulating strategies towards improving waste management in the town. The findings of the study also form a basis for evaluating whether some of the waste should be re-used or recycled.

The local authority administration should identify how community members in their municipality could participate in waste management. The research is also important, as it will assist the authority to evaluate the trends in the town's growth and the impact of this growth on solid waste management services.

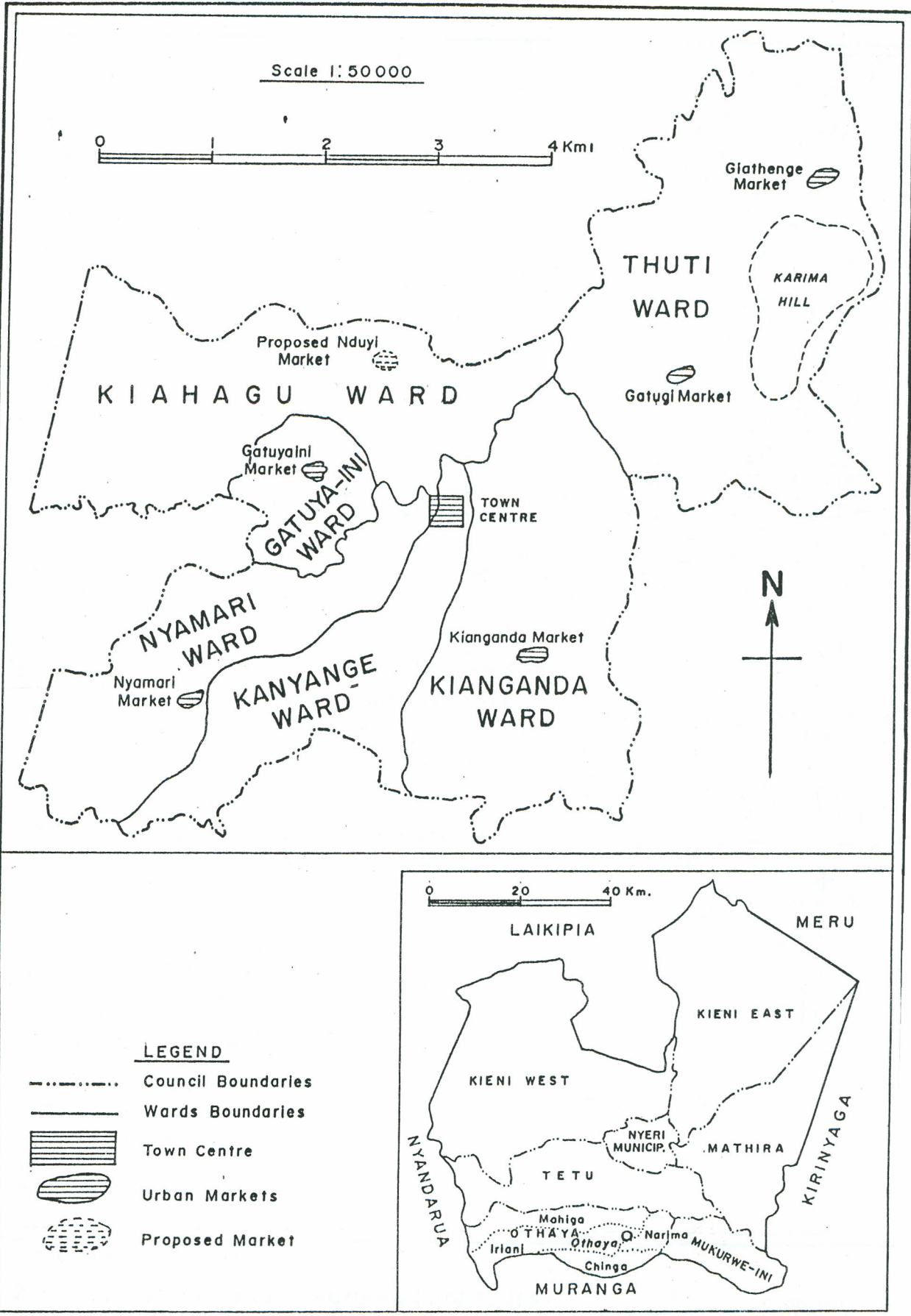
1.9 The study area

1.9.1 Location and climate

The study area is Othaya town, situated approximately 15 km from Nyeri town. It lies on an altitude of approximately 1677 metres above sea level and has a jurisdiction of about 28 km² (Fig.1). The rainfall regime is bimodal with the long rains occurring from March to May and short rains from October to December. The area experiences both warm and cold temperatures with July being the coldest month when temperatures go below 18⁰c (GOK, 1989). Most of the area is generally hilly and dominated by a series of ridges and valleys (Fig. 2). Where there are plains especially near the stadium, they are usually small.

1.9.2 Geology, soils and land use patterns

In general the present landscape in Nyeri District originates from repeated faulting and lava outpouring dating as far back as the early tertiary period 25 million years ago.



Source: Othaya Town LADP, 1994

Figure 1 Location of Othaya Town



KEY

-  Contours
-  River
-  Built-up Areas

Scale 1:2500

Source: Othaya Town LADP, 1994

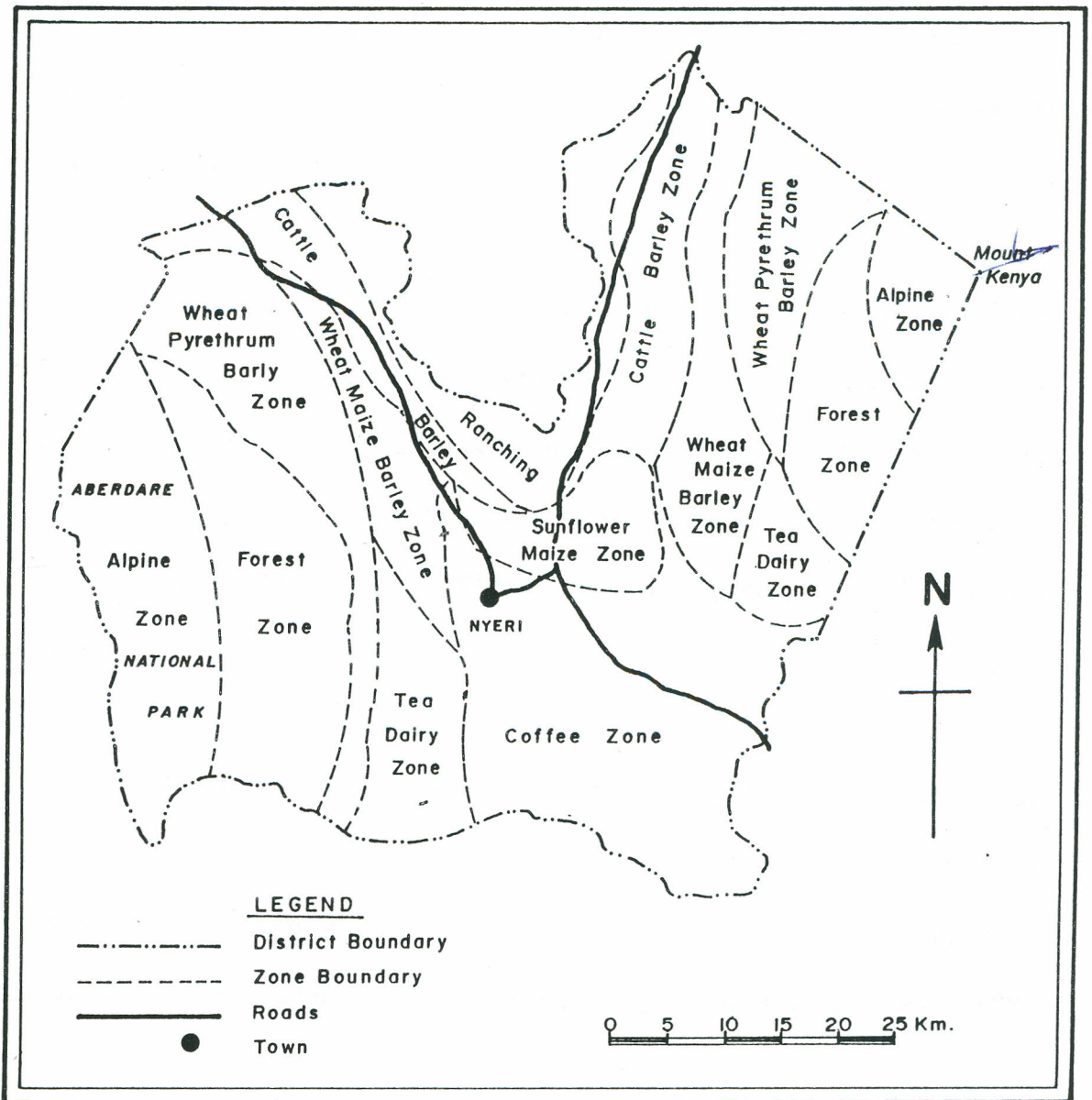
Figure 2 Othaya Town Relief Features (contours)

Today most of Nyeri district is covered with tertiary volcanic rocks stretching from east to west. The northeastern parts of the district are covered with volcanic Kenyte and Kenyte agglomerates (**GTZ/GOK, 1993**).

Soils and landuse patterns are thus in close proximity to the district ecological zones or vice versa and this has direct effect on the district's production potentials. Othaya falls in the lower highland zone that borders the forest zone. Soils in this zone are well drained, deep, friable and quite fertile. The fertile soils facilitate a number of agricultural activities with tea and coffee being the dominant cash crops. Dairy farming is also practiced with great emphasis on zero grazing (Fig. 3).

High population density in the division has a definite effect in land holding and usage. This is reflected clearly in the land divisions where the average size of a holding is 1.5 hectares and is still falling due to population increase. Thus the only feasible method of increasing crop production is through intensified agriculture in order to increase yield per unit area.

Other crops grown especially for subsistence purposes are maize and beans during long rains while vegetable and fruits take first priority in the short rains. The land utilization follows rain amounts and duration and other environmental factors that favour the particular type of crop grown in each season (**GOK, 1989**).



Source: Farm Management Handbook of Kenya, by Jaetzold R. and Schmidt H., 1982

Figure 3 Nyeri District Agro-Ecological Zones

1.9.3 Population

Othaya is the third largest town in Nyeri District and has the trade pattern characteristic of a small-scale business center with approximately 18,000 people in its catchment area. These people are mainly engaged in tea, coffee, livestock and food crop farming. The town has approximately 1,500 households and 16,000 market attendants and about 390 business premises (GTZ/GOK, 1993).

Like other small towns in Kenya, Othaya town has been steadily growing at a fairly steady rate. According to the 1989 population census, the population of the town grew by approximately 14,687 persons, an increase of 4,114 people from the 1979 census estimates of 10,537 persons. This indicate an approximate 39 percent population increase in a span of 10 years between 1979 - 1989 or an annual average growth rate of 3.9 percent (GOK, 1989).

This growth resulted from both natural increase and from migration of people from rural areas seeking employment and other economic activities in the town. Since the town is an important urban center within the division, it will continue to have an increased population. Table 1 shows the population increase during the plan period of 1994 - 1998.

Table 1: Estimated population growth in Othaya

Year	Number of inhabitants
1979	10,573
1989	14,687
1993	17,184
1998	20,294

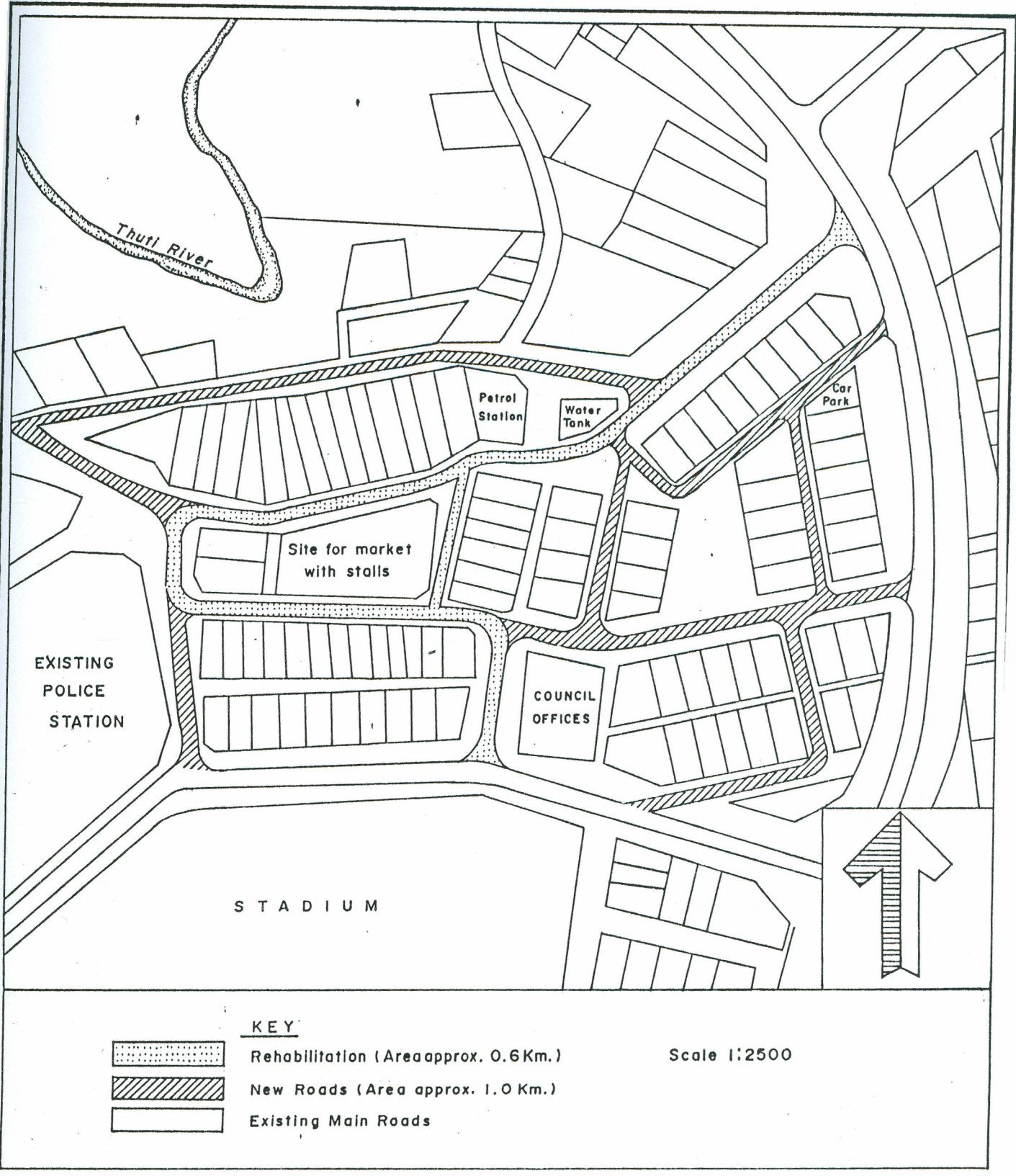
Source: GTZ/GOK, 1993.

1.9.4 Commercial activities

The town is a busy regional commercial centre. There are many wholesale and retail shops which supply farming implements, seeds and chemicals as well as common consumer goods. There is also a lively agricultural open-air market that runs everyday.

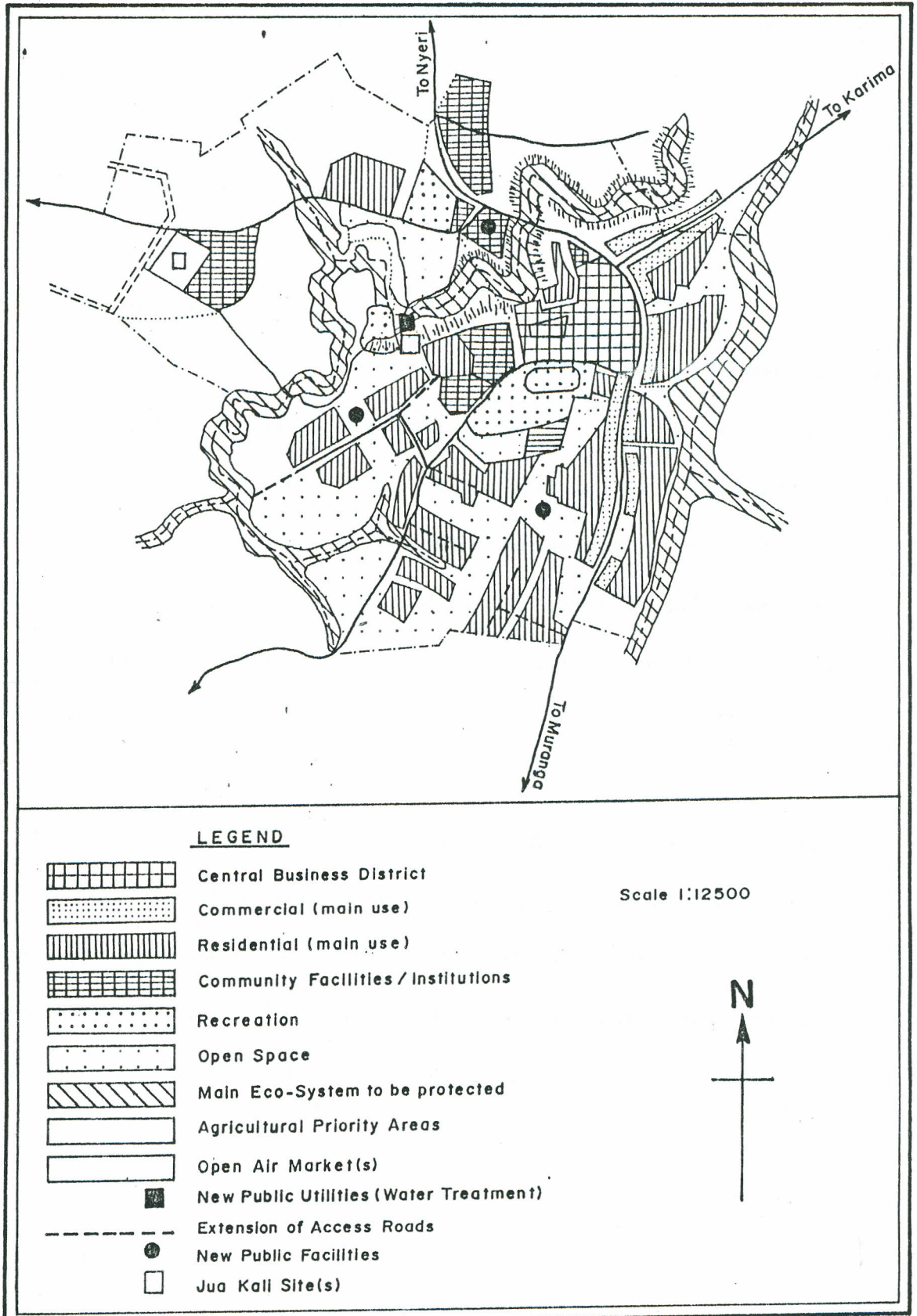
The service sector in the town also thrives with many hotels, bars and restaurants catering for town residents and the surrounding community. In banking and finance, the town is well served by major Kenyan banks such as Barclays and Kenya Commercial Bank. Despite having a high potential hinterland there is little agricultural processing that takes place in the town. There are no major industries but numerous small-scale industries such as timber, sawmills and furniture production.

On the informal sector the town has quite a number of *jua kali* workers and hawkers. Others include motor vehicle mechanics, cycle repairs, carpenters and metalworkers. Hawking business including selling of second hand clothes (*mitumba*), and shoes operate at the peripheries of the stadium. Figures 4 and 5 show the towns spatial plan and settlement



Source: Adapted from Othaya Town LADP, 1994

Figure 4 Othaya Town, Plots and Roads Layout



Source: Othaya Town LADP, 1994

Figure 5 Othaya Town outline Spatial Plan and Settlement Structure

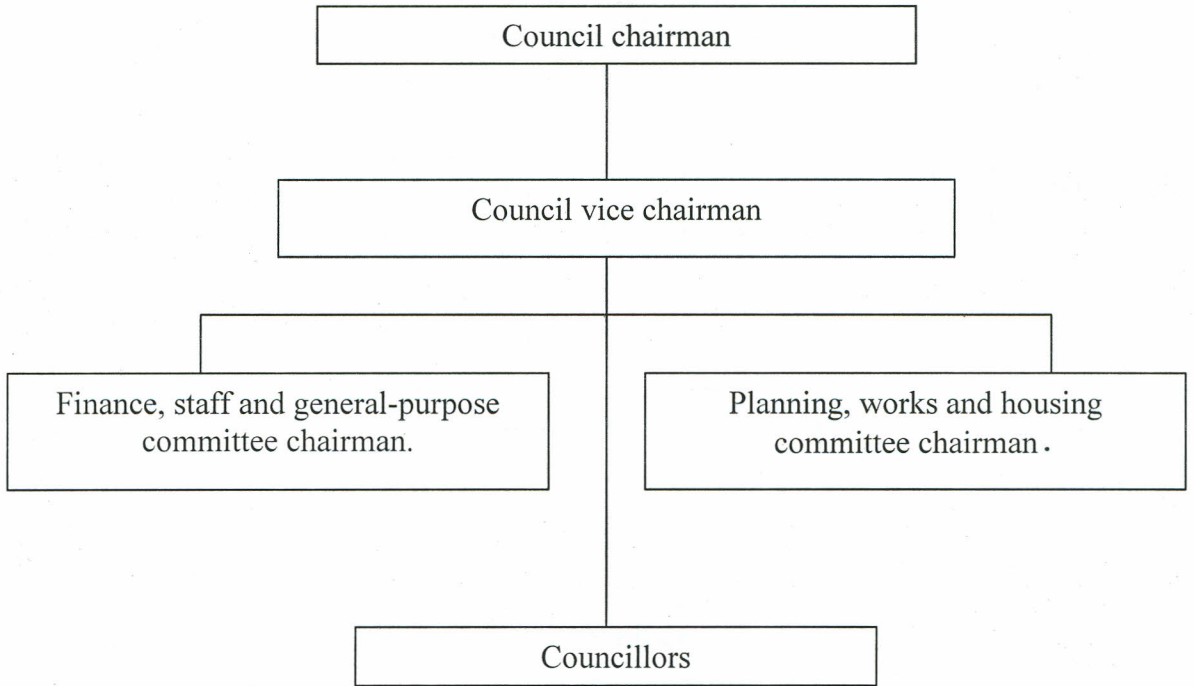
structure. The town is also an important administrative center with most government departments. These include Office of the President, Cultural and Social Services, Agriculture and Livestock Development, Health and Judiciary, among others. There are also several non-governmental organizations in the town.

1.9.5 Town council organization

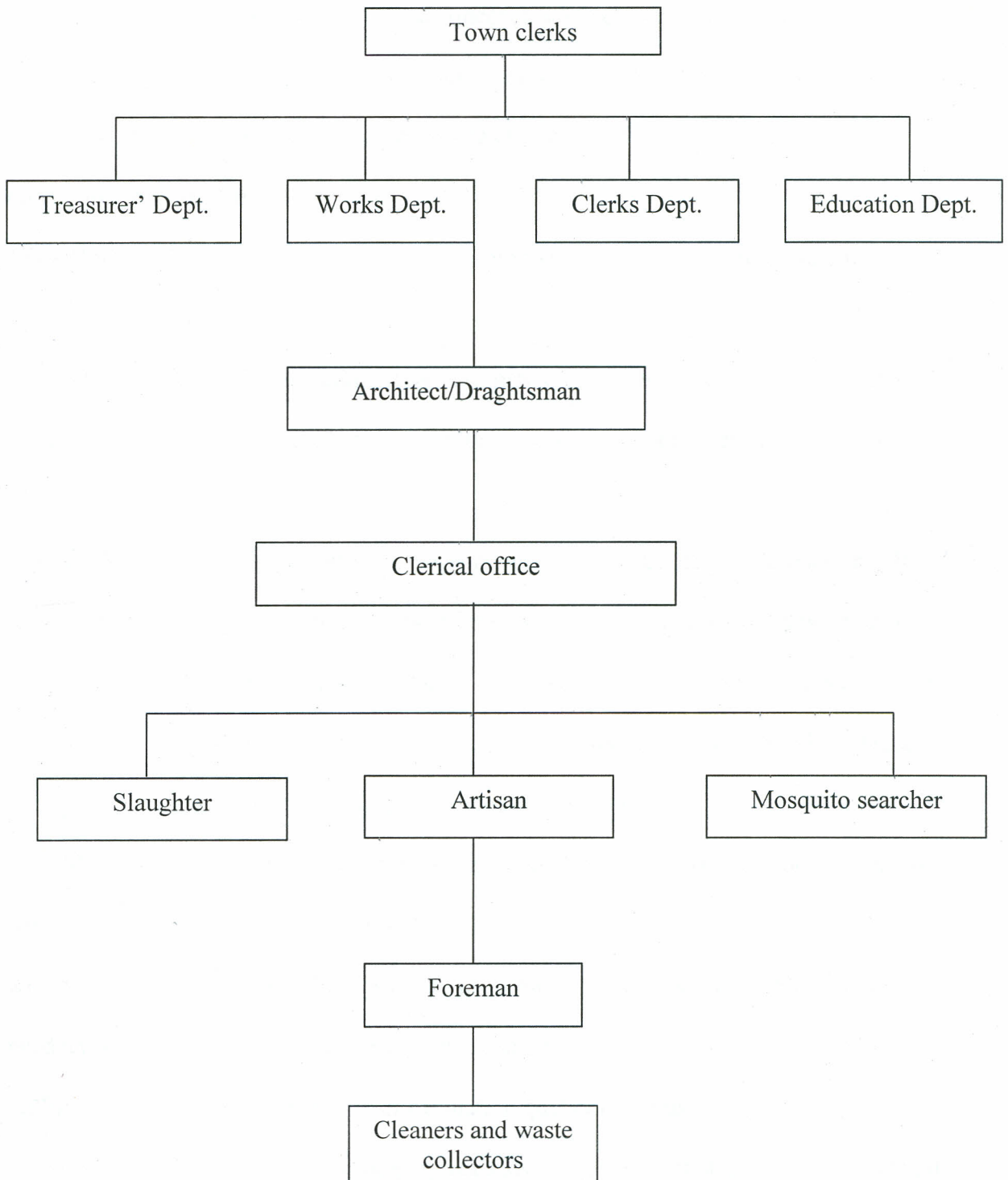
Othaya town was elevated from a market center to an urban council in 1979 and to a town council in 1991. It has six electoral wards namely: Gatugi, Kianganda, Nyamira, Gatuyaini, Ndiyu and Kanyange (Fig. 1). There are six councilors and two nominated ones. The council has formed two committees to oversee the development of the town. These committees are Finances, Staff and General Purpose Committee and Town Planning, Works and Housing Committee (Figs. 6 and 7). The Education, Health and Social Services committees have not been established yet.

The management of the council is shared among the town clerk's department, the treasurer's department, the works' and planning department and the education department. Each of these departments is headed by an officer who sees its day to day running and reports to the town clerk who is the councils' chief executive. Waste management presently falls under the works and planning department.

Fig.6: Committee Structure of Othaya Town Council



Source: GTZ/GOK, 1993.

Fig. 7: Othaya town council Organaisational chart

Source: GTZ/GOK, 1993.

1.9.6 Definition of terms

The study made use of several terms and concepts, some of which are defined below.

ENVIRONMENT: The aggregate of the surrounding things, the living and the non-living and the condition that influence the life of any organism or population including human beings.

ENVIRONMENTAL PROBLEM: The degradation and depletion of environmental assets and the degradation of rural and urban living environments.

WASTE: Any discarded material whose use potential has been diminished by physical or chemical modification or whose generation was secondary or unintended consequence of some other primary activity.

SOLID WASTE: Garbage, refuse, sludge or any other discarded material resulting from industrial, commercial, mining operations, agricultural and community activities.

WASTE MANAGEMENT: The full range of activities that accompany custodianship and disposition of wastes from point of generation to the point of disposal. embraces all aspects of waste handling storage, transportation and disposal.

RE-USE: Case where certain discarded materials are re-used or material does not involve the changing of its basic form or function.

RECYCLING: Process in which waste is processed and recycled as a new material or product such as organic waste processed into compost.

APPRAISAL: An act of estimating or evaluating quality or status.

COMMERCIAL REFUSE: This category consists of wastes from stores, offices, fuel and service stations, restaurants, warehouses and hotels. The wastes typically consist of packaging and container materials, used office supplies and food wastes.

DOMESTIC WASTES: Also referred to as residential refuse or domestic waste, this category comprises wastes that are the consequences of house hold activities.

TRIANGULATION: This is a form of cross-checking where accuracy comes from diverse information and different sources, not statistical replicability.

FLEXIBILITY AND INFORMALITY: This is where plans and research methods are semi-structured and revised, adapted and modified as the PRA proceeds.

SMALL TOWN: This means an urban centre or town centre with a population ranging from 10,000 - 25,000.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Population growth, increasing urbanization, industrialization and rise in standards of living have all contributed to an increase in both amount and variety of waste generated in most countries (UNEP, 1992). The quality of statistics in solid waste arising and disposal continues to be very variable because the temporal and spatial assessment and monitoring of environmental trends is often hampered by lack of comparable data at regional or global scale.

Information on waste arising particularly on industrial and hazardous wastes is often difficult to assemble. This due to inefficient data collection methods, infrequent surveys, reluctance of generators to supply information and lack of law enforcement agencies (UNEP/GEMS, 1991).

Wastes can be classified conveniently with respect to their source. Major categories include household and consumer wastes, industrial wastes, agricultural wastes, and energy production wastes (heat) and sewage sludge. An another criterion is that which classify waste by hazard and by composition.

2.2 Urban Solid Wastes

Municipal wastes are relatively a small part of the total waste arising when compared with waste arising from industry, agriculture and mining. For example municipal waste account for only 6%, 5% and 8% in European Economic Community (EEC), U.K. and

Japan respectively (UNEP/GEMS, 1991). The term municipal waste applies to those wastes generated by households and to wastes of similar characteristics derived from shops, offices and other commercial units.

Waste production and composition are related to the level of industrialization and levels of income. Per capital generation varies between 2.7 Kg to 4.0 Kg per person per day in high income countries to as low as 0.5 kg per person per day in the lowest income countries (Cointreau, 1982). The waste consists of paper, plastics, glass, metal, ashes, grit, dust and vegetable matter. Table two shows the municipal composition in Britain and Nigeria (Holmes, 1984).

Table 2: Composition of municipal wastes in Britain and Nigeria

Waste type	Britain	Nigeria
Plastics	7	-
Glass	10	-
Paper	29	13
Metal	8	5
Ashes/grit/dust	25	20
Vegetable matter	21	60

*Figures given in %

h

Municipal solid waste management depends on the population of the community and its density. Small municipalities may need little organized collection service but as communities grow and people begin to live in close proximity, it becomes increasingly important to have organized solid waste collection and disposal systems. This is because it is more difficult for household owners to get rid of their own wastes safely and effectively. People in a residential setting may dump waste at a point and with eventual accumulation create a public health hazard together with utilizing valuable space needed for other purposes.

Local authorities have found it difficult to dispose off the ever increasing amounts of solid wastes without either causing pollution of air, land, water or wrecking their municipality budgets (**Clark, 1978**). For example, in developed countries more than 75% of the urban populations have access to municipal waste services in contrast to developing countries where only a small proportion of the population in many urban areas has access to municipal waste services.

Lack of proper collection and disposal methods lead to environmental pollution. Collection in most cases tends to be concentrated in commercial areas, markets and city centres. In other parts waste collection and disposal is left to individuals or local communities or may be left to accumulate in the streets. Many small businesses, commercial units and hospitals in developing countries rely on municipal waste services; thus the waste streams collected often contain some hazardous constituents like solvents, paints and bacteria. Careless handling may thus pose a threat to human health.

2.3 Waste collection

The need for adequate collection and disposal of solid waste in urban areas is based on aesthetic and health considerations. Only a fraction of the urban areas in developing countries are provided with any form of collection and disposal services and often such services have been confined to the town centres (**Habitat, 1988**). The inability of local authorities to maintain a regular solid waste collection system in the urban areas in Kenya is compounded by lack of awareness by the communities of the health hazards involved in uncollected refuse.

Studies in Kenya show that an estimated 30-50% of solid wastes generated by urban production remain uncollected (**GTZ\GOK, 1993**). In informal settlements residents dispose off their waste individually by burying or throwing it on open ground and road reserves.

A study by **Mbugua (1979)** on waste collection showed that local authorities are faced with three main problems as they deal with waste. These are lack of adequate collection equipment, inadequate management systems and inadequate disposal sites. Other studies elsewhere however identify either route or financial aspects as the root cause of the woes in the collection process (**Cointreau, 1982**).

2.4 Waste disposal techniques

Fraquer (1983) contends that of the various arbitrary branches into which we divide the protection of the environment, waste disposal is in some ways the most complex. For hazardous wastes in particular, the problem can be more long term, thus calling for greater expertise in order to decide the means which will be employed in different waste categories. Disposal of waste, including its handling and transportation, is today a branch of advanced technology. The problem is to ensure that all those who handle wastes, the producers, transporters and disposers have a clear understanding of what this implies.

There are various methods of waste disposal. These range from simple open dumping to complex methods like pyrolysis and deepwell injections. **Lum and Skarajan (1982)** observe that the technology for solving most waste disposal problems is available and that the appropriateness of which to adopt for a particular situation depends on socio-economic and cultural factors. A survey done in Kenya by the GTZ in 1993 showed that crude dumping is practiced by a large number of local authorities.

Khan (1991) also observes that the increasing proximity of such sites to habited areas makes this form of disposal intolerable and an eye sore. The usefulness of various processes to meet the needs of a certain disposal system is a function of economics, the type of input and output streams and the expected timetable of development of the process to a time where it is technically feasible for large scale operations. The main techniques of waste disposal include sanitary landfill, composting, incineration and recycling and resource recovery.

2.4.1 Sanitary landfill

A sanitary land fill is a solid waste disposal site which has been carefully selected, designed and prepared for use and at which the waste is compacted to reduce volume and covered with soil at the end of each day. It is the cheapest, simplest and satisfactory method of disposal of solid wastes when land is available and sufficient. In most countries where there is no shortage of land with suitable geological formation, landfill remains the predominant form of disposal.

Studies have shown that in Britain, Canada and United States of America landfilling accounts for 90%, 70%, and 70%, respectively. Nutrient pollution of ground water near the landfill, smells, formation of climate relevant trace gases and generation of hazardous mycotoxin when organic wastes are dumped in an anaerobic area are complications that result from landfilling (Werlan, 1992).

2.4.2 Composting

This is the conversion of the organic component of the solid wastes by the process of biological degradation under controlled conditions to form compost. Compost is a material that can be used as a soil conditioner or fertiliser with the addition of appropriate chemical supplements. The method could be manual or mechanical and ensures destruction of pathogenic organisms as well as converting wastes into a usable resource for sale.

The process of composting may be limited by various factors like land availability, need for secondary disposal of the un-compostable material, community sizes, existence of available compost market among others. Research done in Kenya has shown marketing to be a major limiting factor to this process.

2.4.3 Incineration

This is the process of reducing combustible wastes to an inert residue by burning at high temperatures of about 1,700 - 1,800⁰C. At this temperature all the combustible materials are consumed, leaving a residue of ash and non-combustibles having a volume of between 5 to 25% of the original volume (**Pettyjohn, 1972**). This process is used where land is very expensive, calorific value of wastes is high and moisture content of wastes low.

For solid wastes with low calorific value and high moisture content, incineration could require supplementary fuel, a factor that together with high capital costs render such systems expensive to construct and operate. This process is also limited by the need for secondary disposal and problems of air pollution by dust, smoke, vaporized metals and dioxins.

2.4.4 Recycling and resource recovery

Many governments faced with a rapid growth in volume of municipal wastes are actively encouraging recycling of materials from domestic or municipal waste streams. This has a number of benefits, such as saving on the costs of waste disposal, and substitution of

secondary materials for virgin ones. **Khalil (1986)** points out that recycling of waste resources has expanded both in range and scope in Kenya. Though considerable potential still remains, little information exists on how much of particular waste products are being recycled.

Within a span of ten years, however, attempts have been made in waste resource use with recycling becoming extensively practiced in some areas. A study by **Ikiara (1988)** showed recycling of scrap metal such as iron, steel, lead and copper being highly practiced. **Khadaka (1988)** however argued that the progress of resource conservation in Kenya is disappointing and asserts that waste recycling could generate considerable income and savings in foreign exchange. He concludes with a strong policy recommendation for initiating a recycling industry for paper, glass, plastics and metal. In recent years recycling has improved with high degree of success.

The major form of recycling in Kenya is done through scavenging, which at present is done in major towns as an informal activity. Most of the involved wastes include paper, plastics, metallic compounds and bottles (**Gachamba, 1993 and Ogutu, 1993**). Success of recycling however depends on favorable market conditions.

2.5 Environmental and health risks of solid wastes

Although public health aspects of wastes are serious, **Weinner (1990)** noted that health is seldom of primary concern when municipalities decide on disposal methods. **Clark (1978)** contends that solid waste management is an important facet in environmental hygiene and needs to be integrated with total environmental planning.

Municipal wastes are mostly organic and when left for a long time without collection they can pose health risks. The wastes in most cases act as breeding places for various disease vectors like flies, mosquitoes and rodents. A proliferation of this situation could lead to outbreak of diseases like malaria, typhoid, dysentery, plague and even cholera. In Kenya, this is not uncommon and especially in major towns where there are open and uncared for solid waste heaps.

In the tropical and semi tropical countries heat and humidity accelerate the decomposition of refuse giving rise to bad smells and providing ideal sites for insects. A research done in a recycling plant in Denmark showed that after three months of functioning cases of occupational illness appeared with preference to respiratory and allergic reactions. Manual sorting of un-separated house hold garbage have been shown to have high risk of pulmonary diseases, toxic alveolitis, gastro-intestinal problems and irritation of the eyes, among others (**Malmros, 1994**).

Methods involved in solid waste collection from street bins in most third world countries are usually manual. Squatting or stooping posture adopted to fill baskets cause inhalation of contaminated dust and droplets (**Bachtmann, 1993**). **Maryland (1966)** and **Coupe (1976)** have further shown that urban wastes could also have environmental effects like loss of aesthetic values, reduced value of property, water pollution by lecheate, among others. This has gone further to bring about indirect effects such as loss of foreign exchange as places become less attractive tourists and investment destinations (**Cointreau, 1982**).

2.6 Community participation

Waste disposal is not the sole responsibility of a particular municipality. Those who generate waste have a contribution to make and for smooth functioning of a waste collection and disposal system it is essential that the understanding and the co-operation of citizens be obtained. The success of any effort in this direction needs the cooperation of the people through public education and awareness on the importance and benefits of community participation.

Research has shown that in low-income areas waste removal is rarely a priority as people's lives are dictated by survival economics and so are their reasons for taking any action. To people in these areas emphasis should be on the economic benefits that accrue from solid waste recycling and re-use. In the high income areas residents are even ready to pay extra money for waste evacuation instead of relying on the local authorities. Another important requirement for success in

community participation is the parallel provision of other services such as infrastructure. The role of private individuals or companies also falls in this area. This could be either collection or supplying bins or cans. **Munuve (1990)** confirms that this has been done with some success in Nairobi by the Chandaria Foundation. **Ruto (1988)** however says that this option is limited by some local realities such as lack of proven local expertise and local entrepreneurs with the kind of capital required to manage a system effectively. There is also the question of accountability. Some private waste collectors have been known to collect waste in city estates only to dump it at the roadside away from the town.

2.7 Conclusion

It's clearly evident that substantial research has been done in the field of waste management especially in big towns in the last decade. Most of these past studies were however, focussed on either one or two aspects of the waste management processes such as; collection and storage, collection and disposal, problems in waste management and administration. There is therefore lack of recognition that waste management revolve around a complex interaction of various factors.

Most of the studies have also disregarded the small upcoming urban centres, which are developing very fast. As a consequence most of these towns are getting polluted with wastes due to inadequate and inappropriate methods of collection and disposal. In most Local Authority Development Programmes, waste management is not given any priority and falls under public health department or in the engineers department. For most waste

streams, the main method of disposal is dumping with little regard to the environment. Another issue is that of community participation, which though highlighted in most researches as important, has been largely, ignored in most studies. Lastly, most past researches have failed to recognise that waste management is an environmental issue, which is greatly related to development, and that management structures must be pegged to town growth. The use of big towns could have been a great bottleneck in seeing the whole issue in totality. The intended research was thus aimed at appraising the situation in Othaya town, which is a small developing town. In the next chapter the methods used to meet the objectives are discussed.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

The research design used was an evaluative (descriptive) one. The one specifically chosen for the study was "A MODIFIED PARTICIPATORY RAPID APPRAISAL (PRA)". This is a research technique developed in the late 1970's and early 80's by researchers in international development as an alternative and complement to conventional sample surveys (**Chambers and Belshaw, 1983**).

It is a method of learning from and with community members. The main features in the technique include mixed techniques, on spot analysis, flexibility and informality, triangulation among others. PRA is important as it allows the analysis of local conditions under which proposed interventions are promoted and is conducive to collecting data regarding values, opinions, objectives and ingenious technical knowledge as well as biophysical and economic information.

3.2 Sampling and sample description

The population from which the study sample for this research was drawn consisted of either the permanent residents of the town or those who work in the town and move to their respective rural homes. The specific target groups however were the commercial and residential households. The total number of schedules was 120.

The random sampling technique was adopted for this study. This process was influenced by the mode of residential setting in the town and was feasible as the population was of local communities who are usually reasonably well confined (Clark, 1978; Luck, 1982). Direct observations were made using a checklist on the visual effect of a phenomenon (for example a dumpsite) under observation. A municipal questionnaire was also administered to the local authority head of department concerned with waste management.

3.2.1 Questionnaire

The questionnaire was used to secure "Authoritative Opinion" information. This is the opinion of the authorities and individuals with outstanding qualification in the area under study. This questionnaire was used to gather information related to waste generation, collection, disposal, facilities, personal health risks, and pollution problems, among others.

The questionnaire was directly given to the potential respondent (in this case the town draughtsman). Since some data required some time to fill, the questionnaire remained with the respondents for one week. The initial face to face contact was essential for establishing rapport so as to explain the purpose of study and motivate the respondents to seek the not immediately available data.

3.2.2 Interview schedules

These were for the household and commercial waste generators. The type of schedule was highly structured and contained a specific set of questions that were administered to the respondents along with pre-determined response categories. A few open-ended items were also included.

This type of interview schedule is advantageous since it allows same set of data to be obtained from respondents thus making easy the process of data handling and analysis. The interview schedules were administered to the various respondents as per the prior sampling done. The subjects were either approached unknowingly or through prior knowledge of the intended interview.

3.2.3 Direct observation

As a research tool, direct observation was used to gather supplementary data that was used as done with a non-participating group of individuals so as to ensure the validity of the items and check out for possibility of any extraneous factors, which may present themselves in the usable data collection. Twenty questionnaires were used for the purposes of pilot testing in Murang'a town. Apart from the above stated reason Murang'a town has similar environmental and economic characteristics as Othaya town.

3.3 Pilot testing

A pilot study was also done with a group of none participating individuals so as to ensure the validity of the items and check out for possibility of any extraneous factors

that may present themselves in the usable data collection. Twenty questionnaires were used for this purpose of pilot testing which was done in Murang'a town, Apart from the above stated reason, Murang'a town was chosen as it has almost similar environmental and economic characteristics as Othaya town.

3.4 Data collection

Data was collected during the month of September and October 1995. The respondents were interviewed at their shops or homes and for those who could not respond immediately they were seen later on. The researcher and one research assistant collected the data.

3.5 Data analysis

The research made use of two sets of data, one from the municipal authorities questionnaire and the other from the interview schedules from the community members. Data from the municipal authorities required detailed descriptive analysis on each of the various aspects in the questionnaire with special regard to patterns and trends in the study area. The residential questionnaire was analysed using descriptive statistics, which included calculation of frequencies, means, percentages, and ranges. Other statistics done included calculation of correlation coefficients between various variables such as waste production, number of residents and rooms in a household. The mode of data compilation and presentation was however not for refined statistical analysis but was used to provide a concise information on which various inferences and conclusions were made in relation to the research objectives.

The formula below was the one used to calculate the correlation coefficient (**Conner and Morrel, 1985**)

$$r_{xy} = \frac{\sum XY}{\sqrt{[\sum (X^2) \sum (Y^2)]}}$$

Where $X = x - \bar{x}$, $Y = y - \bar{y}$, $X^2 = (x - \bar{x})^2$, $Y^2 = (y - \bar{y})^2$ and r_{xy} = correlation coefficient between variables x and y , such as waste production, number of residents and number of rooms in a household.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

The current solid waste management system in Othaya was evaluated to understand its structure and functions and how it can be improved. The data and information obtained was recorded and analysed according to the study objectives.

A total of one hundred and twenty (120) questionnaires were administered to the various respondents. Out of these only ninety-five (95) or 79 percent were accepted for data analysis. The rest twenty-five (25) or 21 percent did not respond to the questionnaires and were therefore not used for data analysis.

In the household questionnaires, only sixty (60) were used out of which only forty-three (43) or 71.7 percent were accepted for data analysis. The remaining seventeen (17) or 28.3 percent were not analysed because they dropped out for reasons such as lack of time and not seeing the need to participate in a process that has no immediate benefit to them, among others. The observation record sheets were used mainly to authenticate data using other tools. The findings of the study are presented in various sections of this chapter.

21/47 x 100
21/47 x 100
21/47 x 100

4.2.1 Sources and nature of wastes

The major sources of waste in Othaya town are the commercial and the residential sources. Wastes from households mostly consist of food wastes (food preparation and leftovers) and paper (packaging, newspapers). These make up about ninety-five (95) percent of all the wastes from residential sources. The remaining five (5) percent comprise of textiles, rubber, plastics, cans and glass bottles. Tables 3 and 4 provide detailed information on the sources of waste and their characteristics in the town.

Table 3: Commercial waste characteristics in Othaya town

Sources	No. of sources	Waste characteristics
Shops	110	Paper, foodstuffs, silt, and cartons
Bars	45	Broken bottles, Bottle/tops, food remains and ashes
Shoe repair	20	old shoes and assembling pieces, leather pieces, polish cans
Textiles	41	old pieces clothes
Butcheries	21	Food remains, bones, ashes
Bookshop/ Printing	11	Papers, waste machine oils
Metal workshop	15	Old pieces of metals of all types
Garages	14	Oils, oil cans, metallic objects
Carpentry	9	Sawdust, wood pieces, broken furniture

Table 4: Municipal and residential waste characteristics in Othaya town

Sources	No. of sources	Waste characteristics
Market	1	Foodstuffs, fruit peels and vegetable wastes,
Street sweeping	N/A	All wastes depending on location
Residential	N/A	Foodstuffs, paper, packaging houses/estates materials

4.2.2 Solid waste generation

Only domestic sources were used in assessing the quantities of wastes produced in the town. According to the National population census of 1989 Othaya town Council had a population of 14,687 with an annual growth of about 4.0 percent per annum. This means that in 1995 an estimated 18,200 inhabitants were living within the town council's area of jurisdiction. Unfortunately it was not possible to establish what proportion of this population live within the core area of the town so as to establish the quantities of wastes generated especially from commercial sources.

The amount of waste from commercial sources depends mostly on the nature of activities going on in the sector. For instance the fact that there are more bars than hotels does not necessarily mean that bars produce more wastes than the hotels. Some shops being strategically placed (such as near the market or at *Matatu* parks) results in their producing more wastes than those in other remote areas of the town.

In developing countries the average solid waste generation rates for residential refuse is usually in the range of 0.3 to 0.6 kg./person with an average of 0.5 kg. /person/day (Cointreau, 1982). Considering that most of the solid waste generated in Othaya town consists of food wastes and wastes from the market and street sweeping with high silt contents, it is reasonable to assume a fairly high density of 500 kg/m³ (GTZAGOK, 1993).

As earlier mentioned 60 households were used in the waste generation study where variables examined included waste production, numbers of residents per household and number of rooms in the house (table 5). Due to the town being small it was difficult to establish the income generation levels as these are mostly dictated by housing patterns, which was not very distinct. Despite this, however, a house pattern system was developed which helped to categorize the town into high, medium and low arbitrary income levels depending on the number of rooms in a household or residential area (table 6).

Table 5: Family size distribution in Othaya town.

Family size	No.	% Proportion
1 – 3	23	53
4 – 7	20	47

Table 6: Waste generation from the residential sector in Othaya town
(a) High level income

Respondent	Total wt. 15 days	Av. Daily Production	Av. Wt./ Cap./day	No. of residents	No. of rooms
1	35.3	2.35	0.58	4	5
2	23.8	1.83	0.37	5	6
3	24.6	1.89	0.47	4	5
4	22.4	1.52	0.50	3	6
5	16.7	1.28	0.64	2	6
6	25.4	1.69	0.56	3	6
7	34.4	2.64	0.53	5	6
8	15.5	1.03	0.50	2	5
9	30.75	2.19	0.44	5	6
10	23.7	1.82	0.60	3	6
11	27.3	1.82	0.46	4	5
12	5.1	0.39	0.39	1	5
13	39.0	2.78	0.46	6	5
14	37.3	2.86	0.71	4	5
15	20.1	1.54	0.51	3	6
16	14.71	1.05	0.52	2	6
17	31.5	2.10	0.42	5	7
18	21.0	1.50	0.75	2	7
19	24.9	1.68	0.41	4	7
20	19.2	1.36	0.68	2	7

(b) Middle level income

Respondent	Total wt. 15 days	Av. Daily production	Av. Wt/ Cap./day	No. of residents	No. of rooms
1	23.2	1.78	0.59	3	4
2	25.9	1.72	0.57	3	3
3	29.4	1.96	0.49	4	5
4	16.3	1.25	0.41	3	5
5	21.7	1.44	.48	3	2
6	24.9	1.96	0.39	5	2
7	18.4	1.31	0.65	2	2
8	23.7	1.69	0.42	4	2
9	10.9	0.99	0.49	2	2
10	23.7	1.48	0.49	3	5
11	24.6	1.65	0.55	3	4
12	23.1	1.92	0.64	3	4
13	29.8	2.31	0.43	5	2
14	31.5	2.10	0.52	4	2
15	30.5	2.18	0.54	4	5

(c) Low level income

Respondent	Total wt. 15 days	Av. Daily production	Av. Wt./ Cap./day	No. of Residents	No. of rooms
1	22.5	1.61	0.80	2	2
2	29.8	1.98	0.49	4	2
3	24.2	2.01	0.40	5	2
4	26.4	2.03	0.68	3	2
5	17.3	1.44	0.48	3	1
6	22.5	1.60	0.53	3	1
7	19.7	1.79	0.44	4	1
8	32.9	2.19	0.55	4	1

23
20
43

Table 7: Waste management statistics in Othaya town

1	No. Respondents		20	15	8	43
2	% Dropout		0	25	60	
3	Ranges	Waste weight (kg)	0.39 – 2.87	0.99 – 2.18	1.60 – 2.19	0.39 – 2.86
		No. of Residents/family	1 – 6	2 – 5	2 – 5	1 – 6
		No. of Rooms	5 – 7	2 – 5	1 – 2	1 – 7
4	Means	Waste weight (kg)	1.78	1.7	1.83	1.76
		No. of Residents/family	3	3	3.5 \cong 4	3.44 \cong 3
		No. of rooms	5.85 \cong 6	3.26 \cong 3	1.5 \cong 2	4.16 \cong 4
5	Standard Deviation	Waste weight (kg)	0.599	0.34	0.25	0.47
		No. of Residents/family	1.32	0.897	0.866	1.1
		No. of rooms	0.726	1.289	0.50	1.92
6	Correlation Coefficients	Wastes/ Residents	0.855	0.797	0.616	0.817
		Waste/rooms	0.136	0.009	0.311	0.095
7	Regression coefficients	Wastes/Residents	1.958	-2.057	-2.179	9.913
		Wastes/rooms	-0.164	-0.375	0.636	-
8	Means	Mean waste productivity/ Person/day (kg).	0.525 \pm 0.1	0.51 \pm 0.07	0.54 \pm 0.12	0.52 \pm 0.08

*All weights in kgs.

Families in the town have persons ranging from 1 - 7 members with an average of about three (3) persons per household (table 5). Each family participating had its wastes weighed twice a day for 15 days. The results were compared by averaging for each family to produce tables 6 (a), (b) and (c) from which table 7 was developed. The average weight in kilogram per day for all the families was 77.1 kg/day while the average total waste per family was 1.79Kg/day. The average waste weight was 0.52 Kg/cap/day (table 7).

Correlation coefficients between waste production (Kg) as the dependent variable and number of residents in the household and number of rooms in the household as the independent variables were calculated. The correlation coefficient between waste production and number of residents was 0.82 showing that there is a highly positive relationship between waste production and the family size.

The correlation coefficient between waste production and the number of rooms per household was 0.1, showing that there was very little relationship between waste production and the number of rooms in a house. In this case the number of rooms were taken to be point sources of waste in a house. The Council estimates that between 120-150 households require solid waste collection service **(GTZ/GOK, 1993)**.

If we assume the growth rate of the resident housing to be the same as that of the population, (that is four percent at present), it means that there are 139 households, which require waste collection services. Assuming an average of 3 persons

per household and an average of 139 households the average amount of solid waste requiring collection is $139 \times 3 \times 0.52$ Kg./cap/day or 268.4 Kg/day. A study by GTZ in 1993 estimated that 75 percent of solid waste generated from the commercial premises is collected from the CBD. This was estimated to be about 42 m^3 per week. If we assume collection is 100%, then this would be 56 m^3 of solid wastes or about 8 m^3 per day. The total weight is then $500 \text{ Kg/m}^3 \times 8 \text{ m}^3$ or 4000 Kg/day. If waste from institutions like St. Thomas Academy and Othaya Approved School is disregarded it is then reasonable to assume a daily generation rate of about 5.5 metric tones of waste.

4.2.3 Waste storage

Proper storage is an important aspect of waste management. Domestic refuse which is usually composed of dry and wet materials should not be stored in paper bags or wooden boxes unless it is separated. Tables 8 (a), (b) and (c) show results of the responses concerning waste storage, location of dumpsites and fate of wastes after dumping in the town.

Table 8(a): Waste storage

No of Respondents	%	Form of storage
11	12	Iron Bucket
33	35	Plastic bucket/carton
44	46	Store but throw in a dump
7	7	No response
N – 95	100	

Table 8(b): Location of dump

No of Respondents	%	location of dump
27	61.3	In the backyard
17	38.6	At the roadside
n = 44	99.9	

Table 8(c): Fate of waste after dumping

No of Respondents	%	Response
53	55.7	Stays there
35	36.8	Removed by Council
7	7.3	No Response
n = 95	99.8	

Results in the tables show clearly that waste storage is very poor in the commercial and domestic sector in Othaya town. In the domestic sectors, 34.7 percent of the people store their waste in plastic buckets or cartons which are very small and can not hold waste for two days (minimum time to which the Council collects the waste). About 46.3 percent of the people do not even have storage facilities and just dump the waste immediately it is produced. In the commercial sector, 11.5 percent of the people use iron buckets, plastic buckets, cartons and metallic containers as storage facilities.

Few residents have the standard recommended waste containers table 8(a) made of galvanized iron. However, most of the containers were rust and highly dented (plates III and V). For those throwing their waste in dumps, 61.3 percent threw it at their backyards while 38.6 percent throw the waste at the roadside. About 38.6 percent of those interviewed in the commercial sector do not store their waste at all, but just sweep it into the streets or drains. In the domestic sector about 61.3 percent of those interviewed dump their waste at their backyards or just at the roadside (plates II ,X and XI).

Waste storage facilities differ from community to community and are mostly dictated by the type of housing and households. For example in Nigeria a household could contain as many as 50 persons and the mode of waste storage is usually a 200-litre drum other than a normal dustbin. Storage facilities also depend on the income levels since there is a positive relationship between income levels, family sizes and waste generation (**Holmes, 1984**).

The living patterns in a community are therefore important in determining the types of capacities of waste storage facilities. Household units and not individual houses should be encouraged through legislation or otherwise to have dustbins. **Holmes (1984)** recommends that landlords must be made to provide special waste storage facilities in their plots. This approach seemed to work well in Oasis estate in Othaya and makes waste collection by the council very efficient.

Another notable issue in waste storage is the lack of sanitary facilities for storage especially in the commercial and market places. In most cases there were no dustbins and therefore wastes were stored in poor containers. This leads to littering of the town. Waste heaps are rarely covered, protected from vermin and sometimes there are no restrictions to access. Sometimes employees of the council and scavengers are encouraged to sort through the wastes and take materials that they find can be of use (**Khadaka, 1988**).

This type of situation is unsatisfactory and can be remedied to a larger degree by low cost measures such as restricting access, fencing of the storage areas to minimize any wind blown litter providing covers in storage facilities and also ensuring regular and frequent collection of the wastes.

Recent developments however show that better containers are replacing the traditional galvanized dustbin receptacles. It has been subject to various problems such as reduced lifespan due to careless handling during collection and also rusting and vandalism. The introduction of plastic bins and disposable paper sacks systems have improved the situation especially for the refuse handlers as there is a marked reduction in weight handled. They are also more hygienic, eliminate dust, litter and noise problems during collection.

In Othaya town a variety of facilities are used for primary storage and most of these are temporary containers such as cardboard boxes, plastic buckets and plastic carrier bags. These containers are mostly unserviced thus not ensuring a sanitary storage of refuse.

Many of the primary storage facilities commonly used require protective facilities such as lids to interrupt the breeding process of insects and pests such as mosquitoes and flies and rodents. It is important that storage facilities be weather proof, washable and robust enough to meet the exigencies of normal use (**Habitat, 1983**).

4.2.4 Waste collection

Waste collection in Othaya Urban Council is the sole responsibility of the Council Works Department. The department is also in charge of wastewater treatment sanitation and also maintenance of Council roads, buildings and other facilities. The Council collects refuse daily except when the tractor has broken down or is involved in other Council work. Except in some housing estates (such as "Oasis" or Nyota), the Council does not collect waste from the residential areas. The Council however estimates that between 130 to 150 private residential homes require solid waste collection service but equipment available are not even able to meet demand for commercial premises in the CBD.

Although waste is collected twice weekly in the Central Business District (CBD), some shopping areas were observed not to have bins resulting in the dumping of waste on the ground/drains. This make waste collection by council workers difficult and time consuming as it has to be shoved up to the trailer. On average the trailer makes four trips on Mondays and Tuesdays to the dumpsite and sometimes six times due to refuse generated in the market.

On Wednesdays and Thursdays the trailer makes an average of two to three trips except on public holidays when more trips are made the following day. In a daily working week therefore the minimum number of trips made to the dumpsite is fourteen.

The trailer dimensions are 3.025 m length by 2.025 m width by 0.370 m height; a volume of approx. 2.266 m³. Since the refuse usually exceeds the height of the side walls for a full trailer load it is reasonable to estimate the volume of waste carried per trip to be 3 m³. This would amount to 42 m³ per week or 21 tons of waste per week. This shows a daily collection of 3 tons and if the daily production is 5.5 tons, then only 54 percent of the waste is collected daily leaving 46 percent littering the town or in the many dump sites in the town and the residential areas. This figure conflicts with the one given by the MLG/GTZ project which showed that 75 percent of the waste is collected leaving only 25 percent. The reason is that the data was obtained from the CBD.

Waste collection is an important aspect in waste management and is a sector that changes fast due to changing technologies, refuse characteristics, manpower recruitment and retention and thus presents the greatest cost to waste managers (**Elkington and Shopley, 1989**). This is a really technical area that requires the input of various factors that emanate from detailed calculations and well thought out considerations.

A proper constituted waste collection must consider storage facilities (communal or individual), locations of the facilities, areas of influence, transport routes, housing patterns,

population densities, climates and limitations of the different technologies available. To acquire the most cost effective and sustainable collection system there must be calculations in variations of emptying intervals, collection facilities, waste volumes and population densities. In reality, however, the ideal locations may not be possible to use since they may not be accessible for residents and collection vehicles. This calls for selection of realistic locations that provide good access for both residents and the collection vehicles.

The sites should also be safe for people as they dump their wastes, should not hamper normal traffic, commercial activities or the general population. Ironically the best sites are those formally used for illegal dumping as the populations already accept them. This was common in Othaya and has proved to work in Nairobi .

One thing that stands out is that location of collection sites is a compromise of many factors that include accessibility, space, walking distances, local town structures and population, among others. This calls for discussions with the local communities in order to reach workable agreements.

Routes of collection and transportation vehicles are also important in waste collection. This enables usage of capacities of the collection vehicles to the utmost possible extent on one hand and going shortest distances on the other. This save running costs and even the number of vehicles and manpower.

According to route planning, an operation schedule should always be in place, determining the days of service for each collection site, route and time schedule. This should also consider the local situations such as market days and sufficient time for maintenance and repairs in case this cannot be done after the normal shift.

4.2.5 Waste disposal

After collection, wastes have to be disposed off to avoid any danger to the environment. Unless the wastes are recycled through salvage and reuse for the original purpose or a downgraded one disposal is merely a matter of relocating the wastes. Individual residents of Othaya have different disposal arrangements for their wastes as seen in Table 9.

Table 9: Waste Disposal options in Othaya town.

No. of Respondents.	% Proportion	Disposal option
36	37.9	Local authority
58	61.1	Self-burn/bury
1	1	Non response
95	100	

As seen in section 4.2.5, the council, in regard to collection of waste or refuse does not serve half of the residents. Thus most of the residents (about 61.1%) just dispose off their wastes individually (table 9). Most residents do self-disposal of their wastes either through burning (plate II) or by just dumping in pits and holes on the ground where the waste gets buried with time. Notable also is the absence of private contractors in waste

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management in the town. This is because of low economic returns associated with waste disposal in the town due to its small size. The Council disposes of solid waste in Othaya town in crude open dumps on an undeveloped government plot located about 400 metres from the town centre near river Thuti (plate XII). This method of waste disposal is not appropriate due to its proximity to the town and due to the breeding of mosquitoes, flies and rats as observed during the field survey. These are known vectors of common infectious human diseases like malaria, cholera and typhoid. The dumpsite is also located on a sloppy area that promotes pollution of water by leachate and other chemicals from the dump. Offensive odours emanating from this dumpsite also pollute the air in the vicinity.

This area also could be subject to abuse by scavengers, who do the informal waste recycling, as there are no sanitary structures at the site. However the council has an intention of stopping using this site and one located about 6km from town has been proposed. This is an ideal place which, according to the Works Department, is going to be manned using the latest waste management procedures (plate IV). It is an open place not close to a water body, has relatively few homes around and could take about ten years to fill up (GTZ/GOK, 1993).

There are quite a number of disposal options available, which include crude dumping, controlled tipping, incineration, composting, among others. The selection of each of any

of these methods is subject to consideration of many factors. Most local authorities enjoy disposal options, accordingly cost and convenience have in most cases been the deciding factors. There thus has rarely been any strategic approach to disposal methods based on regional landuse planning and care for the total environment.

Before choosing any method, there should be a good understanding of the stringent requirements of any disposal option. This includes its cost and the effects it could have on the environment. In Othaya, for example, landfilling has been chosen as the option of waste disposal. There should be an evaluation of the environmental concerns that can occur at the site resulting from waste such as leachate, littering, surface runoff, and risks to scavengers among, others. Site characteristics such as adjacent landuse, hydrology, geology, soil patterns, topography and climate should also be considered. These characteristics have various effects on the wastes and hence related to the environment.

4.3 Staffing and waste management equipment

Currently there are four Departments in Othaya town Council. These include the Town Clerk's, Treasurer's, Works and Education departments (fig 8). Solid waste management falls under the Works and Planning Department and involves collection, transportation and disposal of waste in the town. At present this section has a staff of 15 people who are involved in street cleansing, drain desilting and refuse collection.

A foreman who works under the draughtsman is responsible for allocating duties to other staff. In every working day the first task begins with sweeping the town, then the workers are split so that some assist in cleaning the drains and others in refuse collection. The same workers are usually utilised whenever there is maintenance of other infrastructure facilities. The number of the workers is not adequate for solid waste management since even the commercial premises are not fully catered for.

For purposes of waste management and infrastructure maintenance, the Council has various equipment at its disposal. Solid waste collection and disposal is effected using a small agricultural tractor (plate VI). The trailer is small and old making the collection efficiency of solid waste in the town low. Table 10 shows the tools used for waste management in the town. Most of the tools are worn out or damaged due to wear and tear.

Table 10: Tools for Waste Management

Name of tool	Available number	Required Number
Rakes	5	15
Wheelbarrows	2	10
Shovels	3	15
Fork Jembes	4	10
Round mouthed Shovels	0	10
Fork Spades	5	14

Source: GTZAGOK, 1993

It is apparent from the table that tools needed to effectively manage waste are not sufficient. For example out of the 10 round mouthed shovels bought in 1988, none exists today. At present there is a big shortage in equipment in the town. If the tools are to be increased then more people will need to be employed to assist in collection and disposal. The proposed increase in the number of tools is practicable as it will strengthen the maintenance capability and bring about a sustained waste management process.

4.4 Financing waste management

The Council charges a conservancy fee to operate and maintain the town's cleaning services. Business premises and hawkers are charged 350 and 200 shillings respectively on an annual basis. This works out to a mere 4 shillings and 2.40 shillings per week respectively. The Council also proposes to charge 600 shillings per annum to collect waste from the residential premises.

During the financial years 1991/92 and 1992/93, the Council received collection fee amounting to Ksh. 57,000 and 62,000, respectively. Expenditure for waste management could not however, be calculated as all expenditures are lumped together. There is however more revenue that be can collected from the more than 425 operational businesses from whom conservancy fee can be charged netting the Council approximately 95,175 shillings per year.

This is however just 26 percent of the total money used by the council per year for the cleansing services in the town. The Council should increase the conservancy fee by at least 50 percent to meet this short fall. The town also has 150

residential premises that require waste collection and if the average were 600 shillings per annum this would fetch the council 90,000 shillings per annum. Table 11 shows the operational and maintenance expenditure for the Works and Planning section.

TABLE 11: The operational and maintenance expenditure of the works section

	1991/92	1992/93	1993/94
Total council budget	124,115	152,130	164,025
Operation & maintenance	—	—	—
Fuel & oils for tractor	1,440	1,510	1,700
Repair for tractor	1,200	1,865	2,050
Salary for 14 employees	15,539	16,091	18,698
Total	18,179	19,466	22,448
% Operation & maintenance exp. Over total budget.	29.3	25.6	27.4

Source: GTZ\GOK, 1993.

The budget clearly shows that other than operational and maintenance of infrastructure, facilities are not budgeted for. The operational and maintenance also take more than one quarter of the total budget.

4.5 Community participation

The role of a community in the success of any project is very crucial and waste management strategies that reach their implementation stage without the involvement of the community are bound to fail. Community participation in waste management may be in the form of efforts of the community to collect and transport waste to a few central places (plate I) where the municipal refuse collection service will remove it for final disposal. The other is the effort of the community to extract certain materials from the waste for reuse for commercial purposes (plate VII).

The ratings of the services rendered in the town (table 12) clearly show that residents are quite aware of the services the municipality should provide. Road maintenance and waste collection were seen to be the poorest services while water and the state of the market were gauged to be the best.

The poor rating for waste collection and poor roads could be attributed to the fact that these are services which are easily noticed. The town actually has poor roads and the fact that no waste collection is done in the residential estates gives these services a high poor rating. Water provision is also not essentially the work of the Council but the Ministry of Water Resources and this explains the high good rating given to it.

Table 12: Residents grading of various services in town.

Service	Very good		Adequate		Poor		No response	
	No.	%	No.	%	No.	%	No.	%
Roads	10	10.5	21	22.1	59	62.1	5	5.3
Water	24	25.6	59	62.1	2	2.1	10	10.2
Waste collection	1	1.1	21	22.1	68	71.5	5	5.3
Sanitation	10	10.5	42	44.2	30	31.5	13	13.8
Market	20	21.1	41	43.2	26	27.3	8	8.2

Asked whether they would participate in a waste management program, about 84.2 percent of the respondents had a positive response and only 9.5 percent had a negative response. The residents needed to be told the type of participation was required for which, differing responses were given (Table 13).

Table 13: Distance residents would walk in rubbish bins were installed.

Distance (metres)	No. of respondents	% proportion
10	43	45.1
50	21	22.1
100	16	16.3
No Distance	8	8.1
No Response	12	8.4
n = 95		100

As noted earlier, one form of community participation would involve the transport of waste to some communal points. Most residents would want to walk a distance of ten

metres. This is a small distance that cannot make much difference even if a collection vehicle is used. The closest distance to a communal centre should be maximum of fifty metres and as seen from the Table 13, only 22 percent would want to walk this distance. Most of these people are shopkeepers who would not want to leave their businesses to take wastes to a communal centre while others are those that produce bulky waste like the carpenters at the various furniture marts. Below is an example of a typical answer given in this category.

"Our greatest desire is to see our community/Country have the best standards of living just like any other nations in the world. Any efforts to make it better/improve the present situation would be highly appreciated and we would cooperate fully."

Studies in environmental psychology show that involvement through public participation reduces friction, resentment, resistance, rejection and confrontation (**Bent, 1976; Hickman, 1994**). The altitude of people to solid waste management in Nairobi confirms this. Those involved in the process of conceiving articulating and implementing solid waste management policies identify more with the program. This way the people are more reluctant to destroy, attack or damage what they have participated in making (**Khadaka, 1988**).

A solid waste management plan should thus, before implementation, include the community it will be used to serve. The planning should be people oriented and the planners should give people what they want and not what they think is best for them (**Habitat, 1989**). The argument here falls on two grounds: it is difficult to change people's attitudes unless they want to change, and that they are not likely to give up their habits, customs or goals just because the planner asks them to do so (**Bent, 1976**). People, however, can be forced to change, but this is not suitable or sustainable.

The second argument is that the planner has no right except in special circumstances to force people to change their behaviors. They (planners) should know that lifestyles and their underlying goals do not develop in a vacuum but they are functions of the existential situations with which people must cope and are related to people's education and income levels.

Holmes (1984) contends that participatory planning arrangements which involve target groups in making decisions about goals, practices and policies are likely to act as a health check on the careerist dimension of professionalism by focusing attention on the human consequences of some decisions. Consultation means feed back which provides vital information to administrators on the effectiveness of the bureaucracy in dealing with participating members.

4.6 Potential for Recycling of Waste

Resource recovery is another major area in which the community could participate. Since high costs experienced in solid waste transport and collection, reduction of the quantities through easy separation and recycling is a very effective means of achieving savings. In Othaya town, recycling is informally done. For example, food wastes from hotels and some households are collected by farmers and used as animal food.

At the dumpsites a number of people (about 7 to 12) are engaged in informal recycling such as use of scrap metal and the sale of compost to farmers for soil reconditioning. From the few examples above, there is economic potential that can be derived from waste recycling/ re-use in Othaya town.

At the individual level, very little resource recovery is taking place as only about 33.6 percent of the sample population retain any material either by re-using, giving out or reselling it. Out of the percentage sampled 46.8 percent re-use or re-sell waste paper; 15.6 percent glass and plastics, 9.4 percent metals and 28.1 percent food wastes. Though this could seem, to be low level recycling, it is very encouraging for such a small town.

Asked if they could store waste if they were paid, 13.6 percent of the people said they could keep any waste, 32.6 percent said they could keep none while 43.2 percent said it would depend on such factors as bulkiness/space; trade agreement (financial rewards); the type of waste and the duration of keeping the waste.

4.7 Pollution and human health risks

There are various activities in waste management that could result in pollution and risks to human health in Othaya town. From waste storage to waste disposal, various forms of waste pollution and management issues that could result in direct risks to human health and the environment were observed. These are highlighted below.

- (a) In the residential areas most people do not store waste but just dump it in places close to their residential areas (plates II, VII, and XI). The wastes pose danger to estate children and residents. Since all wastes are thrown here children could get into contact with contaminated items, poisons or get cuts from broken bottles or cans. The residents also expose themselves to risks since areas are breeding sites for disease vectors such as mosquitoes, rodents and flies. This was observed especially in residential areas where the waste stays for quite sometime before it is collected and/ or buried.
- (b) In the commercial areas, poor waste storage and in- adequate collection results in the town being littered with wastes. This is more so with paper that gets blown away hence littering the town (Plate VIII). Some of this waste finds its way into the storm water drains where it causes clogging and blockage. In the market centres, waste mixtures from various products such as cabbages, fruits, bananas, potatoes result in rotting heaps that are a nuisance to market users. In general it is the aesthetic state of the town that is mostly affected.

- c) During collection, the workers are exposed to various risks as they wear little or no protective gear during this process. The draughtsman confirms various injuries from cuts and bruises by the workers. Wastes from other places create good habitats for disease causing pathogens and vectors such as flies, rodents, and mosquitoes that could affect the workers' health.
- (d) The mode of waste dumping was also an issue observed that could have profound effects on the environment and human health in the town. The present dumpsite is so close to the town (about 200 metres). Since it also acts as a place for prolific breeding of disease vectors, there is a chance that an outbreak of a disease attributed to these vectors can be disastrous. The dumpsite is also located in a place that is steep and slopes directly into river Thuti. During the rainy season waste from this dump is swept directly into the river causing water pollution. This could directly or indirectly affect the water users and/or those that consume vegetables grown by using the polluted water.
- (e) Scavenging is a flourishing business in Othaya town. Scavengers are usually young people who deal mostly with recyclable articles like paper, bones and bottles (plate VII). These people, however, expose themselves to great health risks during their work since they do not wear any protective clothing like boots or gumboots. Their constant and direct contact with wastes exposes them to pathogens and germs in the wastes. They also face risks of cuts from broken bottles and metallic objects, which could result in diseases such as lockjaw disease.



Plate I: A typical waste storage point. Notice the wastes littering the door point due to scavengers and waste recycling processes.



Plate II: Wastes in a backyard being burned a rampant phenomenon in the town especially where the council does not extend its services.

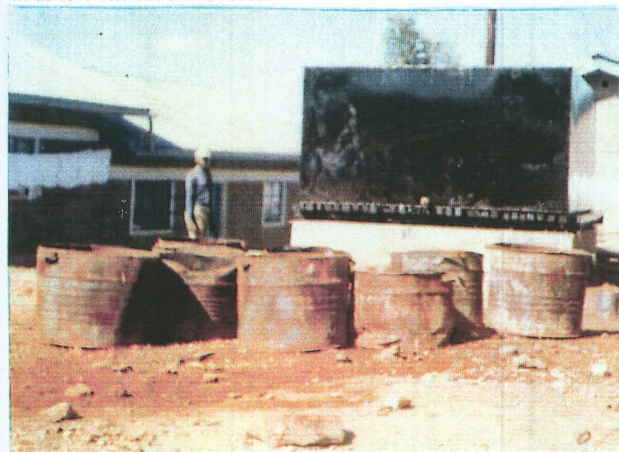


Plate III: Half drums used as storage bins in an estate in the town. Notice the rough edges, rust and dents that could pose danger to waste handlers.



Plate IV: The new waste dumping site located reasonably far from the town. The site is a lowly populated area and will take about ten years to fill.



Plate V: A waste storage facility at a commercial premise in town. Notice the rust, and the sharp rough edges that could pose danger to waste handlers.



Plate VI: The waste collection tractor, modified to pick wastes and deposit them in the trailer, a process that saves time, energy and lowers the collectors contact time with the wastes.



Plate VII: A waste recycling process in the town. This bones collected from dumpsite and butcheries are sold in Nairobi.



Plate X: Wastes from a workshop strewn near the road. These wastes are always washed away by storm waters where they end up clogging drains and sewers.



Plate VIII: Wastes thrown at the roadside in disregard of the Council constructed communal storage point just nearby.



Plate XI: Wastes thrown at the roadside. Notice the scavenging hens.



Plate IX: A drain clogged with wastes such that water remain stagnant thus creating conducive conditions for breeding of disease vectors such as mosquitoes and flies.



Plate XII: This is the present waste dumping site in the Othaya town located only 400m from the town centre. This is on a slope towards river Thuti thus causing the possibility of water pollution.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

5.1 Research Summary

The purpose of the study was to investigate the management of solid waste in Othaya town. The study focussed on the nature and quantities of wastes, management capability, pollution issues and community participation in waste management in the town.

The study was based on the existing solid waste management system and how the system can be improved for effective waste management in the town. Other factors highlighted in the study were the town structure, population development, existing solid waste generation and waste management structures, economic factors, administrative structure and the role of the community in waste management in the town.

The review of relevant literature cut across all aspects of waste management from generation to disposal. A comparison between waste management in developed and developing countries shows great differences in terms of waste streams, management organization and technologies. The review reveals quite a number of issues regarding waste management in small towns of developing countries where solid waste management is either poor or non-existent. Community participation though highlighted elsewhere as an integral part in waste management is neglected and not incorporated in the waste management system in the town.

A modified Participatory Rapid Appraisal (PRA) methodology was used in the study. This is a research technique that employs several methods, such as questionnaires, interview schedules and observation sheets, in order to better understand the variables under study. This method was chosen since it gives comparable results as other different methods.

Data collection and recording tools were adapted from those developed by **Cointreau (1982)**. This study was carried out in the urban zone of Othaya Division, a small upcoming urban centre in Nyeri District. The findings show a picture of a town in transition in relation to provision of waste management services. The Council, however, has made a good attempt, but the situation is still wanting with the most affected areas being the collection, disposal of waste and community participation.

There is a department concerned with waste management in place with a clearly defined policy framework. The study however revealed the impediment to its success being caused largely by lack of enough manpower, facilities and finances among other reasons.

Pollution was also noticed to be a major problem in the town. This was especially due poor storage of wastes and lack of proper disposal. Recycling is also done in the town as an informal activity mainly through scavenging. With regard to community participation data analysis revealed major differences between various groups in the way they perceive waste service. Most significant differences were those found in various income levels and

those of commercial and residential areas. In this two groups there were significant differences that could have an implication on the way the service is delivered. There was also lack of local support and involvement in the waste management process.

5.2 Conclusions of the study

It is apparent from the study that wastes management, as service in Othaya town, is inadequate since proper structures (administrative or otherwise) are lacking. The infrastructure, financial and the man power resources generally seem to fall short of requirements for planning an effective waste management system in the town. The Municipal Council of Othaya however, recognizes this and its present L.A.D.P actually looks beyond the present in provision of this service to the town residents.

There is need for more detailed information about the present situation and what it is likely to become, given the continuation of the present pressure on the Council in other essential services. This information would have to be followed by concern about resources to assist solutions for instance what would be the most cost effective way of managing the wastes in the town? Is it by charging a conservation fee to the people provided with the services or by subcontracting private firms (as Nairobi City Council) or by giving mandate to private firms to do the work under Council supervision?

There is the necessity for a wide comprehension of these types of issues and the creation of an administrative machinery to link the problem of growth to that of providing a cost effective waste management service. The town Council, in making a form of organization for waste management, needs to carefully look into some factors. These would include local attitudes and cultures, which are likely to play a crucial role irrespective of whether there is a proper organizational framework.

The object of disposal of solid wastes is to do so in an environmentally safe and economically sound manner. The method used should prevent human exposure, air and ground water contamination. The Othaya town council has made a good attempt on this area. Initially there was dumping of wastes almost in the town but this dump was relocated to a place away from the town. The present landfill site is also protected but there need to monitor the site to safe guard against groundwater contamination.

The problem of pollution was also evident in the town. This was observed in the residential and commercial areas in the town. There was however significant contrast between cleanliness standards, which were high in the domestic environment and were often disregarded in the public places. This was due to people's customs and behaviors, which are often difficult to change. There however, should be a strong environmental direction from the Council and the ability to enforce this change.

Poor storage and disposal of wastes poses various degrees of risks to people and the environment. In the open dumps scavengers and waste collectors are faced with dangers of contamination and infections. The residents staying near such places risk infection from diseases that could be transmitted by vectors such as rats, mosquitoes and flies that could breed in such places.

The nature of the society to which the service is provided is also an important factor as there are issues of culture and economy that shape many urban scenes. In Othaya there exists various economic groupings that would require consideration in the provision of the waste management service. The income levels of the town residents differ and this was also reflected in the way they perceived the provision of this service. In the low income areas people did not see why they should be integrated in this service. These areas were ironically the most affected by poorly managed wastes.

There is thus need to recognize that there should be a partnership in the design and operation of the waste management facilities between the community and the council.

From the study it is evident that the public is supportive of policies that lead to reduction in consumer wastes and participation in recycling.

There was however a significant public awareness to the effects of wastes on the environment. The residents were also critical of any shortcomings in refuse storage especially in the open communal bins that stayed for days without collection, poor

collection methods and the effects of poor disposal on the environment. Recognizing the residents' services and that their supporting facilities are integral to the environmental programme of the community partnership is important. This way the Council can overcome adversarial conditions that arise in siting waste management facilities such as dumping or landfilling or communal waste bins. This requires community education and participation process and could even call for baseline survey of citizen attitudes before initiating facilities to determine the level of acceptance of the stated needs of the facility.

Change is however a certainty and as stated earlier waste management is a dynamic service. Changes in waste management services inevitably require more capital and revenue. Progressive authorities as the Othaya Town Council can thus justify their actions as improvements on such important social services demanded by the residents can only be implemented by wise investment.

People concerned with the cost of rate borne services will always ask questions in this progressive age in which more investment is being authorized to combat the ill effects of pollution. In summary the most essential factor in assuring quality service is respect for environmental integrity and aesthetics for the community. This requires a total commitment of the planners, regulators, refuse providers and the community to fulfill their respective roles in environmental stewardship.

5.3 Recommendations

Based on the experience in the field and the findings of the study, it is clear that the current waste management resources are not adequate for providing a comprehensive waste management service in ~~Delhara~~^{Githurai} town. Such a system would demand more physical, financial and human resources, with the aim of improving the management of the waste in such key areas as storage, collection mechanisms, disposal and integration of the community in waste management. The following are some of the recommendations based on the findings of the study.

- a) The town is obviously faced with a demand for an effective waste management service. The organization and management of this service must be properly done in order to meet this demand. There should be an autonomous department that is solely concerned with waste management.

This should be carved from the Public Health Department and should have well trained personnel in the administrative (financial and personnel) and in technical areas(planners). There should also be enough personnel/workers attached permanently to it.

- b) Waste storage should be improved since it is currently very poor. In the commercial sector people should be encouraged to purchase standard waste storage bins, either from the Council or elsewhere. In some towns, the Councils'

stock storage bins and sell them to the shopkeepers at affordable prices in the residential areas. The plot owners/landlords should provide waste storage facilities from which the Council collects the wastes for disposal.

A good example is the Nyota estate where individual residents store their waste in their houses and transport it to the communal collection point at the estate where the Council tractor comes to collect it.

The residents should be encouraged to use bins that have lids to avoid breeding of vectors like flies and mosquitoes. Plastic bins are presently being preferred instead of the traditional galvanized iron bins which are prone to rust and could pose danger to waste handlers.

Those who own the residential plot and rent them should take the responsibility of seeing that they are clean and wastes are stored in good secure places. This would reduce the time for collection since the Council will only collect wastes from a transfer station for a whole plot rather than from individual residents. There is also the need to increase communal waste receptacles in the commercial areas and locate them in areas that maximize convenience to residents and accessibility to waste collectors.

- c) The Council presently collects wastes from the Central Business District (CBD) and only in one residential estate. There is need to improve collection and extend the coverage to other residential areas. This is only possible by improving the collection equipment and increasing personnel involved in waste collection.

There is need for careful selection and operation of solid waste management equipment that is efficient and yet responsive to the physical, social and economic conditions of the neighborhoods in which the service is applied. The Council should as far as possible, use relevant, efficient and indigenous equipment that is less costly to operate.

Labour also should be optimized so as to ensure high productivity in relation to equipment. There should also be minimization of the collection vehicle route trips through proper and scheduled routing. The mode of waste collection should be communal at the residential areas and door to door or curbside at the commercial areas.

- d) The findings show clearly that there are insufficient funds to provide for an effective waste management service in the town. Waste evacuation should be seen as a service just like water provision or electricity whereby individuals pay as much as they use. In waste management this is a rather difficult thing to effect as demonstrated by the failure of "Polluter Pay Principle" elsewhere (**Cointreau, 1989**)

and Ogutu, 1993).The council should introduce a conservancy fee to be charged directly to the landlords or plot owners. The figures to be charged from the population have to be determined after a detailed financing plan has been developed and determined according to the limits accepted by the population in relation to fees for comparable services and to the municipality budget. The introduction of fees in general also needs some political goodwill and approval to be made in advance so as to avoid conflicts.

The Council should also note that a certain share of the population might not be able to pay for the services provided. These people need to be estimated in order to gauge the amount of money lost and raise it through the initial budget.

- e) Participation of the public as the people the service seeks to serve is very important. The Council should therefore develop an integrated community based waste management programme. The residents contend that waste management is one of the poorest services in the town and majority are ready to participate in a program that would improve the prevailing conditions. Community members must be involved at every stage of the waste management process. Interaction should be in two forms: the general public directly affected stakeholders. With the general public it takes the form of information dissemination and feedback.

Stakeholders may include those that have some vested interest in the system being addressed and could include landlords, shopkeepers and people in waste recycling. In dealing with the community the council should bear in mind two principles involved which are communication and conflict resolution. Communication is important and necessary as it enables participants to share information, analyze goals and objectives. Lack of information leads to failure of programmes (**Bent, 1976**).

Conflict resolution on the other hand recognizes that multiple participants bring together multiple ideas, perspectives and biases (**Hickman, 1994**). That even if participants communicate and reach a concensus on goals, conflict will inevitably appear between groups more so during implementation stage. Conflict resolution should be seen as a process of adjustment in which policies and actions are better adjusted and aligned to meet common goals.

The Council should sensitize the community members about the need to participate in the waste management service. This can be done through seminars and public barazas. In such fora the residents should be made to understand the need to store wastes in proper bins and the need to transport wastes to designated collection sites accessible to the collection vehicles.

The need for waste minimization through recovery, re-use and recycling should also be passed on to the residents. Through this processes the Council would be able to save a lot in terms of collection and disposal costs. Those that are presently doing recycling should be encouraged and if possible given some technical support and access to particular items they recycle by the Council.

5.4 Suggestions for further research

As stated earlier, this study did not cover all the aspects of waste management. In the course of the research there arose a number of issues that require further research.

- a) Since the study was restricted to one small town, it is possible to replicate it in other towns. This would give the study a more representative view.
- b) The scope of the study could be widened to involve other types of wastes, principally the clinical and the industrial wastes.
- c) The same study could be carried on a comparative basis where towns could be compared in terms of community participation, technology, collection and transport systems, town structure and sizes, among other issues.
- d) An analytical study should be done to assess the feasibility of resource recovery as a means of reducing costs of waste management.
- e) A more detailed research could be done to acquire information on the best approach that could be used to include the community members in waste management through information acquisition and active participation.
- f) Private investment in waste management an interesting area for further researches.

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APPENDIX Ia

DOMESTIC AND COMMERCIAL QUESTIONNAIRE

1 How many persons reside (live) in this house

_____ adults _____ children

2 What is the nature(physical composition)of your waste
(tick appropriately)

- a) paper
- b) food remains,vegetables peels e.t.c.
- c) textiles
- d) rubber
- e) plastics
- f) metals
- g) wood/woodproducts

3 Where do you store your waste

- a) in a pile no the floor
- b) iron bucket
- c) plastic bucket\carton
- d) don't store but throw away in a dump

if d was your choice above,where is the location of the
dump

- a) in the backyard/kitchen garden
- b) at the roadside
- c) in the corridor/alley
- d) other(specify) _____

4 What is the approximate size of your waste container

height _____
width _____
length _____

5 How often is the waste emptied from your house\shop for disposal

- a) once per week b) once in two days
 - c) once in a day d) once in three days
 - e) irregularly f) others(specify)
- _____

- 6 What are the current disposal arrangements for your wastes
- local authority
 - contractor (private)
 - self(specify whether you burn,compost,bury, e.t.c)

- 7 If you dump your waste, what happens to it
- stays there
 - removed by municipal authorities
 - searched by scavengers
 - others(specify)

- 8 Do you retain any material,either by re-using it or selling
- yes
 - no

If yes which waste type

- paper
- glass/ plastics
- metals/ clothes

- foodwastes
- others _____

- 9 What do you sell the above mentioned material

article quantity price how often

1 _____

2 _____

- 10 What wastes would you store if you were paid
- Any
 - None
 - Depends

If c was your choice explain

11 Where do you reside(go) after work

- home in the rural areas
- stays in a room/house behind the shop
- stays in a rented residence in town

- 12 Grade the various services accordingly.

	v.good	adequate	poor
road maintenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
water	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
waste collection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
sanitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
electricity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13 Tick any three services on order of priority you would like to see improved

- a) water c) wastes collection
b) sanitation d) road maintenance

14 What do you see as the biggest environmental problem in your community

- a) poor drainage d) dust
b) security e) poor roads
c) lack of water f) uncollected wastes

15 If rubbish bins were installed, how far would you walk to use these facilities

- a) 10 meters b) 100 meters
c) 50 meters d) would not walk at all

if your choice is d, explain

16 Would you participate on a program to improve solid waste collection in your community

- a) yes b) no

if yes, which among the choices below would you like to take part in (please tick one)

- a) Taking wastes to a distant communal collection point
b) Cleaning the town at regular intervals
c) Separating wastes on request into recyclable and disposable
d) Public awareness education

APPENDIX 1b**QUESTIONNAIRE FOR MUNICIPAL AUTHORITIES
I GENERAL INFORMATION**

1 Name of municipality _____

2 Population of municipality (give figures for the last five years).

1990 _____

1991 _____

1992 _____

1993 _____

1994 _____

3 What is the estimate of the transient residents _____

4 What is the population growth rate(%)

5 What percentage population has access to solid waste collection services

_____ %

6 Under which department does the solid waste services fall in your municipality

7 What is the growth rate of waste generation

_____ %

II WASTE COLLECTION AND TRANSPORT

1 How big is your refuse collection service area

_____ Km²

2 What percentage of the population have

a) House to house collection _____ %

- b) Communal container collection _____ %
- c) No collection _____ %
- 3 How much (approx.) waste is generated daily by these residents and their activities (use 0.5-0.6kg /day/cap.)
_____ tons/day
- 4 What percentage of the waste generated daily do you estimate is collected
_____ %
- 5 How frequent is the waste collected
- a) Within residential areas
[i] once per week [ii] twice per week
[iii] thrice per week [iv] any other(specify)
- b) Within commercial areas
[i] once per week [ii] twice per week
[iii] thrice per week [iv] any other(specify)
- 6 What is the normal location of waste bins in the following areas(roadside,pavements,inside e.t.c)
- a) Residential areas

- b) Town centre

- 7 (i) Is there a planned route of collection which the collection vehicle follows (please show on the map)
- (ii) How strictly is this route followed

- 8 Are there private collection operations
(i) yes (ii) no
- If yes how many operations\companies

- For each of the above, name the type of waste they deal in

- Is there any monitoring and policing of the performance for private companies?

9 Is there a separate collection system for hazardous and clinical wastes

i) yes ii) no

If yes how is it done

10 What are the municipal methods of charging for the collection and disposal of wastes

11 How is the waste loaded into the vehicle

- i) mechanical
- ii) manual
- iii) combination of i and ii

12 How is the waste unloaded at the dumpsite

- i) manual
- ii) mechanical
- iii) combination of (i) and (ii).

13 How does the waste collected vary seasonally, in types and amounts

types _____

amounts

II WASTE DISPOSAL

1 what modes of waste disposal do you use in your town

- a) composting
- b) open dumping
- c) sanitary landfilling
- d) incineration
- e) any other(specify) _____

2 If a combination of methods are used specify and give an approximate % of wastes disposed and the type

method % types

3 If dumping or sanitary landfilling is done, please answer the following questions

i) How many dumpsites are there

ii) Have the estimate of the remaining capacity of the dump-sites been done

a) yes b) no

iii) How long has the site been in use _____ years

iv) What is the surface area available _____ Km²

v) What are the topographical characteristics of this area

vi) Has the test for surface water presence been done at the sites (i) yes (ii) no

vii) What is the nature of the surrounding landuse

a) farming

b) residential

c) industrial

d) any other(specify) _____

viii) What is the distance of this site to

a) the nearest human settlements

_____ kms

b) the nearest water body e.g river

_____ kms

ix) Is there presence of scavengers at the dumpsite

a) yes b) no

if yes give the types

(i) animals

(ii) people

(iii) birds

x) What equipment and facilities are available at the dumpsite

a) water b) sanitation c) firefighting

d) any other(specify)

EQUIPMENT OPERATION AND MAINTENANCE

1 What type of equipment do you use for solid waste collection

- a) vehicles b) waste bins c) tractors
d) shovels, brooms, brushes e) any other (specify)

2 For vehicles and tractors specify:-

- a) make and mode (whether open, covered, tipper, handcarts, donkeycart e.t.c)

b) how many

- (i) tractors _____ (ii) trucks _____

- (iii) hand/donkeycarts _____ (iv) others _____

c) How procured (got)

(donated, imported, locally assembled, bought)

trucks _____

tractors _____

3 Waste bins: -

	type 1	Type 2	Type 3
Construction material			
Size/volume			

b) How are the bins supplied to the waste generators

- i) by the council-free
ii) by the council-bought
iii) bought by the waste generators from elsewhere iv) other (specify)

c) Is it enforced that all waste generators should have bins

- i) no ii) yes

4 Is there a central place for maintenance of waste management facilities

- i) yes ii) no

if yes, explain

5 What usable fleet(trucks,tractors)is usually down

$\frac{\text{trucks/tractors}}{\text{total no. of trucks/tractors}} * 100$

trucks _____%

tractors _____%

6 What percentage of landfill equipment is usually down

$\frac{\text{equip.down}}{\text{total no of equip}} * 100$

_____ %

7 What is the no of mechanics per usable equipment item
(e.g one mechanic per 2 trucks)

trucks _____

tractors _____

bins _____

others _____

8 Briefly describe availability and condition of maintenance of equipment

9 Is the refuse equipment assigned to one operator or is it
generally available to various users as part of an equipment
pool

10 Is there a checklist for daily maintenance activity

(i) no (ii) yes

11 Do the drivers and operators receive any training on equipment operation and
maintenance

i) no ii) yes

if yes are there refresher courses

i) no ii) yes

12 What system is used for drivers operators to report and record maintenance needs

- i) verbal-daily,immediately
- ii) written down in a checklist
- iii) does not exist

13 Has the municipal authority ever innovated any equipment for use in waste management

- i) yes ii) no

if yes describe the equipment usage and advantage over others

	1	2	3
Equipment description			
Advantage			

14 Is there good procurement of supplies and basic spareparts or are delays incurred in order to await these items

15 Is the equipment for waste management used for other purposes

- i) yes ii) no

if yes,please specify

equipment other uses

a) _____

b) _____

PERSONNEL

1 Do you have specific personnel that deals with waste management

- i) yes ii) no

if yes what percentage of municipal workers do they represent

personnel in waste management *100
all municipal workers

_____ %

2 Are there incentives for workers to provide more effective and productive work

i)yes ii) no

if yes specify(gifts,promotion,offs e.t.c.)

3 Is the collection crew assigned to specific areas where rapport (friendship) may develop between them and the residents

4 What type of upward mobility opportunities are there to collection workers e.g can they advance to be foremen

i) yes ii) no

if yes, explain how this is done.

5 Have any workers at any one time reported a health risk posed by the wastes

i) yes ii) no

if yes,explain what type

6 How many accidents/injuries occur to employees whilst carrying out their work (avg. occurrence/employee/p.a.)

7 What type of accidents/injuries occur to employees while on duty

8 What illnesses contacted by the employees have been traced to waste management processes i.e. collection, transport,or at the dumpsite

9 Are the employees provided with protective clothing

i) yes ii) no

if yes,what type of clothing

VI EXPENDITURE (Express in local currency)

1 What are the total capital requirements for solid waste management in your municipality _____ Ksh.

2 What are your operational costs/expenses in:-

a) Equipment _____

b) Administrative _____

c) Insurance/Taxes _____

d) Workers wages _____

e) Other workers _____

GRAND TOTAL

-----Ksh.

VII RECYCLING AND RE-USE/RESOURCE RECOVERY

1 Are there any recycling industries/processes currently in operation .

i) no ii) yes

if yes, list them _____

2 Are there recycling industries/processes in operation

<u>waste type</u>	<u>yes</u>	<u>no</u>	<u>number</u>
(i) paper	___	___	_____
(ii) plastics	___	___	_____
(iii) glass	___	___	_____
(iv) metal	___	___	_____
(v) others			_____

3 Is the municipal authority involved in the recycling industry

i) no ii) yes

if yes what wastes are involved

4 Are there separate bins for different waste types

i) no ii) yes

5 Is there informal waste recycling in your municipality

i) no ii) yes

if yes what type of wastes are the scavengers usually interested in

6 Does scavenging interfere with the municipal waste management

i) yes ii) no

if yes, how

7 Is there demand for recycled items in your municipality

i) no ii) yes

if yes specify three most demanded by priority e.g compost or paper

8 Do you feel recovery is technically and economically feasible in your area

POSSIBLE PROBLEMS

Listed here are various problems incurred in waste management.

Tick the four most prevalent in your municipality and arrange them by order of priority.

- a) Residents who indiscriminately dump waste in streets and drainage channels.
- b) Insufficient staff.
- c) Access to low income areas (narrow streets) and unplanned settlements
- d) Lack of funds to operate the collection system efficiently
- e) Poor maintenance of vehicles, unavailability of spare parts and lack of technology to repair them.
- f) Insufficient number of bins and capacity.
- g) No regular schedule and route for waste collection
- h) Others(specify)

Priority 1 ____ 2 ____ 3 ____

APPENDIX Ic
OBSERVATION DATA SHEET

1 Name of municipality

2 Waste sources (commercial)

	source description	Waste types
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

3 Scavenging (i) present (ii) absent , if present

	by whom	waste involved	for what
1			
2			
3			
4			
5			

4 Short and long term waste pollution problems present.

	Present	Absent	Risks/problems
Illegal Dumps Mosquitoes Rodents Flies Others			
Scavengers People Animals Birds Others			
Lecheate			
Dumpsites Mosquitoes People Animals Others			

4 Equipment

	Type	present/ absent	Condition	number
1				
2				
3				
4				
5				
6				

5 Low income areas

(i) accessibility _____

(ii) dumps _____

(iii) drainage _____

6 Presence of dwellings or water bodies at/near dumpsites

(i) dwellings _____

(ii) water body(dam,lake,and river e.t.c)

7 Peoples' attitudes and behaviors-observable characteristics

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