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Household Solid Waste Management in Limbe Cameroon; Practices, Problems and Prospects

BY

Din-Louis Georges

(PAIDWA0070)

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Supervised by:

DAN EKONGWE (PhD Fellow)

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THESIS FINAL SUBMISSION FORM

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Matriculation Number of Student:	MS/MA/PAIDWA0070
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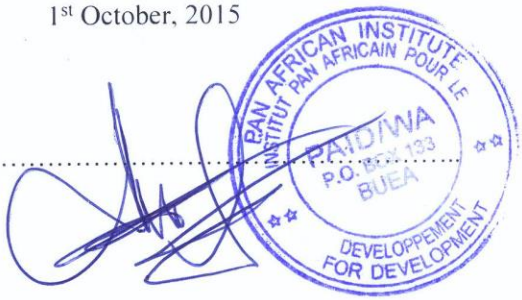

Statement of Originality

This is to certify that this thesis titled '**HOUSEHOLD SOLID WASTE MANAGEMENT IN LIMBE, CAMEROON: PRACTICE, PROBLEMS AND PROSPECTS'** submitted to the Pan African Institute for Development-West Africa, Buea in partial fulfillment of the requirements for the award of a Masters (MSc.) Degree in Sustainable Development is the original work of DIN-LOUIS GEORGES (PAIDWA0070).

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PAN AFRICAN INSTITUTE INSTITUT PAN AFRICAIN POUR LE DEVELOPPEMENT FOR DEVELOPMENT PAID/WA P.O. BOX 133 BUEA

Dan EKONGWE (Ph.D Fellow)

DECLARATION

I hereby declare that this dissertation is the result of my own investigation and relentless efforts, except where otherwise stated. The research was carried out at **PAN AFRICAN INSTITUTE FOR DEVELOPMENT-WEST AFRICA** under the supervision of **Dan EKONGWE (Ph.D Fellow)**

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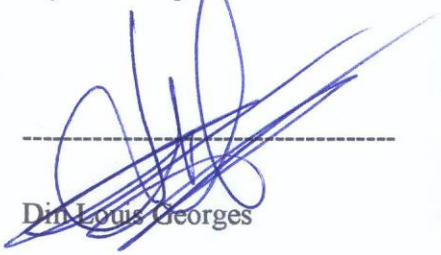

Din Louis Georges

June 215

DEDICATION

This study is dedicated to my son, Kitarvidzem Michael Njoh-Din.

TABLE OF CONTENT

CHAPTER THREE

MATERIALS AND METHODS

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF FINDINGS

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMENDATIONS

Acronyms and Abbreviations

LIST OF ACRONYMS

CBO	Community Based Organization
CNIC	Chantier Navale et Industrie du Cameroun
CDC	Cameroon Development Corporation
EPA	Environmental Protection Agency
FEICOM	Support Fund for Local Councils
GIS	Geographic Information System
HYSACAM	Hygiene et Salubrite du Cameroun
LCC	Limbe City Council
MINUDH	Ministry of Urban Development and Housing
MINTAD	Ministry of Territorial Administration and Decentralization
MINEPRD	Ministry of the Economy, Planning and Regional Development
MSWM	Municipal Solid Waste Management
NGO	Non-governmental Organization
OECD	Organization for Economic Corporation and Development
SONARA	Societe Nationale de rafinage
SWM	Solid Waste Management
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environmental Program
UNDP	United Nations Development Program

LIST OF TABLES

LIST OF FIGURES

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ABSTRACT

Generally, cities in the developing world face challenges in solid waste management and the situation in Limbe, Cameroon is no different. The city has an urbanization rate of 52% and it is estimated that its population will reach 150,000 inhabitants by 2020. Proper planning of waste management from generation to disposal will therefore ease waste management in the future. Accordingly, this research seeks to examine To assess the type and quantity of waste generated in the Limbe municipality; To assess the municipal waste management practices in Limbe and To investigate the problems faced by stakeholders in waste management in Limbe**.** In carrying out the study interviews, questionnaires and participant observation were used as the methods to collect data. The data was analyzed using the Statistical Package for Social Sciences (SPSS) and excel spreadsheet. The results reveal that, urbanization, rising income, increasing commercialization and household size leads to an increase in the generation of Household solid waste. Being a fast growing town managing solid waste in Limbe has become a big headache for municipal authorities in Limbe. The Limbe City Council and central state authority need to commit more resources for the keeping of Limbe clean and green and bring in community participation. The study recommends that a special agency for waste management should be created since this will reduce the confusion associated with having several agencies working on waste management at the same time. Also, Municipal authorities should start introducing composting and recycling programs of waste management.

Key Words: **Household, Solid Waste, Practices, Problems and Prospects.**

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND TO THE STUDY

Rapid urban development facing developing countries including Cameroon has come with serious environmental challenges concerning solid waste management. Solid waste arising from domestic, social and industrial activities is increasing in quantity and variety as a result of growing population, rising standards of living in most African countries and the development of technology (Dickerson, 1999). Solid waste management (SWM) is a common term that encompasses a wide variety of activities and practices that describes unwanted residues of any given culture.

Human activities generate waste which can be harmful to the environment, animals, plants and the ecosystem. However, only a careful management can limit the damage done to the environment and conserve scarce resources (Powell, 2001). SWM is an important facet of sustainable development for any country and global initiatives support the prioritizing of SWM.

Global effort to maintain the quality of the earth's environment is linked to sustainable development and is now propounded by governments as well as international organizations. For instance, a clean environment and effective waste management systems was one of the UN Millennium Development Goals MDGs. This recommendation, (on like in Agenda 21) MDGs indirectly advocates sustainable Solid waste management (SWM) within the framework of the 'seventh goal' which addresses environmental sustainability. The aim is to foster the integration of the principles of sustainable development (SD) into each country's development policies and programs (UNDP, 2007).

Waste generation dates back to man's origin and the early way of life which principally was foraging through the nomadic experience and pattern of life. The abandonment of the nomadic way of life led to the creation of permanent communities. With mutations and evolutions that have accompanied humanity, waste that was earlier given low priority in most communities

increasingly gained attention for proper management. Recently, and through communal and municipal actions, conferences and training workshops as well as government action waste management has become a conjecture for responsible public health and safety (Pichtel, 2005).

The fundamental environmental issue in industrial and developing countries throughout the world over waste is the identification and management of waste streams (Twardowska, 2004). As urbanization continues to take place, the management of solid waste becomes a major challenge posing major public health and environmental problems for many countries. As a result, development must be sustainable, in the sense of reducing the ecological footprint while simultaneously improving the quality of life – for ours and future generations – within the capacity limits of the globe (Lundström, 2007).

The characteristics and quantity of Municipal Solid Waste Management (MSW) arising from domestic, commercial, and industrial activities is not only the result of growing population, rising standards of living and technological development, but also due to the abundance and type of the natural resources from the country or community (Dongqing *et. al*, 2010). The approach for SWM also varies and should be compatible with the nature of a given society. For instance, many studies on MSW management structures and systems in developing countries have revealed that the quantity of waste and composition vary according to the characteristics of the area and the management must be adapted to limitations common to such environment. These limitations are attributed to immaturity in terms of expertise in developing appropriate models and effective legal framework for the MSW management. As a result, the citizens and the community depend on the municipal authorities for solid waste collection and disposal (Puentes, 2004).

Consequently, looking at the problems and challenges that have plagued municipal authorities in carrying out their duties is pertinent because it will help to design possible solutions. Such a prospect will facilitate the task of the municipal authorities by guiding their decision making process, practice and help encourage research on sustainable ways to address this growing problem.

According to Pearce, (1994) developing countries face several major problems as a result of solid waste management and has been classifies thus:

- Health hazards from uncollected waste

- Health hazards from collected but poorly disposed of waste
- Economic burden of waste disposal on towns and cities.

According to Flintoff, (1984), the total population of developing countries accounts for more than 70 % of the world's population. Waste management in these countries is of grave concern from two points of view: Firstly, the process of urbanization and population concentration that is inextricably linked to waste management issues is progressing at a pace that is much faster than was ever experienced by today's industrialized countries. The issue of waste management in developing countries, therefore, has emerged as a critical and impending disaster. Secondly, these countries often have difficulty in streamlining the institutional systems, administrative bodies, management capabilities and human resources that are needed to take the lead in solving solid waste problems. It is thus difficult for them to respond effectively to the emerging challenges of solid waste management.

In Cameroon, like other African countries, waste management is poorly practiced. The study of Manga et al, (2007) indicated that solid waste management services are rudimentary. The practice is primarily concerned with the collection and dumping of waste without proper management methods. This form of management is due to factors such as inadequate financial resources, low levels of law enforcement as well as poor governance and lack of human resource. Moreover, current regulations do not adequately address waste handling or disposal. Inefficient implementation of waste management policies and documentation is affected by a duplication iof functions and responsibilities between several governmental agencies and the local councils (Manga et al, 2007). Furthermore, the infancy of literature on local cases makes it inadequate for the proper functioning of waste management. In this regard, waste management in Limbe is inefficient in hazard minimization because sustained efforts have not been developed in the domain of waste education, collection, transportation, treatment and final disposal. The sustainable management of solid waste systems is necessary in order to minimize environmental and public health risks worldwide (Manga et al, 2007). The balance between the specific components of this system in delivering sustainable waste management are already well understood and established in most developed countries, unlike in developing countries like Cameroon. Waste management could be efficient through the involvement of all stakeholders

that is, waste generators, waste processors, formal and informal sectors, financial institutions and private initiatives such as non-governmental and community based organizations (Manga et al, 2007).

1.1.2 Geo-Historical Background: Location and Biophysical Characteristics of Limbe

Figure 1.1: Map of Cameroon showing the Study Area

Source: http://en.wikipedia.org/wiki/File:Southwest_Cameroon_divisions.png

The republic of Cameroon which is found in the Central African Region (2°-13°N and 8°-16°E) is situated on the extreme north-eastern end of the Gulf of Guinea. This exposes the territory to a variety of natural hazards, some of which are associated with volcanic activity. Such hazards are concentrated around the Cameroon Volcanic Line (CVL), especially around Mt. Cameroon, (Zogning et al, 2009). Cameroon shares boundaries with the Atlantic Ocean, Nigeria, Central African Republic, Equatorial Guinea, Gabon and Congo Brazzaville. Cameroon is located between Central and West Africa, but belongs to the Central African Union. It has a surface area of 469,440km² and population of about 20 million inhabitants (Eyong and Mbuagbo, 2003; Manga et al, 2007).

The climate of Cameroon results from the combined convergence effects of the tropical oceanic low-pressure zone and the inter-tropical front within Africa. Two distinct seasons are witnessed in the country: a long rainy season normally up to 7 month (March-October) and an extremely short dry season (November-February). The south-westerly monsoon winds are the most predominant with wind speed reaching 18m/sec (Eyong and Mbuagbo, 2003). The duration of the rainy season and the amount of rainfall decreases from south to the northern part of Cameroon. Apart of these characteristics there are three major climatic zones that can be identified in the country and include the following:

1. The Equatorial zone in the south, which is characterized by abundant rainfall (about seven months) and forest vegetation;

2. The Sudanian zone in the north-central part of the country, which is characterized by a combination of grasslands and scanty forest vegetation;

3. The Sudano-Sahelian zone in the north, which is characterized mainly by semi-arid grassland vegetation (Asong, 2010).

Geographically, Limbe is situated between longitude 9° and 13° E and latitude 4° and 9° N. Climatically, Limbe is dominated by the equatorial climate of high rain fall and high temperatures. The yearly average temperature is 26.5°c, and yearly average rainfall is above 250 mm, while the annual average related humidity is above 82.5%. According to the World Bank census (2010) Limbe which was formerly known as Victoria has a population of about 120, 000 inhabitants with an estimated percentage of 2.9% growth rates. The city is divided into 4 local councils namely: the Limbe city council managed by a Government Delegate; then Limbe 1, Limbe II and Limbe III managed by Mayors.

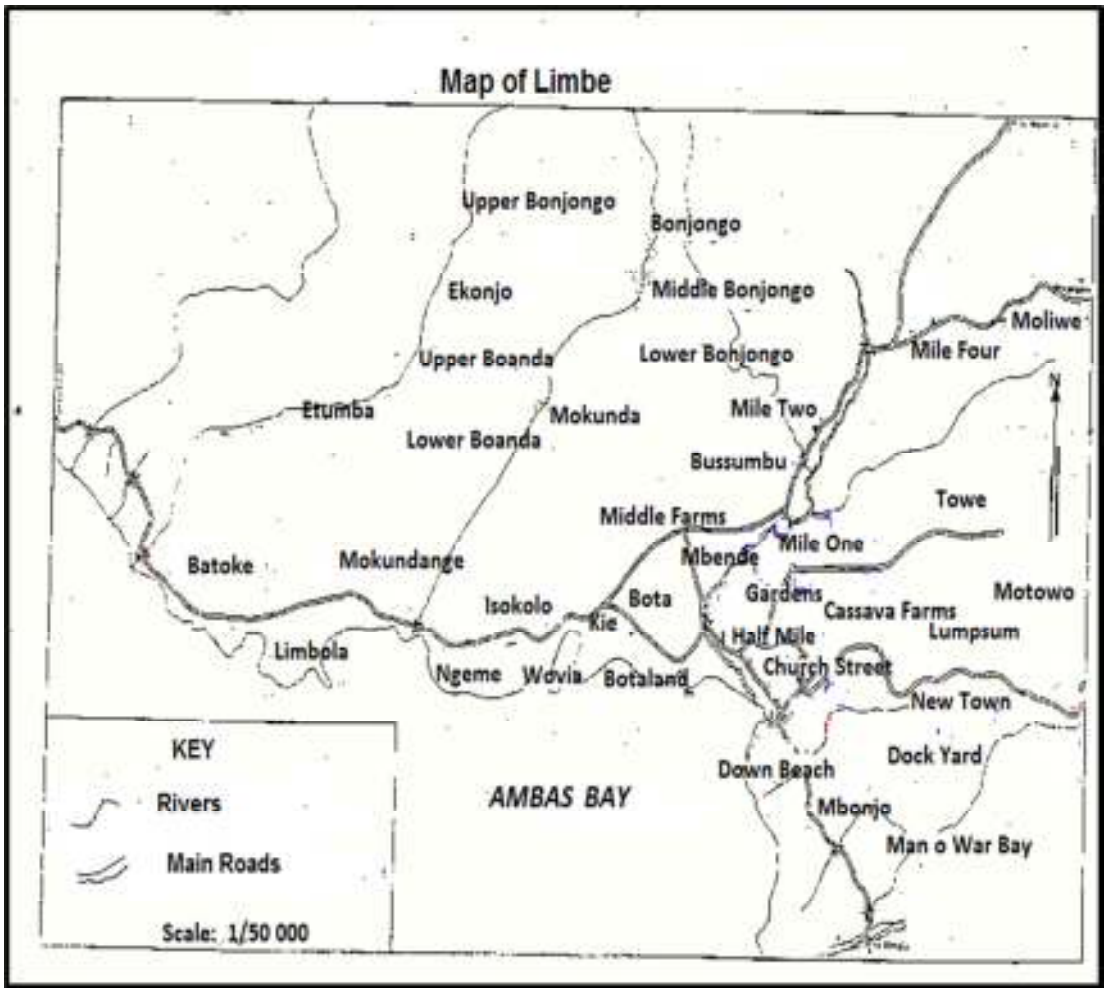

Figure 1.2: Map of Limbe

Source: Awum et al 2000

For instance, a growing night life culture, tourism and motel/bar life will generate waste of a certain category principally plastic and seasonal domestic waste. The fishing industry of historical significance has environmental connotations linked to public sanitation and pollution from increasing fish smoking. These activities increasingly generate interest with researches and studies on environmental protection and it is from this background that the motivation for my study was developed.

Figure 1.3 R Hellgrewe painting of Victoria-1908

Figure 1.4 Present day Traditional fishing boats on the Limbe beach

Figure 1.5 The Limbe coastlines with Bioko in the background

1.2 STRUCTURE OF WASTE MANAGEMENT IN CAMEROON

In Cameroon, waste management has developed at a gradual pace over the past decade. Many ministerial departments have the mandate to implement solid waste management regulations and the highest body responsible for municipal solid waste management in Cameroon is the Inter-Ministerial Commission for Municipal Waste Management (ICMWM), created under the direction of Prime Ministerial Decree No. 95/230/PM of31/04/95. It is charged with formulation and policy development for appropriate municipal solid waste management strategies. According to Cameroon Law on Environmental Management No. 96/12 of 5/ 08 1996:

> "Waste shall be any residue from the production, processing or utilization process, any substance or material produced or, more generally, any movable and immovable goods abandoned or intended to be abandoned" and "Waste management" shall be the collection, transportation, recycling and elimination of waste, including the monitoring of disposal sites."

Limbe was selected because it is one of the fastest growing cities in the country due to increasing industrialization, commercialization and demography caused by recent migration into the city. The population growth is about 2.9% per annum and the population will reach 200,000 inhabitants by 2020 (LCC). This population increase as argued above is also due to the fact that the city is experiencing economic expansion and this attracts people from all over the country. Hence, the challenges to manage household waste will continue to grow, and for this it is important to address the problems of solid waste management to ensure that the kind of problems faced in Douala and Yaoundé in matters of waste management do not occur in Limbe or rather can be handled more effectively.

Limbe has the unique opportunity and challenge for the study because of the diversity and categorization of its waste which include solid, liquid and hazardous health disposable waste. The first category comes from seasonal variations as well as the points of increasing commercialization as argued above and which is the focus of this study. Table 1.3 shows the responsibility of key ministerial department on waste management in Cameroon. On the other

hand table 1.4 shows the laws and regulations guiding waste management in Cameroon and the statutory order which gives them the legal jurisdiction or powers of implementation.

1.2.1 Institutional Framework for Waste Management- Cameroon

Table 1.2 Activities of Ministerial Departments related to Waste Management-Cameroon

Ministry	Responsibility in SWM	Statutory order
Ministry of territorial administration and decentralization (MINAT)	Follow-up and implement regulations for organizations and functioning of Councils; Oversees the execution of the budget of the government' council support fund(FEICOM); Restoration of hygiene and public sanitation; supervises Urban Councils which are responsible for follow-up and control-industrial waste management, management of all public spaces and infrastructure; Sweeping of streets, collection transportation and treatment of household waste ,	Circular letter No.0040/LC/MINAT/DCTD of 04/04/00, Order No. 00072/MINAT/MINVILLE of 21/05/00, Law No. 714/23 of 5/12/74, Law no.2004/18 of 22/07/04
Ministry of Mines, Industries and Technological Development(MINMITD)	Develop strategies for industrial development and the control of Classified and commercial installations for pollution, security, hygiene and industrial nuisance; Define norms for industrial pollution; List of dangerous, obnoxious and polluting facilities in order to inform the public; Develops regulations governing installation and exploitation of facilities classified as dangerous, obnoxious and polluting	Decree No. 99/818/PM of 9/11/99, Order No. 13/MINME/DMG/SL of 19/04/77, 02/MINMEE/DMG/SDAMI Of 4/01/9
Ministry of Economy and Finance(MINEFI)	Financial control of organizations benefiting from supplementary budgets and autonomous public establishments, i.e. Councils; Responsible for managing the Finance Law as enacted by Parliament.	Constitution Decree No. 2004/320 of 08/12/04
Ministry of Urban Development and Housing(MINDUH)	Develops and implement Urban restructuring, management strategies, sanitation and drainage; Defines and enforces norms of hygiene/sanitation, collection and/or treatment of household waste; Liaises with international agencies for urban development	Order No. 00072/MINAT/MINVILL of 21/05/00
Ministry of Environment and Nature Protection(MINENP)	Collaborates with other agencies to define measures for the rational management of natural resources; Effective control of investigation and pollution in the field; Specifies the criteria(project specific) and supervises environmental impact assessments	Decree No. 2005/0577/PM of 23/02/05 7), Order No. 006/MINEP of 08/03/05
Ministry of Public Health(MINPH)	Creates Hygiene and Sanitation Units in Councils; Renders technical support to the Hygiene and Sanitation Units Councils, Proposes norms for collection, transportation and treatment of industrial, domestic waste and emptying of septic	Order No. D67/NS/NN/ST/SG/BMPHP/ NNPA of 11/08/87, Circular letter No. D69/N6/DMHK/SHPA of

	tanks; Designs and implements public education campaigns on hygiene and sanitation.	August 1980

Table 1.3 Showing Legal Frameworks for Waste Management in Cameroon

Law	Points related to waste management	Statutory order
Law relating to Environmental Management(No.96/12 of 5/08 1996)	modalities for the conduct of Environmental Impact Assessments(EIA) and categories of operations subject to EIA; Specifies air emission and waste water discharge standards; Set conditions for issuing authorizations for allotment and management of land for uses, i.e. industrial, urban; Prescriptions relating to waste elimination by persons producing or treating waste; Stipulates the terms of reference for the supervision of municipal dumps by the competent authorities	Decree No. 2005/0577/PM of 23/02/05, Order No. 006/MINEP of 08/03/05
National Environmental Management Plan	Five year amendable plan; set up environmental information system; Preparation of bi-annual reports on the state of the environment in Cameroon, e.g. identifying problems arising from urban pollution and devising suitable micro-projects to mitigate the problems	
Law relating to the installation of Classified establishment(Law No. 98/15 of 14/07/98)	Stipulates two types of Classified establishments (Class 1 and Class 11).Dump sites are classified as Class II establishments for which operations and management must followed prescribed guidance. It sets out the regulations governing the installation and exploitation of facilities classified dangerous, obnoxious and polluting	9/11/99, Order No. 13/MINMEE/DMG/SL of 19/04/77, 02/MINMEE/DMG/SDAMIC of 04/01/99
National Water Code (Law No. 98/005/of 14/04/98)	Provides framework for the exploitation of water resources including waste disposal, Specifies modalities for the protection of surface and groundwater from pollution (including from dump sites).	Decree No. 2001/165/PM of 08/05/01
New Urban Strategy, 1999	Partnership among the state, local council and authorities and civil society in urban intervention in areas such as solid waste management.	

Source: Manga et al, 2007

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1.3. WASTE MANAGEMENT HIERARCHY

The Waste Management Hierarchy was first put into use by the United States Federal legislation in the Federal Facilities Compliance Act of 1992. However, Waste Management Hierarchy had been used for most of the decade before it was incorporated into the Federal Facilities Compliance Act of 1992. The Waste Management Hierarchy is itself an evolution of the waste management ideology of the"3 Rs"; (i.e, to reduce, reuse and recycle). The Sustainability Hierarchy, like the Waste Management Hierarchy, is a statement of ideology (Envirobiz, 2010).

Waste management hierarchy is a widely accepted order of waste management options. The European Council in its Waste Directive of 1991 sets the hierarchy of waste management options as follows:

1. Waste prevention
2. Recovery
3. Safe disposal

However, for a long time, the waste management hierarchy was ordered as follows (Kirkpatrick, 1992) reduce, reuse, recycle, recovery and disposal. The hierarchy is intended to encourage people to re-think not only how their waste is managed and divert away landfill, but also how they can reduce the amount of waste they produce.

Explanation of the five steps of the hierarchy is exposed in the diagram below.

Fig 1.6 Waste management hierarchy

Source: Pongrácz et al. 2010

1.2.1 Reduce

as well as looking at reducing the amount of things we buy, particularly goods which are not constructed or packaged using recyclable material, the reduce step can be applied to the general "think green" motive such as turning lights and electrical items off when not in use.

1.2.2 Reuse

It can be applied to the composting of certain food waste materials but also things like repairing damaged furniture or buying second hand goods. Many consider re-use as the second preferred option after waste minimization. Re-use for the same purpose is included in the waste minimization options by EEA, but re-use for another purpose is listed as "waste management option". Re-use, is however not included in recovery options of Table 3, neither is defined as such in waste legislation, only related to packaging end end-of-life vehicles. Re-use is best defined by Lox (1994): as use, for the second or more time, of a product for the same purpose, under the same form and with the same properties of the material as the first use, the material having constantly remained under the same form between several uses.

1.2.3 Recycle

Waste is sorted by the kind of material it is constructed of, then it can either be processed to produce a higher quality product or "down cycled" to produce a low-value raw material. For recycling to be environmentally beneficial, the effects of the collection, transportation and reprocessing operations must be less harmful than those resulting from the extraction and processing of the virgin raw material that the recycled product replaces. Recycling actually only occurs once the secondary material has been converted into a new product, or is utilized in another way. Thus, the availability of markets for the secondary materials generated is fundamental to the success of recycling. For recycling to be environmentally beneficial, resources use optimization guidelines have to be considered (Pongrácz *et al*. 2010)

1.2.4 Energy Recovery

This is the process of creating energy by incinerating waste material typically using material which cannot be recycled into a usable product.

1.2.5 Disposal

Any remaining waste which cannot be recycled or used for energy must be disposed of in an appropriate manner. Both of the hierarchies are correct, and all of these concepts are widely used. Lime falls under this section which is disposal as there is little or none of the above methods being practiced on a bigger scale. The relative order of new and old hierarchies is illustrated bellow

Table 1.4 Different stages of waste management hierarchy

New hierarchy	"Old" hierarchy
Waste prevention	Waste minimization
Recovery	Re-use, Recycling,
Safe disposal	Incineration
	Disposal

Source: Pongrácz et al. 2010

One of these hierarchies is using waste prevention as the most preferable option, and the other waste minimization (Pongrácz et al. 2010)

1.4 STATEMENT OF THE PROBLEM

Public planning in the area of solid waste management is an extremely complex subject especially when dealing with planning collection routes, sitting processing facilities, as well as choosing locations for landfills and planning what will become of the landfill once they are full. Such challenges and the impact of waste disposal on the environment have led to the search for sustainable solutions in waste management in both developed and developing countries.

The disposal and burning of domestic waste can cause profound strain on the environment, contamination of ground water resources, organic and inorganic pollution of nearby surface

water and carbon dioxide released from landfills as the main disposal site. Economic and population growth, urbanization and industrialization as well as commercialization are responsible for the challenges that national and the local government council's face in their efforts to organize a sustainable waste management.

In 2006 the global amount of municipal solid waste generated reached 2.02 billion tones, representing a 7% annual increase since 2003 (Global Waste Management Market Report 2007).

Before now studies have been conducted on waste management in Cameroon and in Limbe. For instance, Mbeng *et al*. (2012) carried out a study on waste characterization in Limbe as an element of household waste management operations. The study focused on the composition of household waste in the municipality. Manga *et al* (2007) examined waste management in Cameroon and looked at policies and how these institutions are set to better handle this situation. This study therefore attempts to identify and document the existing practices, problems of solid waste management in Limbe, as well as propose possible solution for an effective and sustainable waste management in the Limbe municipality.

Waste management is an exercise that has moved from manual to scientific operations. Such include when planning collection routes, siting processing facilities, as well as choosing locations for landfills and planning what will become of the landfill once it is full. AS many waste managers will attest, planning routes for garbage, yard-waste and recycling collection is complex and includes many factors such as planning collection routes, including the number of stops, fuel efficiency of the collection vehicles, as well as measuring each load of garbage into the trucks.

To this effect, efforts have been made to enhance solid waste management from urban agglomerations like HYSACAM in Limbe,, yet many problems persist and this is the focus of this study. Such problems include the measure of collection/week, the distance and zonal mapping of the collection routes as well as inappropriate dump site. Furthermore, there is the problem of a very ineffective process of measuring the volume and weight of each truck load of collected waste. Although these challenges could come from multiple sources such as the lack of the political will from the government to allow local councils to autonomously handle the waste management, local councils themselves need to develop effective and sustainable system and implement sound practices and policies for sustainable waste management.

This study therefore, examines the way forward for the Limbe City Council in matters of waste management in partnership with HYSACAM by asking the following questions:

1.5 THE OBJECTIVES OF THE STUDY

The general objective of this study is to assess the practices, problems and prospects of municipal solid waste management in the Limbe municipality.

1.5.1 The specific objectives will include the following:

1. To assess the type and quantity of waste generated in the Limbe municipality.
2. To assess the municipal waste management practices in Limbe.
3. To investigate the problems faced by stakeholders in waste management in Limbe.

1.6 RESEARCH QUESTIONS

In other to achieve the research objectives, the following research questions were raised:

- What type and quantity of municipal solid waste is produced in the Limbe municipality?
- How is municipal solid waste managed in Limbe**?**
- What are the problems faced by the stake holders involved in waste management?

1.7 THE SIGNIFICANCE OF THE STUDY

The justification for this study stems from the fact that solid waste management globally is shifting from manual to more scientific and technologically advanced methods and models. The practice and problems of solid waste management in Limbe at least from the stand point of this study suggest that the can be better options to manage waste in the city if effective attention, research and community participation is undertaking. The study therefore will help the municipality of Limbe develop better management models which will go a long way to improve the hygiene and hence livelihood of the inhabitants. While other towns and cities in Cameroon

continue to grapple with solid waste management, this study attempts to introduce the concept of GIS in waste management as the way forward that will accommodate and facilitate the process of waste management in a town that is witnessing increasing commercialization, population and rapid urban development.

1.8 ORGANIZATION OF THE STUDY

The study is organized in five chapters and each chapter deals with a specific theme of the study. Chapter one is the introduction of the study and focuses on the background of the study, statement of the problem and research questions as well the significance of the study and limitations of the research. Chapter two examines the literature review and theoretical framework. Chapter three examines the research methodology and Chapter four is the presentation and analysis of data otherwise described as discussion of the subject matter of the study. Lastly, Chapter five presents the summary findings, conclusion and recommendation of the study.

CHAPTER TWO
LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter reviews the relevant literature on waste management and presents the theoretical framework of the study. The literature is diverse and covers the different themes of the work including definition of terms. The section that deals with definition of terms is important because it facilitates understanding of the work and simplifies the technical language of the subject since the study is increasingly inter- disciplinary.

2.1 DEFINITION OF KEY TERMS

2.1.1 Sustainable:

Since the 1980s sustainability has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability as a part of the concept sustainable development, that of the Brundtland Commission of the (United Nations on March 20, 1987): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

2.1.2 Solid waste

The term solid waste may be used to refer to municipal waste and falls under seven categories: residential (household or domestic waste), commercial, institutional, street sweeping, construction and demolition, sanitation and industrial wastes (Rush B, 1999). Likewise, municipal solid waste refers to solid wastes from houses, streets and public places, shops, offices, and hospitals, which are very often the responsibility of municipal or other governmental authorities. Solid waste from industrial processes is generally not considered as municipal. However, because this waste finally ends up in the municipal waste stream, it should be taken into account when dealing with solid waste. Synonymous to solid waste are terms such as "garbage", "trash", "refuse" and "rubbish" (Zurbrugg, 2000) especially in some literature in North America.

There is still no single scientific definition of solid waste. The notion of solid waste was not used in its current meaning until the twentieth century (Savas, 1977).

According to (Pongracz, 2002), the notion of waste is relative in two main respects.

- When something loses its primary function to a given user, it becomes waste. Therefore, one person's waste output is often someone else's raw material input.
- The notion of waste is relative to the technological state of the art and to the location of its generation.

2.1.3 Waste emission

At present waste continues to be disposed of on the land, in intermediate zone of the ground, air and water. Environmentalists and waste management practitioners coincide that disposal of waste still poses a major environmental problem. For instance Bidlingmaier, (1990), says MSW has the potential to contaminate our natural environment (air, water and land), if its disposal is not correctly managed, thus affecting human health and compromising ecological conditions. Landfills have been historically associated to environmental issues such as gas emissions, surface and ground contaminations and land cover issues.

2.1.4 Leachate

Waste can also affect water and soil through the slow escape of Leachate from waste disposal sites, heaps of garbage, and inadequate waste collection systems. Leachate is known to be contaminated water that percolates through waste. Bilitewski *et al*. (2000) define leachate as "all contaminated water that has been in contact with waste".

Porteous (2000) further notes that leachate properties differ depending on the type of waste, the physical condition where it is generated, weather conditions, and the chemical processes occurring in disposal sites or landfills. Extensive research on leachate from MSW has shown that it includes a high level of organic components from household waste. Leachate is characterized by a high concentration of ammonia and organic nitrogen compared to uncontaminated water. The leaching of household waste that is untreated can produce a substance with a "high biochemical oxygen demand" BOD which has negative effect on neighboring water sources.

2.1.5 Solid Waste Management (SWM)

The World Bank (2011) definition of Solid Waste management means "to collect, treat and dispose of solid wastes generated by all urban population groups in an environmentally and socially satisfactory manner using the most economical means available". In his paper, Schubler (1996) separates the definition of Solid waste management into two. Solid waste is defined to include "refuse from households, non-hazardous solid waste from industrial, commercial and

institutional establishments (including hospitals), market waste, yard waste and street sweeping" and the management of the waste is a cyclical process which includes "setting objectives, establishing long-term plans, programming, budgeting, implementation, operation and maintenance, monitoring and evaluation, cost control, revision of objectives and plans".

Squires (2005) further explain that the objective of solid waste management is basically the use of resources efficiently in the process of waste materials. According to Baud et al, there are a range of actors in urban solid waste management and they can be clustered into four groups which are the public sector (national authorities, local authorities and local public departments) constituting a central set of players; the private sector (large and small registered enterprises carrying out collection, transport, disposal and recycling); the small-scale, non-recognized private sector (waste pickers, itinerant buyers, traders in waste materials and non-registered small-scale enterprises); local community and its representatives (NGOs and CBOs) . In recent years there been differences in the opinions about how solid waste should be managed. (Obirih-Opareh, 2004) looks at one of the issues concerning solid waste management whether it should be decentralized, whether it should be under community participation, privatized or whether it should be managed a combination of all these different actors. The focus here is how SWM practices were organized and the PCPs that happened or did not happen under the SWM activities.

2.1.6 The principles of waste management

The principles of waste management, as identified by Schubeller *et al*. (1996) are "to minimize waste generation, maximize waste recycling and reuse, and ensure the safe and environmentally sound disposal of waste". This means that waste management should be approached from the perspective of the entire cycle of material use which includes production, distribution and consumption as well as waste collection and disposal. While immediate priority must be given to effective

Collection and disposal, waste reduction and recycling should be pursued as equally important longer-term objectives.

2.1.7 Land filling:

According to Narayana, (2009) Land filling is the deposition of waste either in a specific land area with the goal of preventing such waste from impacting negatively on the environment. The landfill directive has its roots in the hierarchical prioritization of waste management options- giving maximum preference to prevention of waste, with reuse, recycling, recovery options following and land filling having the least priority.

According to Bogner *et al,* (2007) despite being widely considered as the least desirable option, the most prevalent approach to the disposal of waste globally has been the utilization of landfills. This remains an important aspect of the solid waste management (SWM) plan of most countries and varies in structure; ranging from sanitary landfills, to semi-controlled landfills and uncontrolled (or open) dumpsites (Remigios, 2010). Sanitary landfills are designed according to specifications which help to ensure minimal impact of disposed waste on the environment.

2.18 Incineration:

Thus, energy could be gained from incineration of waste or landfill gas combustion, which may be used to generate electric power (from steam under high thermal conditions) or produce heat for buildings through boilers (Williams, 2005). In the reduction of solid waste volume by 70 to 80% lies also a main advantage of this method of waste disposal, as this minimizes the quantity of waste that is eventually sent to the land fill. Consequently, for nations where land space challenges exist for example, Japan and Singapore, incineration is a popular waste disposal option (Williams, 2005).

According to Williams (2005), simultaneous production of heat and power (combined heat and powers) from landfill gas and incineration makes optimum energy recovery from (organic) waste achievable. However, in comparison with their initial forms, new products that arise from incineration of waste (liquid and air discharge inclusive) pose more difficult management and environmental challenges- a development which has increasingly seen many countries banning this option for waste management

2.1.9 Types of Solid waste

Usually, solid wastes are one of three types namely: municipal wastes, industrial wastes and hazardous wastes (Asnani, 2006).

- **Municipal waste**

The definitions of terms and the classifications used to describe the components of solid wastes vary greatly in practice as well as in the literature. The definitions presented above are intended to serve as guide for municipal solid wastes (Colas, 2000).

- **Industrial wastes**

Industrial wastes are waste arising from industrial activities. They include rubbish (associated with the support personnel), process wastes, ashes, demolition and construction wastes, special wastes and hazardous wastes. (Colas, 2000).

- **Hazardous wastes**

Hazardous waste are classified as wastes that pose a substantial danger, either immediately or over a period of time, to human, plant or animal life. A waste is classified hazardous based on the fact that it exhibits any of the following characteristics: ignitability, corrosively, reactivity (Asnani, 2006).

2.2 THE CONCEPT OF WASTE MANAGEMENT

Gbekor (2003) refers to waste management as involving "the collection, transport, treatment and disposal of waste including after care of disposal sites". Similarly, Gilpin (1996) has defined waste management as "purposeful, systematic control of the generation, storage, collection, transportation, separation, processing, recycling, recovery and disposal of solid waste in a sanitary, aesthetically acceptable and economical manner". To Schubeller *et al.* (1996), municipal solid waste management is "the collection, transfer, treatment, recycling, resource recovery and disposal of solid waste in urban areas".

From these suppositions, it can be deduced that waste management is the practice of protecting the environment from the polluting effects of waste materials as a measure to protect public health and the natural environment. Thus, the priority of a waste management system is the

provision of a cleaning service which helps to maintain the health and safety of citizens and their environment (Cooper, 1999). In this regard, Gilpin, cited by Baabereyi, (2009) regards the business of waste management as a professional practice which goes beyond the physical aspects of handling waste. It also "involves preparing policies, determining the environmental standards, fixing emission rates, enforcing regulations, monitoring air, water and soil quality and offering advice to government, industry and land developers, planners and the public."

Waste management, therefore, involves a wide range of stakeholders who perform various functions to help maintain a clean, safe and pleasant physical environment in human settlements in order to protect the health and well-being of the population and the environment. Effective waste management is, however, a growing challenge to all municipal governments, especially in developing countries. One reason for the challenge is that reading the positions advocated above one realizes the absence of waste generators in the chain of production or the life cycle of waste management systems. It could be argued that it is important to identify the sources of waste and build a historical gradient of the exercise to be able to determine the high periods and simpler categorization of waste from any particular region. This is so because waste from colonial societies which were at infancy within the framework of an emerging world economy produced waste significantly small and diverse from the present society of multi-billion dollar industries.

2.3 EFFECTIVE PARTNERSHIP FOR WASTE MANAGEMENT

Obiri-Opareh (2003) defines partnership as "enduring, mutually beneficial relationships between two or more actors based on written or verbal agreement and having a concrete, physical manifestation. The author further notes that the core objectives of partnerships in basic urban settings is to deliver services in a more effective and efficient way. In the case of waste management for example, these can be garbage bins, transfer stations, disposal sites and collection vehicles). On his part, Gray (1989) defines partnerships as "a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited visions of what is possible".

From an institutional point of view, the OECD (1990) defines partnerships as "systems of formalized co-operation, grounded in legally binding arrangements or informal understanding, co-operative working relationships, mutually and adopted plans among a number of institutions. They involve agreements on policy and programme objective and sharing of responsibility,

resources, risks and benefits over a specified period of time: Effective development requires sustainable partnerships at different levels of government, the private sector, donor groups and the civil society.

Public - Private Partnership (PPP) can be defined as a partnership in which government and private companies assume co-responsibility and co-ownership for the delivery of city services (Ahmed and Ali, 2004). For example, the partnership between the Cameroon Government and HYSACAM whose nature and structure can be linked to the legal framework reached at the Rio de Janeiro and the Kyoto agreements from 1992. The partnership was reached in 2007 with HYSACAM to improve on the collection of garbage in Cameroonian towns. HYSACAM is an off-shot of a multi-national waste management company in France called VEOLIA PROPRIETE Sa. The mother company is engaged in water, energy, transport and waste management and it is globally established in thirty eight countries with a good reputation in service delivery and improvement in environmental conditions.

HYSACAM is expected to conform to international standards as prescribed by the Kyoto agreement. The main goal of the Kyoto Protocol was to contain emissions of the main anthropogenic (human-emitted) greenhouse gases (GHGs) in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to make the reductions. The treaty is a follow up to the main principles of the original 1992 UN Framework Convention. The Kyoto Protocol's first round commitments are the first detailed step taken within the UN Framework Convention on Climate Change (Gupta *et al.*, 2007). The Protocol establishes a structure of rolling emission reduction commitment periods. It set a timetable starting in 2006 for negotiations to establish emission reduction commitments for a second commitment period. It is important at this stage to show a historical gradient and build up to the Kyoto agreements. As concerns for the environment and climate change gathered momentum amongst researchers, academic institutions, governments and international organizations, discussions through international networks led to the need to develop a legal framework to allow the world community to operate regarding the environment according to official standards. The high water mark came in 1992 first with the Rio de Janeiro declaration; a time line is shown below:

1. **1992:** The UN Conference on the Environment and Development is held in Rio de Janeiro. It results in the Framework Convention on Climate Change

2. **1995:** Parties to the UNFCCC meet in Berlin (the 1st Conference of Parties (COP) to the UNFCCC) to outline specific targets on emissions.

3. **1997:** In December the parties conclude the Kyoto Protocol in Kyoto, Japan, in which they agree to the broad outlines of emissions targets.

4. **2002:** Russia and Canada ratify the Kyoto Protocol to the UNFCCC bringing the treaty into effect on 16 February 2005.

5. **2011:** Canada became the first signatory to announce its withdrawal from the Kyoto Protocol.[14]

6. **2012:** On 31 December 2012, the first commitment period under the Protocol expired.

2.4 THE HEALTH CHALLENGES OF POOR WASTE MANAGEMENT

Elliott *et al.* (2000) examined cancer incidence in over 14 million people living near 72 municipal solid waste incinerators in Great Britain from 1974-86 (England), 1974-84 (Wales) and 1975-87 (Scotland). In the study, observed-expected ratios (age-standardized) were tested for a decline in risk with distance up to 7.5 km from each incinerator. An elevated cancer risk for residents living in close proximity to the incinerators was reported for all cancers combined, i.e., stomach, colorectal, lung, and liver cancer.

After controlling for socio economic status, Jarup *et al*, (2002) cited in a Department for Environment, Food & Rural Affairs report (DEFRA, 2004) on environmental and health effects of waste management in the United Kingdom, found no excess risk for those living within 2km of a landfill site for each cancer types they studied in the United Kingdom.

To explore the possibility that the previous results published might have been due to using a rural control site, Mohan *et al*. (2000) surveyed an additional six communities. 4,200 respondents were interviewed by telephone and asked about their respiratory health, smoking and other risks factors, as well as what they thought of their neighborhood's air quality. Results

from the telephone interviews indicated a higher prevalence of self-reported respiratory symptoms in one community near a hazardous waste incinerator when compared with its control group.

Hu *et al*. (2001) investigated the chronic effects of emissions from three different waste incinerators on pulmonary function of both healthy and sensitive subjects with chronic respiratory symptoms. A total of 1,018 participants underwent a Spiro metric test once a year between 1992 and 1994. Three measures were used as surrogates of exposure: living in an incinerator community, distance from the incinerator, and an incinerator exposure index, which was a function of the distance and direction of each subject's residence to the incinerator, days downwind, and average time spent outdoors.

Overall the results generally showed no statistically significant association between pulmonary function and exposure from these three incinerators

Tango *et al.* (2004) conducted Japan's first-ever large-scale national study to examine the adverse reproductive effects associated with proximity to 63 municipal solid waste incinerators that emit high levels of dioxin. The adverse reproductive outcomes of mothers living within 10 km of from the 63 municipal solid waste incinerators were examined using vital statistics records of live births, fetal deaths, and infant deaths. The number of observed cases was compared against the expected cases calculated from national rates adjusted for region. Observed versus expect ratios were compared for decline in risk or peak-decline in risk with distance up to 10 km from the incineration facilities. During the study period, 1997-1998, Japanese mothers had 225,215 live births, 3,387fetal deaths, and 835 infant deaths. There was no statistically significant increase in adverse reproductive outcomes for residents living within 2 km of a facility.

Regarding our study, Limbe maintains one method of disposal and that is land filling which comes with its own problems and challenges as noted above. Once waste is landfilled, complex and variable chemical and biological degradation commences in the presence of moisture and naturally occurring micro-organisms. Five stages have been recognized in this degradation process which are; designated 'initial adjustment', 'transition', 'acid formation', 'methane fermentation' and 'final maturation' (Environmental Protection Agency (US), 1995). Landfill

produces carbon dioxide (CO_2) and Methane gas (CH_4), and also carbon monoxide (CO) but it is mostly related to burning of waste (Westlake, 1995).

Leachate management is also a major concern. The volume of leachate directly correlates with the precipitation rate and Limbe has one of the highest precipitation rates in the country. Municipal solid waste (MSW) leachate contains a wide variety of hazardous, toxic or carcinogenic chemical contaminants (EEA 2000). Table 2.1 shows potential effects of poorly managed waste systems on humans. It shows a variety of diseases and their causes.

Table 2.1: Showing diseases linked with waste

Disease	**Parasite**	**Disease Vector**	**Breeding Ground**
Malaria	Plasmodium vivax Salmonella typhoid	Mosquitoes from disposal sites	Standing water, ponds, untreated landfills and open dumping
Cholera	Vibrio cholera	Mosquitoes from waste disposal sites	Standing water, ponds, untreated landfills and open dumping
Typhoid	Salmonella typhoid	Infection of humans by fleas and contaminated food	Water borne pathogens
Pneumonia	Mycoplasma pneumonia	Inhalation of contaminated air	Polluted air
Bronchitis	Mycoplasma pneumonia	Inhalation of contaminated air	Polluted air
Paratyphoild	Salmonela paratyphoid	Sucking blood from human and infected merogoite	Open dumps, standing waters and open ponds

Source: Mount Mary Hospital, 2004

2.5 THE MANAGEMENT OF GLOBAL MUNICIPAL SOLID WASTE

The challenges of waste generation and disposal can be traced to the development of human congregations as communities. The accumulation of waste was a consequence of the way of life due to littering of food and other solid wastes. This has been linked to the breeding of rats and the outbreak of plagues and epidemic which killed many Europeans in the 14th century (Tchobanoglous *et al.* 1977).

Increasing population, urbanization and industrialization in the different regions of the world have contributed to a major increase of industrial and municipal waste. Urbanization induces a

consumer based society characterized by increase in concentration of people and industrial/commercial development. This implies an accumulation of waste which needs to be properly disposed of and managed safely.

Solid waste management is one of the main responsibilities of both urban and rural communities and the fundamental objective of solid waste management programmes is to minimize the pollution of the environment as well as utilize the waste as a resource.

Although per capita waste generation rates in developing countries is less than in higher-income countries, the capacity of the local authorities to manage waste from collection, to recycling or reuse and disposal, is limited (Barton, et. al., 2007). Targets can be achieved using methods that can be afforded by the community over the long term and with less risk to the persons involved. An input of universally valid skills or techniques, or a set of similar culture-neutral attitudes defines management itself, while management of waste requires particular kind of intellectual insight, which would be expected to yield value-specific solutions to local problems (Kapoor, 2009).

A research carried out by Couth, *et al* (2010) reveals that the average inorganic content for urban municipal solid waste in Africa is around 56 percent and its degradation is a major contributor to greenhouse gas emissions. Rapid population growth overwhelms the capacity of most municipal authorities to provide the basic services.

Adequate municipal solid waste management is much more than a technological issue; it involves other issues such as institutional, social, legal, and financial considerations. Also, it involves coordinating and managing a large workforce and collaborating with many other stakeholders including the general public (Zurbrugg, 2003). Table 2.2 shows the growth of the urban population in the world, with projection to 2015, the table shows a steady growth of the urban population and this trend will continue.

Table No 2.2 Percentage of population living in urban areas – with projections for 2015

Region	1950	1975	1995	2015
Africa	14.6	25.2	34.9	46.4
Asia	15.3	22.2	33.0	45.6
Latin America	41.4	61.2	73.4	79.9
Industrial countries	54.9	69.9	74.9	80.0
World	29.7	37.8	45.3	54.4

Source: Adapted from U.N. 1998

Low income areas have higher population densities and the lowest level of municipal solid waste service provision **(**Louigueur, 2007**).**Through poor sanitation conditions in low-income neighborhoods there are health threats to residents including the wider population due to poor disposal units and management mechanism. According to Vaishali (2009) much of the waste generated worldwide (57-85percent) where primarily disposed in landfills including open and engineered landfill. The figure below shows waste disposal methods in some countries. You see that a country like Japan has a more balanced approach with recycling taking about fifty percent of disposal methods. While other countries like the USA, Germany, Ireland and Mexico use more of landfills and incineration see fig 2.1

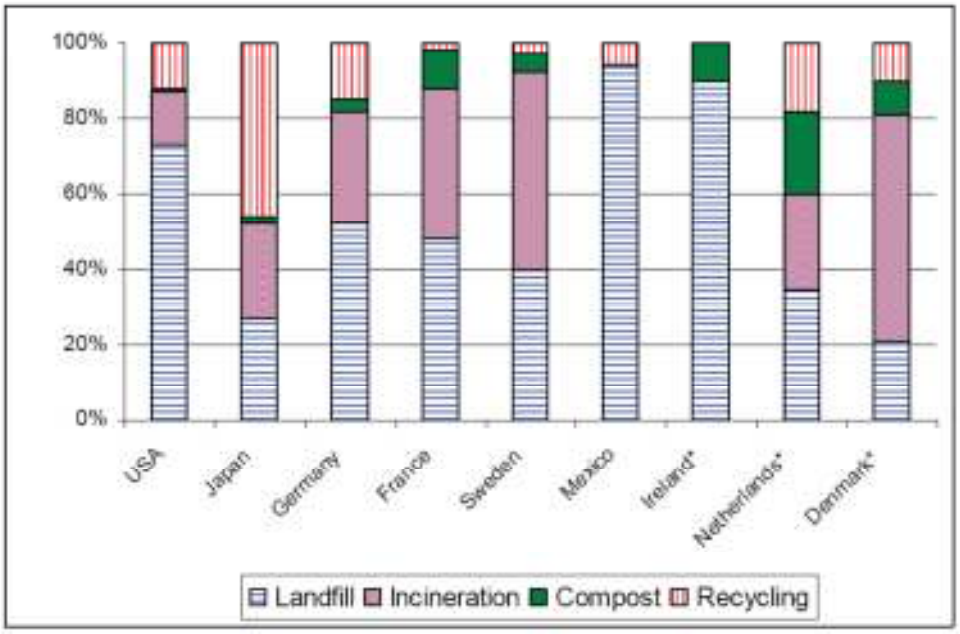

Fig No 2.1: Municipal solid waste treatment in various countries

Source: Cortinas de Nava, 2001

2.6 SOLID WASTE MANAGEMENT IN DEVELOPING COUNTRIES: THE AFRICAN EXAMPLE

According to Palczynski (2002) solid waste management policies and programs in some African cities Ghana and Kenya were formulated and implemented by government agencies without significant public participation. The emergence of environment protection and compliance to international standards peaked in Africa as part of the developing world in the 1990s as part of public demands and sensitization to government actions, policies and laxity. Political and social changes across the African continent in the early 1990s led to the growth of nongovernmental organization (NGOs) in diverse sectors including environmental non-governmental organizations. These organizations have through various campaigns and working conferences fostered increased awareness about environmental issues including waste management. The task of local governments especially in urban areas is to ensure the provision of healthy and stimulating environment for their inhabitants. Such global consensus is due to the closeness of

local governments to the people and their responsibility for delivering municipal services to all its citizens (Hardoy*, et al*, 1992; DCD, 1999).

A feasibility study on solid waste incineration for the largest cities in Kenya, Malawi and Zimbabwe (DFID, 1999) reveals that, 75-80% of municipal solid waste was organic. While in India, 70% was organic (Yedla and Parikh, 2002), and reported values for Dhaka city (Bangladesh) from domestic properties were between 85% and 95% (JICA, 2005; BCAS, 1998). In developed countries, total organic content is lower typically 6% of which in some cases only 10 percent is composed of food waste and the rest made of paper and cardboard (Tchobanoglous and Kreith, 2002).According to UNEP (2005), the rate of waste generation generally increases in direct proportion to that of a nation's advance in development. Failure to provide a management system could result in greater environmental degradation with increase health risk to the urban population.

As much as waste generally can be managed by municipalities of different countries in Africa, like else where it is important to evaluate what has worked well so that such models can be replicated in other African communities. This way the principle of environmental friendliness can gain and gather momentum as an aspect of human reality and scientific fiction as argued by many in the increasing debate on climate change and human contribution to the process.

For this reason, this study examines the scope, nature and form of waste management in Cameroon by focusing on Limbe as an emerging city with both municipal and urban properties. Limbe is an emerging industrial city experiencing rapid urbanization and population growth, and poorly organized waste management will create a lot of health and environmental problems.

Poorly disposed waste end up in the rivers, gullies and water ways around the city and the proliferation of waste like plastic for example will lead to flooding in the wet season since such waste will choke and block passages of the drainage and sewage systems. In the long term, the absence of effective action to clear the waste will cause disruption of the infrastructure and lead to water logging which in turn leads to environmental health problems. Through standing water and accumulated forage health hazards such as high incidence of malaria and mosquito breeding areas.

Increasingly, authors argue that waste management challenges area positive outcome for environmental consciousness, (Stoyanov, 2000; Dhir Newlands and Dyer 2003; UNEP 2005;

Dhamija, 2006; Nhamo, 2008; El Haggar, 2010; Robertson, 2012).These groups of authors focused on the environmental and economic impact of plastic waste (Nhamo, 2008; UNEP, 2005). The environmental impact on big cities is devastating and for a city like Limbe it will be very difficult if a comprehensive plan is not put in place.

In other towns in Cameroon for instance Douala, strategies have been developed to manage plastic waste; plastic waste recycling is attracting big business with high income potentials. The project seeks to make the collection, transportation and disposal of solid waste (including plastic waste) a means to which the low income earners of the municipality will generate income (UNDP, 2009).

Equally, the United Nations Development Program (UNDP) project on solid waste management in Nairobi (2006) focuses on a sustainable solid waste management system for the city of Nairobi. The main beneficiaries will be the urban poor through increased sanitation conditions in the informal settlements and the development of income generating activities related to solid waste.

In relation to the Limbe project, the goal will be first to support the creation of an enabling policy environment for sustainable solid waste management practices. Then increase the capacity of actors within government and the informal sectors to develop effective information and networking systems and promote and develop pro-poor partnerships.

The project is modeled on the comprehensive plastic waste management strategy for the city of Nairobi by (Kenya National Cleaner Production Centre, (2006).The model of the project is based on the 3R approach that focuses on **reducing, reusing and recycling generated wastes**. The 3R approach was endorsed by the World Summit on Sustainable Development (WSSD) as an effective means of achieving sustainable consumption and production.

The 3R policy calls for an increase in the ratio of recyclable plastic wastes, further reusing of raw materials and manufacturing wastes, and overall reduction in resources and energy use. It aims to set up a sound material's economy where the consumption of natural resources is sustainable. This strategy seeks to bring together in a form of a working partnership key plastic waste management stakeholders. According to the Nairobi model the City Council of Nairobi, relevant Government ministries, regulatory agencies, business associations, plastic manufacturers,

retailers, research institutions, NGOs, youth groups, informal waste recyclers, community based organizations (CBOs), consumers, donors, and the media) into a functional Plastic Waste Return Scheme and/or buy back scheme that will facilitate the collection and returning for reuse, recovery and recycling of all categories of plastics that find their way into the city environment under what is referred to as the "Expanded Stakeholder Responsibility".

From another perspective Wienaah (2007) examines the Ghanaian experience and shows how the problem affects every urban area. He also proposes solutions and the benefits of recycling this plastic waste which can create jobs and income for some people. Furthermore, he argues that plastic waste component of MSW is problematic because it is non-biodegradable and therefore can stay in the environment for a considerable length of time causing all sorts of problems.

From the above evaluations it can be argued that the management of plastic waste through combustion (incineration) is not environmentally friendly and sustainable since it releases carbon dioxide, a major contributor to global warming (greenhouse effect). Landfilling with plastic waste is not also desirable since plastic is non-degradable and no economic value would have been derived from the waste in that case.

The best option for sustainable plastic waste management is therefore through recycling. This is so because the benefits of recycling of plastic waste are numerous and are also environmentally friendly in comparative terms with the other methods of waste disposal. Through recycling of plastic waste, we can have material and energy recovery and therefore added value will be derived from the waste instead of regarding it as garbage or trash.

According to a study conducted in Accra, Ghana by GOPA Consultants in 1983, plastic waste accounts for 1-5 percent (of net weight) of the total amount of waste generated (Lardinois and Van de Klundert, 1995). Since then, there has been a tremendous increase in plastic waste particularly sachet water bags due to growing urbanization and consumption pattern.

Converting waste plastics into resources demands an examination of the methods that can be used to generate income from waste plastic**.** In doing so one must consider that due to lack of an integrated solid waste management, most of the plastic waste remains uncollected since they are

not properly disposed of in the appropriate manner. Such practices lead to negative impacts on the environment and leads to public health.

Waste plastics cause littering and choking of sewage system due to the long periods required for its natural decomposition. Plastic waste is often the most visible component in waste dumps and open landfills. In most of the situations, plastic waste recycling could also be economically viable since it generates resources which are in high demand for instance plastic shoes.

Plastic waste recycling has great potential for resource conservation and GHG (greenhouse gases) emissions reduction such as producing fuel. These methods of resource conservation can be important for national and local governments where rapid industrialization and economic development puts pressure on natural resources. Some of the developed countries have already established commercial level resource recovery from waste plastics such as Australia. Therefore, having a "latecomer's advantage," developing countries can learn from these experiences and technologies available to them. UNEP has developed a programme on integrated solid waste management to support capacity building and technology transfer and under which a set of guidelines on development of ISWM Plan (UNEP,2009).

Solid waste management problems in developing countries are different from those found developed countries. This can be justified by the fact that the very composition of their waste is different from those of developed countries and solid waste rates average only 0.4 to 0.6 kg/person/day, as opposed to 0.7 to1.8kg/person/day in fully industrialized nations (Cointeau, 1982; Blight and Mbande, 1996). Thus a cost effective comprehensive solution that can create jobs is required.

2.7 WASTE MANAGEMENT AND THE ENVIRONMENT

The percentage of toxic materials in the MSW has increased in the past decades after synthetic materials became widely manufactured, consumed, and discarded (Geiser,2002).The toxic materials, if mingled with other non-hazardous waste in the MSW stream and ended in landfills, generate the greatest impacts on the environment through the life cycle, compared to all the other waste management options (Denison, 1996; El-Fadel *et al.,* 1997; Morris, 2005)

2.7.1 Complaints about Noise and Odour from Landfills

From the data provided by the Chartered Institute of Environmental Health (CIEH, 2003), the numbers of complaints associated with odour and noise from landfills can be estimated thus: Odour: estimates of between 4,000 and 10,000 complaints/year in the United Kingdom! Noise: approximately 300 complaints/year. A total of between 12,000 and 30,000 complaints of odour are also received annually by local authorities. An accurate total cannot be estimated because of incomplete reporting to the CIEH, and the unpredictable pattern of complaints (e.g. a single incident may generate one complaint, or hundreds of complaints). This estimate is therefore of poor quality. The total number of noise complaints recorded by the CIEH is approximately 400,000/year. This value is of moderate quality. This indicates that landfills account for a significant proportion of odour complaints, likely to be between 10% and 25% of all odour complaints received by local authorities. Landfills and other waste management operations are unlikely to account for a significant proportion of noise complaints.

2.7.2 Effects of Waste Management on Plants

The principal route by which incineration processes could affect flora is via the deposition of substances emitted to air. Emissions of acid gases or nutrient species to air could have significant impacts on sensitive habitat sites. These issues are managed via the identification of critical load functions for different habitat types, and assessment of actual deposition of acid gases or nutrient nitrogen species against these critical loads. Lichens are particularly sensitive to deposition of sulphur dioxide.

Lisk (1988) cited studies that demonstrated bioaccumulation in plants and accumulation in soils of metals emitted from incinerators. The review also illustrated that bioaccumulation appears to be species dependent. A study from Finland (Kukkonen and Raunemaa 1984) suggested that concentrations of 10 elements (bromine, calcium, chlorine, iron, nickel, lead, silicon, titanium, vanadium and zinc) in birch leaves demonstrated a strong inverse relationship with distance from an incinerator. This phenomenon was noted from only a few elements in grass samples from similar locations. Experiments undertaken with cabbage and barley (Wadge and Hutton 1986), Lisk also noted that incinerators could contribute to acid rain which could then affect plants.

Mika *et al* (1985) found no phytotoxic effects around an incinerator ash disposal site adjacent to a freshwater wetland.

2.7.3 Effects of Waste Management on Animals

The principal route by which incineration processes could affect fauna is via the deposition of substances emitted to air. The possibility also exists for soil contamination via leaching of substances from incinerator ash streams.

Reineke and Ash (1984) carried out a study showed that earthworms living within contaminated soils exhibit a fivefold increase in dioxin levels in tissues compared to the surrounding soils within 5- days, indicating that bioaccumulation occurs.

Travis and Blaylock (1995) discuss mercury dispersion from all anthropomorphic sources including MSW incineration, and subsequent bioaccumulation in fish, the paper also indicates that up to 58% of human mercury uptake is via fish and 31% via vegetation.

2.8 Urban System Theories and Waste Management

Intensive human activities in cities often require imports of resources and transform raw materials, energy, and water into the built environment, air emissions, and waste. As early as 19th century, Marsh looked into the historical degradation of nature along with human development and asserted that humans had played a destructive role in the nature transformation. He contended that humans should respect the laws of nature and act as coworkers of the nature, because man and nature shape each other (Marsh,1864).Wolman's (1969) analogy of city activities as a metabolism process represents pioneering research on system-wide impacts on resource consumption and waste generation in an urban environment (Decker et al., 2000).

Wolman argued that "the metabolic cycle is not completed until the wastes and residues of daily life have been removed and disposed of with a minimum of nuisance and hazard". Wolman further demonstrated the problem in the case of water use in a hypothetical city in the U.S. With a particular focus on waste materials, Bower (1977) introduced the concept of "residuals" and the model of residuals-environmental quality management (REQM), and the criteria to evaluate

REQM strategies. Since the first study by Wolman half a century ago, at least 20 comprehensive studies have been undertaken across the world (Kennedy *et al* 2010). It is noteworthy that a majority of the current case studies are located in European or Asian regions. It appears only two studies were conducted in the U.S.; one by Zucchetto (1975) in Miami, and the other by Ngo and Pataki (2008) in the Los Angeles County.

Researchers have found that material flow analysis, especially at a refined geographical scale, is rather constrained by data availability than by methodology (Leigh et al., 2007).Data requirements are particularly a challenge for urban system analysis also because a uniform unit of measurement is typically needed. Three common types of measurements have been adopted by researchers in urban system models: (1) material masses (such as Niza, Rosado, and Ferrão, 2009); (2) energy (such as Odum, 1983); and (3) land area, which is associated with studies of carrying capacity and ecological footprint. Carrying capacity refers to "the level of population or development that can be sustained in an area without adversely affecting that area beyond an acceptable level"(Randolph, 2004). Even if technology innovations may increase the carrying capacity, researchers represented by Meadows argued that the current pace of population growth, industrialization, pollution, resource depletion may create the limits of growth on this planet in an abrupt way (Meadows et al., 1972, 1992). Ecological footprint measures the amount of biologically productive land area needed to sustain resource consumption and to assimilate residuals from a person, a region, or an activity, such as manufacturing a computer (Wackernagel and Rees, 1996). Embedded in life-cycle thinking, ecological footprint analysis can be used as an indicator for self-sufficiency and sustainability in an easily comprehensible way.

Both theoretical and empirical studies on urban systems suggest that urban and environmental systems are interdependent and thus we must consider environmental processes as drivers of urban change (Alberti, 1999). Urban systems cannot be sustainable if it requires more resources than it can produce and generates more waste than it can assimilate.

The integration of urban system models and economic system analysis, although not always recorded in the same unit of measurement, represents a significant advancement in system analysis in that previously separated systems are finally considered as one unity. Based on the

regional economic input-output model that was developed by Leontief in 1936 to trace the flows of goods and services among sectors, Leontief and Ford (1972) extended the economic input-output model that originally developed to examine air pollution problems. Pattern (1976) and Finn (1977) extended the framework of economic system to ecological systems. Applications of environmental input-output framework have proliferated after these pioneering studies (Thoss and Wiik, 1974; Hendricks, 1982; Xie et al, 1991; Bouhia, 1998; Chen, 1990, 1992, 2000). These studies have covered both marketable environmental goods (e.g., water supply for production and consumption) and non-market environmental goods (e.g., water Inventory Rivers, lakes, etc.).

2.9 INSTITUTIONAL FRAMEWORK

Institutional framework refers to the laws, rules and regulations or the existing structure that facilitates or prohibits partnerships or collaboration between the state authority and private stake holders in waste management. According to Schudler (1996) the institutional conditions for municipal solid waste management include the institutional structures and arrangements as well as the organizational procedures and the capacity of the institutions. Key components of the institutional framework include the following:

2.9.1 Distribution of Functions and Responsibilities

This regards the distribution of functions, responsibilities and authority between local, regional and central government institutions and between local governments in metropolitan areas including CBOs and NGOs in the area of MSWM. This is important because if local authorities are given the ability to manage their affairs as it has been proven, the bottom up approach to waste management will be very effective. Also giving responsibilities to competent individuals will make waste manage better.

2.9.2 Organizational Structure

The institutions responsible for MSWM , include the coordination between MSWM and other sectors and/or urban management functions. A well structural organization for waste management is necessary in Cameroon.

2.9.3 Incentives and Interests

Incentives are seen as the principles and motivations underlying partnerships. According to various scholars, "the general principles upon which incentive systems should be based include the need to ensure that risks and rewards are commensurably and fairly distributed among the parties concerned and that they are tailored to specific project objectives" (CII, 1991; Bennett and Jayes, 1996; Barlow *et al*., 1997). Clark and Wilson (1961) have grouped incentives under three categories, namely; material incentives, purposive incentives and solidarity incentives. Material incentives include tangible rewards such as money in the form of wages, fringe benefits and patronage. Purposive incentives includes intangible rewards that are related to the goals of an organization and solidarity incentives are rewards from being part of an organization, examples of this are sociability, status and identification.

Incentives are the forces that will drive two actors to come into partnerships, in this case the local government and the community organizations including NGOs go into partnerships. According to Ahmed and Ali (2003), partnerships will not be effective and sustainable, if there are no incentives for the actors to enter into it.

2.9.4 Accountability

Yaaba 2012 define accountability as 'the liability to give an account of what one has done, or not done, to another who has authority to assess the account and allocate praise or blame. The concept of accountability is broad and envelopes more terms such as public exposure, monitoring, control, oversight, punishment and public exposure. Accountability has two dimensions which are enforceability and answerability. Enforceability is defined as "the capacity of accounting agencies to impose sanctions on power holders who have violated their public duties" and answerability is defined as "the obligation of public officials to explain what they are doing; and enforcement, the capacity of accounting agencies to impose sanctions on power holders who have violated their public duties" Schedler, (1999), defines accountability as subjecting of power to the threat of sanctions; obliging it to be exercised in transparent ways; and forcing it to justify its acts. According to the World Bank (2004), in service provision there are long routes and short routes of accountability. The short route is when the citizens can hold the

service providers accountable themselves, and the long route is when the community a mediator to voice to demand accountability.

Most of the literatures consulted focused on other aspects of waste management like health challenges and the general problems faced by most developing countries. However this study looks critically at the problems faced by all stakeholders in municipal solid waste management in the Limbe municipality. The study focuses only on household waste management which is very important as it generates more than 70% of waste in the lime municipality. Most of the recommendations are tailored for a better access to waste services that suits the community.

2.10 THE SIGNIFICANCE OF GIS MODELING IN WASTE COLLECTION AND TRANSPORTATION

Modern and scientific models of disposal, collection and transportation of municipal solid waste are crucial for an environmentally friendly approach and a cost effective means of solid waste management. However, the process demands knowledge of the geography of the study area; that is the problem of vehicle routing since each vehicle must travel in the study area visiting every communal waste bin in a way that minimizes the total travel cost. This is so because they are most often defined in terms of distance, time, fuel consumption, amount of waste from each truck and the tonnage per day or week as well as CO_2 emissions. However, the problem of optimizing the route system of solid waste collection networks is not convention

The effectiveness of the decision making process depends on proper processing of the information made available to the authorities concerned. In this regard, the use of GIS as a support tool has gained currency as a result of technology maturation and increase of the quantity and complexity of spatial information handled (Santos et al., 2008). In this regard, some authors have researched route optimization regarding waste collection in both developed and developing countries. In the process they have incorporated the environment and transport minimization, through improved sitting of transfer stations (Esmaili, 1972), landfills (Despotakis & Economopoulos, 2007) and treatment installations for integrated regional waste management (Adamides et al., 2009; Zsigraiova et al., 2009).

According to Johansson, (2006) and Kim *et al*, (2006), optimization of waste collection and transport involves the novelty of spatial modeling techniques and GIS. These models can provide more effective and sustainable economic and environmental savings in waste management through the reduction of travel time, distance, fuel consumption and pollutants emissions These systems are particularly absent in the Limbe and HYSACAM partnership for waste management in the Limbe city council area.

Tavares *et al.* (2008) have argued that effective decision making in the field of management systems demands the use of vehicle routing techniques that are capable of using new technologies such as the geographic information systems. For example, the use of GIS 3D modeling in the island of Santo Antao in the republic of Cape Verde, an area characterized by a challenging topography, they achieved up to 52% fuel savings compared to the shortest distance, even travelling a 34% longer distance.

In another study in the US Sahoo *et al.* (2005) presented a comprehensive route-management system, the Waste Route for the optimal management of nearly 26000 collection and transfer vehicles that collect over 80 million tons of garbage every year for more than 48 states of USA. The Implementation of Waste Route from March 2003 to the end of 2003 yielded 984 fewer routes, saving $18 million.

On his part, Alvarez *et al.* (2008) presented a methodology for the design of routes for the based on a "bin to bin" collection in relation to paper and cardboard waste in five shopping areas of the city of Leganés Spain. In this study, the authors proposed system was based on GIS technology and optimized urban routes according to different restrictions. From the comparison of their system with the previous situation they concluded that the proposed "bin to bin" system improved the quality of the paper and cardboard in the containers and avoided overflows thereby reducing the percentage of rejected material.

Teixeira *et al*. (2004) applied heuristic techniques to solve a collection model in order to define the geographic zones served by the vehicles, as well as the collection routes for recyclable waste collection of the Centre-Littoral Region of Portugal. The study indicated that proper modelling of the collection procedure can provide cost effective solutions.

Nuortio *el al.* (2006) developed a GIS-based method for the optimization of waste collection routes in Eastern Finland. They estimated an average route improvement in comparison with the existing practice of about 12%. Moreover they proposed a combination of routing and rescheduling optimization. This combination in some cases introduced extremely significant savings (~40%). They concluded that by allowing rescheduling it is possible to significantly increase the improvement rate.

Apaydin & Gonullu (2007) developed an integrated system with the combination of GIS and GPS technology in order to optimize the routing of MSW collection in Trabzon city, northeast Turkey. The comparison of the proposed optimized routes with the existing ones revealed savings of 4–59% in terms of distance and 14-65% in terms of time, with a benefit of 24% in total cost.

Karadimas & Loumos (2008) proposed a method for the estimation of municipal solid waste generation, optimal waste collection and calculation of the optimal number of waste bins and their allocation. This method uses a spatial Geodatabase, integrated in a GIS environment and was tested in a part of the municipality of Athens, Greece. After the reallocation of the waste bins, their total number was reduced by more than 30%. This reduction had a direct positive impact on collection time and distance.

Chalkias & Lasaridi (2009) developed a model in ArcGIS Network Analyst in order to improve the efficiency of waste collection and transport in the Municipality of Nikea, Athens, Greece, via the reallocation of waste collection bins and the optimization of vehicle routing in terms of distance and time travelled. First results demonstrated that all the examined scenarios provided savings compared to the existing empirical collection organization, in terms of both collection time (savings of 3.0% -17.0%) and travel distance (savings of 5.5% - 12.5%).

Finally, Kanchanabhan et al. (2011) attempted to design and develop an appropriate storage, collection and routing system for Tambaram Municipality in South Chennai, India using GIS. The optimal routing was investigated, based on population density, waste generation capacity, road network, storage bins and collection vehicles. They roughly estimated 30% cost-savings with this approach.

CHAPTER THREE

MATERIALS AND METHODS

This chapter discusses the methods used in carrying out the empirical aspect of the study. Two main sources for collecting data are used; the primary and secondary sources. Secondary data was obtained from the national, regional, and a community level of society was summarized using qualitative and quantitative research methods. Other secondary information was obtained from national statistics, reports, and studies.

Primary data was gathered through consultative interviews with national and local institutions that play varying roles within the solid waste management system. Quantitative data were gathered through a questionnaire survey conducted at the household and individual level within the chosen study area.

3.1 STUDY DESIGN

A sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample (Kothari 2004). In order to understand the waste streams, the study area was divided into five zones adapted from HYSACAM's collection points. Within these zones a purposive sampling was used to select one neighborhood from each zone based on demography and income, which the questionnaires had to be distributed. This is because the study had to include both rich and poor neighborhoods. Then a systematic sampling Technique was used for the distribution of the questionnaires. These techniques where used and tested in other studies like ***Waste Management in Jamaica*** by Jenifer Post in 2007 and ***Waste Characterization As An Element Of Household Waste Management Operations*** by Mbeng *et al* 2012.

. The rationale for the selection of households was based on the following reasons:

- Household is one of the most important institutions in a society and within which the gender norms are expressed, reinforced and reflected in large institutions of society.

- Household is a basic unit of society where individuals both cooperate and compete for resources (World Bank, 1999).

As a result, an understanding of the effects of social factors on service programs can be examined through households. To analyze these data SPSS 13.0 and excel spreadsheets were used. However, in order to select a statistically significant sample from these communities it was necessary to identify the study area boundaries. Fig 3.1 below identifies the areas which the samples were collected from.

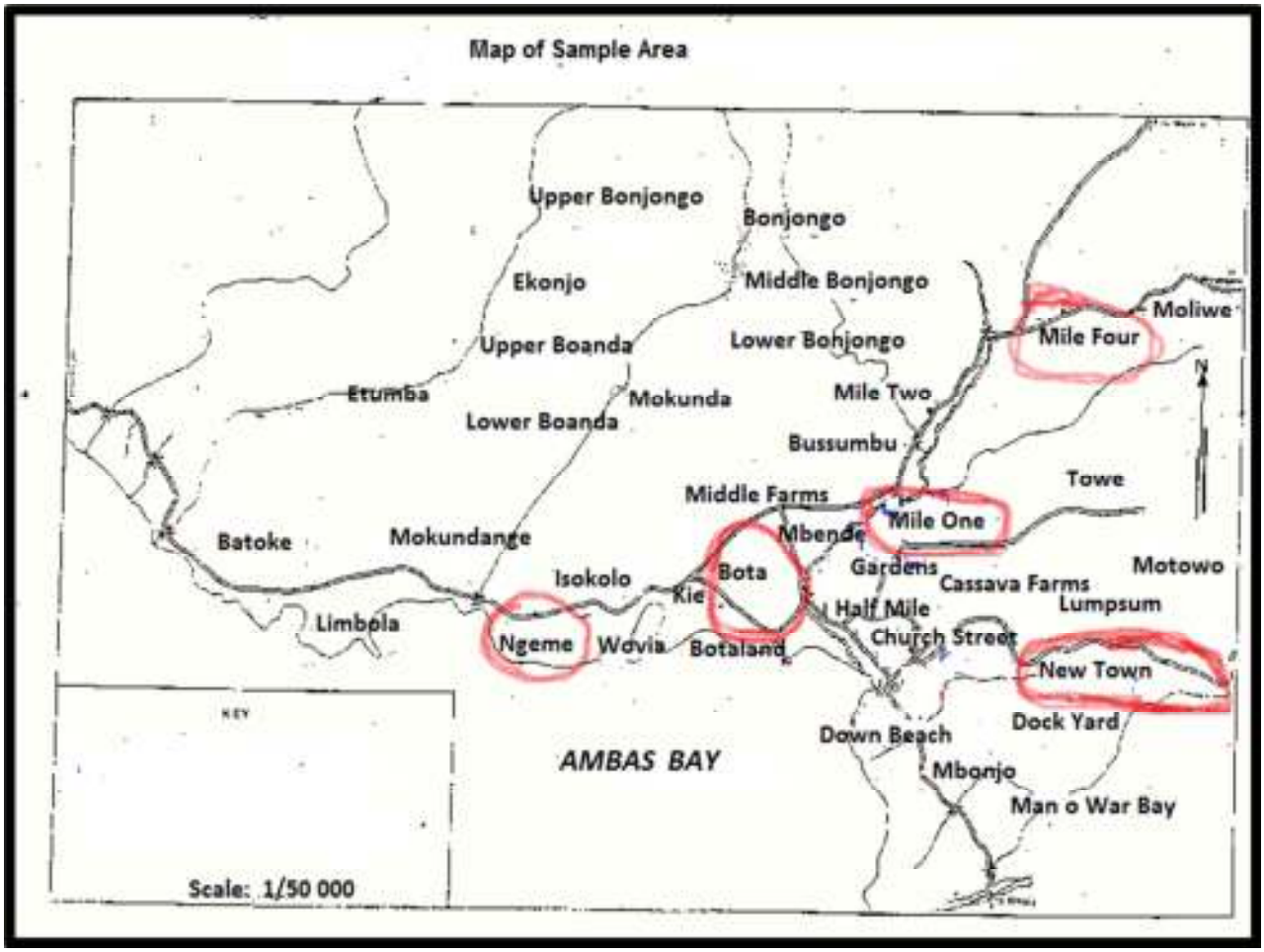

Figure 3.1 Map of sample area

Source: Adapted from Awum et al. 2000

For data presentation through current and future projections in graphs and in tables as well as categorization regarding the various waste streams and the list of materials that cover recyclable and non-recyclable materials.

3.2 DATA COLLECTION

1. Listing material types after the demarcation of various waste streams. It is important to decide on the list of material types which might be available in various waste streams.
2. Timing for sample collection to get a representative sample or data. Waste disposal patterns often vary according to the time of day or week. Therefore, based on the economic viability, the study collected data covering the entire period and chain of disposal.
3. Communal education was principal in the process for waste sampling. Without community sensitization waste management cannot be complete or effective. Community knowledge played an important role in identifying and planning appropriate timings for data collection for the various waste streams and different types of materials. This was essential because there must be effective regulations for disposing of certain types of wastes at certain timings such as residential waste or commercial waste whether in the morning or during certain days of the week.

3.2.1 Interviews

The consultative interview targeted three main respondents namely; the waste management company HYSACAM, Ministry of Urban Development and the Limbe City Council.(see table 3.1 for a list of those interviewed and their dates) Interviews were chosen as one of the methods for gathering data because the information provided by the respondents is a source of qualitative information to describe the existing solid waste management system as well as assess the factors that may influence public participation and the overall success of waste management in Cameroon.

Table 3.1: interviews with main stakeholders and their positions and interview dates

Institutions	position of respondent	location	level	Date of interview
Hygiene et salubrite du Cameroun (HYSACAM)	Limbe Branch manager, chief of exploitation,	Limbe	Private	28th august 2014
	Driver, Head of technical division	Limbe	Private	26th and 27th august 2014
Ministry of housing and urban development	Divisional delegate	Limbe	National	28th august 2014
Limbe City Council	Head of Hygiene and sanitary department	Limbe	Local	1st September 2014

3.2.2 **Questionnaire administration**

Households were selected by a systematic random technique from Five different residential areas in Limbe . Household size (number of people living in the house at the time of the study and making use of the waste bin) was used in this study as a requirement for determining the per-capita waste generation.

Households for the study were selected from two residential areas:

• High income residential areas made up of single detached houses outside the city centre with gardens;

• Medium income residential areas made up of high rise buildings or multiple occupancy properties with no gardens and close to shopping centre or the central business district;

A total of 120 questionnaires were distributed but only 100 questionnaires were returned. Some of the questionnaires were administered directly to assist those surveyed with little or no education and to build a relationship of trust. The area covered included Ngeme, Newtown, Mile One, cite SIC, GRA, cite SONARA and Mile Four which are peripheral neighborhood of Limbe. Questionnaires rely on self-reported data which assumes that the information provided by the respondent is accurate for their solid waste practices and concerns. With the aim of increasing the questionnaire's credibility for the respondent, the survey was prefaced with an introduction

explaining the purpose of the questionnaire and how the responses would be beneficial to the municipality.

While it was easy to get data on the number of persons per households from questionnaires and interviews in these areas, it was difficult to get the actual populations.

The weighing was done with a hand scale and the data were recorded in kilograms on data sheets during all weighing operations. A study period of seven days was chosen with the aim of:

• Providing daily fluctuations during the week days and Week-ends;

• Educating residents of the impacts of pre-selection and source separation on the baseline data.

The sorting procedure was in line with procedures used in waste characterization studies by Mbeng *et a,l* 2012.

Table 3.3 District Sampling Intervals showing the number of Questionnaires distributed and those returned**.**

District	Number of questionnaires distributed/Number of questionnaires returned	Sample interval
New town	50/40	Every third house
Ngeme	10/10	Every other house
Cite SONARA	10/10	Every other house
Cite SIC	10/10	Every other house
Mile One	20/15	Every third house
Mile Four	10/5	Every other house
GRA	10/10	Every other house

3.2.4 Direct observation

According to Yin (1982), observations are a form of evidence that do not depend on verbal behavior, and the method enables the investigator to directly observe the phenomenon under study. On their part, Miller and Brewer (2003)categorized observation into 'unobtrusive observation' and 'participant observation' based on the degree of participation by the researcher, and into 'covert' and 'overt' observations based on the level of awareness subjects have of being observed.

In carrying out this study, a field trip was conducted with HYSACAM which entailed following their waste collection trucks from 6 a.m. to 2 p.m. Their activities and working conditions were observed and notes taken down. This method was useful because it permitted actual and active participation and made it possible to survey the opportunities and challenges open to the

HYSACAM team and employees in the field. The observation was done throughout the week covering HYSACAM trucks as well as timings to follow the patterns to waste disposal in the different zones. All the areas could not be covered and this was overcome by sampling zonal lifestyle.

3.2.5 Secondary data

Secondary data was a review of appropriate literature. A wide variety of literature was covered relating to the key words; waste management, recycling, sustainability, problems and prospects. A thorough critical review of selected literature was conducted. This study was developed with the use of information from primary and secondary sources. Many academics suggest starting all research work with secondary data (Ghauri and Gronhaug 2005).For secondary data a review of the appropriate literature was carried out, a wide variety of recent literature was used. The literature related with key words like sustainable solid waste management problems and prospects.

3.3 Data analysis

The data collected was analyzed using the Statistical Package for Social Sciences (SPSS 13.0) tool and excel spreadsheets. Results were presented using charts, graphs and tables. The qualitative data from interviews conducted with all other categories of respondents were analyzed manually by making summaries of the views of the respondents, supported with data from documentary sources and my own field observations of the waste situations.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF FINDINGS

This chapter is focused on the presentation and analysis of the findings during the period of study.

4.1 DEMOGRAPHIC DISTRIBUTION OF THE POPULATION OF LIMBE

According to Limbe City Council, the population of the city in 2010 was 102,780 inhabitants with a growth rate of 2.9% compared to the national average of 4.1%/ year. The population is projected to grow at an average of 2,900 habitants/ year and Limbe is expected to exceed the 150,000 mark by 2020 according to the World Bank, (2002). Such an increase will bring different geo-environmental and economic dynamics like the life style and consumption habits of the population as well urbanization and settlement patterns accompanied by new challenges for waste management in the Limbe metropolis. Figure 4.1 shows the projection of population growth in Limbe since 2001 indicating an upward trend and showing a steady increase in the population. From about 80,000 inhabitants in 2001 to more than 100,000 in 2010 Limbe has steadily grown into a big city.

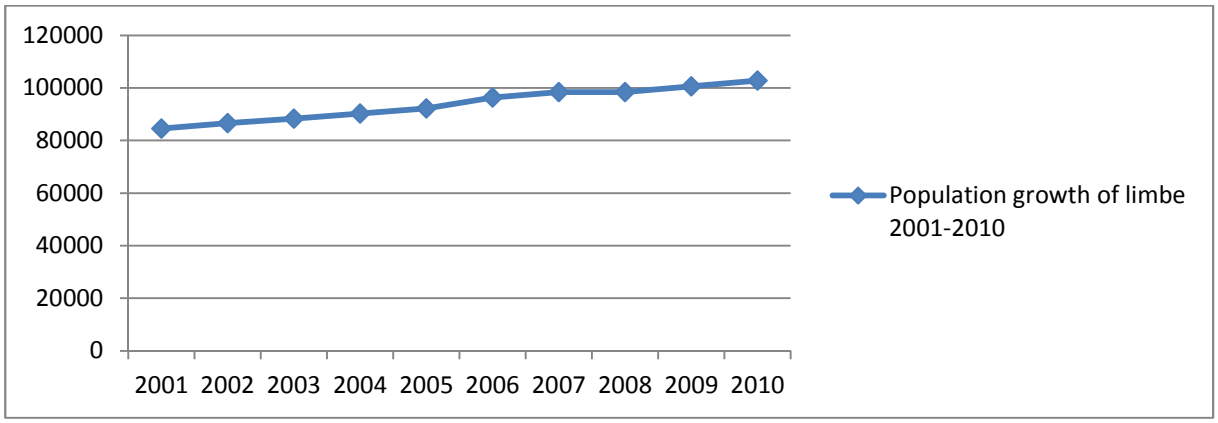

Fig 4.1 Evolution of Population Growth in Limbe 2001 -2010

Source: Limbe City Council

The composition of gender distribution in the study shows that more women participated in the survey. The reason was due to the fact that most men did not want to answer the question that the women were in charge of waste management in the household. Also the questionnaires were administered on a weekend when most families where at home and it showed that mostly women were at home and were in charge of household activities. Fig 4.2 below shows the gender dimension of the survey: 63% of the respondents surveyed are females and 37% males.

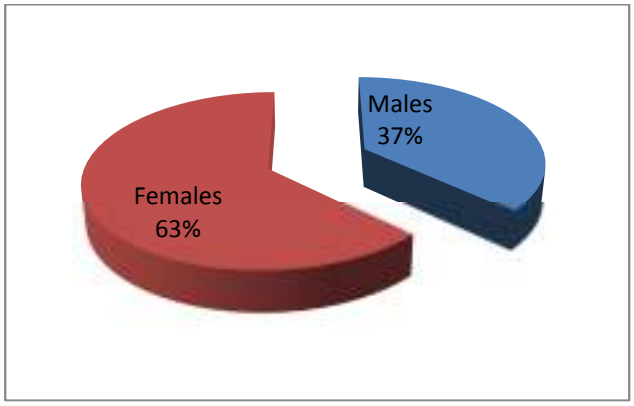

Figure 4.2: Number of Men and Women that Participated in the Survey

Statistics

number of residents in a household

N	Valid	100
Mean		4.06
Median		4.00
Sum		406

Table 4.1: Sample of Population Size and the Average Number of Residents in a Household

As the results on table 4.1 shows the number of distributed questionnaires for the survey was 120 although the amount of returned questionnaires was100. This gave a total sample of household size of 406 and this gave a success rate of about 80%. An average of four people lives in a house.

4.2 TYPES AND QUANTITY OF HOUSEHOLD SOLID WASTE GENERATED IN LIMBE

4.1.1 Type of Municipal Solid Waste generated in Limbe

There are different types of waste produced in the Limbe municipality and are composed of the following; household waste, industrial wastes, Clinical wastes, Wastes from Construction sites. Nonetheless, this study is focused principally on household waste as provided in table 4.2.

Categories	Food waste	Garden waste	Plastics	Metals	Papers	Glass	Textiles
Sub-categories	Food remnants,	fresh and decaying leaves, vegetation and other garden waste	Plastic bottles and packaging	Cans and bottle caps, ferrous metal and aluminum items	Newspapers, magazines, office papers, junk mails and envelopes	Glass bottles and jars	Clothes and shoes

Table 4.2 Composition of Household Waste in Limbe

Table 4.2 shows that the production of solid waste in Limbe is complex and diverse and the type of waste generated depends on the location in the city. The table only indicates household waste because it is the focus of this study. However, since the scope of the study and the management of solid waste demands identification of the various waste systems or better categorization, the study further divides the city into five zones of categorization and zonal location of each waste produced.

1. Zone A: This zone is composed of Down Beach, Mbonjo, Man o War Bay, and Doke Yard. The area is spatially populated and generates principally domestic waste and seasonal fishing waste. Also there is increasing tourism, night life and location of offices. For this reason our discussion according to the data and the future projection of increasing population and socio-economic growth warrants a pilot project.

2. Zone B: This area is composed of New Town which is the largest and most populated area in the Limbe metropolis. Historically, the zone has accommodated the increasing urbanization and population with characteristics of slump housing. The area is densely populated and composed principally of domestic waste.
3. Zone 3: The zone represents the central business Distritof the Limbe metropolis and composes of Mile One, Gardens, Mbende, Cassava Farms and Half Mile. This area is densely populated and composed principally of domestic waste. According to Brian Tracy, communication and inter personal skills can be of tremendous assistance to enhance collection and facilitate disposal of waste.
4. Zone D: This zone includes Bota Land, Isokolo, Mukundange, Ngeme, Limbola and Batoke. The major characteristics in the area are increasing urbanization and population as well as tourism and hotelier, waste here is composed principally of domestic waste and industrial waste with the presence of SONARA, *Societe Nationale de Rafinage* and CNIC, *Chantier Naval et Industrie du Cameroun*. The major challenge in the collection routes is traffic caused by exiting oil and petroleum tankers as well as poor road network including a rough terrain that hinders effective and timely collection of waste.
5. Zone E. This zone covers Mile Four (4) which and is characterized by increasing commercialization and urbanization as well as population growth. Waste here is composed principally of domestic waste. The problems for HYSACAM include time management, fuel consumption and difficult terrain for collection of waste.

4.1.2 Quantity of Municipal Solid Waste Generated In Limbe from 2010 To 2014

The trend in the per capita generation for Limbe was lower than those of some low income countries (World Bank, country assessment report, 2000). A Mean was carried out to get the daily average of waste generated households in Limbe and figures show that as of the time the study was carried out average daily waste generation in Limbe stood at 1.5 kg a day this is a very significant increase in 14 years. The World Bank report of 2000 which gave low income countries a per capita generation of waste of 0.68 kg is therefore outdated, because if we take into account rapid economic growth, changing income levels and life style, adoption of new technologies and a population boom this figure will be higher. The figure 4.3 shows that 56 % of

the population reported their average waste generation/day between 0-5 kg and 37% putting their figure between 5-10 kg/ day. This is a significant increase in the per capita generate rate of limbe, falls in line with some studies like Abu-qdais *et al*. (2007) found it statistically significant but weak negative relationship between waste generation and household size in Abu Dhabi (R2 = 0.11) who have based their argument on the observation that household size and waste generation are strongly linked.

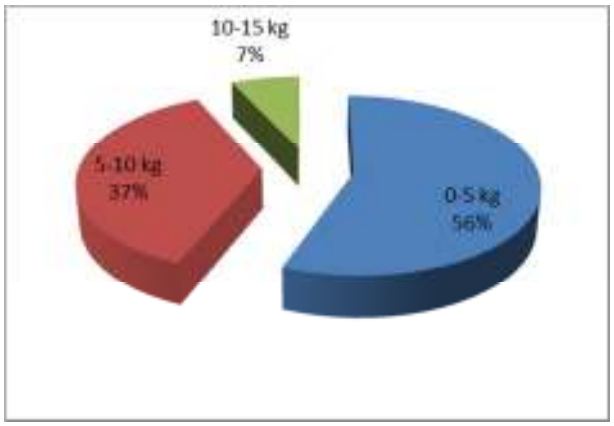

Fig 4.3: estimated amount of waste generated/day in Limbe

As figure 4.4 shows a total of 33,002 tons of wastes was collected in 2010, 30,246/ton in 2011, 26,450.03 tons in 2012, 27,527.92 tons in 2013 and 13941.86 tons by mid-2014. There was a dip in the amount of tonnage collected from 2012 and this was due to many factors which prevented HYSACAM from meeting up with the 100 tons day which as fixed by the legal framework and contractual terms with the Limbe city council.

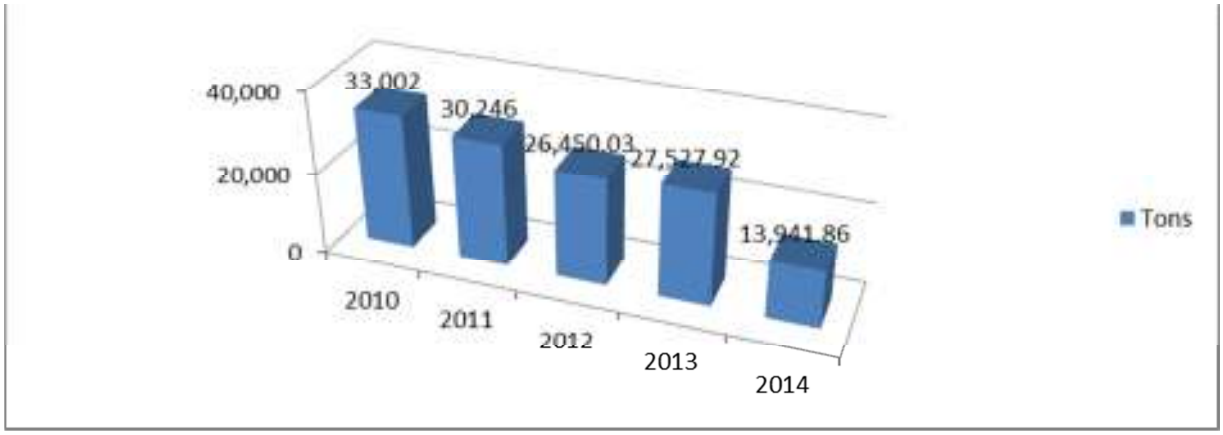

Fig 4.4: Total Distribution of Yearly Collected Waste in Limbe Municipality (2010-2014)
Source: HYSACAM

A further breakdown of the collection data from HYSACAM is displayed on table 4.3 with monthly collection figures for 42 months for four year in the limbe municipality. The irregularity in the amount of tones collected per month is due to in part to frequent breakdown of trucks and insufficient amount of trucks present at the time to meet up with the rising waste generation in the municipality.

Year/tons	2010	2011	2012	2013	2014
Month					
January	2932	2166	2430	2150.12	2799.80
February	2725	2123	2346	1670.38	2576.92
March	3179	2676	2318	2237.12	3293.36
April	2686	2575	2086	2353.54	2829.58
May	2959	2600	1988.16	2007.72	2442.2
June	2762	2450	2119.96	2305.28	
July	3050	2664	2136.04	2401.18	
August	2475	2599	2252.46	2583.82	
September	2662	2663	2172.68	2384.34	

October	2489	2551	2591.52	2548.34
November	2759	2611	2205.15	2361.48
December	2324	2568	1804.06	2524.74

Table 4.2: Amount of Waste Collected from 2010 to 2014 in tons by HYSACAM in Limbe

Source: HYSACAM Limbe

4.3WASTE GENERATION IN RELATION TO INCOME AND HOUSEHOLD SIZE

4.3.1 The Correlation between Income and Waste Generation

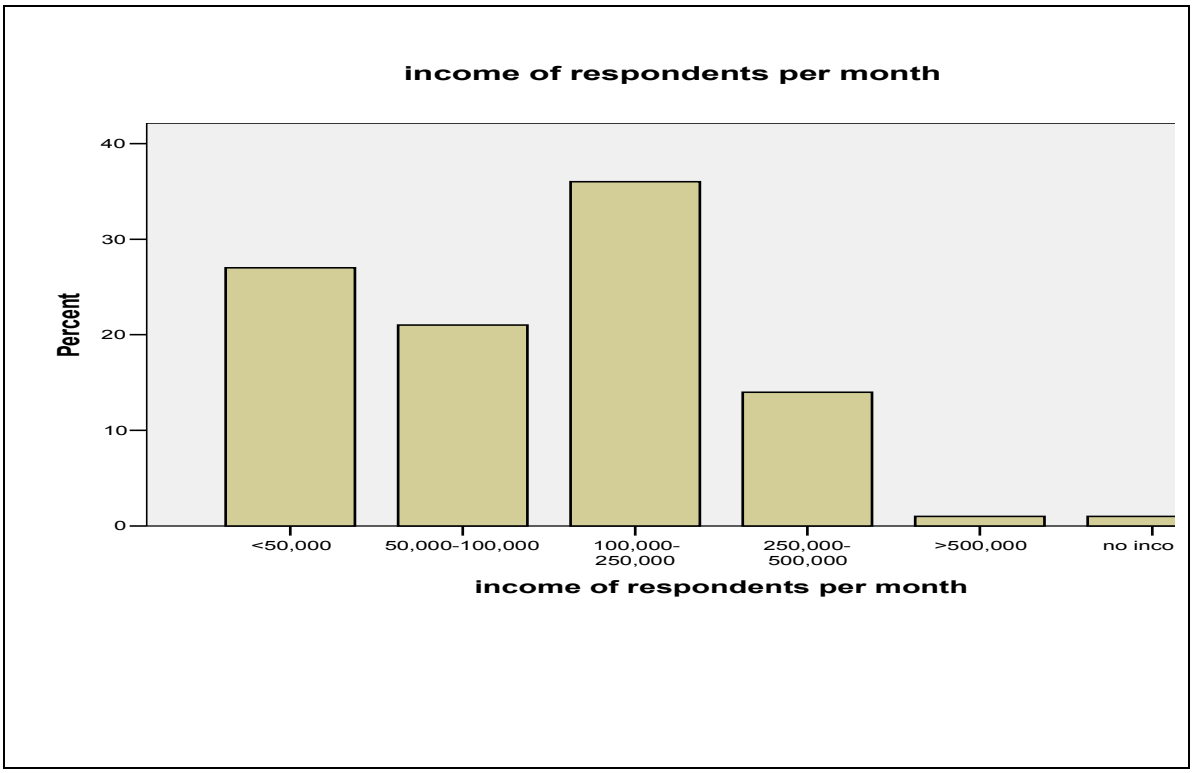

Fig 4.5 Income Distribution of Respondents who participated in the Survey in Limbe (CFA Francs**)**

According to the income distribution, Majority of the population fall under the mid-level of 100,000-250,000 FRSCFA. 35% of the population reported a monthly income that fall between

100, 000 FRS CFA to 250000 FRS. Less than 28% reported 50, 000 FRS as their monthly income. 20% of the income fell between 500,00frs to 100,000 FRS, about15% of respondents fell between the high income bracket of 250,000frs to 500,000frs and about 1% reported income of over 500,000frs a month.

Pearson correlation was carried out to evaluate the relation between income levels and the amount of waste generated by each household. The results (as shown in table 4.3) show a significant relationship confirming that, increase income affects life style of households as well as the consumption habits. In this event they generate more waste than low income inhabitants. The Pearson coefficient for the relationship between income and the amount of waste generated is (table 4.3) .367 and it is positive. At .367 the results show a strong relationship between the monthly income of a family and the amount of waste they generate.

		income of respondents per month	estimated amount in kilograms of waste produced by a household daily
income of respondents per month	Pearson Correlation	1	.367**
	Sig. (2-tailed)		.000
	N	100	100
estimated amount in kilograms of waste produced by a household daily	Pearson Correlation	.367**	1
	Sig. (2-tailed)	.000	
	N	100	100

Table 4.3 Correlation between Income and Daily Amount of Waste in Limbe

The findings indicate that income is a welcome development with the tendency to generate more waste. Income in Limbe rose by more than 15% since 2005 (Institute National des statistics). Increase in income leads to more consumption, and in our study from 0.68kg a day of waste generation in 2000, to the current waste generation rate in Limbe is at 1.5kg/day which is a significant increase. It was therefore observed that an increase in income leads to an increase in the amount of waste generated per day.

4.3.2 The Correlation between Household Size and Waste Generation

The findings indicate that the population of Limbe will exceed 150,000 by 2020. With an annual growth rate of 2.9% this will increase the amount and diversity of waste produced daily, and more resources would be needed to be committed to waste management. A bivariate analysis conducted on household size and the amount of waste generated (tale 4.4) shows a positive relationship with (P=.395) thus accepting the view that household size is positively related to the amount of waste generated/day in a household.

		estimated amount in kilograms of waste produced by a household daily	number of residents in a household
estimated amount in kilograms of waste produced by a household daily	Pearson Correlation	1	.395**
	Sig. (2-tailed)		.000
	N	100	100
number of residents in a household	Pearson Correlation	.395**	1
	Sig. (2-tailed)	.000	
	N	100	100

Table 4.4 Correlation between Household Size and Daily Production of Waste in Limbe

Few studies in Cameroon have investigated the relationship of waste generation to household size. According to Abu-qdais, et al (2007) there is a relationship between waste generation and household size. He argues further that as the number of household occupant's increases, waste generation has been found to decrease per person, mainly because of economies of scale in the consumption of goods and packaging in developing countries.

Nevertheless, he found a statistically significant but weak negative relationship between waste generation and household size in Abu Dhabi (R2 = 0.11). Adedibu (1988) results from a waste characterization study in Ilorin, Nigeria, revealed that, the number of people living in a house can fluctuate from week to week as relatives move in.

According to UNEP (2005) generation rates and composition are unique from country to country and even between communities within a country, since they are affected by factors such as degree of industrialization; extent and nature of socio -economic development and the climate.

When the residence increases this is followed by the amount of waste they generate which will also increase. This argument by UNEP corroborates the position of the studies mentioned above. The size of households is an important predictor of the amount of waste generated, so also is household income and consumption habits.

1.6 WASTE MANAGEMENT PRACTICES IN LIMBE

4.4.1 Collection, Transportation and Disposal of Waste In Limbe

HYSACAM is a private company and part of the VEOLLA Propriete Sa.a global agglomerate in waste management. In Cameroon and throughout its waste management structure (except for councils like Bamaneda that opted out of the arrangement) waste management contract was awarded to HYSACAM and since a formal contract with the city council in Limbe, has been doing so. The company was created in 1969 in Douala and has services in Douala, Yaoundé, Bafoussam, Kribi, Limbe, Penja/Njombe, Sa'a/Obala, Soa, Mbalmayo etc. The number of employees totals about 1500 including the permanent staff. According to the Limbe City Council the contract stipulates that HYSACAM is to dispose of at least 100 tons of waste from the streets of Limbe per day. In Limbe the Company has 105 workers including 34 women.

In executing their services their equipment's include brooms, wheelbarrows, rakes, mobile dustbins and truck for collection of waste from points at particular routes in the town. Below are pictures of some waste management Practices in the Limbe Municipality.

Figure 4.6 shows a series of pictures with blocked drainages filled with poorly discarded waste, an open dump in a residential area and waste piling up days before collection in Limbe. The implications of these practice is the increased presence of mosquitoes and the presence of odour due to these poorly discarded waste. This shows that the current practices in Lime are not sustainable and require a proper strategy in other to better serve the community in terms of waste management services.

Figure 4.6 Unsustainable Waste Management Practices in Limbe

The table 4.5 below gives us the amount of vehicles in circulation and the models used by HYSACAM as of May 2014 in Limbe. There were eight (8) in total because others were on repair or broken down. The tonnage is also displayed in other to portray the capacity of each truck. This small amount of vehicles possessed by HYSACAM makes it impossible for them to fully carry out their mandate and that is why we see waste pile up for days before collection as the small numbers of trucks have to do more rotations in other to meet up with demand. This in turn rings wear and tear on the trucks and might lead to frequent breakdowns.

	Tonnage	Number of vehicles
Compactor trucks (10 tons)	10	4
Paris-model trucks (maximum 5 tons	5	2
Dustin carrier (2 tons)	2	2

Table 4.5 Number of vehicles in Circulation by HYSACAM Limbe

Figure 4.7 shows from left to right a compactor truck and a Dustin carrier operated by HYSACAM in Limbe

4.4.2 Hysacam Work Schedule

According to the work plan of HYSACAM, there are two work shifts that last from 6 - 2 pm and from 4- 10 pm. The work day starts at 6 am and only two trucks are allowed to leave the company headquarters located which is located in Bota. The collection of waste starts from Unity Quarters and then proceeds using the door to door collection method and following the collection route. Added to this casual method there are fixed collection points where trucks pick up waste and they are located at specific points in town, (table 4.6).

There are twenty five fixed collection points facilitated by $6m^3$ green plastic and metallic containers. The population is expected to drop their waste in these containers which unfortunately do not carry markers to facilitate the separation of waste. Actually, some locations have double containers which could be used to promote waste categorization and separation such as bottles and plastics or other hazardous waste especially in the areas such as Mile One where clinical or hazardous medical waste is generated from the hospital. table 4.6 below shows the twenty five collection points according to HYSACAM classification. In the effort to reclassify the collection points we have in this study, grouped them according to the five zones discussed earlier in the chapter.

Zonal Location of HYSACAM's 6m3 green Collection Containers in Limbe		
1	Zone A	Dock Yard 1, Dock Yard 2, Fish Area, Man O War Bat,
2	Zone B	Mawoh Bridge, Lifanda City, Sabis Prince, Main Garrage New Town, Cemetery New Town, Snail Area, Tomatoe Market
3	Zone C	Coconut Island, Ambassy Bay, Mbende, Cassava Farms, Unity Quarters, Animal Farms and Maternity Quarters
4	Zone D	Ngeme New lay Out, Da Crown Hotel, Opposite Fini Hotel Bobende, Batoke
5	Zone E	Mile Four Market, MTN Antennae

Table 4.6: HYSACAM'S Fixed Collection Points in Limbe

Source: HYSACAM

As seen above the city is divided into sectors and is further partitioned into zones. HYSACAM uses 6m³ metallic containers, 0.770 and 0.360 plastic containers. There are also120 liter plastic containers used for manual cleaning and sweeping enhanced with wheelbarrows. Previously, 59 waste paper baskets were installed around the city but most of them after being damaged have not been replaced.

Out of the myriad of containers reported in the survey the most widely used storage method by the household are closed containers with lid. As shown in figure 4.8 the study found out that 52% of the community uses this storage method. The second method is the use of plastic bags with 34% of the community.

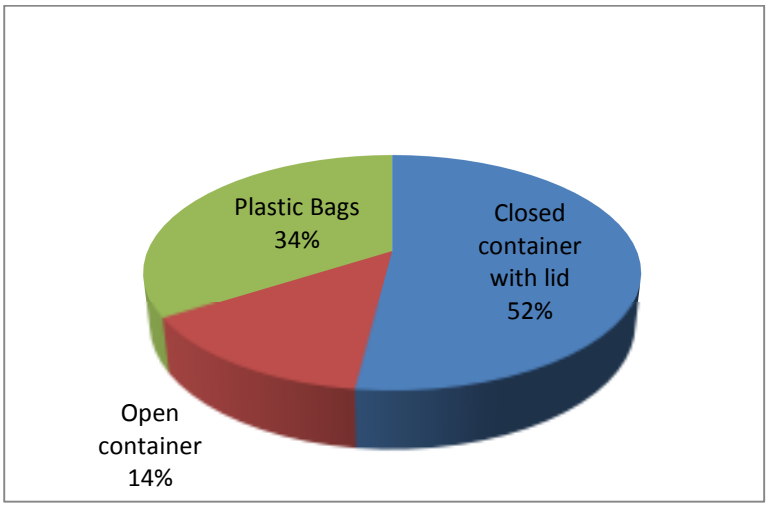

Figure 4.8: Household Storage of Waste according to the Survey in Limbe

In terms of household waste disposal method widely used table 4.7 shows that the most used disposal method by the respondents is the garbage truck for paper, plastics, metals and glass and

90% of the community indicated that they use this method. Only 2% of the community whom we identified as small scale farmers practicing composting and recycling, 23% recycle their yard waste and 17% their food waste. The practice involves using domestic waste such as food for animal feed and yard waste for manure.

	Food waste	Yard trimming	Plastic	Paper	Metal	Glass
	%	%	%	%	%	%
Burn		10	4	16	1	
Bury	3					
Dump in yard	1	1	1	1	1	2
Dump in River	2	2	1			
Dump on the Road	8	2	2	2	2	2
Garbage truck	53	54	90	81	94	96
Recycle	17	23	2		2	
Reuse	15	6				
Compost	1	2.0				

Table 4.7: Most Preferred Disposal Methods by the Population of Limbe

Regarding education in waste management table 4.7 shows that there is some knowledge about waste management methods. 25% of the communities recycle their garden waste and 20% recycle their food item. This attitude indicates a glimpse of hope because such behavior can encourage sensitization and benefit future programs on recycling and other waste reduction strategy. Source separation of waste from the beginning of the chain or life cycle is important when consideration is given to the quality of the final recycled or composted product.

	Food Items	Plastics	Paper	Metals	Glass	Garden Waste
	%	%	%	%	%	%
Reuse	18	4	5	1	1	16
Recycle	20	1	2	5		25
Reduce	11	23	17	19	22	10
None above	51	72	76	75	77	49

Table 4.8: Sustainable Waste Management Methods used by Respondents in Limbe

4.4.3 Street Cleaning

The main streets of the Limbe metropolitan area are swept daily while the secondary streets are cleaned twice a week. Unpaved roads in neighborhoods and villages are not part of this sweeping schedule and collection of waste is not organized by any standard calendar. As a result, unpaved roads and areas of challenging terrain are usually filled with litter. The consequences of such over sight lead to nuisance and odour from abandoned and rotting waste. Other setbacks include the increasing blockage of water ways in these areas of the town.

4.4.4 Market Cleaning

Markets in the Limbe municipality have the same sweeping schedules and that is the day after the major market days of Wednesday and Saturday. The cleaning calendar of the streets seems to have been organized with respect to this pattern of marketing activities.

4.4.5 Sweeping of Green Belt

This practice is employed by the Limbe City Council and increasingly it is being used by other councils around the country. The practice involves the cleaning of public space and rehabilitation of its green environment and habitat. For instance the Community field area at the roundabout at Black and White junction and the area opposite the Central Police Station (which has now been ceded to the Limbe Botanic Garden).

4.4.6 Beach Cleaning

Municipal beaches such as Down Beach and Mile Six are cleaned daily and general public campaigns are carried out. The “Clean up campaign” is a campaign to keep Limbe clean and is run under the supervision of the Hygiene and Sanitation Department of the Limbe City Council. Cleaning of surroundings and business premises takes place twice each month between 8 am and 12 noon with all government offices, public and private businesses closed to respect the exercise and uphold commitment from the public. However, an exemption levy of 500 FRSCFA for taxis encourages non participation.

4.4.7 Transportation of Waste

Figure 4.8 shows 25 main collection points operated by HYSACAM in Limbe. Most of these fixed locations are served by the Dustin carrier. These fixed collection points are located in areas where they can be easily accessed by the collection trucks. Due to rapid urbanization and

sprawling these collection points need to be increased in other to accommodate more neighborhoods that are not served.

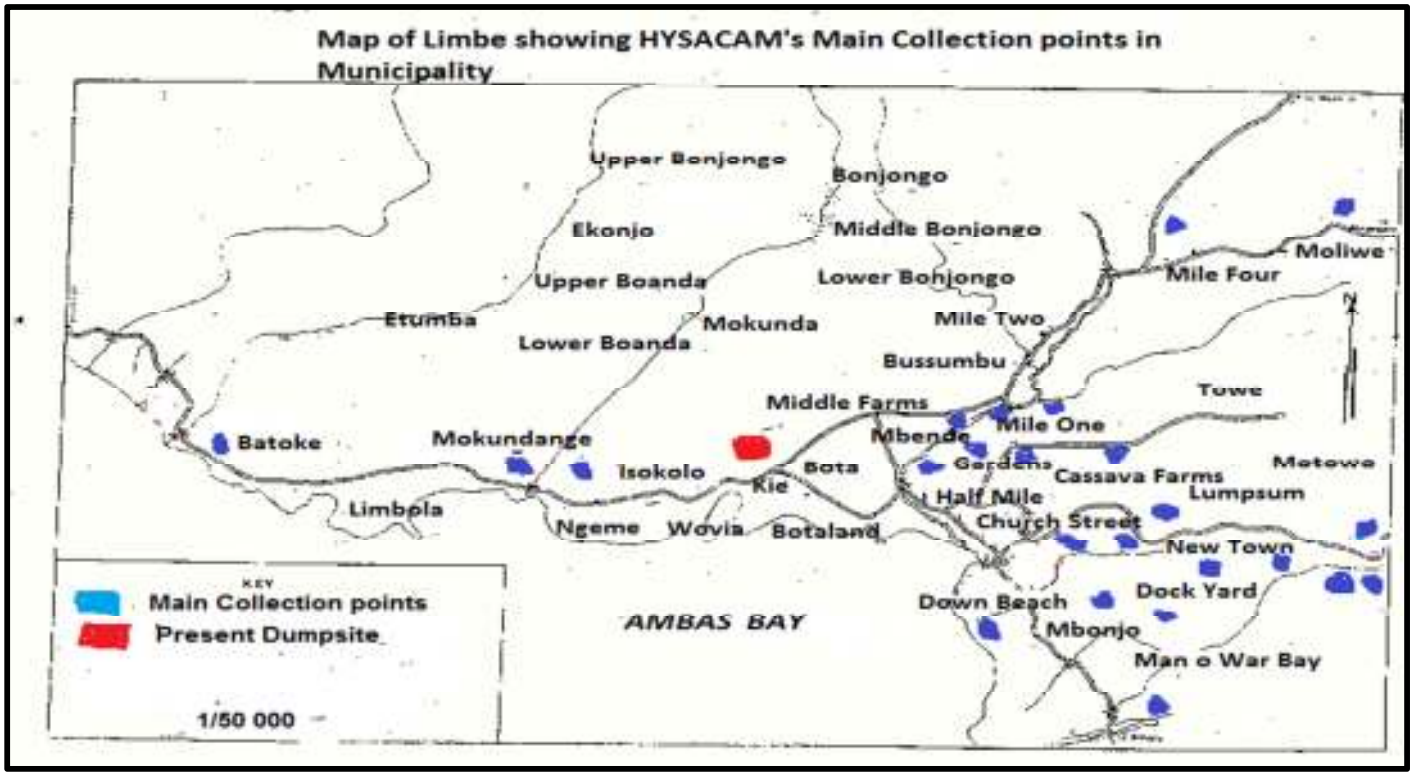

Figure 4.8 Map of HYSACAM collection points in Limbe

Source: Adapted from awum et al. 2000

In terms of transportation and the organizational sense of the exercise tables 4.9, 4.10, 4.11 below show the frequency of waste collection by HYSACAM in the months of January, February and March for 2013 in Limbe. In this exercise the number of trips made by HYSACAM trucks and the number of trucks in the operation during each sortie and the weight of the trucks is indicated to facilitate understanding of the process.

Table 4.9: Monthly Data for January2013: Daily Collection of 82.69 Tons/Day

	Number of trucks in operation	Number of trips	App. Weight at dump site (tons)
Compactor trucks (10 tons)	3	99	1026.56
Paris-model trucks (maximum 5 tons)	2	105	564.18
Dustin carrier (2	1	145	559.40

tons)			
Total	**6**	**506**	**2,150.12**

Table 4.10: Monthly Data for February 2013: Daily Collection of 64.24 Tons/Day

	Number of trucks in operation	Number of trips	App. Weight at dump site (tons)
Compactor trucks (10 tons)	3	88	739.52
Paris-model trucks (maximum 5 tons)	2	133	396.74
Dustin carrier (2 tons)	2	170	534.12
Total	**7**	**494**	1670.38

Table 4.11: Monthly data for March 2013: Daily Collection of 86.04 Tons/Day

	Number of trucks in operation	Number of trips	App. Weight at dump site (tons)
Compactor trucks (10 tons)	4	97	916.16
Paris-model trucks (maximum 5 tons)	2	99	434.50
Dustin carrier (2 tons)	2	226	886.46
Total	**8**	**565**	**2237.12**

Source: Limbe City council

From the above figures provided by the Limbe City Council it can be seen that in January 2013 an average of 82.69 tons per day was collected by HYSACAM and in February of the same year 64.24 tons was collected with the availability of 7 vehicles. The drop in tons was due to the frequent breakdown of the collection vehicles. Consequently, HYSACAM could not meet the collection stipulations. In March due to the addition of one more truck after repairs there was an increase of the amount of tons transported.

4.4.8 Disposal

Disposal is the end point in the life cycle or chain in solid waste management and usually poses the main challenge due to its long term effect on the surrounding environment. After collection the waste in Limbe is transported to a dump site situated at Karata around Kie in the Bota Land area and this is the main and only municipal dumpsite. It is an open dumpsite and there is no

form of recycling practiced except for organized action by scavengers picking up valuable items. When a section of the dump site is full it is covered with laterite to allow for the process of natural decomposition. Figure 4.9 shows the process at the dumpsite in Karata. It should be noted that this is not a landfill but an open dump site which is filed with soil for natural decomposition to take place (Figure 4.10.)

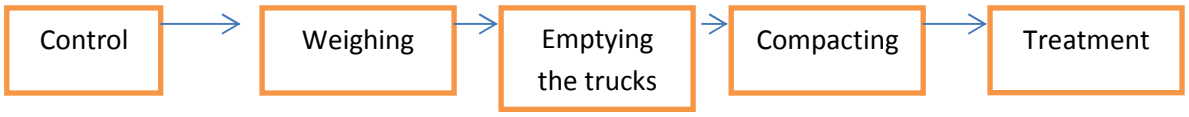

Figure 4.9 Disposal Process by HYSACAM

Figure 4.10 Picture showing the practice of open dump site, at the Municipal Dumpsite in Limbe-Karata, Botaland

4.5 PLANNER'S ROLE IN SUSTAINABLE WASTE PLANNING

All these practices as analyzed above are unsustainable and require a new approach for waste management in Limbe and other localities. Apart from the conventional way of thinking that waste management starts from generation, another model will probably be very effective if we start from the actual process of production.

A study conducted by Fobil, *et al* (2002) examined the waste stream generated from three residential groups in Ghana: (High, Middle and Low residential areas). Fobil and colleagues found that the waste stream generated by different groups "consists of entirely different proportions of the waste components". The authors suggest that different waste management schemes should be adapted to the various residential areas.

This brings into light the relationship between proper urban planning and waste management because the cities are organized to play a role in the type of waste they generate. Industrial zones will not produce the same kind of waste as residential zones. From the data above it was realized that road network in Limbe also plays an important role in the collection rate in the city while the high residential areas benefit from frequent collection, low residential areas do not because of the ad nature of roads in these areas. Figure 4.11 gives a rational planning process, which will help make waste management better and lead to more efficient process in communities.

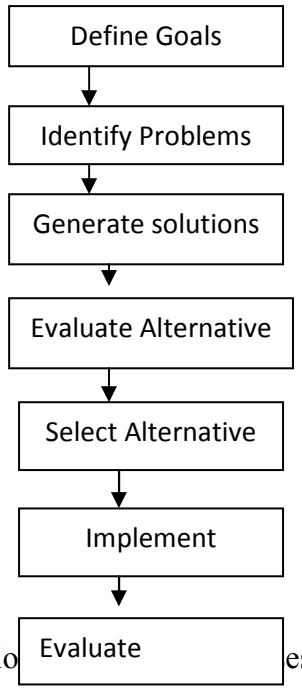

Figure 4.11 Ratio es

While city planners' involvement in waste management has been largely limited to waste infrastructure siting, planners have great potentials to contribute to sustainable waste planning in terms of both practice and research.

First of all, planners have a special focus on spatial implications of policy making and are familiar with local and regional demographic characteristics as well as the built environment, which provides the basis for material and waste flow analysis and community-specific waste management policy design (Leigh et al., 2007). In particular, there is great potential for planners to identify material flows through urban systems, given that land use and zoning determines the destination of material inputs and source of waste generation.

Second, planners have access and can make the influence on infrastructure planning, which could include not only landfill and WTE facilities, but also recycling centers, drop-off sites, and even remanufacturing facilities within urban centers. Strategic plans, such as locating waste management facilities in Greenfield, can mitigate environmental consequences of material flows, advance closed-loop production systems within urban areas, and promote increased economic opportunities for urban residents (Leigh, *et al.,* 2007)

Third, planners are adept at using local data for dynamic estimates of infrastructure and community planning, and waste management programs may naturally fit in the long-term plan. Thus, planners naturally process the knowledge and skills for long-term waste management planning. One approach of integrating waste management into long term planning could be designing urban sustainability indicators from a system perspective and promoting regular data collection in a consistent format.

Fourth, planners hold a holistic view of a region and are most capable of managing the highly interdisciplinary issues of waste management. A good understanding of the complexity in waste management helps minimize the conflicts between stakeholders and planning objectives in waste planning, from the beginning of material extraction and production, instead of the narrow focus on its final destination.

Fifth, planners have the access to influence the business development strategies and promote environmentally conscious production activities. In particular, planners can promote the network of businesses that cooperate with each other through exchange or sharing of resources

(information, materials, water, energy, infrastructure and natural habitat) to achieve both economic and environment gains, as the notion of "industrial symbiosis" suggests.

Sixth, a more vigorous approach than the voluntary one discussed above for planners is to advocate for federal legislations and coordinated regional efforts for management. Even and consistent enforcement methods should be developed to discourage waste export to other regions, facilitate advancement and adoption of green technology, and promote self-reliance of waste management for each urban region.

Lastly, planners can and should contribute to public education and help transform the public perception of waste. In particular, public education should address the life cycle impacts of consumption and the long-term risks of waste disposal facilities, which are immediately tangible and measurable. Economic incentives and technology advances still need the support of public education to be feasible and efficient for waste reduction, which is the primary condition for urban sustainability.

4.6 PROBLEMS AND COMMUNITY PERCEPTION OF MUNICIPAL SOLID WASTE MANAGEMENT IN LIMBE MUNICIPALITY

In the present situation of MSWM in Cameroon and Limbe in particular, two basic questions arise:

1. how effective have the present schemes been in meeting the desired Objectives
2. What challenges need to be over combed to transform existing situation into sustainable ones?

4.6.1 Public Perception on Services Provided By HYSACAM

According to the survey carried out for this study, the population indicated that there were waste disposal problems in the Limbe community. 79.4% of population acknowledged that there is a problem of waste collection and disposal (Fig 4.12). But their response was diverse when asked why they thought that there was a waste problem in their community.

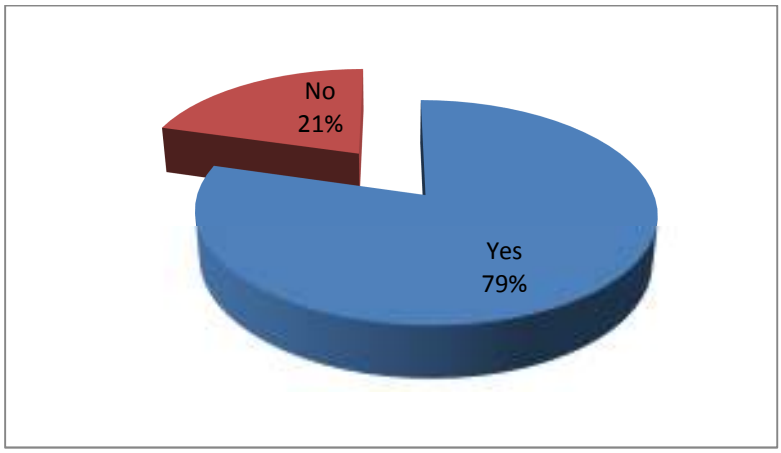

Fig 4.12: Community Participation in Waste Disposal Methods

Table 4.12 shows that the distribution of waste problems in targeted communities in the city is three-fold:

One, communities from Ngeme in zone D, New Town in Zone B, Mile Four in Zone E and Mile One in Zone C blamed poor waste management on the frequency of service provided HYSACAM.

Two, the same communities complain of litter as well as the absence of garbage containers to put in their garbage. On the other hand those living in residential areas did not have complaints on the way waste is managed in the city. This can be explained by the fact that this zone enjoys regular collection done through door to door methods. The diagram below illustrates the position of these communities.

District	Nature of the Problem reported				
	Pile of Garage	Litter	No containers	Garbage Regular collection	No Litter
New town	53%	10%	35%		
Ngeme	75%	2%	15%		
Cite SONARA				95%	2%
Cite SIC				85%	10%
Mile One	63%	12%	25%		
Mile Four	79%	11%	5%		
GRA				93%	4%

Table 4.12 Communal Categorization Waste Management Problems

4.6.2 Perception on Health

From field data 98% of the population said they were concerned about diseases related to improper waste manage while only 2% did not respond which shows that majority of the population know that waste has negative effects on their health if disposed of haphazardly. Blocked drainage (showing in fig 4.14) undoubtedly, serves as breeding grounds for mosquitoes, which contributed to diseases such as malaria. In addition, blocked drainage also caused flooding in Limbe especially around the Down Beach area. This result is in line with the findings of Lambi (2001) who noted that in most parts of the Yaoundé and Bamenda, streets are partially or wholly blocked by solid wastes. Sharing the views of Raymond (1968), the problem of solid waste disposal is difficult, since vast quantities of it are produced by an industrial society. Their released nutrients encourage blooms of undesirable algae in water bodies. Frequently, wood and paper wastes have been burned together which only causes air pollution. In Limbe many people turn to burn their household wastes while some dispose theirs in water bodies, posing environmental problems as the gas released from these substances (carbon monoxide) or CO. Figure 4.13 also demonstrates the presence of plastic bottles and papers in gutters along major streets in the city of Limbe

Figure 4.13 Evidence of waste disposed in gutters in limbe

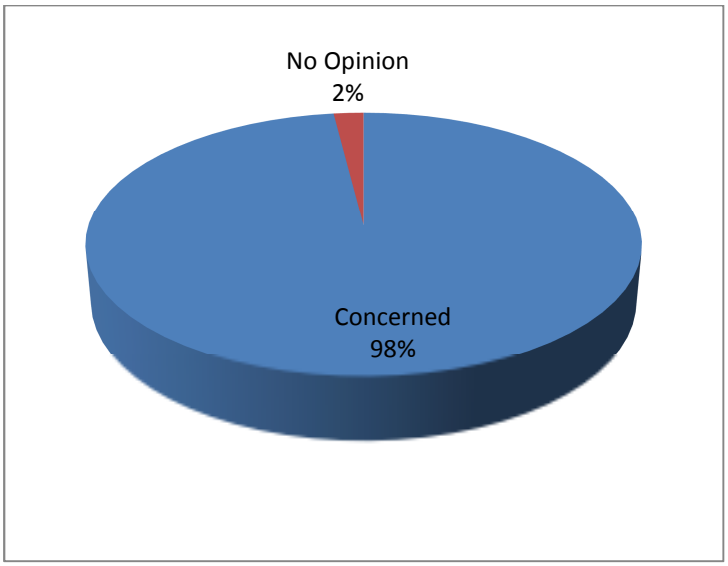

Figure 4.14 Concern about Diseases related to improper waste disposal

4.6.3 Perception about the environment

The result from field observation in Limbe shows that, the population prefer to dispose of their waste like papers and plastic bottles in gutters, such waste may stay within drainage for very long periods of time. As Figure 4.15 shows despite these habits 95% of the population are concerned about litter on roads and environment which doesn't play well with the beauty of the

town. The net figure 4.16 below also shows that 87% of the population are concerned about flooding due to illegal dumping of waste in rivers.

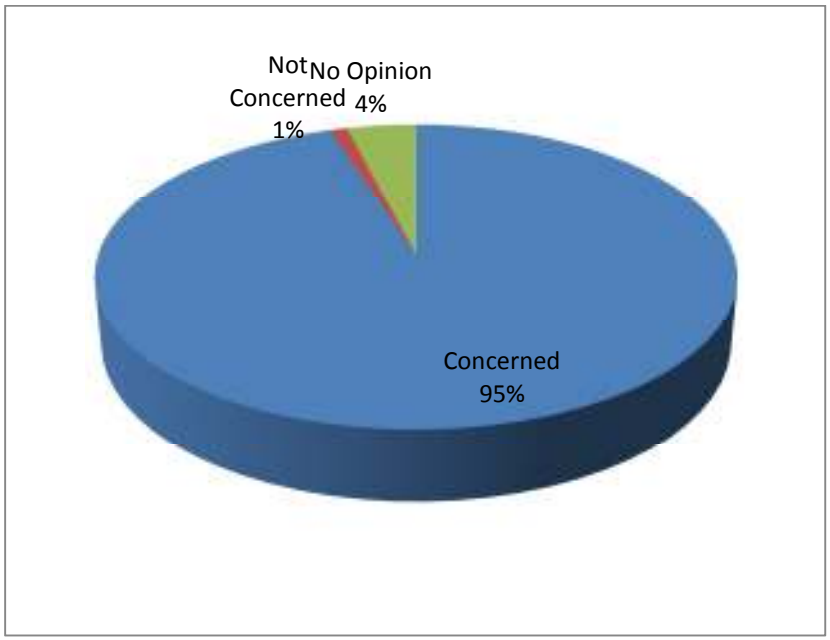

Figure 4.15 Concern about litter on the environment and Aesthetics in Limbe

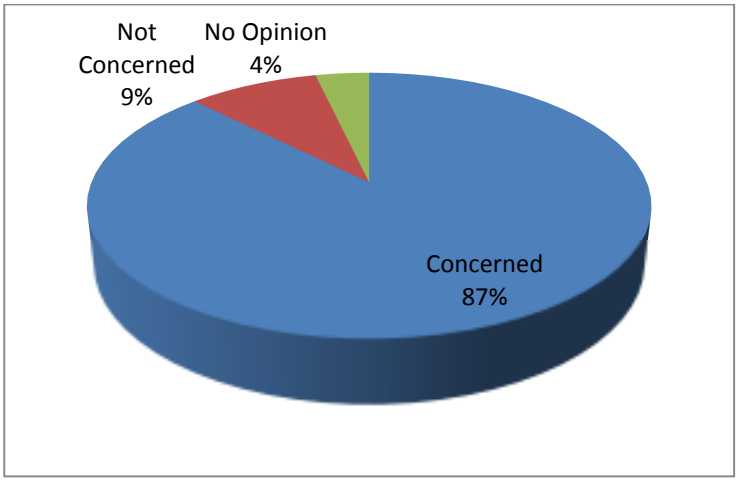

Figure 4.16 Concern about dumping of waste in rivers and gutters that ause flooding in Limbe

CONSTRAINTS

4.6.4 ECONOMIC FACTORS

According to Hoornweg and Bhada-Taa (2012) developing countries annually spend USD 46 billion on MSW management and are estimated to spend another USD 40 billion to cover the service delivery gap. Considering the projected increase in MSW generation, their financing needs could surpass USD 150 billion annually by 2025 (Hoornweg & Bhada-Tata, 2012). In Cameroon the removal of household waste represents almost 20% of the municipal budgets of Douala and Yaoundé totaling CFA 42 billion (€64 million) and CFA 35 billion (€53,5 million) respectively (Ymele, 2012).

In Limbe the costs for the city council was about 85 million CFA 2013 to manage household waste (Limbe City Council, 2013). The taxation index for municipal solid waste management in Cameroon is based on a system of direct local taxes attributed for the provision and financing of local services such as street lighting, water supplies and the removal of household waste. The government allocates 85% of the finances necessary for the management of waste in Cameroon's main cities from state budget and the councils pays the remainder 15%. With increasing waste production and cost the challenge and burden becomes troubling for the government to shoulder more than 50% of the budget each year. The government spent 30 billion CFA on MSW management in 2012 and the cost is expected to rise to about 95 billion CFA by 2030 (Ymele, 2012).

4.6.5 INSTITUTIONAL FACTORS

The study noted that too many regulatory bodies exist in the waste management sector in Cameroon. Problems with enforcement are a reflection of a lack of supportive text for the implementation of the statutory instrument. For instance, the technical description and special rules on dump disposal Law 96/12 Chap. IV Sec. 1 Art. 47 (2) 51.1 lays out the conditions for the authorization of discharge of pollutants into the environment; air, water or soil.

Law 96/12 Chap IV Sec. I Art.53 also directs conditions for the authorization of discharge of pollutants into the air, water and soil. As a consequence regulatory enforcement officials are

compelled to apply guidelines that pre-date the present law. This is evident with Decree No. D67/NS/NN/ST/SG/BMPHP/NNPA of August 11th 1987: Circular letter No. 69/N6/DMHK/SHPA of August 1980 instead of aforementioned decrees, upon current and recent laws (i.e. Art. 43 (2), 47 Part 111, Sec. 1 of Law 96/12 of August 1996) and in some cases either apply or adopt arbitrary guidelines or ignore the regulations entirely. This does not provide a clear regulatory framework for the operation of waste management.

Furthermore, the cumbersome nature of these statutory provisions limits efficient delivery and enforcement. For example, the duties of monitoring and evaluation for regulatory compliance are devolved between four ministerial departments and this affects enforceability due to the lack of clarity and definition of responsibilities. Many of the inspectors interviewed in this study cited the lack of manpower, finances, expertise, testing facilities, and equipment as impediments to the enforcement of the regulations. Incomplete regulations, lack of clarity of roles and the absence of coordination are evidence of poor administrative planning.

Despite Governmental efforts to create and implement legislation relating to sustainable waste management and environmental protection, the current policy framework is not adequate, which leads to lack of effective engagement of industry, commerce and the general public on more sustainable waste management practices. In the Limbe Municipality and Cameroon in general, this suggests the need for the implementation of more robust measures including drawing lessons from best practices from tested models on waste management.

However, it could be argued that for a successful implementation of best practice examples, there is need for such models to be adapted to the local reality in Limbe and Cameroon in general. Such measures will guarantee the active engagement of the stakeholders in order to ensure successful delivery of the sustainable waste management practices; for instance, the Strategic Planning Guide (SPG) by Wilson *et al*., 2003; Read and Wilson, 2003). The Guide lays down procedures for assisting decision makers in actively engaging with stakeholders in the decision making process. They have argued the model ranges from identifying the baseline situation for MSWM in the city and then establishing a framework for the delivery of sustainable waste

management solutions. The SPG has already been shown to be a key document in developing economy (Manga et al. 2012).

The major problem faced by the Cameroon Government is common to other developing countries. According to Manga et al. (2007), there exist a duplication of service and responsibilities in the ministries concern. This leads to inefficiencies and a waste of both resources. The current regulatory system operates a top–down approach in decision making wherein the ministerial departments are able to exercise control over local councils which have limited autonomy. These results politically influenced decisions rather than scientific reality. This situation is common in the provision of technical assistance from the government and its agencies in the local councils.

The delivery of waste management services is a statutory duty for the municipal councils. They are responsible for the provision and maintenance of infrastructure, e.g. Waste disposal facilities; financing of all activities related to waste management; street sweeping, collection, transportation and disposal of household wastes as well as the management of all public spaces and infrastructure. To discharge these duties and provide such services the council raise funds from three main sources:

- Taxes and revenues generated by council activities;
- Supplementary budgets from the state through MINEFI and,
- Lending facilities from the Government's Council Development Fund (FEICOM). Supplementary budgets are subject to scrutiny by MINEFI which is responsible for allocation of government funds on the basis of projected fiscal revenue flows.

Waste management related responsibilities are under the jurisdiction of the Health and Safety Officers in the Hygiene and Sanitation Units of each Municipal Council. The highest qualified staff in each authority is the supervisor who is usually health worker. The Council has the responsibility for creating and managing these units with responsibility for waste management. The council has the power to subcontract such responsibilities to third parties, such as the case of HYSACAM as a specialized waste management company.

The Limbe Council like others in Cameroon opted for this option, to engage HYSACAM, because like the other Municipal authorities, Limbe City Council faces the same problem that of the absence of qualified and skilled staff. This means that in the case of default or a breach in the execution of the contract, the Limbe City Council faces the problem of evaluation. For instance, the Council demands that HYSACAM should execute a daily collection of 100 tons of garbage. The weighing system at the disposal site does not provide adequate measuring mechanisms for the council. Measurements are carried out by approximation. To solve this problem the council can afford to attach weighing technology to the carriage so that when the measurement can be made accurate before the vehicles reach the final deposit site.

There is also the absence of a bottom up approach for waste management, allows the central government to execute policies unsuitable for the local environment and councils. This is a major obstacle for effective waste management in Limbe. Furthermore, the lack of funding hampers the project on waste management since adequate fund is needed for effective sensitization campaigns on proper techniques of waste management. Another reason is the lack of autonomy in matters of finance with the council. Despite the decree on decentralization and regionalism the councils still do not have enough powers to manage their finances autonomously. For example, the budget needed for the collection and disposal of waste is controlled by the government through MINDUH (Divisional Delegate of Urban Development and Housing Limbe, 2014). Another example is the difficulty of the council to handle the challenges posed by the present and only dumpsite in Limbe. There present dumpsite needs to be shut down and moved to the periphery of the city because within its area of location there is increasing population and expanding urbanization. Ultimately, the will be problems of nuisance to the population owing to the odour and related effects from the fields. This is a major problem with waste management. In the US, for example, it is a major problem for waste management company to even secure a license due to the difficulty attached to regulations relating to environmental sanitation and the effect of waste management to societies such as health hazards that have been found to include cancer.

4.6.6 Urban Planning and Geomorphologic Aspects

Figures 4.17 and 4.18 attempt to demonstrate how the terrains in some quarters in Limbe make it difficult for HYSACAM vehicles to move easily or maneuver their way through the narrow streets of the town. Furthermore, the challenges of the terrain in some communities make it difficult and limit the access to some areas of the city. HYSACAM drivers have complained about such effects from the difficult maneuvers of the trucks that often leave them tired at the end of their work shift. They also show the terrain of Limbe and how rapid urbanization has made the population to build on slopes and difficult terrain compounding the problem of waste collection further.

Figure 4.17 partial view of residential areas in Limbe and the terrain

Figure 4.18 narrow streets in Limbe

Furthermore, there's a behavioral problem from the larger community who have consistently failed to develop the attitude to respect the official points of collection. There is little sense of organization in terms of community participation in solid waste management especially with regard to the timing of the exercise. Some residence keeps their waste longer and unattended and will only dispose of it when it begins to decay. Such attitude toward waste management needs to change. HYSACAM workers also complained that people frequently throw burning things into the plastic containers setting them on fire and this requires the expensive exercise of changing the waste containers. In all there is need for public education on the characterization, categorization and management of solid waste. This point marks the difference between waste management in developed countries and developing countries like Cameroon. Despite a legal framework that makes the exercise legal rendering culpability, less respect is paid to the practice because it's not yet a culture to punish defaulters.

Another major problem observed is time management it is very important in waste management to think about how to save time. For example during field visits it took us eight (8) hours to complete just two neighborhoods which is a very important factor. Because a reduction in the time used to collect waste will definably reduce fuel consumption and save money. Also as the map shows the dumpsite is located at the center of the of municipality this a problem because trucks leaving Batoke, Man o war Bay and Mile Four have to travel through the municipality to

reach the dumpsite which is time consuming and that lead to more fuel consumption and odour pollution.

Another factor is the lack of technology to facilitate the work of the waste management company. A good example is during field trip the drivers have to estimate when the truck has reached it maximum capacity. And a final weighing takes place at the dumpsite that is where we get an accurate measurement of the amount of waste collected. And other forms of technology can be adapted to our environment to best suit our communities.

4.7 WASTE MANAGEMENT IN LIMBE AND SOUND PRACTICES

The United Nations Environmental Program in 2012 gave some gloal guidelines for sound environmental practices in waste management. These guideline could be adapted to local environments. Decision makers need to assess how the specific, prevailing background conditions constrain the choices available. It is unlikely that all of the following points will be important in any one instance, but the list of conditions that help to determine what sound practice is includes:

Level of development

- economic development, including relative cost of capital, labor, and other resources;
- technological development; and
- Human resource development, in the MSW field and in the society as a whole.

Natural conditions

- physical conditions, such as topography, soil characteristics, and type and proximity of bodies of water;
- climate temperature, rainfall, propensity for thermal inversions, and winds; and

- Specific environmental sensitivities of a region. Conditions primarily affected by human activities
- waste characteristics density, moisture content, combustibility, recyclability, and inclusion of hazardous waste in MSW; and
- City characteristics size, population density, and infrastructure development.

Social and political considerations

- degree to which decisions are constrained by political considerations, and the nature of those constraints;
- degree of importance assigned to community involvement (including that of women and the poor) in carrying out MSWM activities; and
- Social and cultural practices.

These background conditions can occur in a huge number of combinations. This means, once again, that decision making has to be honed to a particular situation. The Source Book, in its role of offering guidance on sound practices, refers to these conditions where they affect what should be considered sound practice, but it cannot substitute for on-the-ground analysis of the interplay of these factors.

An example or sound practice

The Latin American model for integration of small-scale waste collection enterprises with the formal waste collection system is an example of sound collection practice. These systems were developed in the Andean countries and are increasingly being copied in some Central American countries and can be applied to African cities like Limbe.

The enterprises are paid by the municipal government or by a community organization to provide collection using muscle-powered or semi-motorized carts. They serve marginal or hilly areas which are not currently served and which collection trucks cannot reach (UNEP 2012).

Due in part to the low cost of the equipment used, collection tends to cost approximately two-thirds as much as standard motorized collection methods. Administrative costs are minimal, particularly because members of the enterprise take part in its administration as well as in its operation. Finally, operation and maintenance of the equipment is quite simple and inexpensive and can usually be done by a member of the enterprise (UNEP 2012).

What qualifies this model as a sound practice is its wide reach in terms of creating benefit. The community benefits since it gets waste removal service. The city benefits, since it secures collection service at 65% of the "normal" cost and satisfies its mandate to maintain public cleanliness. Local individuals, especially single mothers, are often the first to respond to a call for the formation of such an enterprise, and benefit through creating jobs for themselves (UNEP 2012).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMENDATIONS

This research work titled "***Household Solid Waste Management in Limbe, Cameroon; Practices, Problems and Prospects*** "is aimed at looking at the major problems in waste management in the city of Limbe by identifying the opportunities and challenges in the chain or life cycle in solid waste management in Limbe. To achieve its objective, both primary and secondary data were collected and analyzed using the Statistical Package for Social Sciences (SPSS) and excel spreadsheets. The key findings are summarized below:

5.1 SUMMARY OF FINDINGS

In summary, the following findings were made:

1. The result revealed that a diverse municipal solid waste is being generated in the Limbe and the type of waste generated depended on the source. The different sources of municipal solid waste identified include: household, health centers and industries.

2. Existing MSWM practices is not sustainable as the practice constitutes issues in the environmental protection and sustainable development debate that is still wanting of deserved attention. Management has been built over a long time on the basis of "keep Limbe clean" thus focus has always been placed on collection and disposal. Addressing these issues implies evaluating the various stages in the existing MSWM systems for Limbe and a proposed system to upgrade the existing systems.

3. The challenges and perceptions that confronts effective waste management and which limits management from becoming sustainable includes: infrastructure and logistics; poor urban planning and geomorphological factors; poor landfilling practices, inadequate funding; political and other institutional aspects.

5.2 CONCLUSION

The research aimed at examining the problems associated with municipal solid waste management in Limbe and recommends measures to improve waste management in the face of increasing urbanization. The study has shown that solid waste management has become a big problem in Cameroon. The challenges and perceptions that confronts effective waste management and which limits management from becoming sustainable includes: infrastructure and logistics; poor urban planning and geomorphological factors; poor landfilling practices, inadequate funding; political and other institutional aspects; long held perceptions about waste. Existing MSWM practices is not efficient as the practice constitutes issues in the environmental protection and sustainable development debate that is still wanting of deserved attention.

Besides, there is also the lack of required legal framework to enforce existing by-laws on waste disposal, and to check the poor waste-handling attitude of the population as well as the inability to enforce standards on land use and shelter development within the city. This continues to frustrate the efforts of local governments in their attempts to keep the city clean and safe. The frustrating waste problem, however, has also been caused by poor governance practices in the organization of waste disposal. Municipal authorities in the country have failed to promote partnership with the waste-producing public and to involve them in the various aspects of waste management including needs assessment, financing, waste collection and final disposal.

5.3 RECOMMENDATIONS

In response to the conclusions presented the following recommendations are provided for improving the management of household waste for the residents of the study area. The recommendations are specific to each stakeholder that should be involved in the strategic planning of the specific interventions. The recommendations are based on the synthesis of information gathered in the survey findings, in-depth interviews and available literature.

The way forward in solid waste management is to introduce a system whereby the chain and life cycle of waste management can be controlled by technology. In the age of globalization there are

models where information and data about waste management is run using suitable GIS systems. The system functions in a way that the sortie route and collection points are introduce into a GIS system to generate a workable framework or model specific to the realities of the study area. The daily or weekly tons of waste generated in the study area fitted in a GIS system to produce zonal mappings that facilitate the identification of waste categorization and separation. Furthermore, the vehicles can be monitored from a central point during the collection process. New Landfills should be opened on the three outskirts locations of the Limbe municipality in other to save the travel time and save cost for the waste management company. Areas around Batoke, Bimbia and Mile Four should be considered for further research in a bit to create new landfills.

In other to address the problem of terrain there should be an introduction of muscle powered vehicles in these areas so that waste management services should reach even the most inaccessible areas in lime especially those in areas with elevated terrain.

An animal feed program which can be derived from food waste should be introduced. In this regard 52.3% of the community acknowledged that they either grow crops or rear animals. This means that introducing animal feed program from food waste will be important. According Post (2007) promoting animal feeding program is a preferred method of managing food waste and that composting has it disadvantages for the following reasons: a community composting program should be introduced in which a central location chosen for materials can be processed. However this particular program requires the availability of the raw materials and a market for the finished products. Also the community has to also put in place ways to sustainably manage the program.

Another waste reduction strategy is to encourage recyclable production of goods to allow access to recyclable products. More eco-friendly articles which will facilitate the reduction of the amount of waste generated. Because these materials will be easily eliminated from the waste streams by recycling them each time they are used to produce other goods. Furthermore companies starting up on eco-friendly solutions like recycling of plastics and other materials should be given incentives by the government of Cameroon. Loans and grants should be made available to encourage such initiatives and this will be very important to develop the green

economy in the country. Instead of starting waste management from generation, a new Model is proposed to government starting from the Production of goods and services that will facilitate the actual disposal process. Figure 5.1 gives us a clear view of the process.

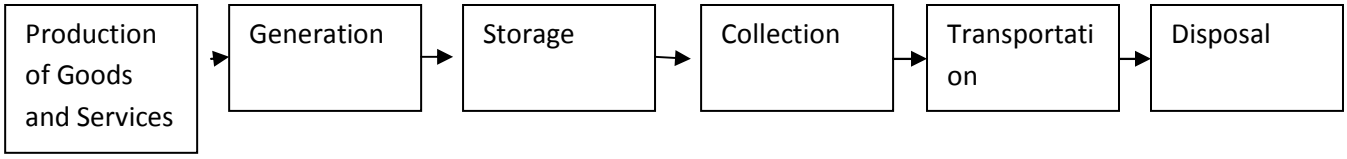

Figure 5.1: A new approach for Municipal Solid Waste Management in Cameroon**.**

Waste management should equally be mainstreamed through education and public sensitization systems. Literature has a supportive role for public education in successful solid waste management programs. In order to raise public awareness and encourage behavioral change and thereby gain public participation public campaigns should be part of the strategy including punitive methods for violators of the program. The development of effective public education campaigns is a step in realizing the cultural transformation that is necessary for solid waste management reform in Cameroon. In this regard, the Limbe City Council should collaborate with Non-governmental organizations to transmit the message to the local population.

The ultimate goal should be to encourage public participation in source separation programs Also programs educating the population about source separation. The table 5.1 illustrates the willingness of the population to participate in better waste management program, 69.0% reported unwillingness to pay for recycling pickup; the community did not demonstrated enthusiasm for other programs not associated with an incentive for them. On the other hand 93% were willing to participate in a program that paid for each bottle they returned; this shows that incentives would have to be given to motivate the public to participate in a program of that nature. However all the population were interested in more information on composting, reuse and recycling with this enthusiasm to learn it is but important to introduce these programs.

Table 5.1 Respondent's Willingness to participate in Waste Reduction Program

	respondents willing to to pay for pick up of these recycling materials from home		respondents willing to participate in program to compost food and yard waste		respondents willing to participate in program that pays for each plastic bottles they returned		respondents that will like more information about compost, reuse, and recycle	
	Count	%	Count	%	Count	%	Count	%
dont know	7	7.0%	11	11.0%	1	1.0%		
No	69	69.0%	2	2.0%	6	6.0%		
Yes	24	24.0%	87	87.0%	93	93.0%	100	100.0%
Total	100	100.0%	100	100.0%	100	100.0%	100	100.0%

Planners should also be involved in the waste manage planning process. This because planners will tend to ring out a better process which will probably lead to better organization. The involvement of the community in the planning process is very important and should be taken seriously because without their participation the process will be cumbersome since they are the producers of waste. Thus a top down policy application should be stopped and a bottom up approach should be used. According Post (2007) community participates in a program or project on waste have a 90 percent success rate. The following can be done to ensure effective participation by the community;

- Share findings and recommendations with residents of study area and conduct consultation for opinions and feedback
- Form a steering committee for planning process (Community members and stakeholders)

The current collection service is reaching only a fraction of the study area population, and in response to the current collection situation, unsustainable disposal methods are utilized to dispose of non-biodegradable materials, like metal, glass, and plastic. The inadequate services are of great concern to the community and 74% conveyed the need for improved service, recommending a collection frequency of everyday. In light of the concern of residents and the expressed need for increased services, HYSACAM should work with the community to establish a collection schedule that meets the needs of the community, by matching the disposal cycle of the residents. Furthermore the amount of plastic containers distributed in the city is insufficient; more should be done following the zonal proposition of this study.

Appropriate legislations for a comprehensive waste management law should be enacted in Cameroon. The law should allow for the harmonization of the functions of the different ministries in the waste management sector. The law should also make provisions for PPP in waste management and provide the municipalities and City Council with adequate funds to match the growing need to waste management.

The government is doing a good job by constructing new roads in limbe which has given access to once inaccessible neighborhoods to waste trucks from HYSACAM. Example is the Mile One - Bota hospital road and the Mbende-Lumpsum road. Plans are in place to pave more roads in Lime which is very important.

5.2 Implications for Further Research

The study examined urban solid waste problem in Limbe, particularly the constraints to waste management efforts in the country. In the course of the study, however, a number of themes have been identified that critically affect the organization of solid waste management in Limbe. These areas include appropriate technologies for solid waste management, waste management financing, the governance of waste management, urban land use and housing planning, waste stream studies for data generation, liquid waste disposal, medical waste disposal and E-waste disposal. These other factors should benefit from further research in other to understand and plan urban development.

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Appendix-I **QUESTIONAIRE FOR HOUSEHOLD SURVEY**

1. Personal information of respondent

Please provide the following information for the occupants in the household.

Household member No.	**Age**	**Gender** **1 Male** **2 Female**	**Education Level** **1 FSLC** **2 O/levels** **3 A/levels** **4 Tertiary** **5 Other** **6 No school**	**Employment** **1 Employed** **2 Unemployed** **3 Student** **4 Retired** **5 Not of working age** **6 Don't know**	**Income/month in FCFA** **1.< 50,000** **2. 50,000-100,000** **3. 100,000-250,000** **4. 250,000-500,000** **5. >500,000** **6.no income**
Respondent					
2					
3					
4					
5					
6					
7					

Which person is responsible for taking care of the garbage from your house? (Please indicate on the above table)

WASTE CHARACTERISTICS IN LIMBE

Waste generated by your home monthly consists of ; (if no precise data is available give the nearest estimate)

Types of waste	100%	75%	50%	25%	15%	10%	5%	2%	1%
	9	8	7	6	5	4	3	2	1
Food Items									
Papers									
Metal									
Glass									
Garden waste									
plastics									
Other (please specify)									

What is the estimated amount of waste produced by your home daily? Please tick one

i. 0-5 Kg

ii. 5-10 Kg

iii. 10-15 kg

iv 15-20kg

V More than 20 Kg

Problems of solid waste management in Limbe

Do you think that your community has a waste collection or disposal problem?

Yes ☐ No ☐

Why or why not, please explain ……

……

	To the following 11 questions, please answer with either: yes, no, or don't know.	**Yes**	**No**	**Don't Know**	
1	Have you ever heard about composting?				
2	Have you ever heard about recycling**?**				
3	If a recycling program was set up, that collected materials like plastic, paper, metals, etc, would you be willing to separatethese into separate bags for collection purposes				
4	Would you be willing to pay for pickup of these recycling materials from your home?				
5	Would you be willing to participate in a program to compost food and yard waste?				
6	If you were paid for every plastic bottle that you returned to the grocery store, would you participate in a program to return the plastic bottles?				
7	Would you like more information about how and what types of garbage you can compost, reuse, and recycle in order to reduce the amount of garbage that you need to get rid of?				

Do you make use of the following waste options? Yes No (please indicate the waste type and method used)

Waste type	**reuse**	**recycle**	**restore**	**reduce**
Food Items				
Papers				
Metal				
Glass				
Garden waste				

Where do you dispose of your waste?

Types of Garbage	Burn	Bury	Dump			Garbage truck	Recycle	Reuse	Compost	others
			River/gully	In yard	On road					
	1	2	3	4	5	6	7	8	9	10
Food waste										
Yard trimming										
Paper/cardboard										
Plastic										
Metal										
Glass										

How often do you dispose of your household waste?

	Frequency of disposal	
1	One/weekly	
2	Twice/weekly	
3	Thrice/weekly	
4	Other(please specify)	

How far do you agree with each of these statements? Please tick one box per row.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Public education about proper garbage management is one way to fix the garage crisis					
correct garbage management should not be taught in schools					
The purchase decisions that I make an increase or decrease the amount of garbage my house holds must get rid of					
People throw garbage on the streets and in the drains and gullies because they have no other means of getting rid of their garbage					
The recent government ban on plastic bags from shops and general usage					

Please describe how your household stores the garbage from the house select any choice below.

1	Closed Container, please describe;
2	Open container, please describe
3	Plastic bags
4	Pile in the yard

5	other
6	Don't know

Does your household rear animals or grow crops for household consumption? Yes No (please tick one)

To the following questions please tell me whether you are;	concerned	Not concerned	No opinion
	1	2	3
How concerned are you about the piling of garbage for many days before collection?			
How concerned are u about illegal dumps polluting rivers, streams and wells?			
How concerned are you about the diseases that are related to improper storage and disposal methods like malaria?			
How concerned are you about health risk related to burning garage?			
How concerned are you about flooding due to garbage looking drains and gullies from improper garbage disposal?			
How concerned are you about the service provided y the garage truck in this area?			
How concerned are you about litter in this area?			

In your opinion what is the best method to dispose of waste.

Recycle	
burn	
Increased collection frequency y waste truck	
Restore	
Reuse	
Reduce	
compost	
Don't Know	

Appendix – II: Authorities and Waste Management Agency Survey List

- Who is responsible for solid waste management in Limbe? Where does this agency derive its power from (constitution, acts, and regulations etc)?
- Does the agency hold enough power to formulate rules, laws or policies pertaining to solid waste management in Limbe? If not, who formulates such rules, laws or policies?
- Who finances solid waste management in Limbe? Is it the local municipality, or the central government? What are the financial provisions? Does the local municipality collect taxes, levies etc for solid waste management?
- What is the current population being catered to by the waste management agency?
- What is the situation in terms of infrastructure (number of waste collection vehicles, personnel employed for waste collection and management etc)?
- How is the waste collected and transported in Limbe municipality area? Describe the method of collection, e.g. pick-up by tractors/trucks; individual drop-off, transfer station, and frequency of collection;

- What are the major components of solid waste management currently practiced?
- Identify problems with the system, e.g. dumping along the access road.
- Is there any reduction or reuse programmes? Describe in details if any.
- Is there any composting of organic wastes? Is there any centralized or backyard composting? If so, how many households participate? Is there any institutional composting e.g. by municipality office, school, etc.
- Describe any barriers to participation in composting activities
- Is there any recycling programmes? Describe (if any) the programs for paper, glass, metals, cardboard, and plastic. Give details of collection and separation.
- Describe any barriers to participation.
- How many dumps are in operation? How far are they from the town? Are there any households near these dumps?
- Is there any abandoned dumps? Where are they located?
- **What is the state of operation for this dump site?**
- Who manages the operation of dump?
- Is the site supervised during operation hours?
- Is the access to the site is controlled (fenced, locked)?
- What kind of waste is not accepted in the dump site?
- Are the wastes separated? If yes, How?
- What is the method for filling (trenching, burying, dumping down a hillside, piling, compacting, covering etc)?
- What are the problem with this site ?
- **Questions on nature of waste composition**
- What are the major constituents of waste (Organic, biodegradable, non-degradable, inorganic, plastics etc)?
- How has waste composition changed over the years (trends and changes)?
- What has been the major area of concern in terms of waste composition (particular article/item, changing nature of composition etc)?
- Are existing policies adequate to promote sustainable waste management? If not, what are the policies issues that needs to be looked into? Who are the main players? How to bring them to a common platform? What are possible road maps in this regards?
- What should be the areas of priorities in terms of waste management (reduction, composting, source separation, improving collection and transportation of waste etc)?
- Should private sector be involved in sustainable solid waste management? If yes, what role can be played by the private players?

- What role can general people, local solid waste management experts, community, Non-governmental organization, development agencies, government at various levels, can and should play in promoting sustainable solid waste management?