Achievement of sustainable solid waste management in developing countries

– A case study of waste management in the Kavango region, Namibia

Arvid Lindell

Master dissertation 2012
Environmental and Energy System Studies
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Abstract

With an increasingly population and urbanization, the solid waste management have become a major challenge for local authorities in developing countries all over the world. The local authorities must improve their waste management in order to minimize the negative effects of solid waste and to avoid future land use conflicts. At the same time the economical resources are limited and solid waste management puts already today a significant pressure on the local economies. There is a need for a sustainable waste management which offer solutions to issues of social-, economical- and environmental aspects.

This study aims to identify concepts for improving waste management in developing countries and evaluate them from a sustainability perspective. The report consists of a literature review and a case study. The literature review identifies different concepts and investigates the differences between developing countries to determine if it is possible to adopt the same concepts everywhere. Four different concepts for improving the waste management were identified; Integrated Solid Waste Management, Integration of the informal sector, Private Public Partnerships and Decentralization. The term of a developing country were found to lack a standard definition. In fact the differences between countries often referred to as developing were found to be significant in many aspects, even in waste characteristics. The conclusion is that waste management is a decentralized activity which needs decentralized solutions of how to achieve sustainable waste management.

The case study uses the Kavango region in Namibia as an example for the possibilities of utilizing the different concepts. The first step in the case study was to find out about the current waste management. A mixed method of qualitative and quantitative research methods were used to map the current waste management. Examples of methods used are open ended interviews with key stakeholders and waste characterization studies. Two of the results were that only 0.11 kilogram solid waste is generated per person and day in the household and that the household waste consist of relatively low amounts of organic waste (26 %) and relatively high amounts of recyclable waste (> 50 %).

The second step of the case study was to evaluate the current solid waste management from a sustainability perspective. Criteria for a sustainable waste management found in literature were used for a sustainability assessment of the current were management in the Kavango region. Out of eight criteria only two were fulfilled and due to poor efficiency, inability to cover it own costs and severe environmental impacts the conclusion is that the current waste management is unsustainable.

The last step of the case study was to investigate the possibilities and effects of introducing different concepts for improving the waste management in the Kavango region. Several aspects of the concepts were already found in the current solid waste management, however possibilities exists to adopt the concepts in a much more comprehensive way. The conclusion is that the use of one concept does not rule out other concepts. In fact the concepts focus on different aspects of solid waste management and complement each other.

Keywords

solid waste management, developing countries, sustainable waste management, informal sector, Kavango region, Namibia, integrated solid waste management, public private partnerships, integration of informal sector, decentralization

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Supervisors:
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December 2012

Environmental and Energy Systems Studies
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Summary

With an increasing population and urbanization, the solid waste management have become a major challenge for local authorities in developing countries all over the world. The local authorities must improve their waste management in order to minimize the negative effects of solid waste and to avoid land use conflicts. At the same time the economical resources are limited and solid waste management puts a significant pressure on the local economies. There is a need for a sustainable waste management which offer solutions to issues of social-, economical- and environmental aspects.

This study aims to identify different concepts for improving waste management in developing countries and to evaluate them from a sustainability perspective. The report consists of a literature review and a case study. The literature review identifies different concepts for improving solid waste management and evaluates the differences between developing countries to determine if there is possibility to adopt the same concepts everywhere. Four different concepts for improving the waste management were identified; *Integrated Solid Waste Management*, *Integration of the informal sector*, *Private Public Partnerships* and *Decentralization*. The term of a developing country were found to lack a standard definition. In fact the differences between countries often referred to as developing were found to be significant in many aspects, even in waste characteristics. The conclusion is that waste management is a decentralized activity which needs decentralized solutions of how to achieve sustainable waste management.

The case study uses the Kavango region in Namibia as an example for the possibilities of utilizing the different concepts. The first step in the case study was to find out about the current waste management. A mix of qualitative and quantitative research methods were used to map the current waste management. Examples of methods used are open ended interviews with key stakeholders and waste characterization studies. Two of the results were that only 0.11 kilogram solid waste is generated per person and day in households and that the household waste consist of relatively low amounts of organic waste (26 %) and relatively high amounts of recyclable waste (> 50 %).

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Keywords: solid waste management, developing countries, sustainable waste management, informal sector, Kavango region, integrated solid waste management, public private partnerships, integration of informal sector, decentralization

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Arvid Lindell 12 December 2012, Lund

Table of contents

1 Reading the report

This report is divided into three major parts which in total make up the masters thesis; background information of waste management in general, a literature review of solid waste management in developing countries and a case study for the Kavango region. They are created in order to complement each other and should therefore be seen as one continuous study. The intention has been to make a report readable for people with basic knowledge about environmental science in general but with low knowledge of solid waste management. People with advanced knowledge in waste management might therefore find some chapters superfluous.

2 Glossary and abbreviations

Developed and Developing country	Terms for classifing countries according of their level of development, see chapter 4.1for information about different classification methods
Hazardous waste	Waste which might be harmful for human or environmental health, e.g. Medical and chemical waste
Household	The basic residential unit for shelter and consumption. Is not necessarly equal to family
Informal sector	Activites with the purpose of income generation without being regulated or registered
Organic waste	Waste which can be broken down in a reasoneble amount of time by bacterias and other microorganisms
Recycling	Reuse of material from waste for producing other items
Scavenging	Reclaiming of valuable waste at a disposal site or from transportation vehicles
Solid waste	See chapter 4.2, often shorten to waste only
Urbanization	The process of changing the population distibution towards a bigger proportion of people in urban areas

AFR	Africa region
ECA	Europe and Central Asia region
EAP	East Asia and Pacific region
ISWM	Integrated Solid Waste Management
LAC	Latin America and the Carribbean region
MENA	Middle east and North Africa region
MSW	Municipal Solid Waste
OECD	Organisation for Economic Co-operation and Development

PPP	Public Private Relationship
SAR	South Asia region

3 Introduction

Solid waste has been part of human society for as long as the existence of humans. Traditionally ad hoc solutions have been used opting for minimizing negative health impacts of waste in major cities. Transporting the waste out of areas inhabited by humans has been the primary objective. During the second half of the 20th century some parts of the world started to focus on the disposal of waste. A growing population and urbanization increased the demand of urban land and safe disposal where needed to avoid land use conflicts. Since then other drivers for waste management have been discovered and a number of waste treatment methods have been developed and utilised in the developed part of the world. Today many developing countries are facing a future of population increase and high urbanization rates. The need for a sustainable solid waste management becomes higher by the minute.

Transferring technical solution and knowledge in the field of waste management from developed countries to developing countries can be seen as a way of accelerating the improvement of waste management. However local differences between the area where the technical solutions have been developed and the receiving area complicate a direct transfer of methods and many examples of failures can be found. Quick fixes are therefore not regarded as an alternative for achieving improvements in waste management. Knowledge is needed how different local aspects affect the possibilities for improving the management in developing countries. Using concepts, which takes local aspects into consideration, for improving a waste management system is a way of actively working for minimizes the risk of failure.

One region in need of improving their waste management is the Kavango region in Namibia. In a twinning program with Vetlanda municipality in Sweden, the region launches a three year project to develop a strategic waste management plan for its 200,000 inhabitants.

3.1 Aim of study

The overall aim of the study is to identify different concepts for improving waste management in developing countries and to evaluate them from a sustainability perspective. For this purpose the Kavango region in Namibia act as an object of study.

The report serves as a master dissertation in environmental engineering at Lund University. The report is also part of an ongoing twinning project in waste management between the Kavango Regional Council and Vetlanda Municipality, where it will be used as a knowledge base for future collaboration work. The optimal outcome of the thesis would be a general approach which takes environmental, social and economical aspects of the solid waste management into consideration and is possible to apply in all developing countries. However such a result is based on the assumption that the possibilities for sustainable waste management are the same in all developing countries. To evaluate the validity of such an assumption the following research questions are used:

- What determine the solid waste generation rate?
- How does the waste composition differ from one place to another and more importantly why?
- What are the driving forces for waste management in developing countries?

The findings from the initial part of the thesis will be used in the Kavango case study. The case study aims to describe the current waste management and to present a roadmap for a sustainable waste management in the Kavango region for the future. The case study enables an evaluation of the concepts on another level, since more focus can be put into details. The following research questions are used for the Kavango case study:

- How much waste is produced in the region and what does the composition of waste look like?
- What are the issues of the current waste management and how can it be improved?
- What are the barriers for improving the solid waste management?
- Is the solid waste management in the region sustainable? If not, how can a sustainable waste management be achieved in Kavango?

3.2 Methods

To be able to plan a region's future solid waste management the most fundamental knowledge needed is the composition and quantities of the waste streams. In developed countries this is usually achieved by waste auditing and other quantitative methods in waste characterization studies. (Newenhouse & Schmit, 2000). There are however several reasons why a different approach is needed for mapping the waste management in developing countries. One of them is the range of the waste collection system. Whereas waste collection in developed countries takes place on an extensive centralized scale, the formal waste collection in developing countries is much more inadequate. (The World Bank, 2012). The importance of the informal sector is another reason why an approach which includes other elements of the waste management than waste auditing is needed (Medina, 2010). A more flexible mapping method than only using waste characterization studies is to use complementary qualitative analysis methods, such as open-ended interviews and field observations (Newenhouse & Schmit, 2000).

Another argument of using mixed methods for research on waste management systems can be found in the theories of the methods. Traditionally, qualitative research methods have been used to answer exploratory questions about unknown aspects of a phenomenon, while quantitative research methods have been used to answer confirmatory questions to test theoretical propositions. The use of qualitative and quantitative methods in the same study benefits from the possibility to ask both confirmatory and exploratory research questions and thereby verify and generate theory in the same study. Providing stronger inferences and greater assortment of divergent views are two other benefits from a mixed method approach. (Teddie & Tashakkori, 2009). A mixed approach of both qualitative and quantitative methods is therefore recommended in studies of waste management systems in developing countries. (Medina, 2010)

For the first part of the report a literature review have been conducted. The literature review attends to issues connected to waste management in developing countries in a general perspective and summarizes different concepts for improving current waste management. The second part of the thesis is the case study of the Kavango region in Namibia. A mixed method approach has been adopted in the Kavango case study. Qualitative methods used in the case study are interviews with people representing key stakeholders for waste management, field observations and focus group discussions. For the quantitative methods waste characterization analysis by hand sorting of waste from urban and rural areas and household surveys are used. The results are analysed in a sustainability perspective and possibilities for introducing different concepts from the literature review are discussed.

3.2.1 Literature review

A literature review is commonly used as an integrated part of research. Reviews can be used to identify a researchable idea or to investigate keywords associated to a research idea. A hypothetical literature review follows the following 12 step method (Teddie & Tashakkori, 2009):

1. Identify a research topic
2. Identify keywords or descriptors that are useful in locating materials
3. Develop an overall search strategy for the literature review
4. Search for preliminary sources
5. Select relevant primary and secondary sources
6. Search the library for secondary and primary sources that have been identified
7. Establish a computer and paper trail, including research summaries in yor own words that will be used in the literature review
8. Repeat steps 4-7 as needed
9. Develop themes or concepts that synthesize the literature
10. Relate the themes to one another through an outline of the literature reviue
11. Produce a final literature review that structures or organizes the literature thematically or by important concepts
12. Use the literature review to develop or refine the research questions

A literature review is performed on the topic, solid waste management in developing countries. The twelve steps method described above has been used to give a description of the following themes: Waste generation, Waste composition, Drivers for sustainable waste management and concepts for improving waste management. Published articles as well as relevant reports from organisations have been used.

3.2.2 Qualitative methods

Open ended interviews

One of the most dominant qualitative methods for data collection in this study has been open ended interviews. The questions can be open or close ended. Open ended questions are, in contrast to closed ended questions, mainly used as a qualitative method in initial studies on topics unfamiliar to the researcher. The open ended interview method is important in cross-cultural studies where psychological differences are unknown. Information given from open ended questions is essential to design other data collection methods in the research. (Teddie & Tashakkori, 2009)

Besides how the questions are formulated the structure of interviews is of relevance. In an unstructured interview the questions are not determined on beforehand but emerge from the immediate context. On the other end of the scale the interview can be structured with predetermined questions with same exact wording to all interviewees. Somewhere between there are semi-structured interviews where the topics and issues have been determined, but not the exact wording of the questions. In that case the interviewer decides the sequence and wording along the course of the interview. (Teddie & Tashakkori, 2009)

In structured and semi structured interviews an interview plan is created with questions and topics relevant for the aim of the study. The structured interview plan consists of the exact questions asked during the interview, while the semi structure plan can consist of topics and some example question. Interview plans are used to ensure standardized interviews. Other planning aspects are how many interviewees and how the selection of interviewees is suppose

to be made (Teddie & Tashakkori, 2009). A higher number of interviews need more resources but can at the same time result in more and better material. The necessary number of interviews is determined by the theoretical satiation. When satiation is reached very little new information is given from an extra interview. The complexity of the study object determines how quickly theoretical satiation is reached. Performing too few interviews might however lead to difficulties spotting trends and omitting information. (Wibeck, 2010)

In the case study open ended semi structured interviews are performed as a way to get basic information of the waste management in the Kavango region and to learn more about the perspectives of the people living there.

Focus group discussions
Another interview related method is focus group discussions. Many planning aspects are the same as for interviews. However the fundamental difference from regular interviews is that more than one interviewee participate. A group of people together answer questions and discuss certain issues. As a consequence group dynamics become relevant for the result. If the participants are familiar to each other before the discussion a functioning group dynamic might already exist. However a risk of only including people familiar to each other is that aspects considered as obvious within the group are left out in the discussion.

In the case study focus group discussion is only used when regular open ended interview is seen as inappropriate due to the high number of people want to participate.

Field observations
Field observations are a method to gather information through direct observation of a study site. Direct observation of practices within a certain field is the main means for collecting field observation data. The method is commonly used for familiarizing with a study site before other techniques are employed.

Field observations have been used in the cases study as a complement to other qualitative methods. The method is used to validate results from other methods.

Analysing qualitative data
The data from qualitative research are inductive by nature, meaning that general conclusions are made out of particular facts in data. Categorise data in the search for trends are a common way of analysing the data. Three different analysis strategies are (Teddie & Tashakkori, 2009):

- *Categorical strategy:* The narrative data is divided and rearranged according to categories. The rearrangements enable comparison between the interviews and leads to a better understanding of the research questions. The categorizing process includes predetermined categories. Each category has a number of rules which describes the properties of the category. These rules are used for the categorization. By categories with definitions distinct from each other, data can only belong to one of the categories.
- *Contextualizing:* The narrative text is kept as a whole text. Instead of rearranging the text into categories, interconnections and statements within the text are analysed.
- *Display of data:* The third and last strategy is to make data comprehensible by visual presentations. A summary of the themes emerging from other analyses are presented. This is done in combination of either one of the first two strategies.

A combination of categorical strategy and display of data have been used for the open ended interviews and field observations in this study. For focus group discussion result are instead analysed by contextualizing.

3.2.3 Quantitative methods

Waste characterization study

Waste auditing is a method used in waste characterization studies to investigate the waste composition and quantities. In the European Union a standard method for waste auditing, the solid waste analysis tool was developed in year 2004. Even though it is not anymore regarded as a standard method in EU, it still summarizes the waste auditing procedure. (iC consulenten ZT GmbH, 2004). The EU method for waste auditing is divided into four different phases:

- Pre-Investigation
- Analysis Design and Planning
- Execution of Waste Analysis
- Evaluation of Waste Analysis

In the pre-investigation phase necessary background information about the object of study are gathered and evaluated. It is also possible through a stratification to divide the sampling according to statistical subdivisions. (iC consulenten ZT GmbH, 2004)

During the analysis design and planning phase the type and number of sampling is decided. The planning should also include the aspects of how to get random and representative samples (iC consulenten ZT GmbH, 2004). The most common method for collecting samples is to use a mother sample for each strata, or statistical subdivision, which is divided into smaller samples. A randomized selection of the smaller samples is used for the waste characterization (RVF, 2005). Samples can either be taken from a specific part of a collection system or directly from where the waste is generated (iC consulenten ZT GmbH, 2004).

For the execution of waste analysis the samples are collected. The samples are sorted and weighed. The result is documented in protocols according to a number of categories, depending on the desired level of detail. (iC consulenten ZT GmbH, 2004)

The last step is evaluation of the waste analysis. The raw data is digitalized and statistical values are calculated. The results can also be extrapolated to a parent population. (iC consulenten ZT GmbH, 2004)

There are several limitations of the method; Waste characterization studies demands a large effort if results of a high statistical precision are needed. It is also necessary to consider how to design the analysis in order to achieve the decided purpose. In order to fulfil the purpose it might be necessary to adjust the standard method. (RVF, 2005)

Household surveys

Surveys are counted as a quantitative research method as long as the questions have fixed response alternatives. It differs from interviews due to the lack of communication between the interviewer and interviewee. The survey approach forces the respondents to fit their answers and knowledge to the predetermined categories and is therefore often criticized for the lack of responses freedom. However using surveys might also be beneficial in situations where basic information is needed for other analyse purposes. Surveys can therefore be used in combination to other methods. Another situation when surveys might be a good research

method is when the surveys are to be repeated several times. Surveys with fixed response alternatives are easy to repeat and the results are measurable. (Teddie & Tashakkori, 2009)

Household surveys have been used in this study in combination with the waste characterization study as a way to gather necessary data about the participants.

3.3 Delimitations

Improvement of waste management is a complex process which includes aspects in many different fields. It is not possible to address all issues related to waste management in a single thesis. The emphasis of this thesis is therefore delimited to waste data collection and concepts for improving waste management.

A sustainability perspective includes per definition economical, social and environmental approaches. The experience of the author within these fields varies, with most experience on environmental protection. Due to lack of experience within the fields of economy and social science a risk of leaving out important aspects exists in those fields. To limit the risks important aspects in the different fields are investigated in the literature study. Hopefully including information from researchers more experienced in the fields of social science and economy can make up for the author's own lack of experience.

Even though an approach including developing countries in general has been used in the literature review, the Kavango region in Namibia is the only representative for the developing countries in the case study. The geographic delimitation is therefore set to the Kavango region. An effort has been made to include all parts of the region in the study, however most research methods have been focused on the biggest town, Rundu. Interviews have however been performed with people from Rundu, Nkurenkuru and Divundu. The disposal site at all these places has also been visited. The waste characterization study on the other hand only included households from Rundu and a village in the rural area. For the interviews only people representing companies and institutions in the Kavango region have been chosen. This leaves out central governments, recycling companies and other national stakeholders.

The waste characterization study is also limited to waste from households. Business waste from hospitals, lodges, shebeens, shops, garages and offices are examples of waste generators which is also part of the local waste management. These different waste generators are however included in the open ended interviews, meaning that waste practices of these stakeholders can be evaluated from a qualitative perspective, but not quantified.

4 Background & Theory

4.1 Definition of a developing country

The classification in developing and developed countries is controversial and no general standardized method of such classification exists. Several questions are also raised in the classification process; can a country be fully developed? Is it enough only to include economical aspects? Which indicators should be used? Different organisations attitude towards these questions have led to several classification methods which all can be used when describing a country's development status. The World Bank describes countries according to their gross national income per capita (GNI). This method only includes economical aspects to describe the development status. Depending on the GNI a country classifies as low income, lower middle income, upper middle income or high income. The first three categories are counted as developing whereas the last category is counted as developed. (The World Bank, n.d.). UN has a different view compared to the World Bank. There exists no established definition of developing and developed countries. Kofi Annan, former secretary general, proposed that:

"A developed country is one that allows all its citizens to enjoy a free and healthy life in a safe environment."

As a way of measuring development UN uses the Human Development Index (HDI). The index measures several indicators in the areas of health, education and living standards in the country to classify it in the different categories very high human development, high human development, medium human development and low human development. (Human Development Report Office, n.d.). IMF does also classify countries in terms of developing and developed. A general classification was made in year 1980. Since then several countries have been reclassified between groups. However little information can be found on which bases IMF decisions are made. (Nielsen, 2011). WTO chooses not to define what a developing and developed country is. Instead the country by itself decides if it should be treated as developing or developed when applying for a membership in WTO. Other members may however challenge this decision. (World Trade Organization, n.d.)

Both the World Bank and the United Nations are examples of organizations which actively work with solid waste management programs. Hence their classification systems are the most common to find in literature in the field of waste management. In this report no active choice has been made between the different classification methods. However most of the sources have used the World Bank method. For that reason the literature review also use the World Bank method for classifying developing and developed countries.

4.2 Definition of solid waste

Solid waste can be defined as

"*Solid materials as well as some liquids in containers, which are discarded or rejected as being spent, useless, worthless, or in excess."* (Nelson, et al., 2009)

In another definition waste is referred to as

"Lack of use or value, or useless remains. Waste is a by-product of human activity. Physically it contains the same materials as are found in useful products; it only differs from useful production by its lack of value". (White, et al., 1999).

Both examples from literature describe the reason for waste generation as either *lack of use* or *lack of value*. However this perspective is not necessarily reflected in legislation. In the European Union waste is defined as:

"A*ny substance or object which the holder discards or intends or is required to discard.*" (2008/98/EC, EU waste framework legislation)

The value, or rather lack of value, is in this case not adopted in the definition. National legislation in Namibia, which is described in more detailed in the case study, define waste as

"*any matter, whether gaseous, liquid or solid or any combination thereof, which is from time to time listed by the Minister by regulation as an undesirable or superfluous byproduct, emission, residue or remainder of any process or activity.*" (Environmental management act no.7, 2007)

This is a rather complicated definition and demands an active effort to define each type of waste. However in a proposal to new legislation waste should be defined as:

"*any substance or thing that the holder discards or disposes of, or intends or is required to discard or dispose of,* ***irrespective of its value*** *to any person, and any substance or thing deemed by regulations to be waste* " (Pollution Control and Waste Management Bill, third draft, 2003)

The legislation in Namibia share, or at least might share in the future, the same approach as the European union of only including the usefulness aspect of items. The lack of value is not regarded in either legislation.

4.2.1 Solid waste categories

The solid waste can be categorized according to the origins of the waste streams. There are two main groups. The solid waste-mix generated and collected in urban areas is often referred to as *Municipal Solid Waste* (MSW). The MSW include waste from houses but can sometimes also include waste from industries and small scale businesses in the urban area. The waste is characterized by being heterogeneous. On the other hand there is *homogenous solid waste* generated from industries farms, mines etc, in both rural and urban areas. Waste from these sources is in many cases easier to collect since it is concentrated to certain large producers. The treatment process itself can also be easier to perform because of the homogeneity of the waste. (United Nations Environment Program, 2005)

It is also possible to categorize the waste depending on the character and content. Two main groups in this method are organic and inorganic waste. There are also many alternatives when it comes to sublevels. The inorganic waste can for example be divided according to the material, e.g. plastic, paper, metal, glass etc. (United Nations Environment Program, 2005)

One category of waste which deserves some extra attention is the hazardous waste. Hazardous consist of the two subcategories medical waste and chemical waste. The definition of hazardous waste, used in the national legislation, differs a bit from country to country. The

general term is however that hazardous waste is waste which might be harmful for human or environmental health. Both heterogeneous and homogeneous waste streams may contain hazardous waste. (The World Bank, 2012)

4.3 Management of waste

The life of waste can consists of many steps. The first step is no doubt the generation of waste. As soon as the waste is generated it needs to be managed in one way or the other. Figure 1 summarizes the different steps of waste management.

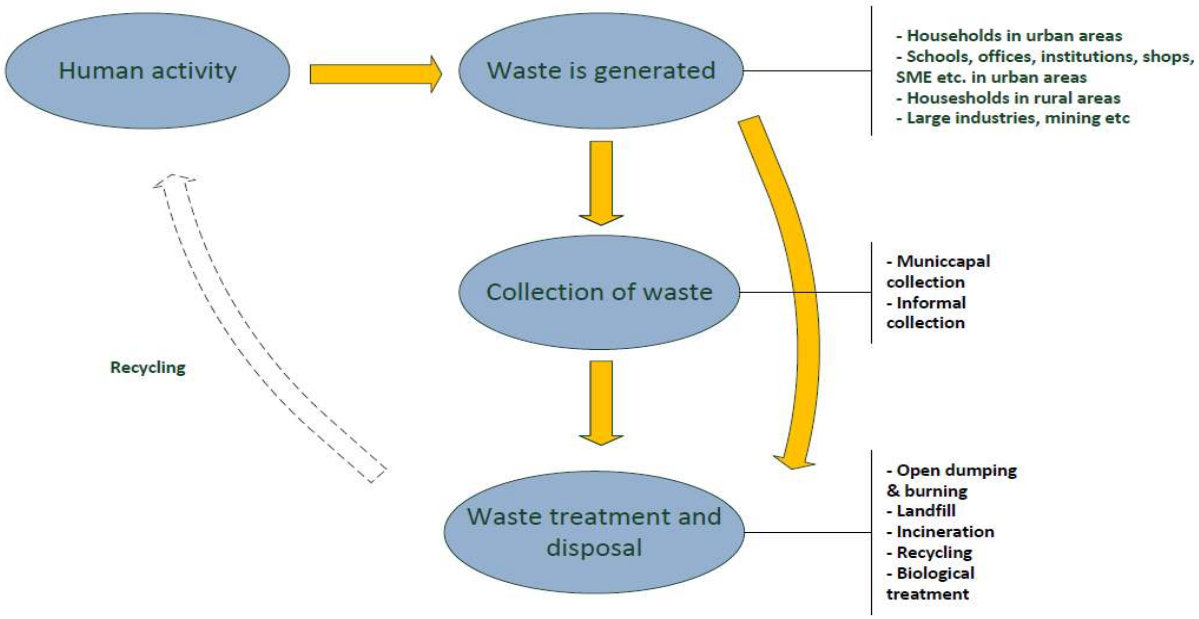


Figure 1. General description of the steps of waste management, with emphasis in developing countries. All solid waste does not necessary go through all the different steps. Many of the treatment and disposal method demands collection of waste, however open dumping and burning occur on a household level without the waste being collected.

4.3.1 Collection of waste

Waste collection is the first step in waste management. As can be seen in Figure 2, the collection efficiency is generally poor in regions with many developing countries. In most developing countries only waste from some of the urban areas are collected. Rural areas are seldom included in any collection schemes. However this does not exclude the possibilities of small scale informal collection in the rural villages. (The World Bank, 2012)

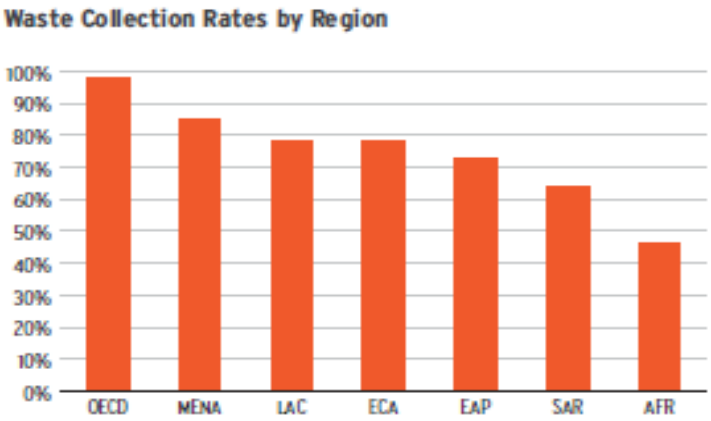


Figure 2. Urban waste collection rate in different regions. OECD has the highest efficiency whereas Africa and South Asia have the lowest. (The World Bank, 2012)

The collection method varies from one city to another. Some examples of waste collection are:

- **House to house collection:** Waste is collected directly from individual houses. For this service, the user often pays a fee.
- **Community bins:** Waste generators bring their waste to a communal collection point in the neighborhood. The solid waste is then picked up by the municipality according to a schedule.
- **Curbside collection:** In a schedule, set by local authorities, solid waste is collected in a neighborhood. People living in the neighborhood place their waste directly outside their houses.
- **Self delivered:** No communal collection. The waste generators by themselves transport the waste to a disposal site, transfer station or similar.
- **Contracted/delegated service:** To encourage collection efficiency a private entrepreneur is contracted to take care of the waste collection. The entrepreneurs in some cases take demand fee for the service directly from the waste generators, in other cases money goes through the municipality who collect fees from the inhabitants and later pays the entrepreneur. (The World Bank, 2012)

A city's waste collection can consist of one, or a combination of several of the examples above. In developing countries the prerequisite for waste collection can vastly differ even within the city border. One example of this is the occurrence of unplanned and densely populated suburban areas, or slums, which lack adequate infrastructure. The possibility of waste collection from the slums might be different from the rest of the town. To cope with this variation a combination of collection method are necessary (Henry, et al., 2006). Different collection method for different type of waste is also common. (Wilson, et al., 2006)

4.3.2 Disposal of waste

Common waste treatment methods are *dumping*, *landfill*, *incineration*, *biological treatment* and *recycling*. The use of method for disposal is different between developing and developed countries. In Table 1 a comparison between African countries and OECD countries are made. In African countries waste disposal occur almost only via dumping and landfill. In OECD no, or low amount of waste is dumped. Instead more waste is recycled and incinerated.

Table 1. Distribution of waste disposal methods in Africa compared to OECD. The distribution is presented in millions tonnes per year and percent of the total waste disposal in the correspondingly region. (The World Bank, 2012)

	Africa		**OECD**	
Dumping	2.3	44 %	-	0 %
Landfill	2.6	50 %	242	42 %
Compost	0.05	1 %	66	12 %
Recycling	0.14	3 %	125	22 %
Incineration	0.05	1 %	120	21 %
Other	0.11	2 %	20	3 %

Dumping

Open dumping is one of the most common waste disposal methods in developing countries. Dumping is characterized by low control, low or none planning and low regulations, consequently dumping sites are also low engineered. Dumping often take place in a centralized scale, but can also be executed on an individual scale. Illegal incineration is also

common as a method to reduce the volume of the solid waste. (Zurbrügg & Schertenleib, 1998)

Landfill
If lack of necessary precaution the practices of land filling are similar to open dumping. The risks and characteristics of uncontrolled and unplanned land filling are equal to the risks and characteristics of open dumping. Sanitary landfills however is built to reduce the possible risks through liners in the bottom to prevent leachates from polluting the surroundings, earth cover to prevent animal access to organic waste, and methane uptake. In low-income and middle-income countries there is a scarcity of proper sanitary landfills. (Medina, 2010)

Incineration
Another waste disposal method is incineration under controlled forms. Uncontrolled incineration at open dumping sites is not included in this category. In the process combustible waste is transformed to energy with the possibility of filtering and monitoring pollution. Experiences have proven developing countries as unsuitable for incineration as a main disposal method. The waste composition of high rate of moist waste makes incineration difficult to perform at low costs. (Medina, 2010)

Biological treatment
Biological treatment is divided into two categories, composting and controlled anaerobic digestion. The former can be executed in low-tech conditions, whereas controlled anaerobic degradation demands a high level of technical knowledge. For that reason controlled anaerobic digestion of solid waste is almost none-existing in developing countries. The lack of the possibility for energy recovery when composting is another important difference. When waste is biological treated, the product can be applied to soil to improve agricultural activities in the area. (The World Bank, 2012)

Recycling
In this report recycling as a waste treatment method is only considered when the material itself is recovered and used in new materials. Hence energy recovery is not included. The recycling process consists of recovery of materials from the waste stream, intermediate processing (e.g. sorting), transportation of material and final processing. The end product of a recycling process can either be a new product or raw materials for manufacturers comparable with virgin materials. (Daskalopoulos, et al., 1998)

4.3.3 Informal sector

In developing countries the informal sector plays a significant role in solid waste management. The informal sector is characterized by being small-scale, often based on household labor, and labor intensive. Per definition the informal sector is also unregulated and unregistered and hence it is not included in social welfare or government insurance schemes. (Ahmed & Ali, 2004; Wilson, et al., 2006). The informal sector is primarily involved in two types of activities, informal refuse collecting and scavenging.

In many cities in developing countries residents areas exists which are not covered by the municipality's solid waste collection service. Local entrepreneurs can see this as an opportunity and arrange an informal refuse collecting system, using pushcarts, tricycle, donkey carts or pickup trucks for transport purposes. Residents do pay a fee as normal for this service (Medina, 2010). Another activity which involves the informal sector is scavenging. In this case the informal sector is driven by economical valuable waste, material which

otherwise would be lost for the society (Medina, 2010). Scavenging can take place at any system level of waste managing, everything from alternative collection, sweeping of streets, hand sorting waste transports and at dumps and landfills. The secondary material collected through scavenging are processed through sorting and cleaning and are then normally traded locally via an intermediate dealer, see Figure 3 . The secondary material can pass several dealers before reaching its end user, e.g. local industry and craftsmen. (Wilson, et al., 2006)

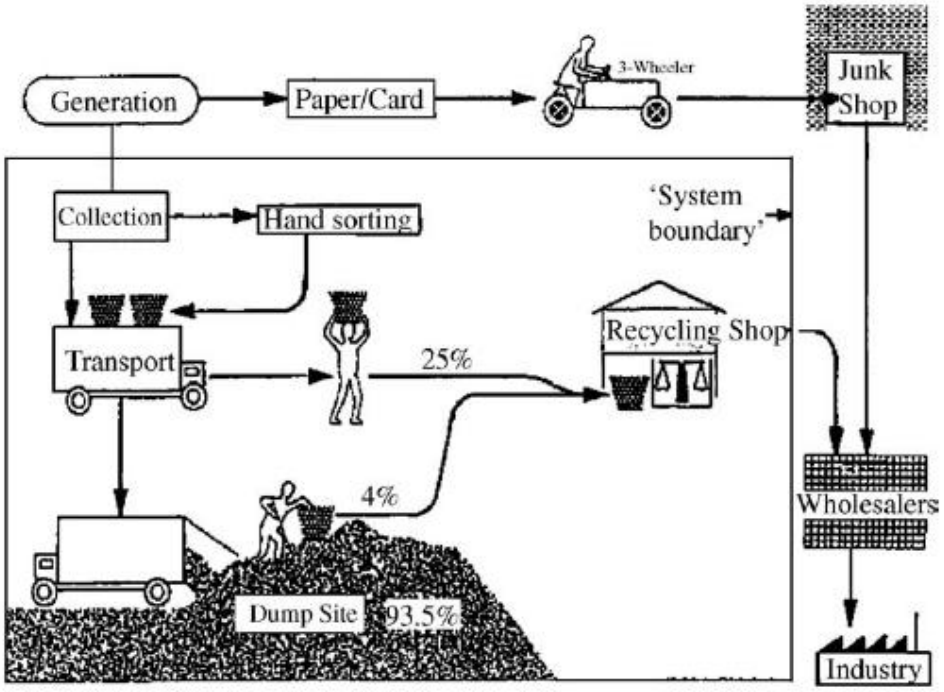


Figure 3. Flow chart example of an informal recycling system. (Wilson, et al., 2006)

4.4 Definition of a sustainable waste management

The concept of sustainable development was first defined by the Brundtland report in year 1987 as:

"development that meets the needs of the present without compromising the ability of future generations' needs". (UN, 2012)

The sustainable development concept was further widening during the UN World Summit in year 2005. The outcome document declared that economic development, social development and environmental protection are three independent and mutually reinforcing pillars of sustainable development. Furthermore the report identifies the following requirement for sustainable development: *poverty eradication*, *changing unsustainable patterns of production and consumption* and *managing the natural resource base of economic and social development.* (UN - Genereal Assembly, 2005)

The possibility of a sustainable solid waste management is an idea commonly used by scientific authors. Focus is however sometimes limited to the choice of treatment processes, such as recycling and energy recovery (Troschinetz & Mihelcic, 2009; Daskalopoulos, et al., 1998). Such a limitation has a tendency to omit important social aspects. For that reason sustainable solid waste management in this report is defined as a part of a society's general sustainable development. The general requisite of a development that meets the present needs

without compromising the future needs, therefore apply. Furthermore sustainable solid waste management should meet the necessary demands of social development, economical development and the environmental protection.

To evaluate if a waste management system is sustainable it is necessary to define a number of criteria for sustainability. The international water and sanitation centre use the following criteria for a sustainable sanitation system (IRC, 2004):

- it is functioning and being used;
- it is able to deliver an appropriate level of benefits (quality, quantity, convenience, continuity, health) to all, including the poorest women and men;
- it continues to function over a prolonged period of time (which goes beyond the life span of the original equipment);
- its management is institutionalized;
- its operation, maintenance, administrative and replacement costs are covered at the local level;
- it can be operated and maintained at local level with limited but feasible external support; and
- it does not affect the environment negatively.

5 Waste management in developing countries – a literature review

5.1 Solid waste generation

Two different alternatives for measuring the solid waste generation are the solid waste generation rate and the total amount of generated waste. The generation rate allows comparison of different countries when investigating why solid waste is generated. However to describe the actual situation, the total amount of solid waste is more relevant since the population of the inhabitants is included. The total amount of generated waste can be used to estimate impacts of the waste management as well as to evaluate different treatment options.

5.1.1 Generation rates

The solid waste generation rates in different countries are presented in Figure 4. Solid waste generation is suggested by UNEP to reflect the lives of people and the activities in the country. With that perspective the waste generation would be a combined function of the living standards of the inhabitants and the region's natural resources (United Nations Environment Program, 2005). This view is also partly shared by other authors who address the income level of the people as the most important factor for waste generation rates (Medina, 2010; The World Bank, 2012). Suggested other factors of importance for the waste generation rate is the degree of industrialisation, public habits, local climate and level of urbanisation (The World Bank, 2012).

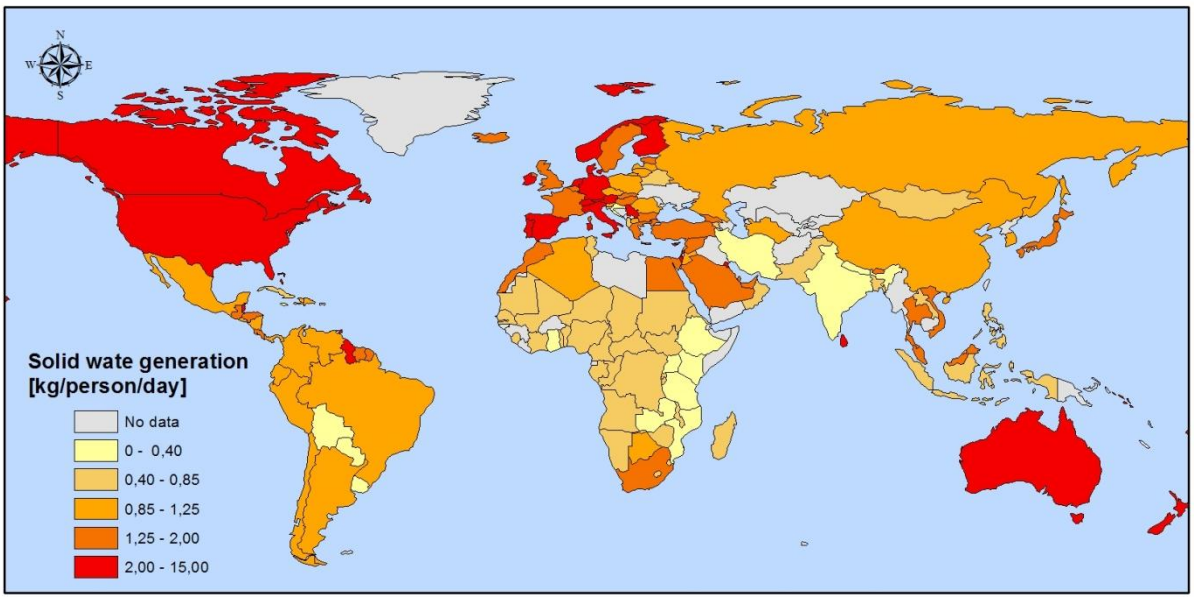


Figure 4. Solid waste generation rates in the world. The map indicates the generation rate to be highest in North America, Europe, Australia & New Zeeland and in some of the Arabic countries. The generation rate is lowest in the sub Sahara part of Africa, South Asia and South America. Source of data: (The World Bank, 2012)

Analyses and comparison of solid waste in different countries of the world are a challenge since the definition of waste differs from one country to another. Furthermore the available waste data are limited. (Wilson, et al., 2012). No model of acceptable quality for estimating the waste generation rates in a region has been identified in literature. In an attempt to evaluate the relevance of the previously suggested factors for waste generation rate, data from the report *What a waste* (The World Bank, 2012) and indicators for the factors in Table 2 have been used in a multiple regression to find out if there are any linear relationships

between the factors and the waste generation rates. For details about this analysis see Appendix E: Statistical analyses of waste generation rates.

Table 2. Suggested factors which explain the generation rate in a country, the respectively indicator and the source of indicator data. Usable indicators could only be identified for living standard, income level, industrialization and urbanization.

Factor	Indicator	Source
Living standard	Human development index	(UNDP, 2011)
Natural resources	N/A	
Income level	GNI per capita	(The World Bank, 2012)
Public habits	N/A	
Industrialization	Percent of GNI from Industry	(CIA, 2012)
Local climate	N/A	
Urbanization	Percent of people living in urban areas	(CIA, 2011)

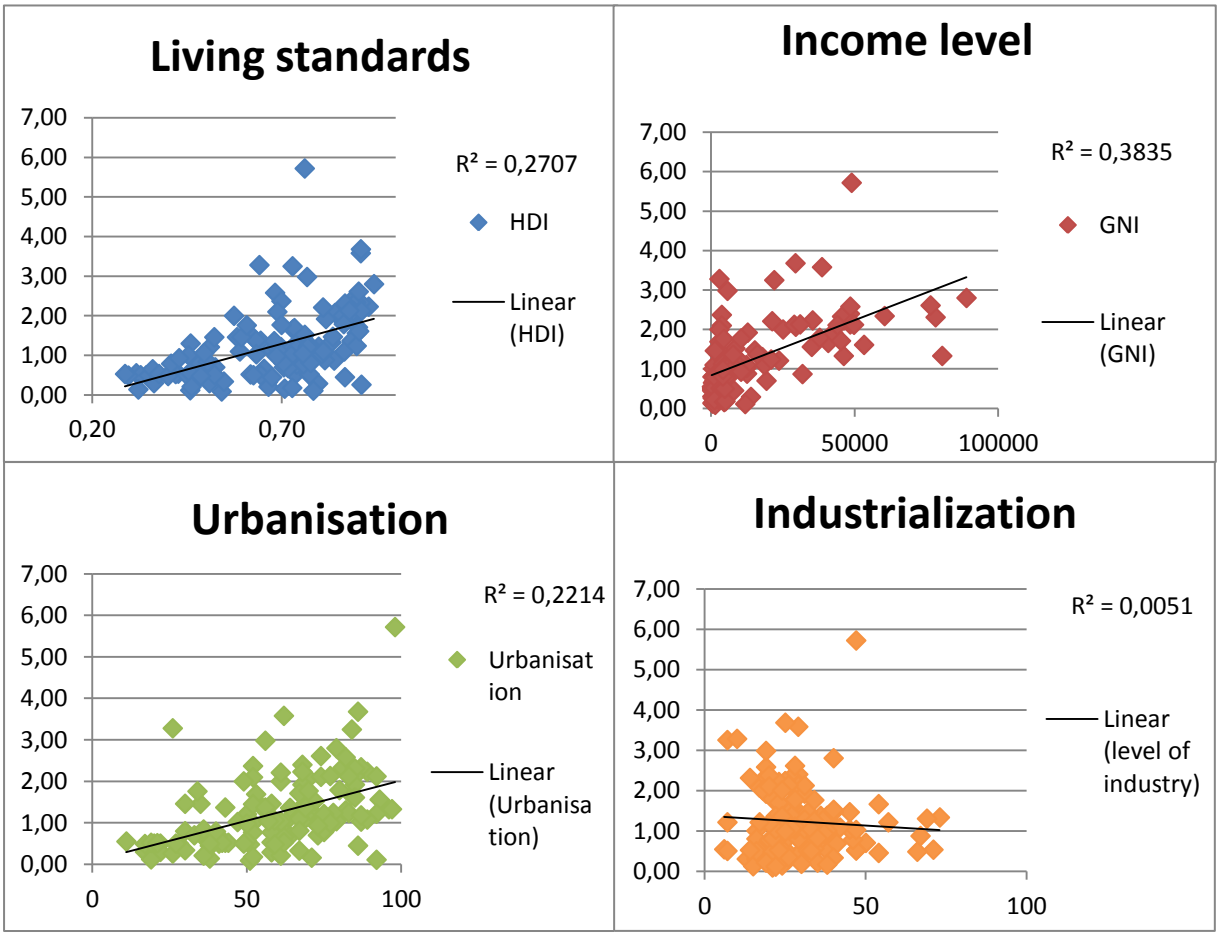


Figure 5. Linear relationship between the waste generation rate (kg per person and day) and the four different factors; Living standards (HDI), Income level (GNI/capita), Urbanization (% of population) and Industrialization (% of GNI from industry). The R square value of the linear regression indicates how well the data fits to the model, i.e. how much of the variation of data which could be explained by the factor. Income level is indicated to be the most important factor with 38 % of the data possible to explain with the factor. Industrialization has the lowest R square value.

In Figure 5 the waste generation rate is plotted against the four different indicators and linear regressions are made. There are some signs of a relationship between the four factors and the waste generation rate. However no single factor was able to explain more than 38 % of the data variance by itself. A multiple linear regression is also made to see if combinations of the different factors are more statistically successful to explain the data. The multiple linear regressions received a R^2 value of 0.43 which is only slightly higher than the 0.38 received when the waste generation were plotted against the income level.

5.1.2 The total amount of generated waste - distribution within a country

A common view among scientific authors is to see the population growth combined with an escalating urbanisation as the main problem when it comes to waste generation in developing countries. (Troschinetz & Mihelcic, 2009; Ahmed & Ali, 2004; Barton, et al., 2008; Zurbrügg & Schertenleib, 1998). The consequence of the population growth and the escalating urbanisation is a concentration of waste to urban areas.

The urbanisation in developing countries has become a large factor in later years and the urban populations in developing countries are estimated to grow more than 150 000 people every day (Troschinetz & Mihelcic, 2009). It is also estimated that 90 % of the urbanisation the next 25 years will take place in developing countries (Ahmed & Ali, 2004).

In most developing countries the per capita income is higher in urban areas compared to rural areas (Medina, 2010). This would also contribute to concentration of the waste generation to cities. However if economic activities, such as large scale agriculture and mining, exists in the rural area large amount of homogeny solid waste is produced (Medina, 2010).

One aspect which complicates the waste management in cities in developing countries is the large number of people living in slum areas. About one billion people are currently living in slums. This is people who lack adequate waste management. The slum areas are also expected to increase if the urbanization increases faster than the local authorities can handle. (Barton, et al., 2008)

5.2 How differs the solid waste composition from one place to another and more importantly why?

The composition of waste determines possibilities for waste treatment and a change in waste composition can therefore have a severe impact on the waste management practices. The composition of waste also determines the effects of improperly managed waste. (Medina, 2010)

A distinct difference between the composition of waste in developing and developed countries is the degree of organic content. In general, developing countries have a larger extent of organic waste, a difference which can be up to three times the degree of organic content in waste from a developed country. (Medina, 2010). In Figure 6, countries are divided according to the degree of organic waste in the waste composition.

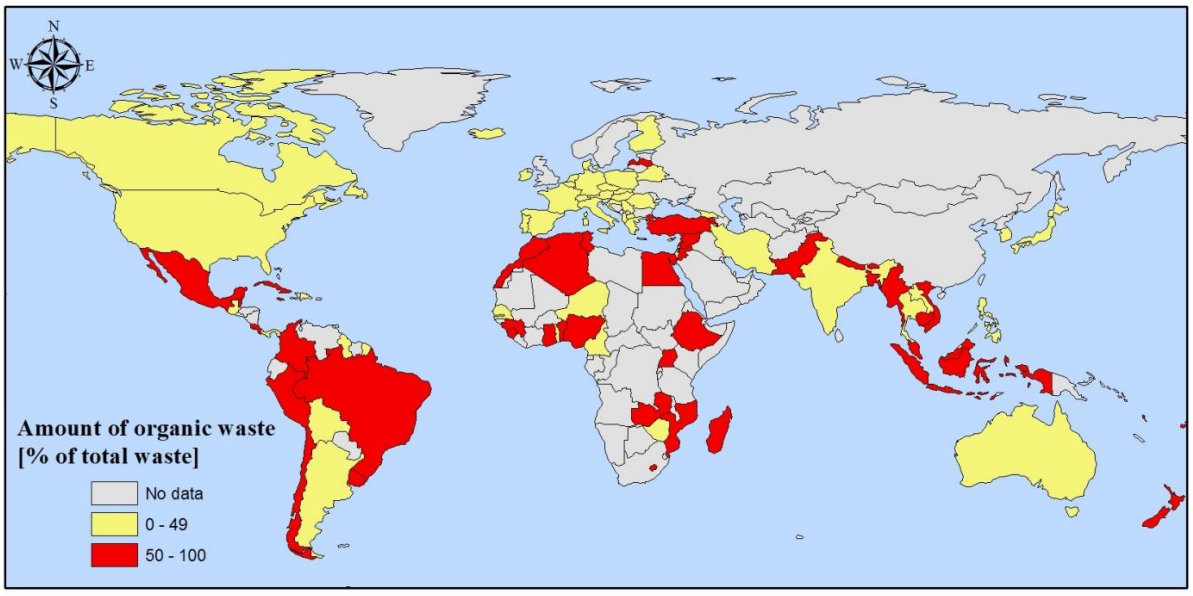


Figure 6. Map over the degree of organic waste in the solid waste composition in a number of countries. Red countries are high organic waste producers, with more than half of the composition being organic waste. The yellow countries are low organic waste producers with less than half of the composition being organic waste. The map indicates that most of the high organic waste producers are located in Africa, South America and Asia. In Europe and North America most of the countries are low organic waste producers. Data used from (The World Bank, 2012)

The difference of organic waste content between developing and developed countries can been explained with the different way of handling food. In developing countries most of the food consumed are fresh fruit, vegetables and unpacked food compared to the consumption in developed countries where a larger rate consists of food packaged in cans, bottles, plastic containers etc. (Medina, 2010). This explanation assumes that most food is produced within the developing country, or region, and at the same time a low proportion of imported food.

There are also regional differences in the composition. Solid waste from humid, tropical and semitropical areas consists of a high amount of plant debris. Regions with distinct seasonal changes in temperature, on the other hand, have a higher amount of ash in their solid waste. The ash originates from heating in the colder winter season. (United Nations Environment Program, 2005)

5.3 Drivers for sustainable waste management

5.3.1 Social aspects

Public health

Protection of public health is often the most important incitement for municipal solid waste management in developing countries. Without proper waste collection the public health can be threaten from several diseases. The quantity of vector transmitted diseases, such as dengue fever (mosquitoes), leptospirosis (rats) and enteric bacteria (houseflies) are higher in absence of proper solid waste management. Waste supply the vectors (mosquitoes, rats, houseflies etc.) with food and shelter. Hence, collecting the waste in urban areas and thereby increase the sanitation level of the population, can be an effective way to reduce the risk of vector diseases. Furthermore the public health can also be threatened by the waste itself. Hazardous waste, such as medical and chemical waste, is in developing countries seldom separated from other waste. Direct contact with hazardous waste can lead to injuries and transmitting of blood diseases. (Cointreau, 2006)

Even when the waste is collected the waste treatment can propose a threat to public health. Dumping waste at inadequate landfills without leaching control is a vast source to contamination of drinking water. Another common treatment option in the developing world is uncontrolled incineration. In these cases, the incineration process is far from optimal, with high emission of VOC (Polychlorinated dibenzodioxins, dibenzofurans, polycyclic aromatic hydrocarbons, etc.) which have been known for causing cancer at high concentrations. (Cointreau, 2006)

Workers health
Working with waste is a high risk occupation with several injuries and health issues. The risk in developing countries have proven higher than in developed countries since the worker is in more direct contact with the waste. Some of the most common issues in solid waste management are: (Cointreau, 2006)

- Respiratory illness from ingesting particulates during waste collection and dusty conditions at open dumps
- Infections from direct contact with contaminated waste
- Puncture wounds leading to tetanus, hepatitis and HIV infection
- Headaches and nausea from anoxic condition in disposal sites
- Lead poisoning from burning materials

Informal workers and health
The informal sector usually consists of poor and marginalized people living in urban areas. It is not uncommon the entire informal sector in a city belongs to the same minority, e.g. Zabbaleen in Egypt. These discrete social groups can earn some money from the waste management and does not necessarily belong to the poorest in a city. However they are always socially distanced from the rest of the population. (Wilson, et al., 2006)

Many informal workers, especially scavengers, are children, pregnant women and seniors. These groups are also more vulnerable to toxics and diseases than other groups. Children intake more water, food and air per body mass than adults and even a low concentration of toxins can disrupt their development. Low immune defense among children and seniors is also a contribution to high risk when exposed to diseases. (Cointreau, 2006)

Most of the informal worker lack protective equipment such as gloves, face masks or even shoes. Many scavengers also live at or near large disposal site. Exposure to emissions and diseases from the waste is therefore not restricted to their occupational time, but presence during their life altogether. Domestic animals such as pigs, goats and cows can also obtain and transmit diseases to their owners. (Cointreau, 2006)

Gender
Before describing gender differences, the cultural differences in developing countries when it comes to waste management, should be noted. The role of man and women in the society highly differ from one country to another. This text should therefore only be seen as generalized descriptions which may not be true everywhere.

Solid waste management includes many aspects which are gender related. The waste itself may not differ from a women and a man, but when it comes to waste management there are several gender specific differences. Women plays a traditionally import role in the household and are often responsible for waste generating activities such as cooking, cleaning etc. The management of the waste inside the household therefore often fell upon the woman. As a

consequence of this women, in many instances, also take more responsibility on a community level when they become aware of the negatively impact of inadequate waste management. (Bernstein, 2004)

The voluntary work by women in waste management at a community level may come from purely altruistic reasons. When the work becomes legitimized and paid as a part of development, women often have to step back for the benefit of men doing the same work, but with a salary (Bernstein, 2004). One activity commonly performed by women are waste recovery through scavenging. The physical level of waste recovery is such that other works with the same level is normally designated for men. Why women are more likely to be involved in material recovery than other work of a similar physical level is a mystery but can perhaps be explained their daily contact to waste in the household. Women also tend to be amongst the most marginalized groups and could therefore be forced into material recovery (United Nations Environment Program, 2005). A woman who has a paid occupancy in waste management often has lower salaries and worse work conditions compared to men. It is therefore crucial that effort is put into development projects to protect and improve the situation of women. (Bernstein, 2004)

Women also have a higher willingness to pay for waste services. Experiences also indicate that household economies managed by women are more reliable users when it comes to payment for waste services. It is therefore necessary to investigate other aspects than income level when determine tariffs for the waste service. (Bernstein, 2004)

5.3.2 Economical aspects

Public finances

Waste management activities can either be financed by public funds or by private individuals through user fees. A simplistic view is that public funds only should be used for financing public goods delivered by public agencies and private goods by user charges. How waste management should be financed would therefore be a question of the character of the activity. Many aspects of waste management do not only favor individuals but the whole public and should therefore be considered as being public goods, for example sweeping of streets and cleaning of public parks. Other activities, such as resource recovery, are more difficult to categorize in public/private goods. (Cointreau-Levine, 1994)

Waste collection and treatment are two activities highly affecting the economy of local authorities in developing countries. Waste management is predicted to consume about 30 % of the local authorities' budgets in developing countries (Henry, et al., 2006). Waste collection is the most costly activity of waste management, predicted to stand for 60-75 % of the total waste management costs (Nemerow, et al., 2009). The costs of disposal and treatment of waste depends on the choice of activity, see Table 3.

Table 3. Costs of different disposal methods in low, lower middle, upper middle and high income countries. (The World Bank, 2012)

US$/tonne waste	Low income <$876	Lower middle income $876-3,465	Upper middle income $3,466-10,725	High income >$10,725
Sanitary Landfill	10-30	15-40	25-65	40-100
Open Dumping	2-8	3-10	NA	NA
Composting	5-30	10-40	20-75	35-90
Waste -to-Energy Incineration	NA	40-100	60-150	70-200
Anaerobic Digestion	NA	20-80	50-100	65-150

A change of treatment method accompanied by higher costs should only be performed if the difference in treatment methods contributes to the public good in such a way that it makes up for necessary subvention from public funds. Another valid option would be if the higher costs are covered by market based revenues. (Cointreau-Levine, 1994)

Economy of the users

One of the basic needs for a cost-recovery system is a working method for collecting money from the people. This can be done either by taxes, or by user fees. Two examples of collecting money are house taxes and user fees connected to water and electricity bills. In the first case the sanitation costs are based on the ownership of a house in urban areas. The latter is based on locally determined tariffs and is combined with billing for other services such as water distribution and electricity. Both methods falls short when it comes to urban informal areas where buildings are unregistered and where access to power grid and communal water is limited. (Zurbrügg, 2002)

Another aspect of importance for the possibility to collect user fees is the local economy and willingness to pay. A poor economy of the people constrains the income possibilities of the local authority and thereby also the possibilities of a proper waste treatment. People are often willing to pay for visible activities, such as collection, but not as willing to pay for less visible activities, such as sanitary land filling. (Zurbrügg, 2002)

Incomes of the informal sector

Two different sources of income exist for the informal sector; User fees in an informal collection system or from scavenging valuable material. The informal sector often consists of poor and marginalized people. The income possibilities for this sector from solid waste management are therefore an example of the linkage between poverty eradication, described in the millennium development goals, and solid waste management. The informal sector is a complement of the formal sector when it comes to delivering waste services, a situation which needs to be considered when changing a waste management system to avoid a loss of income for marginalized people. (Wilson, 2007)

Value of waste
The value of specific waste streams can be an incitement for resource recovery. Examples of resource recovery are recycling of materials, energy recovery and composting. In developing countries common resource recovery activities are collection of recyclable materials and composting. The recycling materials are collected from anywhere in the waste management process, from separate collection at source to scavenging in dumping sites. Due to lack of recycling infrastructure the recycling process normally is centralized. Therefore the recycling activities are in most places limited to collection, separation and cleaning. The materials then have to be transported to a recycling plant. Both transportation costs and the existence of a working market for recovered materials determine the actual value of waste and are important for recycling possibilities. The benefits of composting, from an economical perspective, are perhaps mostly avoiding organic waste in landfills, which reduce the needed capacity of the landfill and the methane gas emissions. The products of composting can however be sold in a local market to farmers and landscapers as a soil improving material.
(Henry, et al., 2006)

5.3.3 Environmental protection

Hazardous waste
A source of environmental pollution is inadequate treatment of hazardous waste. When the hazardous waste is mixed with other solid waste, pollution can occur through leaching from dumping sites and landfills, or by air pollution when burning waste. It is also a health problem for workers and animals that get in direct contact with the waste. (The World Bank, 2012)

Hazardous waste can be divided into the two subcategories medical waste and chemical waste. The largest producers of chemical waste are chemical manufacturing, petroleum industry, waste treatment and remediation, metal production and pharmaceutical production (Rosenfeld & Feng, 2011). The most common sources of medical waste are medical facilities such as hospitals, nursing homes and clinics (The World Bank, 2012). Hazardous waste can also origin from households and be a part of the municipal solid waste mix.

Carbon emissions
Every waste management activity generates greenhouse gases (GHG), either directly from the activity itself or from energy consumption. The actual effect of the GHG emissions is a result of generated emissions during the waste management and the avoidance of emissions from downstream activities. The two most common GHG in waste management are carbon dioxide (CO_2) and methane (CH_4). Examples of waste management activities generating carbon dioxide are transportation from collection, burning and incineration of waste, aerobic digestion through composting and other energy consumption. Methane is primarily generated when organic waste is digested in anaerobic conditions in landfills. Informal landfills and open dumping produce less methane than sanitary landfills due to less anaerobic conditions. Improving treatment conditions in developing countries towards sanitary landfills would ironically lead to larger methane emissions. The global warming potential (GWP) for the different gases, can be seen in Table 4. (United Nations Environmental Program, 2010)

Table 4. Global warming potential for the three greenhouse gases carbon dioxide, methane and Nitrous oxide. As can be seen in the table both methane and nitrous oxide have a much higher global warming potential compared to the equal amount of carbon dioxide (United Nations Environmental Program, 2010).

Greenhouse gas	GWP 20 years (kg CO_2-e)	GWP 100-years (kg CO_2-e)	GWP 20 years (kg CO_2-e)
Carbon dioxide CO_2	1	1	1
Methane CH_4	72	25	7.6
Nitrous oxide N_2O	289	298	153

Landfills are the largest source of GHG emissions in solid waste management and globally stand for a methane emission equally to 700 Mt CO_2-e. The second largest GHG source in waste management is incineration which globally has an annual emission of 40 Mt CO_2-e. (United Nations Environmental Program, 2010).

Protection of local environment
In countries with a scarcity of natural resources, such as drinkable water and arable land, protection of the local environment is a driver for improving the waste management. Inadequate disposal of waste can contaminate sensitive ground and surface water (Wilson, 2007). Two causes for local pollution are inadequate waste collection and improperly disposing of hazardous waste. Uncollected waste might end up sensitive areas and contribute to pollution. Mixing hazardous waste with other municipal solid waste is not only a health problem for workers, but also cause for polluting leachate (The World Bank, 2012)

Daily covering at land-fills and leachate control are two examples of how to adjust the waste management to protect the local environment. Depending on the nature of waste and disposal methods the potential threats differ. In landfills leachates contain high amounts of organic concentrations. However at dumping sites with regularly burning, the amount of organic leachates is lower. Leachate might also contain ammonia, nitrate, phosphate, chloride, calcium, potassium, sulfate, iron and the heavy metals lead, zinc, cadmium and nickel (Cointreau, 2006).

5.4 Concepts for achieving a sustainable waste management in developing countries

Integrated Solid Waste Management (ISWM)
Integrated solid waste management, or ISWM, is a concept for approaching the task of designing a new waste management system, or rationalize an already existing one. With an ISWM approach all aspects of a waste management system, technical as well as non-technical, are important. A genuine relationship between technical and non-technical aspects is considered, with no possibility of changing one aspect without affecting others. As a result technical and non-technical aspects should always be analysed together. (United Nations Environment Program, 2005)

Social desirable, environmental sound and economically viable is the three aims of an integrated solid waste management system. If achieving the spoken aims, the approach is qualified for being called a sustainable solid waste management. The integrated waste management approached is also considered as the alternative which is the most compatible with environmentally sustainable development (Medina, 2010). Many examples of solid waste management system failures can be found in history. The reasons why a failure occurs are seldom due to technical difficulties. Instead politics, economical aspects and institutions are far more important. Integration of governance in solid waste management reduces the risk

and is more likely to be successful (Wilson, et al., 2012). Another more practical benefit originates in the economical differences between waste management activities. While some activities solitary will generate net expenses for the stakeholder, others might even bring an income. ISWM allows an economical independent waste management, where costly activities are included. An economical independent system is referred to as a cost recovery waste management. A situation without cost recovery is when activities with a positive economical situation are stripped from its incomes, leaving other necessary waste activities without the financially needs to be executed properly. (United Nations Environment Program, 2005)

The first task when introducing ISWM is to consider the formal part and legislation of the waste system. All aspects of this should be summarized into one framework, or waste management plan, based on the overall objectives of the waste management system. An international accepted concept in integrated solid waste management frameworks is the waste hierarchy, see Figure 7. The next task is to organize all municipal waste related functions under the same agency to simplify further integration processes. Another important task is to access all waste management costs and opportunities of generating revenues to be able to achieve an integrated financial structure. (United Nations Environment Program, 2005)

Figure 7. An example of the solid waste hierarchy, describing how integrated solid waste management activities should relate to different treatment methods. The top and thereby most preferable waste treatment options Reduce, Reuse and Recycle (the three R's) does together with Recover forms the options of waste diversion. The least preferred options Landfill, Incineration and Controlled dumping are examples of waste disposal. *Controlled dumping is the very last option to be accepted. Uncontrolled dumping should at all costs be avoided. (The World Bank, 2012)

Public Private Partnerships (PPP)

PPP, or public private partnership, is an intermediate alternative to no private participation and full privatisation. In a PPP government and private companies agree upon co-responsibility and co-ownership for the solid waste collection and treatment service. (Ahmed & Ali, 2004)

The most important benefit of PPP is the accessibility of advantages of the private sector (dynamism, access to finance, managerial efficiency, entrepreneurial spirit etc.) combined with the advantages of the public sector (social responsibility, environmental awareness, local

knowledge, job generation concerns etc.). The introduction of the private sector in a municipality solid waste management could relief the burden of the authority's waste management budget, due to higher effectiveness and access to external finance. (Ahmed & Ali, 2004)

Accomplishment of a PPP with all partners acting under mutually favourable circumstances is however not obvious. Both partners have to share the commitment to pursue common goals (Ahmed & Ali, 2004). The public sector interest in introducing a PPP is to save money, whereas the private sector needs to make money. With these differences commitment to common goals is not obvious and can be problematic. (Cointreau-Levine, 1994).

PPP concept originates from the developed world. Hence, there could be difficulties introducing PPP in the developing world where the regulatory framework is generally weak. A poorly executed PPP without transparency, fairness and accountability could even open up waste management for corruption and inefficiency (Ahmed & Ali, 2004). To avoid this situation an important step towards PPP is to strengthen the capability of the public sector, so that proper contract control over the private sector can be executed. (Bartone, et al., 1991)

Integration of the informal sector

About 2 % of the population in Asia and Latin America is involved in the informal sector of waste management. Besides a large number of people occupied in the informal sector, it also plays a significant role diverting recyclable materials from solid waste. Integrating the informal sector simply means making the informal, formal. The main benefit of an integration of the informal sector is the possibility to positively change the social impacts solid waste management have on the informal sector. (Sembring & Nittivattananon, 2010)

Despite the informal sector's relevance for a municipality's waste management most of the governments in the developing world ignore or sometimes actively discourage the informal sector activities. One common opinion amongst local politicians is that the informal sector is associated with unhygienic environment and risk to the public health. Another common opinion is that an integration of the sector would lead to higher costs. As a consequence a political resistance can occur when integrating the informal sector in local waste management. (Sembring & Nittivattananon, 2010)

A suggested conceptual method for integrating the informal sector argues for the following integration steps (Sembring & Nittivattananon, 2010):

- The first step always is changing the negative perception of decision makers about the contribution of the informal workers.
- Establishment of partnerships, or alliances, between individuals in the informal sector should be encouraged.
- An alliance between individuals increases the informal sector's ability to add value to collected materials. This can be done by strengthen social and human capital amongst the informal sector. In informal sector recycling a hierarchy can be assumed, see Figure 8. Partnerships, alliances and co-operation all helps the individuals out by climbing the hierarchy and thereby add value.
- The informal sector then has the possibility to provide individual services and improve living conditions and other infrastructure.

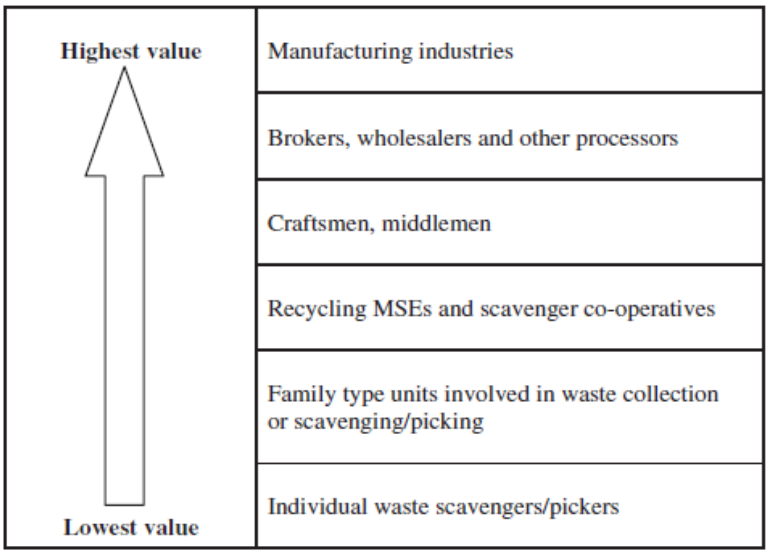


Figure 8. Hierarchy of the informal recycling sector. At the bottom, individual waste scavengers bring the lowest values of the recovered materials. For every step in the hierarchy value can be added. (Wilson, et al., 2006)

Decentralization

There are both non-technical and technical aspects of decentralization. Non-technical aspects comprise the distribution of responsibility between national, regional and local governments. A decentralized approach allows the local authority which in most cases is responsible for solid waste management, also manage all related affairs to the waste management, e.g. collect user fees and other revenues (Schübeler, 1996). The technical aspects of decentralization take place at an even lower scale than non-technical aspects. Differences in physically and socioeconomically aspects can be found even within a city or region. The composition and generating rates of the solid waste differ between neighbourhoods. In middle- or upper-income neighbourhoods the infrastructure is also often better than in low income neighbourhoods, enabling truck based waste collection. The situation in slum areas can however be quite different. A decentralized solid waste management takes these differences into consideration enabling a proper solid waste service for all inhabitants.

A decentralized solid waste management system grants several benefits, it is more flexible, efficient and receptive for local needs and potential. It also eases the burden upon the centralized authority and thereby let the authority focus on their responsibly in legislation, definition of standards, environmental monitoring and support to municipalities (Schübeler, 1996). In slum areas a decentralized solution also actively involves the community and the informal sector (Medina, 2010).

To achieve an effective decentralization it is important that the local authority have appropriate financial and administrative power. The local authority also needs to have sufficient capacity for system planning and operation of the waste management. In many cases the local authority in developing countries need to improve the solid waste management budget to better agree upon actual costs. (Schübeler, 1996)

Aspects of importance

The headline “Aspects of importance” does not relate to any specific concept, instead some conclusions are presented from researchers, on why and when sustainable solid waste management can be achieved.

Troschinetz & Mihelcic have analysed 23 different case studies in developing countries, identified barriers and incentives to recycling. Twelve factors for influencing sustainable waste management were found. The three most important barriers were solid waste management personnel education, waste collection & segregation and government finances. Furthermore, the relationship between the factors was investigated. The conclusion from the research is that sustainable waste management is dependent of stakeholder involvement and collaboration between different sectors. (Troschinetz & Mihelcic, 2009)

Diaz proposes, in a research of waste management in Latin America, focus is needed on the non-technical issues. National policy, institutional capacity, regulatory activity, personnel education, community involvement and financial stability are identified as the most important aspects for a successful introducing of sustainable solid waste management. (Diaz, 1998)

Yongsheng et al. draws the conclusion in a Kenyan case study that community involvement is the most important aspect for any waste management system. A proper waste management is determined by the people's attitude towards the waste. The attitudes can be a result of Socio-economic characteristics, however attitudes can be changed by community involvement activities. (Henry, et al., 2006)

6 Waste management in Kavango

The case study allows a detailed evaluation of the possibilities and difficulties of achieving a sustainable waste management in developing countries and is therefore a good complement to the literature review. The study object for the case study is Kavango region in the northeast of Namibia.

The Kavango regional council and the Swedish municipality of Vetlanda are jointly participating in a twinning program since the year of 2009. The program includes specific projects in different areas such as rescue service and waste management. The waste management project is newly formed in 2012 and aims to improve the waste management in the Kavango region so that:

"By 2030, the citizens in the Kavango Region will have the sustainable long-term local democracy, security, capacitated and better living condition concerning waste managing. The environmental and social impact will be very low."

The project has objectives within three main topics, strategic waste management planning, capacity building at Kavango regional council and public awareness. (River Eman Catchment Management Association, 2012)

6.1 Profile of the Kavango region

The Kavango region is located in the northeaster part of Namibia and share borders with Angola and Botswana.

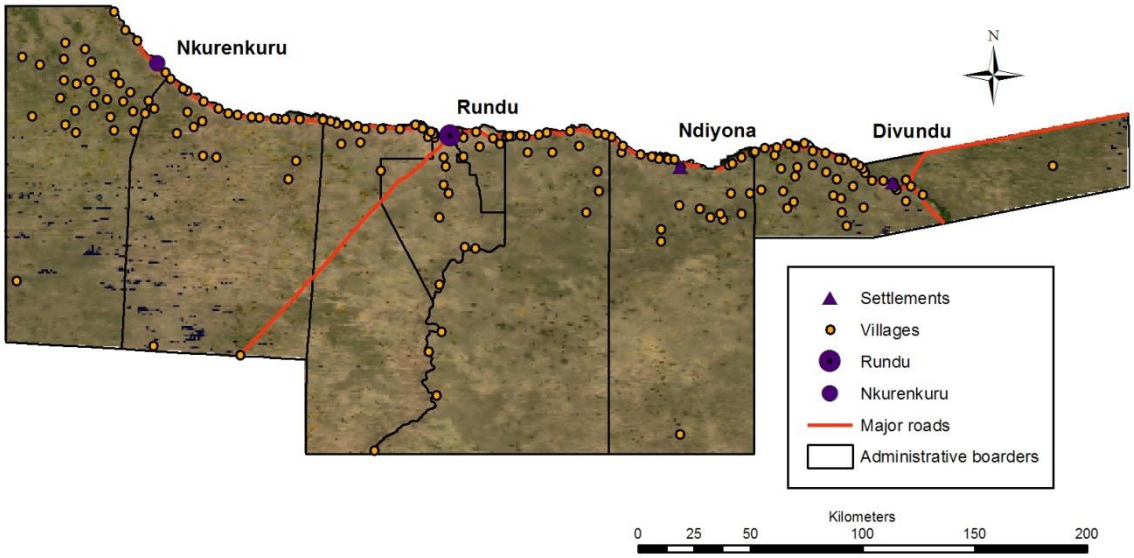


Figure 9. Map over the Kavango region with settlements, villages, towns, major roads and administrative boarders.

Soils in the region are dominated by a deep layer of sand. During earlier, drier times in history the sand was formed by the wind to the shape it has today. Sandy soils allow rain water to drain rapidly and there are also low amount of nutrients in the soil. Around the Okavango River other soils types with a slightly higher nutrient content occur. (Mendelsohn & el Obeid, 2003)

The Kavango region is a dry place where rainfall comes scarcely, however in some parts of the region the average rainfall exceeds 550 mm annually. The rainfall varies from year to year and also within the region. The rainfall is periodical and about 80 % of the rain fall under

December to March. The temperature also varies over the year. During the warmest period in September to November the mean temperature is about 25 °C with maximum temperatures at about 35-40 °C. During the coldest period of May-July the mean temperature is about 16 °C, with a maximum temperature around 30 °C. (Mendelsohn & el Obeid, 2003)

Most of the people living in the Kavango region have their homes near to the Okavango River, which constitute the north border of the region. The Okavango river supply significant amount of the people in the area with freshwater. The catchment area of the river is situated in Angola and Namibia, but most of the contributing runoff to the river occurs in Angola. (Mendelsohn & el Obeid, 2003)

The Region has two towns, Rundu and Nkurenkuru. Rundu is the capital of the region and with its 81 400 inhabitants it plays a key role in many ways. There are also a number of settlements in the region, which of Divundu is the largest. The distance between the two towns and large settlements are rather large; 140 km between Rundu and Nkurenkuru, and 220 km between Rundu and Divundu. (Mendelsohn & el Obeid, 2003)

The population in Namibia is counted in periodical census. Preliminary results from the last census in year 2011 indicates a population of 222 500 people gender distributed as 53 % female and 47% male inhabitants in the Kavango region. An area of 48 742 km^2 gives a population density of 4.2 people per km^2. This is an average population density comparing to other regions in Namibia. However compared to other countries is this a very scarcely populated area. (National Planing Comission, 2012). The population is dominated by young people going to school, work as an employee or running informal businesses (Mendelsohn & el Obeid, 2003). The people in the Kavango region make a living in a various number of ways, see Table 5.

Table 5. Sources of Income. (Kavango Regional Council, 2011)

Source	Percentage of total income
Farming	52%
Pensions	5%
Wages & salaries	21%
Business, non farming	14%
Cash remittance	4%
Other	4%
Unemployed	20%

The lives in urban areas, such as Rundu, and rural areas differ when it comes to sources of income. In urban areas wages and salaries is the dominating source of income. Occupations in Rundu mostly originate from governmental services, private services, shops/stores and small scale production. In the rural areas a combination of farming and wages from public and private services is the dominating sources. There are no large scale industries or mines in the region. (Mendelsohn, 2009). The region is the poorest in Namibia with high number of poverty both in urban and rural areas. The latest statistics indicates that 56.5 percent of the people are poor and 36.7 percent of the people are severely poor. (River Eman Catchment Management Association, 2012)

Cultivation of crops as source of food and income in the rural areas is a difficult task. Due to the sandy soils, dry seasons and high evaporation rate weather conditions are not optimal for cultivation. Mahangu is the crop often cultivated due to its durability in poor soils and low

rainfalls. Cultivation is rarely enough as self sufficient food source and most households in rural areas have at least two sources of income. Nevertheless is the Kavango region often spoken of as a potential breadbasket for the rest of Namibia. However this demands large scale irrigation and high input of resources. Projects aiming at creating such farms have not been successful in the past. (Mendelsohn, 2009)

Another important crop for the rural areas is the Thatching grass. Quite opposite to the Mahangu the Thatching grass is not cultivated for own use but exported to other regions and countries as material for roof-building, example for tourist lodges. Livestock of cattle, goats and donkeys is yet another important food and income source. It is estimated that at least 150.000 cattle and 65.000 goats lives in the region. (Mendelsohn, 2009)

The governmental power of the region is divided between authorities on a national, regional and local level. At the national level the governance is done by the different ministries. Governance at a regional level is done by the ministry of regional and local authorities through the Kavango Regional Council (KRC). The KRC also have a local administrative responsibility for the two settlements Divundu and Ndiyona. Otherwise the two town councils in Rundu and Nkurenkuru are the government's representatives at a local level. In rural areas outside the towns and settlements traditional authorities still have a lot of power when it comes to issues about land-use. (River Eman Catchment Management Association, 2012)

6.2 Key stakeholders

Stakeholders with great importance for the waste management in the Kavango region are referred to as key stakeholders. They can be found at a national, regional and local level. A screening of key stakeholder has been made from literature and interviews with some of the stakeholders. The result of the screening is presented in Table 6.

Table 6. List of key stakeholder for the waste management in the Kavango region

Stakeholder	Geographic level	Influence on waste management
Ministry of Health and Social Services	National	Responsible for the national waste management policy and also to develop and review legislation, standards and guidelines on waste management. Explore alternative methods on waste treatment and consult with stakeholders on ideal places for a disposal site etc.
Ministry Environment and Tourism	National	Ensure and develop policies and legislation for sanitary landfill sites. Also conduct Environmental Impact Assessment
Ministry of Agriculture, Water and Forestry	National	Regulates water pollution, hazardous and solid waste.
Ministry of Trade and Industry	National	Enforce policy to small and medium enterprises and industries regarding pollutants.
Ministry of Works, Transport and Communication	National	Responsible for a routine maintenance and plans for health care risk waste. Also responsible for maintenance equipments (e.g. incinerators)
Large scale recycling companies	National	A key factor for the possibility of implementing a recycling system. Without the large scale recycling companies much waste material would

		not be able to be recycled.
Producers of packaging and other products	National	The industry and especially the packaging industry can decide which material ending up as waste.
Regional town Council	Regional	Developing and implementation of a regional waste management plan. Responsible for waste management in Settlements
Transportation companies	Regional	Supply transport of recyclable waste to large scale recycling companies.
Town councils (Rundu/Nkurenkuru)	Local	Coordinate and provides waste collection and waste disposal sites in respectively town.
Contractors	Local	Is in Rundu hired to provide waste collection services. Responsible for daily collection of waste bins in the town.
Small scale recycle companies	Local	Recycle waste when the value of waste is easily accessible.
Hospital and medical clinics	Local	The hospital in Rundu and all medical clinics generate hazardous waste. The staffs need to deal the medical waste with extra care.
Food stores	Local	The way food store handle the food can influence the amount of biodegradable waste produced. They could also play an important role of recycling glass and plastic bottles.
Other stores	Local	Produces empty packages which could be necessary to collect separately
Building projects	Local	Can produce a lot of incombustible waste. Building projects could also be a market for reusable waste.
Industries	Local	Possible producer of homogenous waste. Currently no such industries are located in the region.
Hotell & Lodges	Local	Generates mixed waste from accommodation and restaurants.
Governmental institution, Offices, Schools	Local	Produce mixed waste from their activities. A source of paper waste.
Citizens	Local	Generate household waste and is also a key factor when it comes to waste collection.
Informal workers	Local	People who scavenge dumping sites after valuable waste. Increases the recycling levels at high health costs.

6.3 Institutional setup

The governance over solid waste management is divided depending on location of the Kavango region. A summary of the different important institutions is described in Figure 10.

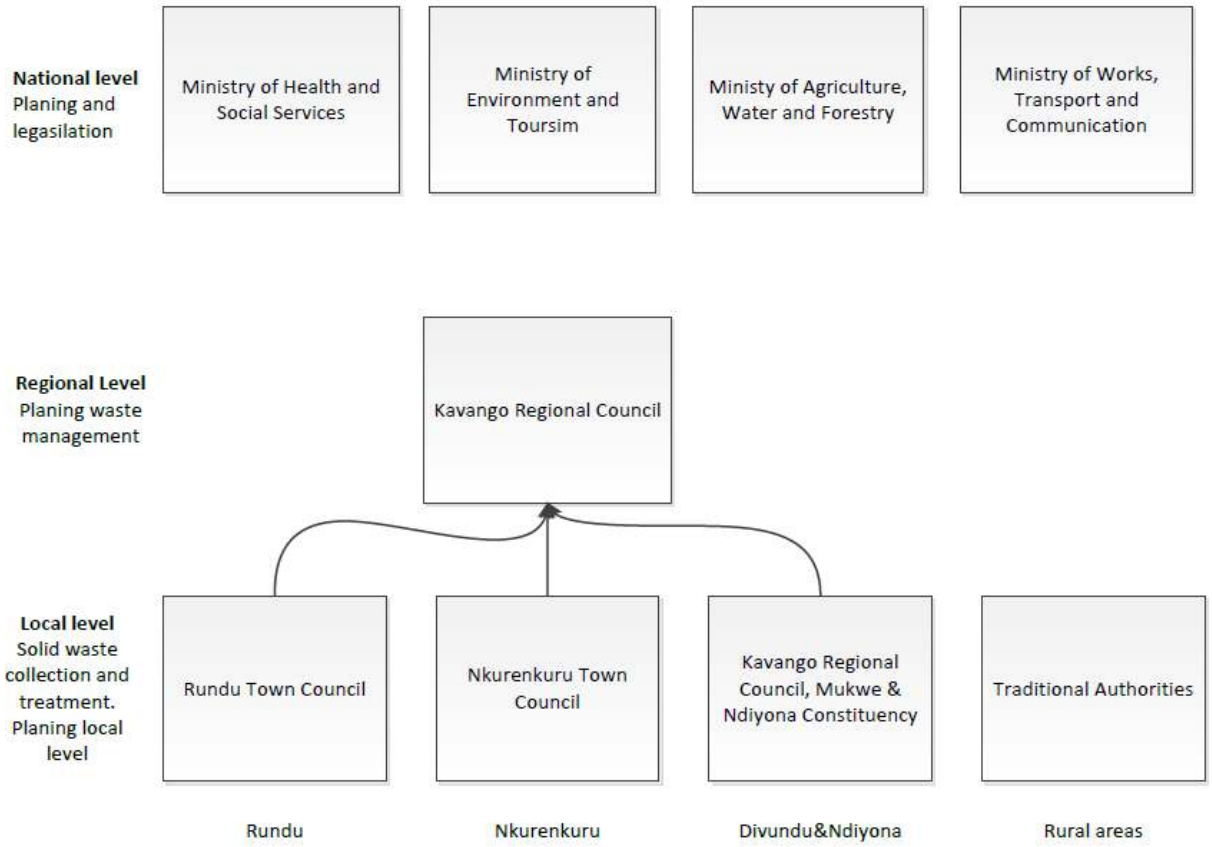


Figure 10. Organizational chart over the waste management in the Kavango region on a national, regional and local level.

6.4 Regulatory framework

There are several international conventions and declarations which incorporate waste management. Namibia has for example signed the *Basel convention on the control of transboundary movement of hazardous wastes and their disposal*, the *London convention on the prevention of marine pollution by dumping of wastes and other matter* as well as the Rio *declaration on environment and development*. (Hasheela, 2009)

On a national level the Namibian government drafted the *Pollution Control and Waste Management Bill* in year 2003. The bill proposes that:

"No person may produce, collect, transport, sort, recover, treat, store, dispose of or otherwise manage waste in a manner that results in or creates a significant risk of harm to human health or the environment."

Furthermore the bill proposes regulation on national waste management plans, waste management licenses, responsibilities for local authorities and import and export of waste. The bill is still to be approved as an act. (Pollution Control and Waste Management Bill, third draft, 2003)

The *Environmental management act* was approved in the year of 2007 and regulates the waste management in a couple of different areas. The act state that reduction, reuse and recycling of waste should be promoted. It also state that waste generation at source should be reduced when the cost is acceptable for the society. (Environmental management act no.7, 2007)

The *National waste management policy* was put together by the Ministry of Health and Social service in year 2010. The main policy goal is to:

"Prevent and reduce health risks associated with exposure to healthcare substances, household, radiation and other waste from healthcare workers, waste handlers and public by promoting sound environmental waste management practices."

Two of the objectives of the policy were to design appropriate means of safe and sustainable waste management and to provide a legal framework for development of waste management legislation. In addition the policy provides an implementation plan and indicators to measure the implementation process. (Ministry of health and social service, 2010)

On a regional level the Kavango Regional Council have adopted the following goal:

"By 2030, the citizens in the Kavango Region will have the sustainable long-term local democracy, security, capacitated and better living condition concerning waste managing. The environmental and social impact will be very low." (Kavango regional Council, 2012)

6.5 Previously studies

No previous scientific studies which focus on waste management in this part of the country have been identified. There are however several reports on the subject which might be of interest.

In 2007 a feasibility study of the possibilities to introduce an integrated waste management system were conducted by a consultant, on the behalf of Rundu Town Council. Though not very scientific in its approach, it presents an interesting solution to the waste management problem in Rundu by introducing recycling as an integrated approach. (Rundu Town Council, 2007). The report does not calculate with specific numbers of waste generation and composition for Rundu. The relevance of the results should therefore be questioned.

Another study of interest is a doctoral thesis about the municipal waste management in Namibia in general, with focus on Windhoek. It thoroughly investigates different aspects of the waste management system and proposes possible improvements of the same. (Hasheela, 2009)

In Windhoek the household waste is investigated in periodical audits. The audits investigate the amount of generated waste in formal households in Windhoek. The results are presented in audit reports. (Solid Waste Management Division, 2008) The results of the audits could be used as a comparison to results in the case study.

6.6 Description of field study

An integrated quantitative/qualitative approach described in chapter 3.2 has been adopted. The following methods were selected as most suitable for this study: *Open ended interviews*, *Focus group discussions*, *Household* and *willingness to pay surveys*, *Field observations*, *Literature review* and *Waste characterization*.

6.6.1 Open ended interviews

Interviews as a qualitative analytical method of waste management allow integration of many different perspectives. A number of 22 people associated with key stakeholders of the waste

management have been interviewed for this purpose. For details about the interviewees see Table 7. Examples of people which have been interviewed are development planners at the Kavango regional council, administrative staff at the Rundu town council and Nkurenkuru town council, staff at the technical office in Rundu, contractors, residents and managers at supermarkets, hotels, medical facilities and garages.

Table 7. Information about the interviewed institutions. Depending if the institution is a provider or user of waste services different interview plans have been used. A total of 22 people have been interviewed at ten different institutions.

Institution	Provider/ User	Number of people interviewed
Kavango regional council	Provider	5
Rundu town council	Provider	4
Nkurenkuru town council	Provider	3
Kavango regional council, Mukwe constituency	Provider	3
Ministry of youth, Nkurenkuru	Provider	1
Contractors	Provider	2
Medical facilities	User	1
Lodges (Hotel)	User	1
Supermarkets	User	1
Garages	User	1

The interviews have been performed as a semi structured interview with open ended questions. The interviews have in general been executed according to the interview plans, but the semi structured approach enabled a flexible approach. Hence questions outside the plans have also been used.The interviewees are divided into two different groups, providers of waste management services and users of waste management services. The interview plans are slightly different for the two groups as different perspectives might be important for a supplier of waste services rather than the user of the same, see Appendix A: Open ended interviews. The length of each interview varied. Generally the interviews with users have lasted for 10 to 15 minutes and for suppliers between 10 and 50 minutes.

The interviews were recorded and transcribed. The information from the interviews were divided into the same categories as for the field observations; *waste generation*, *waste collection disposal and treatment*, *waste characteristics*, *informal workers*, *other.*

Four of the questions in the interview plan also allow a quantitative analysis. These are; *What is waste? How is waste a problem for development? How can waste management be improved? What are the barriers for improvement?* The answers to these questions are aggregated into several standard answers which allow an evaluation of the most common answers. The quantitative results are complemented with qualitative examples of answers. The information of the interviews is used to describe the current waste management system and to design the waste characterization study.

6.6.2 Focus group discussions

When interviews were difficult to perform due to the vast number of people wanted to participate a focus group discussion were used. Focus group discussions are performed more improvised without following the standard interview plan.

Only one focus group discussion was performed with a group of women scavenging on a dumping site. The information from the discussion was used to get a general picture on a specific issue.

6.6.3 Household and willingness to pay surveys

When performing the waste characterization study the household participating also had to answer a smaller survey about their waste management and willingness to pay, see Appendix B: Household surveys, Willingness to pay. The survey also included necessary information for the waste characterization study. The survey was answered by 39 households within Rundu.

6.6.4 Field observations

Direct observations of waste, and waste practices in the Kavango region are in this study refer to as field observations. The need of a scientific method to manage field observations was found early on during the visit of the Kavango region due to the many observations made. Field observations have been made during all kinds of situations and time periods during the two months visit. A small note, which summarizes the observation, was recorded in a notebook directly after field observations were made. Later the same day the note was transcribed in a computer and the information about the field observation is expanded to include the following characteristics:

- Time of field observation
- Place of field observation
- Summary of field observation
- Observation category

The observation category can be one of the following six categories: *waste generation*, *waste collection disposal and treatment*, *waste characteristics*, *informal workers*, *other.* The use of categories is a way of coding the field observations and thereby spot trends and other information which else might be difficult to observe.

6.6.5 Literature review, official documents

Local authorities have been screened for official documents regarding the solid waste management. The contacted local authorities were Rundu town council, Nkurenkuru town council and Kavango regional council. Due to unexpected circumstances the response rate was low and only official documents regarding the economy of Rundu town council were collected. Waste management is however not a separate category in Rundu budgeting. The results of the literature review is therefore of limited use.

6.6.6 Waste characteristics by hand sorting waste

Collection and hand sorting of waste from houses have been carried out in October 2012 as a quantitative method of characterize the waste generated in Kavango. Waste has been collected directly from families in Rundu and nearby rural areas. Thus only household waste was included in the waste characterization study. 53 households were selected to participate in the study during a two week period. Of them 20 lived in the central and formal parts of Rundu, another 20 in the outskirts of Rundu in different informal settlements and 13 houses in the rural village of Kayengona about 10 kilometers east of Rundu. The distribution of different households between the urban areas and settlements can be seen in Table 8.

Table 8. Distribution of households participating in the waste characterization study. Waste have been collected from five different urban areas within Rundu, three different urban areas in the outskirts of Rundu and from one Rural village.

Distribution of households in waste characterization study					
Rundu formal		**Rundu informal**		**Rural areas**	
Tutugeni	5	Sauyemwa	8	Kayengona	13
Safari	4	Ndama	6		
Caravan Park	1	Kehemu	5		
Mellenium park	5				
Nkarapamwe	6				

The participating people living in Rundu were instructed in an information meeting, to which most of them came. In order to include all parts of Rundu in the study a temporary collection system had to be put in place. The household were given five black plastic bags, each with a volume of 150 liter and one plastic bucket with lid. For safety reasons they were given the instructions to put all their waste in the plastic bags except for potentially hazardous waste, which they were supposed to put in the bucket instead. The households in the rural village were instructed in the same way during a field visit.

After one week the waste were collected. Due to difficulties of collecting waste, only 62 % of the households were collected from. The waste was transported to the Rundu technical department were the waste were sorted by hand within a two day period. The following categories were used in the hand sorting:

- Organic
- Plastic
- Paper and cardboard
- Metal
- Glass
- Other

Two to three people were participating at all times in the hand sorting. Waste from each household were sorted and put in small containers, which were weighed when full and between each household, on a kitchen scale with a sensitivity of 50 gram. For each new bag the content were investigated before the sorting started. If the workers judged the content as too hazardous the bags were put aside. In the hand sorting process deviations in form of old waste, minimal waste and other unrealistic scenarios were recorded.

The results were written into household protocols. The result was digitalized and the weight as well as the composition calculated for the three strata groups: formal urban areas, informal urban areas and rural areas. A standard value for the weight of the containers of 0.30 kilograms was used when calculating the weight of the waste.

During the hand sorting some of the households were excluded from the study due to various reasons; for some households the amounts were as low as a single bottle for one week generation. In the other end vast amounts of waste were collected from other households. When sorting the waste from those houses the conclusion were made that the households had taken the opportunity to get rid of old waste, not generated during the week of the study. This was the case with some houses in the rural areas which normally has no ordinary collection,

and with garden waste in Rundu which are only normally collected at an extra fee. Samples were excluded from the study in the following cases:

- Extremely low amount of waste or only waste from one specific category. (3 households)
- Households delivering high amounts of old looking waste, such as rusty tins and cans, see Figure 11. (2 households)
- Households delivering high amounts of waste with a high content of sand. (2 houses)
- Waste excluded due to safety reasons (3 households)

Figure 11. Example of old looking waste as a reason for excluding the sample from the study.

After the hand sorting a number of 23 households, or a quarter of the originally participants, were valid for statistical analysis. The exact numbers can be found in Appendix C: Waste characterization study.

6.7 Result A: Open ended interviews

The results of the open ended interviews are dived into the following topics *Definition of waste, waste as a problem for development, improving waste management* and *barriers for improvement.*

6.7.1 Definition of waste

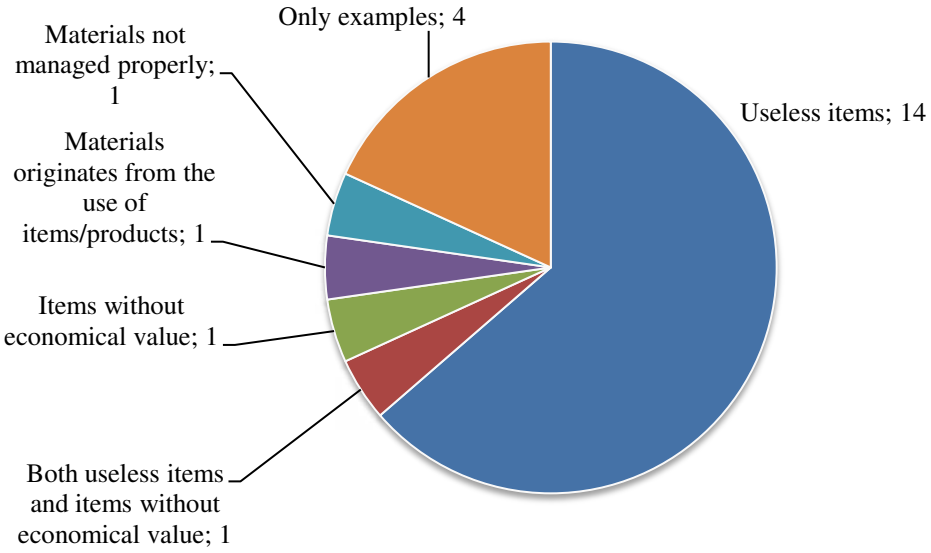


Figure 12. Distribution of answers to the question *How do you define waste?* in the open ended interviews. The majority of the people mentioned the usefulness of an item as the most important factor for defining waste.

The interviews always started with the question *How do you define waste?* In chapter 4.2 two different ways of defining solid waste were revealed; Useless items and items without a value**.** As can be seen in Figure 12, the answers of the interviewees did in most cases mention the useless aspect, but did not the economical aspect. Some examples:

"Things become absolute you cannot use it again, and it becomes waste"

"Waste to my own understanding is everything which is in no use to humans."

"In my own understanding waste are products no longer useful, offspring of the original products."

Two people also specified that the waste is only useless for the person throwing it away. The waste could be useful for another person.

"You could have a very old chair, if I am no longer interested and I don't want to keep the chair, there are times when you either can give it to somebody which is interested, If you not give it to somebody you could also throw it away. It becomes waste to you, but the next person who picks it up it is not waste."

"Waste to me is any items or goods that will no longer be used by a particular person, but it could be useable to the next person. "

In a couple of interviews the economical value of an item was mention as the definition of waste. The vast majority however see the usefulness of the items as the most important definition.

6.7.2 Waste as a problem for development

In the next question the interviewees were asked to identify the current issues with the waste management. The answers in this section are divided into three different categories, environmental aspects, social aspects and economical aspects.

Problem for development - Environmental aspects

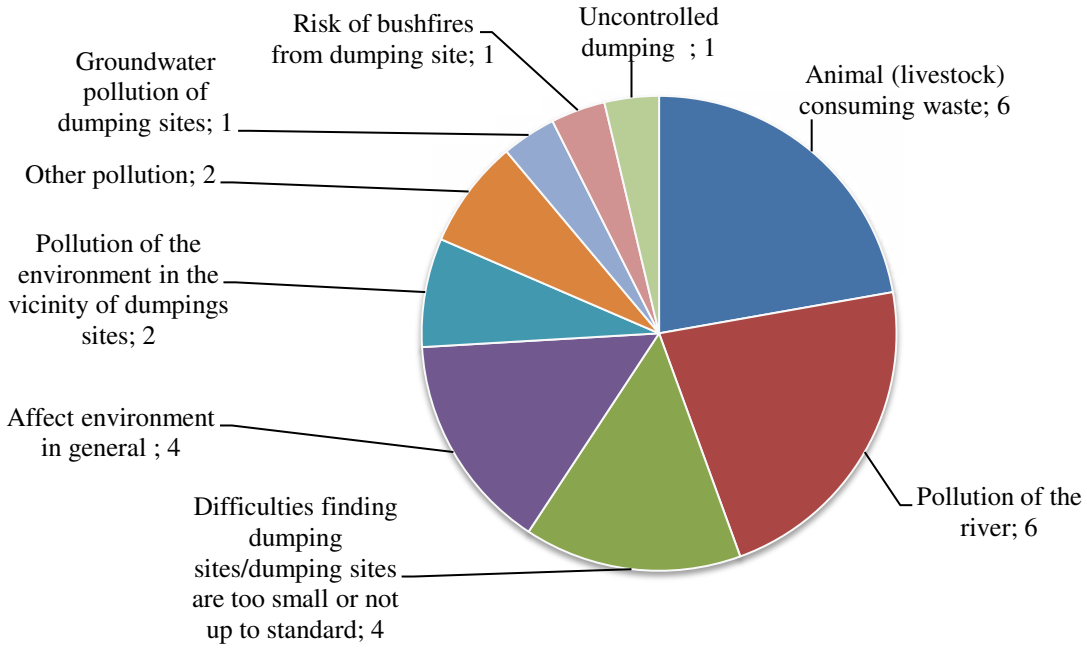


Figure 13. Distribution of the answer concerning environmental aspects to the question *How is waste a problem for development?* The most common answers where animals consuming waste, pollution of the river and inadequate dumping sites.

In the area of environmental aspects nine different kinds of aspects were mentioned. The distribution between them can be seen in Figure 13. A concern for animals who consume waste is common. Some of the people mention the risk of livestock dying while eating plastic, however more people are concerned of infections and pollution transferring to humans when eating the meat.

"This waste in a dumpsite is eaten by our cattle. And the cattle is the same to be slaughter and sold. So you could see that any infection could be taken through that way."

Another common concern is pollution of the river. Several people mention the importance of the river for the people living in the Kavango region as a source of water for drinking.

"Say that we have a lot of waste and we have rain and the waste flowing down with the rain water to the river and mostly the people in this are depending on river water for drinking and cooking. Once it is spoiled it definitely becomes a health hazard."

It is also mentioned that one problem is a lack of knowledge when it comes to how the waste affect the environment. The third frequently mentioned topic is how the dumping sites can pollute the nearby areas.

"The environmental impact, currently it is now difficult for do in the assessment, some of us think we need research and so on. From a theoretical perspective it is important that a proper dumping site needs to be put in place. We do not know any immediate knowledge what impact the waste might have. Even without that immediate knowledge it is good to do it in a proper way. My personal view particularly from the environmental impact is: number one the site where we dispose the waste might have impact in groundwater and so on. That is way the identification of the dumping site needs to be done in a proper way. The disposal method must also be environmental friendly. What we currently do is to take the waste to the dumping site we put it on fire. When we burn it there is some implications. Some of the waste might not burn. And it can have implication on the surrounding environment."

Problem for development - Social aspects

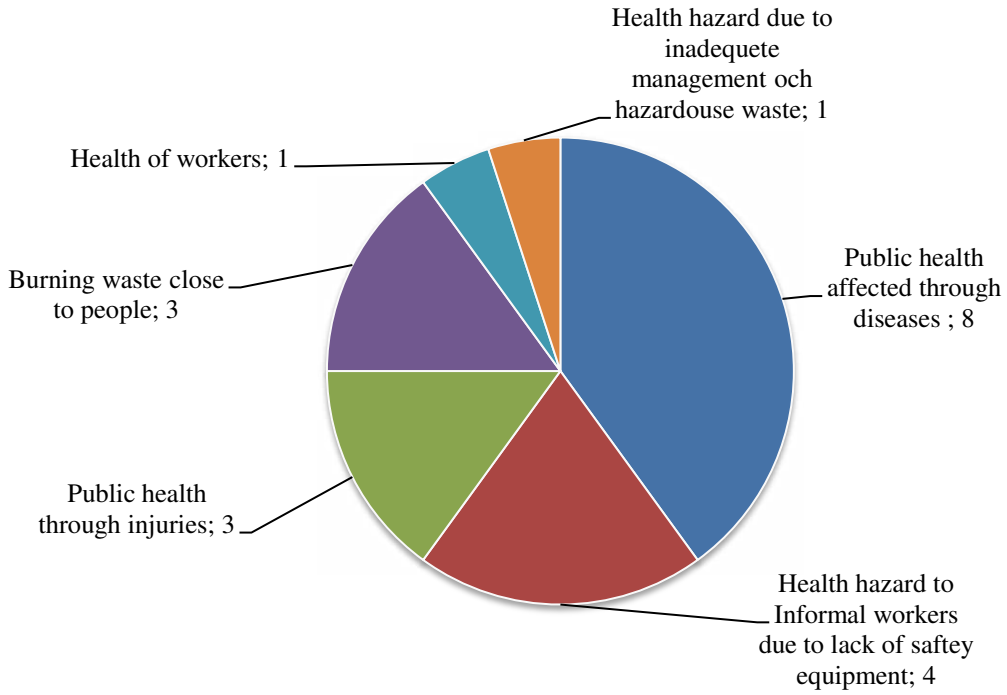


Figure 14. Distribution of the answer concerning social aspects to the question *How is waste a problem for development?* The most common answers where public health affected through diseases, health hazard for informal workers, public health through injuries and waste burning close to houses.

When it comes to social aspects of the waste management all answered were connected to health issues in different ways. The most common answer were about waste as a potential cause for spreading diseases. Out of different diseases a concern for waste increasing the spreading of malaria through mosquitoes is the most common. One person mentioned blood transferring diseases.

"The waste is a problem because is not supposed to be where the people are, it is supposed to be far so it could not harm the people. The waste for example blood there is bacteria there which can harm people. It need proper handling so it can not cause diseases."

"It is a problem when it becomes too much and is not taken care. This can lead, because we are close to the river side, to too much mosquitoes. A lot of people would encounter a lot of problem like malaria diseases. It can pollute the environment leading to an unhygienic environment, so it is not really good for health."

"We use the swamps as a dump site which invites the mosquitoes to breed in those swamps"

Another health hazard worth mentioning is the physical danger of some waste and injuries.

"When it comes to bottles sometime when the children plays there they injure themselves. At the end they needs to be hospitalized and the children cannot go back to school again."

A few people were concerned about how the burning of waste affects the people.

"It could also cause a lot of health hazard. Because sometimes they have only one mean, people have to burn. There is a lot of toxic in the material disposed. When you burn the gases, the fume of that kind of burning it can also affect people when inhaling the gas."

Problems for development - Economical aspects

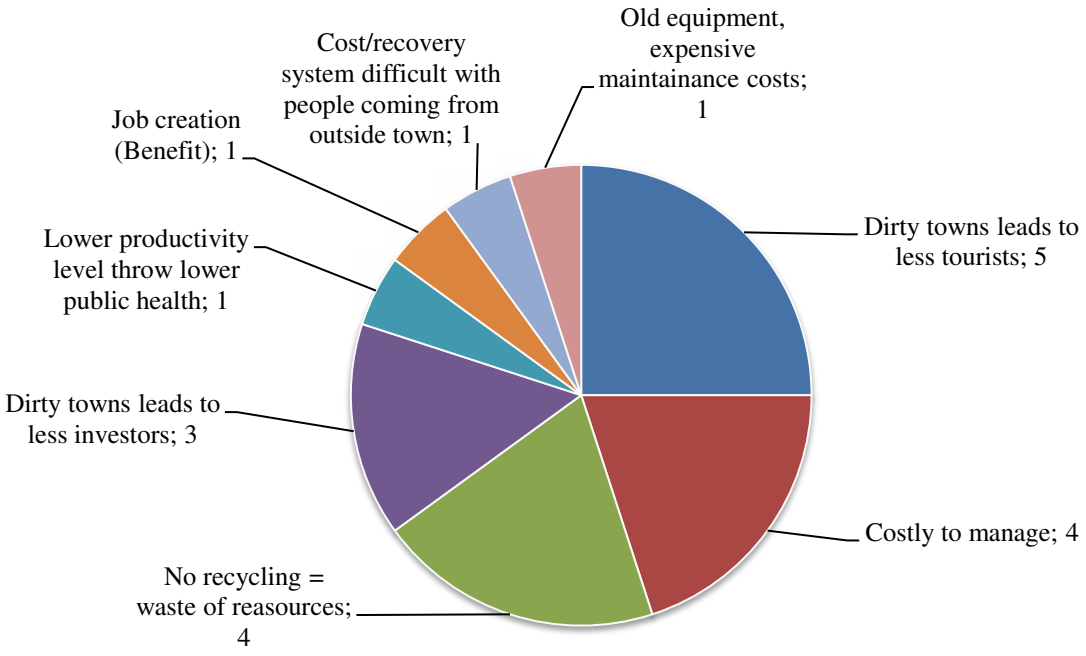


Figure 15. Distribution of the answer concerning economical aspects to the question *How is waste a problem for development?* The most common answers were dirty towns leads to less tourists, costly to manage, waste of reasources and dirty towns leads to less investors.

In the area of economical aspects many people mention the waste effect on the impression of towns as a concern. A bad impression is suggested to act repellent on both tourists and investors.

"Economical impact one is maybe no one wants to work in a polluted environment. We try to convince investors to invest in our area but then if Divundu pollution is such high the investors would not be able to come and invest, because investors need a clean environment to operate in. From their side it is one of their conditions. They would like to operate in clean environment. Also tourists. People who are coming to Namibia for example. In the process it could lead to an economical viability of the area itself."

"Economically it also impacts the economy of the town and the region, simply if not managed properly the investors would not like to invest in such a town. Clean environment attract investors which would improve the local economy."

The two other aspects with more than one people mentioning is the costs of managing waste and the lack of recycling. Another interesting aspect is the connection between health risks and economy.

"The economical impact it is linked to the health issue. If people are affected through the waste management and there health condition could be affected it would translate into productivity even at home or at work. The immediate economical implication is that the waste must be managed properly so the health risk could be avoided."

6.7.3 Improvement of waste management

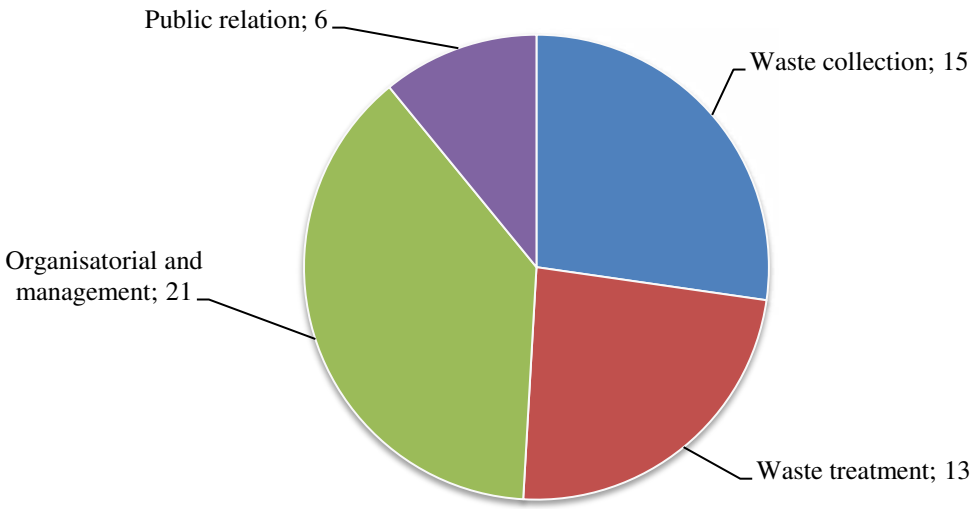


Figure 16. Distribution of different categories of answers to the question *How can the waste management be improved?* Most suggestions concern organisatorial and management issues. Other existing categories are waste collection, waste treatment and public relation.

In the next part of the interview the people were asked to describe how the waste management can be improved. The answers are divided into four differenet categories, see Figure 16. These are *Waste collection, Waste treatment, Organisatorial and management* and *Public relation.* The more detailed subcategories can be seen in Table 9.

Table 9. Suggestions to improvements in the areas of waste collection, waste treatment, organisatorial and management and public relation.

Waste collection	Number of people	Waste treatment	Number of people
More transport vehicles	6	Introduce recycling	6
Seperate collection for some waste (e.g. glasses)	4	Fencing of dumping site/better control over dumping sites	4
Improve the organisation and performance of RTC. Sometimes RTC are late for pickup	2	Seperate dumping sites for different types of waste	1
Introduce communal collection points to approve the efficiency of waste collection	1	Decentralisation of treatment (Medical waste)	1
More cleaning campaigns	1	Improve dumping sites	1
Bigger dust bins	1		
Organisatorial and management	**Number of People**	**Public relation**	**Number of people**
Involvement of central government	2	Improve the awerness level of the people about waste problems and risks	4
Improved national legasilation	2	Signs "no dumping"	1
More workers	2	Fines for illegal dumping	1
Import knowledge from developed countries	2		
Capacity building through training	2		
Improve knowledge about effects from the waste management through studies	2		
More control of contractors - transportation of people must be easier	2		
Involve the companies, parastates initiatives	1		
Improve knowledge about possible improvements and from where to access money	1		
Knowledge sharing with other municipalities	1		
Better infrastructure (Roads)	1		
Waste management plan	1		
Follow national and international standards	1		
Include the informal workers and improve their salaries	1		

6.7.4 Barriers for improvement

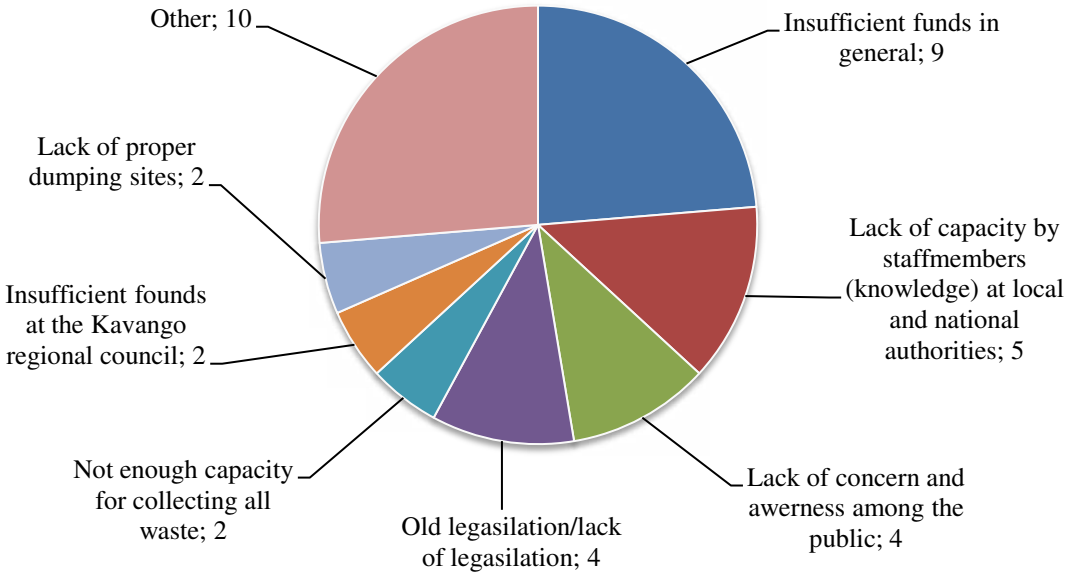


Figure 17. Distribution of answers to the question *Which are the barriers for improvement?* The most common answer in the open – ended interviews were insufficient funds, lack of capacity, low public awareness and insufficient legislation.

The interviewees were also asked to describe the barriers for improvement. The distribution of the different categories can be seen in Figure 17.

The most common category was by far insufficient funds, both in general and for the Kavango regional council. One person summarized many of the barriers with this answer:

"The barriers would be the financial resources, another is because the absence of policies to guide people. But the biggest one I think is the mindset of the will to do it. Those who are in charge need to drive this process. But again for driving a process you need to be competent you need to understand how to drive. The Ministry of environment and tourism need to have people who are trained and have some education in waste management, so that when they drive the process they know exactly what they want and they know exactly how to do it. Another thing in the setup of the government there is so much of the region structure based on old laws that does not seem to coup with the current reality. What we have, does it serve with our current needs? We are just sticking to the old updated law regulation. "

The financial pressure is also mentioned by this person who wanted to have a gravel road to the dumping site:

"The barriers for improvement will be a lack of resources. These things we are planning to do only if we would have assistance from somewhere, somehow it is possible to realize. We should try to ask for finance everywhere where it is possible. If the road to the dump site is to be maintained which is necessary. The current road stops some private people from reaching the dump site and offload the waste along the road. You are required to have a 4x4. We just need a gravel road."

6.8 Result B: Waste characterization, waste from households

6.8.1 Waste composition

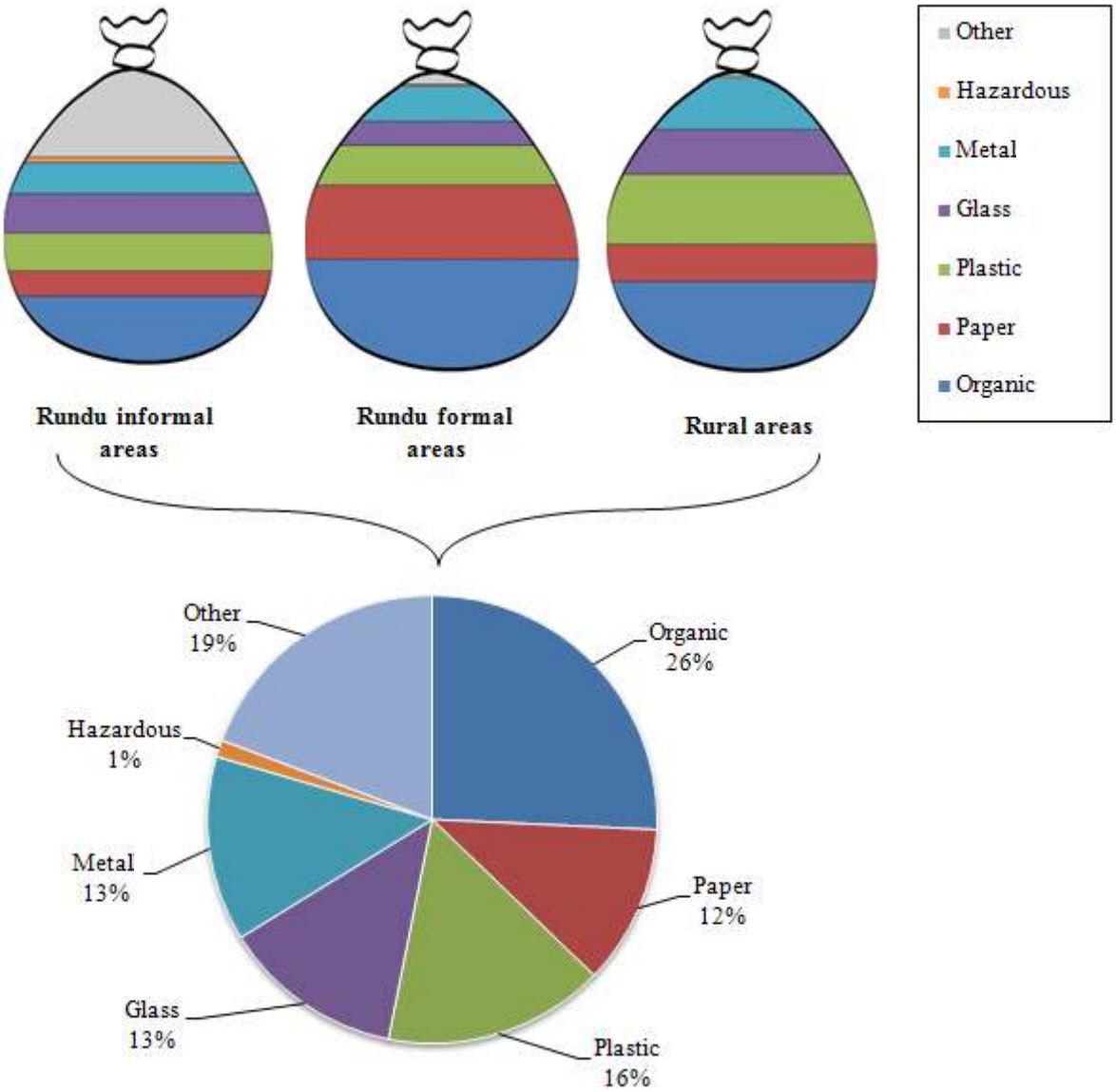


Figure 18. Distribution of the sorted solid waste in the waste characterization study. The three bags on top represent waste from the three different groups; Rundu informal areas, Rundu formal areas and rural areas. Each bag is divided vertically according to the amount of waste within each group. In the chart the distribution of all the sorted waste is presented.

In Figure 18 the results of the waste characterization study is presented. Details about the result can be found in Appendix C: Waste characterization study. The waste composition differs in the strata groups. However since the number of samples were fewer than expected, the classification in strata groups is considered as doubtful from a statistical perspective. The result is therefore presented for all samples. The results indicates that the most common type of waste is organic waste (26%) followed by other (19%). Paper, Plastic, Glass and Metal stands for about the same portion of the weight (12-16%).

6.8.2 Waste generation rate

The distribution of waste generation rates for, each household participating in the waste characterization study can be seen in Figure 19.

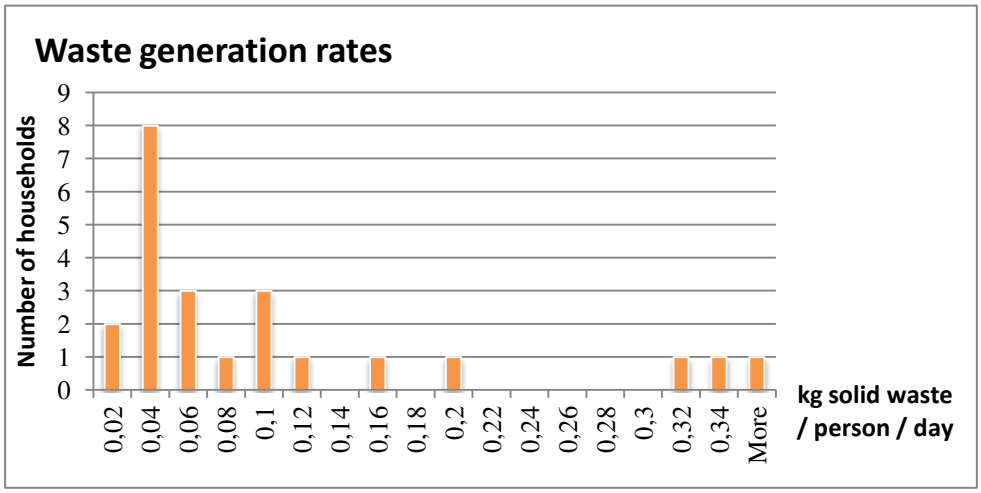


Figure 19. Distribution of waste generation rates for different household in Rundu and rural areas. The numbers are a result of the amounts weighted in the waste characterization study. As can be seen most households produce less than 0.2 kg solid waste / person / day. A few household produce much more which contribute to a higher average generation rate.

The average solid waste generation rate for the three different groups Rundu informal, Rundu formal and rural areas are 0.10, 0.11 and 0.13 kg solid waste per person and day respectively. The median values are slightly lower at 0.04, 0.06 and 0.08 kg solid waste per person and day respectively. The average value for all of Kavango is 0.11 kg solid waste per person and day. The differences between the three groups are low and statistically insignificant.

Due to low statistical differences previously stratification is neglected for the extrapolation of the waste generation rates. In Figure 20 the average waste generation rate combined with population data is used to extrapolate the waste generation for the entire Kavango region.

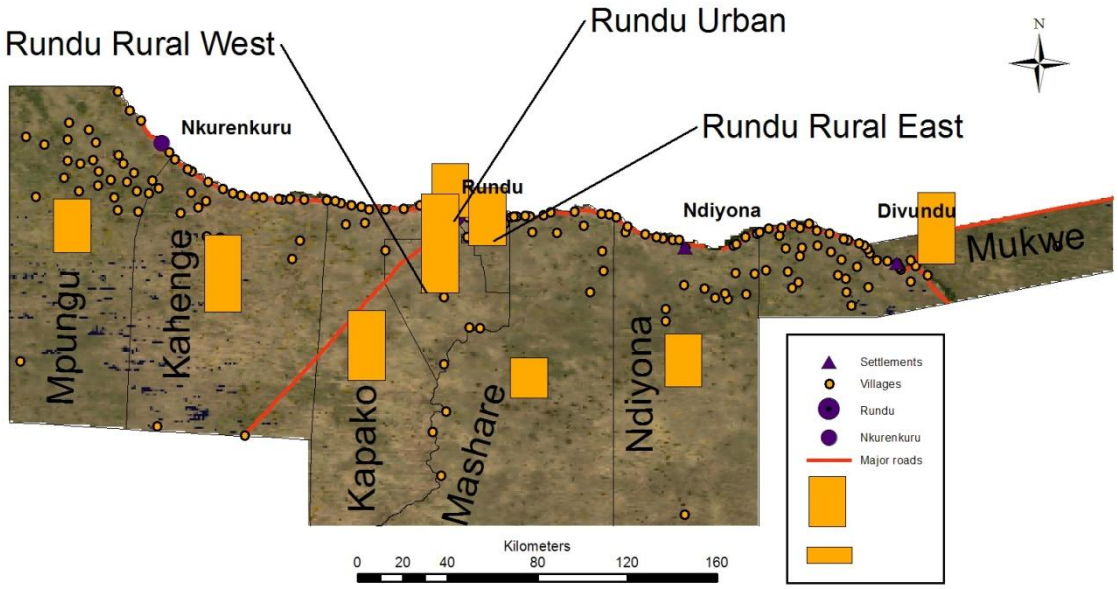


Figure 20. Total amounts of household solid waste generated in the different constituencies in the Kavango region. The highest amounts are generated in Rundu Rural West constituency with approximately 4200 kilogram per day.

In Figure 21 the waste generation rate in the different constituencies has been divided with the constituency area to achieve a waste generation density.

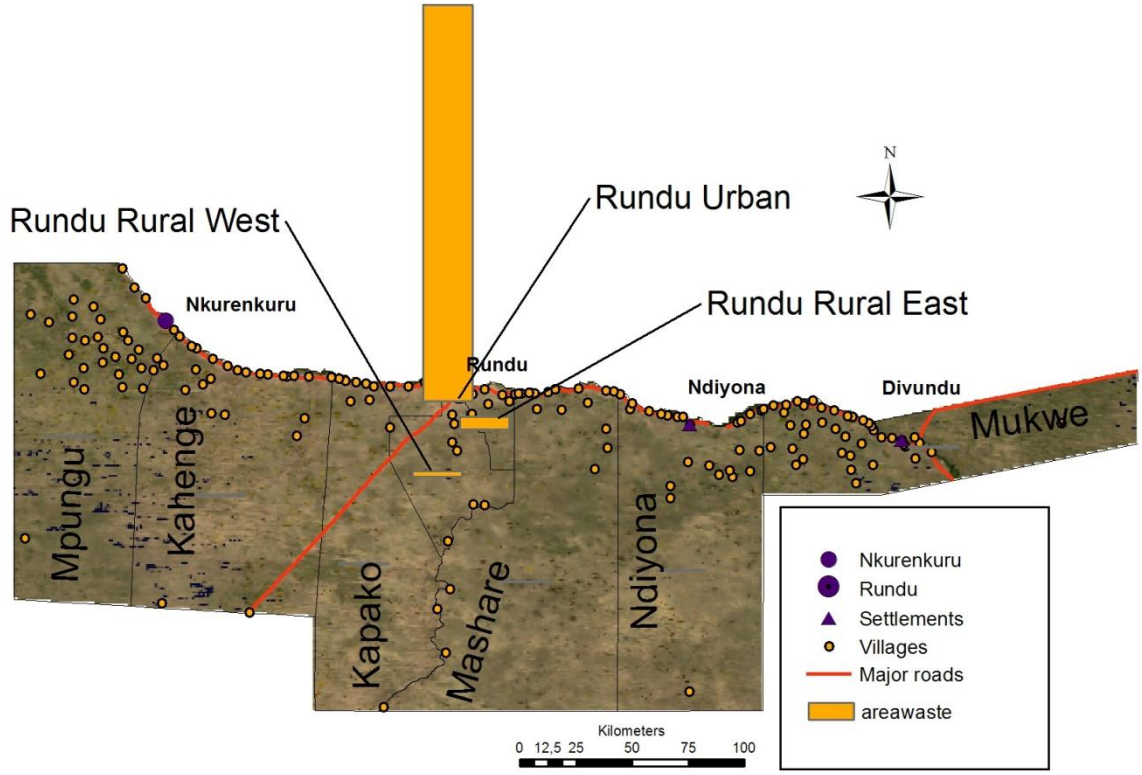


Figure 21. The density of waste generated in the different constituencies in kilogram per square kilometer and week. The highest density can be found in Rundu Urban with 1265 kg/km^2 and week. The waste generation density in other constituencies are far lower and only the two Rundu Rural constituencies have high enough density to be distinguish in the map.

6.9 Result C: Where does the waste go? – A schematic map

Figure 22, the schematic map is a result of information from interviews, focus group discussions as well as a number of field observations. The map does not include any aspects of quantities.

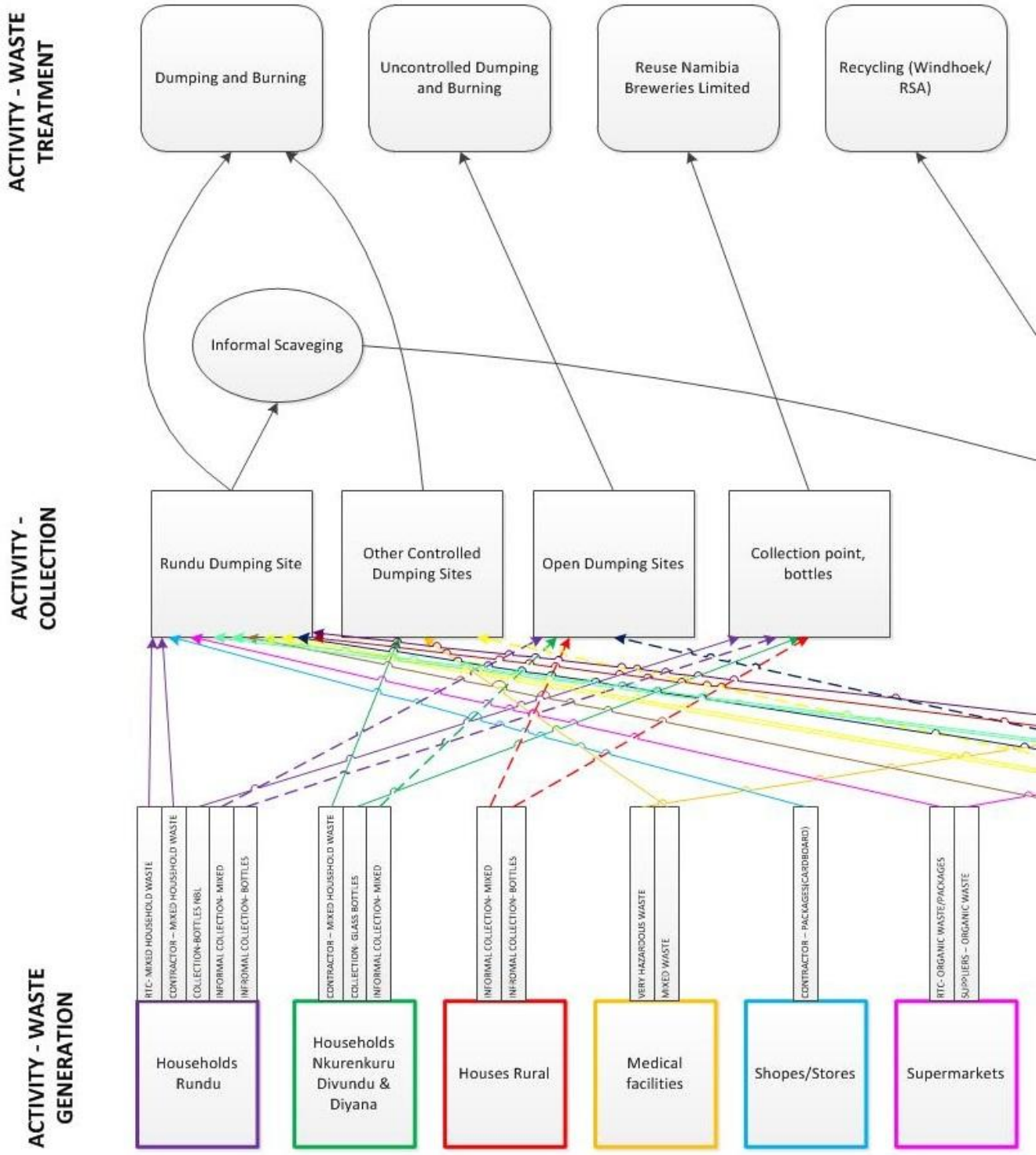
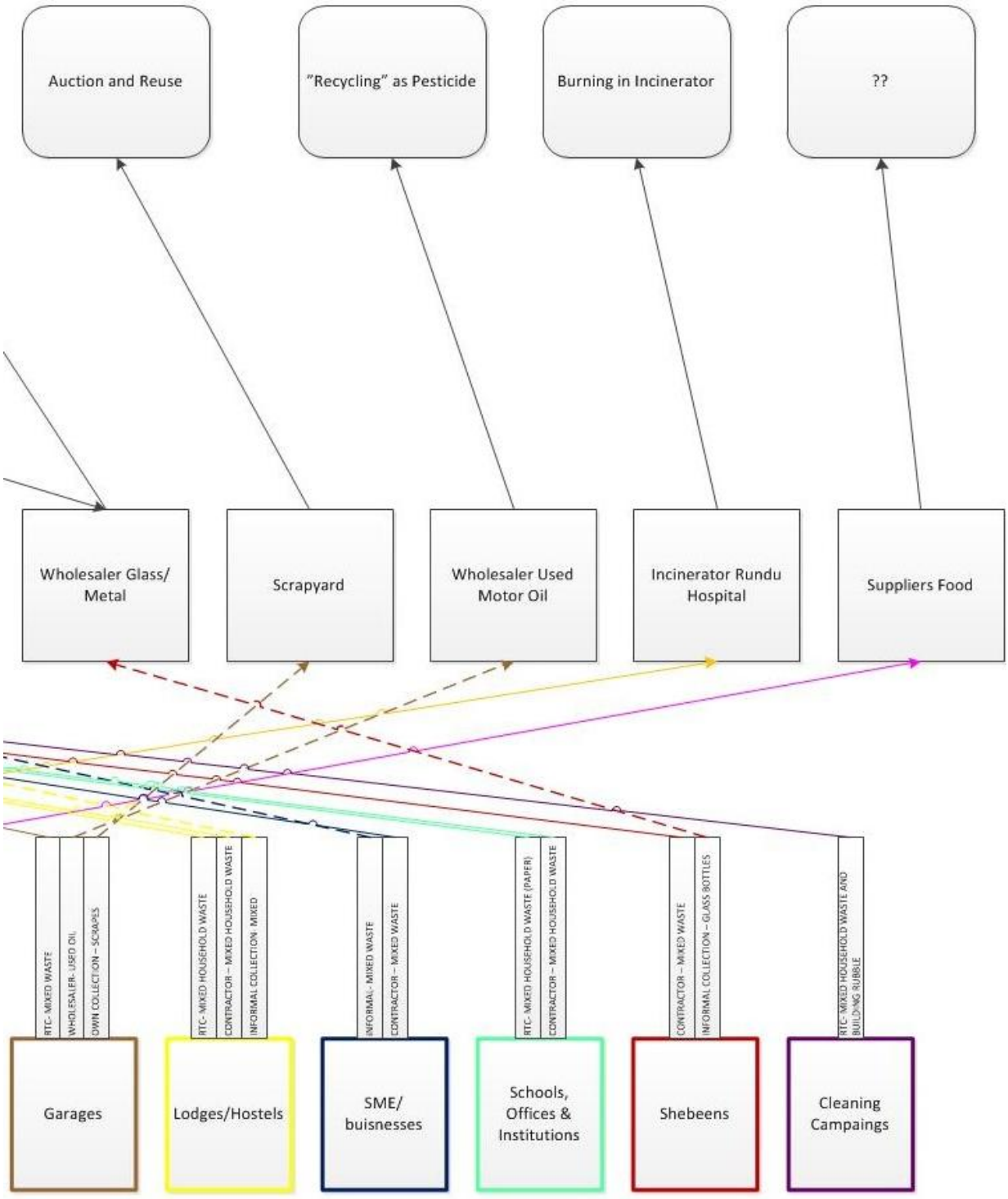


Figure 22. A schematic map over the solid waste in the Kavango region


Auction and Reuse
"Recycling" as Pesticide
Burning in Incinerator
??
Wholesaler Glass/ Metal
Scrapyard
Wholesaler Used Motor Oil
Incinerator Rundu Hospital
Suppliers Food
RTC- MIXED WASTE
WHOLESALER- USED OIL
OWN COLLECTION – SCRAPES
RTC- MIXED HOUSEHOLD WASTE
CONTRACTOR – MIXED HOUSEHOLD WASTE
INFORMAL COLLECTION - MIXED
INFORMAL- MIXED WASTE
CONTRACTOR – MIXED WASTE
RTC- MIXED HOUSEHOLD WASTE (PAPER)
CONTRACTOR – MIXED HOUSEHOLD WASTE
CONTRACTOR – MIXED WASTE
INFORMAL COLLECTION – GLASS BOTTLES
RTC- MIXED HOUSEHOLD WASTE AND BUILDING RUBBLE
Garages
Lodges/Hostels
SME/ buisnesses
Schools, Offices & Institutions
Shebeens
Cleaning Campaings

6.10 Result D: Economy

6.10.1 Costs of managing waste

In an attempt to estimate the current costs for managing the waste in the Kavango region official documents have been screened. Budgeting and economical reports were found to be based on division figures. Solid waste management is a responsibility of the environmental health division at Rundu town council. It is a problem to distinguish the total waste management costs since the environmental health division also have other responsibilities which share common expenses with waste management. These are:

- Food safety
- Occupational health
- Business registration and regulation
- Environmental management
- Inspection building
- Pest control
- Health education

Table 10. Economy of the environmental health division at Rundu Town Council concerning waste management. The direct costs of waste management have the last years been bigger than the incomes. A situation which are projected to continue the next year 2012-2013 as well.

	2010/2011 (N$)	2011/2012 (N$)	2012/2013 (N$)
Income waste management			
Refuse removal Domestic	1062587	846467	1100000
Refuse removal Business			500 000
Garden refuse removal	1173	869	10000
Dustbin rental domestic		237435	400000
Dustbin rental buisness	272460	38240	50000
Fines illegal dumping			30000
Total income refuse	**1336220**	**1123011**	**2090000**
Direct expenses waste management			
Contractor services	1990893	1594641	2800000
Protective clothing		9947	20000
Refuse plastic bags	30797		50000
Vehicle expenses	23973	172384	220000
Repair and maintanance	126164	159111	200000
Total direct expenses refuse	**2171827**	**1936083**	**3290000**
Total expenses Environmental health	**3436581**	**2757727**	**5667352**
Net result Environmental health	**-1273251**	**-383685**	**-1787352**

Some of the direct incomes and costs connected to waste management in Rundu can be seen in Table 10 above. The direct expenses have been bigger than the income possibilities in the

past, and will continue to be so in the next year. The direct cost of waste management stands for 58 % of the total costs of the environmental health division.
A general concern has been razed about how the economy in Rundu town council is managed. National newspapers have been reporting about issues found when the economy has been audited. When it comes to sewage and refuse removal people have been charged at the wrong tariffs. (Isaacs, 2012)

6.10.2 Willingness to pay

Households participating in the waste characterization study were answering the willingness to pay survey. The results of the survey can be seen in Table 11.

Table 11. Results of the Willingness to pay survey. For the formal areas only households without a current waste collection answered how much they were willing to pay for waste services.

Area	Average household size	Current fees (N$/month)	Number of household participating with waste collection	Willingness to pay (N$)	Average value willingness to pay (N$)
Rundu Informal	9	NA	NA	50-500	201
Rundu Formal	4	30-45	10 (50%)	15-450	105

The results indicate a higher willingness to pay for waste services than the current tariff. Households from informal areas are surprisingly willing to pay nearly twice as much as the household from the formal sector. The standard deviation for the willingness to pay survey were 156 N$ for the informal areas and 179 N$ for the formal areas.

6.11 Result E: Practicies of waste collection and waste disposal in Kavango

The information of in this chapter is a summary of interviews, focus group discussion and field observation and should be considered as a complement to the schematic map in Result C. Statements about the waste management in interviews and focus group discussions are utilized to the describe details in the waste management. When possible the statements have been confirmed or rejected by field observations.

6.11.1 Waste collection in Kavango

Collection of waste is a luxury and is not provided to everyone: The communal collection is limited to the formal areas of the towns Rundu and Nkurenkuru where it is performed by the town councils. Kavango regional council also collect waste from the two settlements Divundu and Ndiyona. In informal areas of Rundu and in the rural areas no formal collection occurs. In those areas waste has to be dealt with in other ways. Field observations of open dumping in the vicinity of living areas have been made, see Figure 23. An estimation based on population statistics, from the latest consensus in 2011, is that waste services are offered to 30-50 % of the population.

Figure 23. Example of open dumping in Rundu. Photo taken the 13th of October 2012.

The town council lack adequate equipment to perform effective waste management: A large number of dustbins have been purchased with the intention to increase the effectiveness of the collection. However in Rundu it is not mandatory to have a dustbin and the town council demands an extra fee for renting or selling the dustbin to the household. This has lead to a slow process to get the dustbins out to the people. Households included in the communal collection without dustbins have been observed. A large number of stored dustbins have also been observed within the technical departments of Rundu and Divundu.

The town councils do not have enough collection vehicles to collect all waste. The existing vehicles are not specified for waste collection and consist of smaller trucks. One skipper truck exists to collect the nine containers which have been put out in areas in Rundu outside the normal waste collection areas.

Waste is not collected from communal areas such as parks and the sport stadium: The communal areas where waste is regularly collected are main streets and business area. In these areas modified oil barrels are used for collection, see Figure 24. The capacities of the oil barrels are limited and overflowing waste have been observed at several occasions in the business areas. At an irregularly basis cleaning campaigns are performed. In the cleaning campaign schools and the town council clean the city from the waste which not otherwise collected. This has not been observed.

Waste is collected with the help of contractors: In order to cope with the demands of waste services, the local authorities in Rundu, Divundu and Ndiyona uses contractors for collecting waste. A number of eight contractors collect waste in Rundu and one contractor covers Divundu and Ndiyona. In Rundu each contractor has a certain area from where they are suppose to collect from. The contractor must have their own collection vehicle and staff. Contractors collecting have been observed.

Figure 24. Collection from communal areas. Oil barrels are modified and painted and used as a collection bin. Photo taken the 8th of September 2012

The waste collection is not effective due to frequent breakdowns: A common concern in interviews with users of the waste management system is that waste collection is irregular due to breakdowns of collection vehicles. Problems due to breakdowns can be avoided if back-up vehicles are on standby. Field observations have confirmed that breakdowns do happen, though backups for normal collection trucks can be arranged. However for special vehicles like the skipper truck in Rundu, backups are hard to arrange. As a result breakdowns have a tremendous effect on the possibilities of collecting waste from certain locations. In Figure 25 one of the containers which would normally be emptied by the skipper truck is overflow due to a breakdown. It has not been possible to complete a quantification of the breakdowns.

Figure 25. Unattended container with surrounding waste. The photo is an example of problems during collection vehicles breakdown. Photo taken the 17th of October.

6.11.2 Waste treatment

Kavango lack adequate waste disposal: There are four official dumping sites in the region, one in each town and settlement.

Rundu Dumping site: Rundu dumping site is by far the biggest site. It is fenced and guarded some hours of the day. There exist however no control over who come and dispose waste. It is located a few kilometers west of town outside the informal area Sauyemwa. Waste is unloaded by hand and normally burned to reduce the amount of waste and to avoid plastic waste spreading to the vicinity areas. The dumping site has a bulldozer which is supposed to make sure the site is in order and to push the waste into a manmade pit. There exists no leachate or emission control of the dumping site. Field observations during several visits to the dumping site confirmed the information given in the interviews. The bulldozer was also found to be out of order and have been so for some time (estimated 6 months). As a consequence the waste was scattered uncontrolled at the site.

Nkurenkuru Dumping site: Nkurenkuru have not yet created a permanent dumping site. A temporary dumping site exists a few kilometers outside the town center. The area is neither fenced nor guarded. During a field visit the waste were put into one large pile. Some signs of burning were seen but some waste was left unburned as well.

Divundu and Ndiyona dumping sites: Divundu dumping site is located approximately 10 km west of the settlement. The last part of the road is a several kilometer long sand road which is difficult to access without a 4x4 wheel vehicle. The road was blocked by a couple of cut down trees. The dumping site is not fenced or guarded. In the dumping site a manmade pit is used for dumping and burning the waste. Recently, fire had spread from the burning of waste to the surroundings of grass and bushes. During a field visit scattered waste outside the pit and piles of older waste along the road were also discovered. No field visit was made to the Ndiyona dumping site. Information from interviews describes the dumping site to be similar to Divundu dumping site.

Some of the waste are recycled or reused

Namibia breweries limited, located in Windhoek, are the largest brewery in Namibia. They have together with some of the supermarkets in Rundu introduced a return system for NBL glass bottles in Kavango. The company offers 1 N$ for each of their returned bottle and an extra 11 N$ for the crate. The bottles are shipped back to Windhoek for reuse via a communal collection point. The transport is done by lorries. Only the NBL 750 ml bottles are valid in the system. Quantification of the reuse has not been possible.

Information from interviews indicates that glass also is collected for recycling. An unknown company based in Windhoek is said to buy broken glass. Collection and volume minimization have been observed in Rundu. The recycling market in Namibia is limited and transportation to South Africa is therefore necessary. The value of reclaimed materials at the South African market can be seen in Table 12.

Table 12. Value of recovered material on the South African market in year 2011. (Okavango basin management committee, 2012)

Material	Value on South Africa market (N$ / tonne)
Plastic	648.00
Glass	106.66
Metal (cans)	396.00
Cardboard	199.50
Paper	501.04

People in the informal sector make a living out of waste in Kavango: The informal sector is small, but exists. A group of women, with the size of 30 individuals, make some money from scavenging at Rundu dumping site. They sort out glass, aluminium and iron and repack it in plastic bags. According to a focus group discussion with the women their return is very limited. A big bag of broken glass, which takes a couple of months to collect for two to three people see Figure 26, gives them 60 N$ in return. This would give a monthly salary of only 10 N$ per person. This is an unbelievingly low salary. Even an increase of 25 times their current salary would barely get the people above 1 US$ per day. A few numbers of people collecting broken glass in the centre of Rundu have also been observed. An estimation based on field observations gives an extra number of 10-20 people informally collecting recycling material besides Rundu dumping site.

Figure 26. Informal collection of broken glass for recycling at Rundu dumping site. Photo taken the 10th of October.

No informal waste collection from households has been identified. In areas where the communal collection is limited it would be possible with a complementary informal collection. Since no such system was identified it is assumed that no other informal collection is carried out on a larger scale.

6.11.3 Administration of waste management

Fees are collected in combination with drinking water and sewage: In Rundu the fees for waste services are collected in combination with fees for water consumption and sewage on the same bill. For this purpose each household must have a water meter. This sets a limit in which areas waste service fees can be collected. If introducing waste services in areas without a water infrastructure another approach is needed.

It is possible to dump waste anywhere: Open dumping of waste is necessary for people without communal collection. However a general concern is that nothing is done to protect sensitive location, such as the Okavango River. It is possible to dump waste anywhere without risking any fines. Several signs have been observed telling people not to dump waste. However people do not seem to care very much about them, see Figure 27.

Figure 27. No dumping site with dumped waste in Rundu. Photo taken the 20th of September 2012

7 Sustainability analysis of waste management in Kavango

7.1 Is the waste management in Kavango sustainable?

Using the criteria for a sustainable sanitation system presented in chapter 4.4 the current waste management is analysed from a sustainability perspective. The waste management is only sustainable if it is possible to fulfil all of the criteria. Indications from previously results are used to determine whether a criterion is satisfied. The analysis is summarized in Table 13.

Table 13. Summary of sustainability analysis.

Criteria for a sustainable waste management	Is the criteria fulfilled? — = no ✓ = yes ? = no data	Indications
It is functioning and being used	—	From interviews (Result A) and field observations (Result E) the conclusion is made that waste management is unreliable and forces people to use other disposal methods.
It is able to deliver appropriate level of benefits (quality, quantity, convenience, continuity, health) to all, including the poorest	—	Since no waste collection exist in the poor informal areas of Rundu the criteria is not fulfilled.(Result E)
It function over a prolonged period of time (which goes beyond the life span of the original equipment)	?	No positive or negative indicators have been identified.
Its management is institutionalized	✓	Waste management are performed by town councils and regional council. Informal waste treatment exist, but at a limited scale.
Its operation, maintenance, administrative and replacement costs are covered at the local level	—	Even without administrative and replacement costs, the direct operating costs of waste management in Rundu are higher than the incomes (Result D).
It can be operated and maintained at local level with limited but feasible external support	✓	Besides economical problems for investments (Result D) and some specialist knowledge, the current system is managed with only limited external support.
It does not affect the environment negatively	—	Inadequate waste disposal and lack of collection system in informal areas leads to negatively

		environmental effect (Air pollution, risk of fires, ground & water pollution, animal consumption)

7.2 Utilization of concepts for improving solid waste management

The concepts described in chapter 5.4 are in this chapter analysed from the local perspective of Kavango region. The existence of the concepts in the current waste management, the possibilities to introduce the concepts and possible environmental-, social- and economical effects are discussed.

7.2.1 Integrated solid waste management

Lack of national legislation in the field of solid waste managment and lack of an existing waste management plan for Kavango region are strong indications that an integrated solid waste management approach have not been used in the past.

Estabilishing a waste management plan deeply rooted and accepted at the local authorities and among the inhabitants, is seen as the most critical step for introducing a integrated solid waste management. The waste management plan should also consider nontechnical aspects such as social- and environmental effects of the waste management. The lack of proper national legislation is a problem since aspects of waste management goes beyond the regional boarders, e.g. recycling possiblities. The waste management plan should also set the road forward for how the waste management should be improved in the future. Legsilation deciding how the waste management is to be performed must be based on the will of the people in combination with experties from the field and scientific knowledge.

From a sustainability view an integrated solid waste management approach can only be seen as positive. Environmental, social and economical aspects are included already in the legislation and planing phase of waste management, improving the possibility to create a sustainable waste management. Moreover it is also seen as necessary with a sound national legislation which create good administrative opportunities for the local authorities.

7.2.2 Public private partnerships

Today contractors are used for collection of waste in a substantial part of the formal areas. The town councils and regional council decide which contractor to use through tenders. The local authorities are therefore already today involved in public private partnerships in collection of waste.

When it comes to the collection of waste, more private public partnerships might be difficult to introduce. Since many areas in Rundu are without collection and people are willing to pay for the service it might however be possible for private businesses to start up a wider collection. Administrative issues such as how to collect fees must first be resolved.

Public private partnerships can be a way to increase the efficiency of waste collection and to attract external founds through private investors. However in order to maintain a partnership capacity building at local authorities is important. Firstly the right demands must be set for tenders so the contractors fulfil the standards. Secondly the local authorities need a working system for evaluating the contractors. Thirdly a good communication between the local authorities and the contractors needs to be maintained in order to resolve issues in an effective

way. A proper working PPP would lead to less costs and new possibilities which can improve the development of a sustainable waste management. However a poorly executed PPP can lead to worse working conditions, a less effective waste collection, inadequate waste treatment and a negative public opinion on waste management. Consequently PPP can be a way to improve the economy in waste management, but must be carefully monitored by the local authorities in order for the partnership to contribute towards a sustainable waste management.

7.2.3 Integration of informal sector

Rundu town council has made small efforts to regulate the informal sector. This has led to prevention of children at the Rundu dumping site. However the informal sector activity and waste recovery is unregulated and not integrated.

An integration of the informal sector can be done in two different fields, collection and treatment. It is possible as in the same way as described in the PPP introduced an informal collection of waste in the informal areas and integrate that to the communal waste management. No such activities have been identified, but if the opportunity would arise it would be an opportunity to extend the communal waste collection to more people. For the field of waste treatment integrating the informal sector can be performed in a scale from low to high integration. At the lower end the group of women scavenging at the dumping site would continue their business without local authorities' interference. A good communication would be needed so the dumping site can be properly managed but other issues as safety equipment and selling the items would be done by the women themselves. At the other end a waste management separation plan could be introduced, hiring the already experienced women. Somewhere in the middle would perhaps be to continue the current scavenging but combining that with job assignments such as monitoring the dumping site and make sure the area outside the fence are clean from waste. In return the women could get safety equipment and an extra salary.

Introducing informal collection in combination with communal collection points demands an improved infrastructure of containers and skipper truck. The pressure on the dumping site would also increase. However the extended collection would be beneficial for social and environmental aspects. The possibilities to integrate the scavenging informal sector are interesting for lowering the pressure of the dumping site and to increase the amount of waste for recycling. The most important barriers for this would be the market for recovered resources. Without a good market it would be impossible to expand the number of recyclable items to also include other waste fractions beside glass and metal. It is also a question of the amounts of waste. Are the amounts of waste high enough for creating an economical feasible sorting plant? The environmental benefits of recycling waste are dependent of the needed transportation distance and the material which the recycled items replace. For the informal sector integration could lead to safer working conditions and possible higher incomes.

7.2.4 Decentralization

The waste is managed at an intermediate decentralization level in the region. The two towns have their own town councils with responsibility for waste management and for the two settlements Kavango regional council is responsible, with a local office in Divundu.

The waste management could be decentralized even further and especially in the informal areas which is not included in the current waste collection. Finding an administrative and organisation for this is perhaps a key issue.

A further decentralization could be a way to include more people in the waste collection system and thereby decrease waste management negative effect on some environmental and social aspects. One benefit is also that a successful decentralization would automatically improve the awareness level of the public. A decentralized system could also find solutions to the problem how to collect fees from people without water meters.

8 Discussion

8.1 Sources of error

When performing field studies a choice of method always has to be made. This must be done carefully since choosing an inadequate combination of methods might end up with limited results, or in worst case even false conclusions. Investigating waste management in a field study has proven to be difficult due to the high number of aspects involved. A classical choice of quantitative methods, such as waste characterization might be good to get an overview over the waste and to monitor changes. Waste characterization demands however a lot of resources in form of people and time. It has also been proven difficult to cover all population within a waste characterization study since the normal collection rate is low in many developing countries. In this study the issue was solved by introducing temporarily collection systems. However this solution also affects the result, since people get aware of the study and possibly change their habits. Three consequences which affect the results when introducing the temporary collection system were:

- People avoid throwing things in general since they do not want to participate in the study. When introducing the household to the study only one member of the household were present. It is possible that only parts of a household participate in the study. The consequence of this is that the waste generation in Kavango can be underestimated.
- A free temporary system can be seen as an opportunity to get rid of old waste which is not produced during the time of the study. The consequence of this can be an overestimation of the waste generation in Kavango.
- People avoid throwing away certain types of waste due to integrity issues, misunderstanding instructions or a poorly planned collection operation. The consequence of this might be false conclusions of the waste composition.

Out of the three cases above, the first and second case can be easily spotted as outliners. The third case is harder to discover since the natural variation of waste from households, cover small variations in waste composition. Another source of error in the waste characterization study is the selection of samples. Due to lack of resources only 120 kilogram of approved waste were characterized, which are a relatively small amount of waste. The low number of participating household makes the result of the characterization less secure.

Another source of error which can be applied for both open ended interviews as well as for waste characterization is the aspect of achieving representative selections. For the interviews the selective aspect was the interviewee's occupation. For example people were nominated to be interviewed at local authorities only because of their occupation. The corresponding aspect for waste characterization was living area. By balancing the selection in different occupations/living areas the expectation is that the selected people/household are representative. When the data sample is small the selection of people gets even more important. Making radical conclusion based on quantified results should be done with caution due to the low number of samples since even a small shift of balance of representative samples affect the results.

Subjective consideration is unwanted in research. Avoiding subjective considerations however, could lead to a less flexible research method. In this study it was necessary with an adjustable research method which could be modified due to new information. A semi

structured interview enables for example the questions to be modified depending on the interviewee. A subjective filter had also to be put on in the waste characterization study to cope with flaws in the method. The aim has been to make as few subjective considerations as possible. How subjectivity affect the results are impossible to measure in numbers but is nevertheless an important source of error.

Interview methods are based on good communication between the interviewer and the interviewee. To be able to get representative result the interviewer has to be observant when interviewee does not tell all of the truth. Several times during the open ended interviews the most interesting information was told after the interview ended. Even though such information was not included in the results it did provide several new perspectives. The fact that some information were kept from the interview itself is seen as an indication of information suppression. Even though most answers felt honest and a good communication were achieved with the interviewee it is impossible to know if all information were given. Cultural differences between the interviewee and interviewer also contributes to communication difficulties

8.2 General discussion

The main aim of this thesis was to investigate how sustainable waste management can be achieved in developing countries. For several reason this was hard to accomplish. The classification of countries in developing and developed countries was found to be inadequate in the waste management field, since there is a vast range of level in development among the countries normally referred to as developing countries. Despite the fact that no standard classification of development exist, it is fair to say that the level of development affects aspects such as local economy, level of education and industrialization. Even though no statistically significant correlation was found between such aspects and waste generation in this study, a general scientific opinion is that the level of development influence the waste generation. As a consequence the waste generation and composition would also vary within the group of developing countries. It is therefore not appropriate to claim that one single solution could be enough for solving the waste management problems in developing countries. In fact, the decentralization of waste characteristics which occur in all countries also makes it difficult to use the same waste management methods even within all regions in a country.

The issue of defining a sustainable waste management is also relevant for approaching the main aim. If seeing sustainability as absolute, a solid waste management can only be one out of two things; sustainable or unsustainable. The need for waste management, and perhaps even more waste disposal, can be seen as a result of an unsustainable civilization. The question then arises if waste management, from a sustainability perspective, can and should be separated from the society itself. Even if an isolation of waste management is accepted sustainability is problematic to evaluate. In an evaluation of sustainability only two results can be given, yes or no. The result would be theoretical and not very useful for improving the waste management. A suggestion is therefore to use continuous indicators to evaluate how far from sustainable a solid waste management system is. In this study only absolute indicators where identified. Developing continuous standard indicators of a sustainable waste management would not only make evaluation of waste management systems easier but also increase the awareness of sustainability aspects among people working with waste management.

The nature of waste data is a problem for the field of statistical analysis. Definitions of waste in national legislation differ from one country to another and waste characterization data can have unsatisfying information about how data have been collected. Analyses which compare data from different countries and from different studies have to be able to handle these variations. In developing countries the choice of characterization method is crucial for the results, since waste can be diverted by the informal sector. Depending on where in the waste management system samples are taken the result would differ. On top of that, seasonal variations can have an impact on the data. The consequences of the data variation are that trends are difficult to spot and statistical valid conclusions impossible to make when comparing data from different locations. In the literature review, chapter 5, a statistical analysis of waste data from several countries was made. All of the waste data came from the same report, which in turn had a number of sources. The results of the analysis were statistically inconclusive even if some trends are indicated. It is possible that a correlation between the living standard (HDI), Income level (GNI/capita), Urbanization and waste generation exist even though it was not proven in this study. A better analysing method, and perhaps a different perspective, is necessary to be able to make valid statistical conclusions.

Several drivers for improving the waste management were found in the literature review. The drivers belongs to all three of the sustainability fields; social aspects, economy aspects and environmental protection. Improving local waste management should be done with consideration of as many drivers as possible. For a local authority with responsibility for waste management this complexity might be difficult to comprehend. It is therefore necessary with future initiatives and tools which can be used as a help at a local level. Some concepts were found in literature for improving a waste management system. None of them might be good enough for achieving a sustainable waste management alone. However all of the concepts focus on important aspects of the waste management and a combination of concepts could therefore be used to get a more comprehensive tool.

A repeating issue in this thesis is the difficulties of making scientific research on a global or even national scale when it comes to waste management due to local differences. A theoretical issue therefore exist whether knowledge how to improve waste management can be utilized on a centralized scale when waste management itself are decentralized. This issue are crucial for the conclusions of this thesis. Can the results and conclusions from the Kavango region be extrapolated to developing countries as a whole? The answer to this question is both yes and no. The solid waste situation varies in developing countries, both when it comes to the character of waste and the economical-, social- and environmental-aspects. Methods for working with solid waste in one part of the world might not work in another part. However, the criteria for a sustainable waste management should be the same in all parts of the world. It is possible to describe the objectives for improving waste management in general terms, but the road to sustainability must be flexible and adoptable everywhere.

8.3 Discussion Kavango

The case study focusing on the Kavango region resulted in a numerous of different results. Some of the most important results are discussed below.

Interviews

Since a vast amount of information was given in the open ended interviews, an attempt has been made to process the information to spot trends and to pinpoint the most important information. A majority of the interviewed people shared the same view of how to define

waste. This might sound as a technicality, but if people do not agree up on what waste is, it is difficult to work together to improve the waste management. How a person defining waste can be seen as an indication of the awareness level and knowledge about waste. In line with the Namibian legislation the usefulness aspect was the most commonly answer of how to define waste. Nevertheless some people used other definitions or even had difficulties to give an answer at all.

When it comes to waste as a problem for development a number of common aspects were mentioned. Animals consuming waste, pollution of the river, dumping sites and a general negative effect on the environment were the most common answers regarding environmental aspects. Compared to less common answers such as ground water pollution, these are issues visible for the public. For social aspects various issues connected to health were a common answer. In a region as Kavango highly affected with diseases, e.g. HIV and malaria, the result is not very surprising. People at local authorities have to deal with the health issues on a regular basis and seems to have knowledge how to connect waste with the diseases. Only a few people mentioned the burning of waste as a health problem. This is a problematic since burning is the most common waste treatment option. Low knowledge about negative affects reduces the possibility of people understanding the needs of improving the waste management. People are more diverged when it comes to economical aspects. The most common answers where either connected to the economical impact of dirty towns, costly waste management or waste of resources. The impression of the answers is that the economy of waste management is seen as a limit rather than a possibility. This perspective usually comes back later in the interviews when discussing improvements and barriers.

In the interview a vast number of ways how to improve the waste management were suggested. Many of them were connected to organisatorial and management issues, but not the five most common suggestions; *more transport vehicles*, *separate collection for some waste streams*, *introduce recycling*, *better control over dumping sites* and *improving the awareness level of the people*. With the exception of a few common answers many of the suggestion were only mention by one or two people. Hence there is no consensus of how the waste management should be improved. Personal perspectives and experiences, lack of knowledge and no obvious answers are all possible explanations of the diversity.

Insufficient funds where the most common suggested barrier for improvement. With this in mind it is hard to understand why so few people mentioned economical aspects for improving the waste management. People seem to take the need for external funding for granted. Three other common answers were lack of capacity (human resources), lack of public awareness and lack of legislation. This is all non-technical aspects which demands education and national efforts to improve.

Waste Characterization

One of the major parts of the field work was the waste characterization study. The result indicating that a quarter, or 26 weight %, of the waste in Kavango are organic waste and about half the waste are material which can be recycled, such as paper, plastic, glass and metal. As a relatively poor region in a developing country the proportion of organic waste was expected to be higher. According to the theory poor regions produce fewer amounts of packages and therefore a higher proportion of organic waste. This is based on an assumption of a self sufficiency food production in the region. In Kavango some food are produced, but the region still import processed food from other parts of the country and even more from South Africa. This can be an explanation to the low proportion of organic waste.

The waste generation rates are low with an average value of 0.11 kilogram solid waste per person and day. This cannot directly be compared to other statistics, since the waste characterization study in this case only included waste directly collected from households. Solid waste generated by smaller businesses and from public places is normally also included in the municipality waste management and therefore part of most waste characterization studies. Compared to world statistics for waste generation, only a few countries have an average waste generation below 0.4 kilogram solid waste per person and day, see Figure 4. A waste generation of 0.11 kilogram per person and day is very low even if the numbers for Kavango region are incomplete. Another interesting aspect is the variation of waste generation. Quite many households produce lower than the average amount, while a few produce much more. The dynamics in waste generation is not well understood and an interesting field for future research. When extrapolating the waste generation rates at a region level, with perspective on the constituencies, the amounts of the generated waste is fairly equal among the different constituencies, see Figure 20. The extrapolation is based on the population level in the different constituencies. The density of generated waste is also investigated with the result that Rundu Urban is by far the constituency with the highest amount of generated waste per area. This could be used as an argument for concentrating waste collection efforts to the Rundu urban area. A high density of generated waste would lead to a higher pressure on the area in terms of health and environmental impacts. The extrapolation does have limitations since population data were not found at a more detailed level than constituencies. Some constituencies do have relatively high population density in certain sub-areas.

Waste map

The schematic waste map is not an absolute description of the waste management in the Kavango region. However four different aspects in the result are worth discussing. Firstly the map shows all identified informal waste management activities, or at least activities outside the municipal waste management. As can be seen the informal waste management are not limited to scavenging of materials. Both other collection and dumping of waste occur without going through the local authorities. This waste management are not institutionalized and are therefore uncontrolled. Special consideration must be taken to include the uncontrolled waste management if an improving program for waste management is put into place. Secondly the map indicates a complexity of different waste activities. Many different participants handle waste. Thirdly some examples of existing recycling systems exist. If a decision is made to introduce a more comprehensive recycling system, the work of designing the system should start by looking at the presents recycling activities and incorporate them. Fourthly hazardous waste in form of medical waste is taken care of with consideration. However the same consideration is not present when it comes to chemical waste. This is perhaps not a great problem today, but plans for future establishment of industry plants demands a proper handling of hazardous waste in order to avoid severe negatively impacts on the environment.

Economy

Unfortunately economy numbers where only identified for Rundu town council and the numbers are inconclusive. Some direct costs of the waste management are presented but the numbers are an underestimation since hidden and shared costs are omitted. However when comparing the direct costs to the incomes from waste collection it is evident that a cost recovery system is not in place. Including other costs makes the difference between the costs and incomes even more obvious. It is a problem to create a cost recovery waste management when the real costs are unknown. A first step to get the economy in order would therefore be to make sure that the real costs are present for the solid waste management. This could be

done by changing the routine for budgeting and present activity based costs instead of only including the aggregated division based numbers. From the willingness to pay study it is also clear that households are in general willing to pay more than the current tariffs for services. The willingness vary from one household to another and a recommendation is to perform a larger survey to get good material for future tariff planning

Practices of waste collection and waste disposal in Kavango
The chapter describing the practices is a channel for including other aspects not included in the other results. It was important to include this in the results to give a general description of the waste management in the Kavango region. The chapter also presents necessary information for the sustainability analysis in chapter 7. A few of the aspects are discussed here.

A collection activity worth discussing is the cleaning campaigns. At a regular basis, areas inside Rundu which are not included in the normal collection are cleaned in a cleaning campaign. Schools and volunteers participate in the campaign. Besides a cleaner environment the awareness level of waste also benefits from the activity. With appropriate precaution for health issues increasing the occurrence of cleaning campaigns could be used to both increase the collection range and to put waste issues on the agenda.

The disposal sites in the Kavango region are not up to international standards, not even to national legislation. Without fences and leachate control, the dumping sites are easily accessible and risks contaminating one of the most precious resources in Namibia, safe drinking water. The burning of waste is a common procedure at the dumping sites and the knowledge about the negative effects of burning is low. As mentioned in the discussion about interviews, this is considered as a major issue for improving the waste management.

Some numbers are presented in Table 12 about the economical value of recovered materials. The value of the resources not only sets the limit for which kind of material can be recycled, but also how much the recycling activities are allowed to cost. Recovering material from the Kavango region should be plausible to accomplish within the economical value of the materials. Transporting the materials to the market in South Africa is decisive if a recycling system can be put into place. The next step in designing a recycling system should be to investigate why only glass is recycled today and to investigate how the recyclable waste can be transported as cost efficient as possible.

Other
By using criteria, found in the literature, the waste management in Kavango have been evaluated in the sustainability analysis in chapter 7. The criteria are not very detailed and a certain level of informal judgement is needed for the assessment. Two out of eight criteria are considered as fulfilled in the Kavango region. For one of the criteria not enough data is collected to make an assessment. The waste management are not considered as sustainable until all of the criteria are fulfilled. Consequently the current waste management in Kavango is not considered as sustainable. By using the sustainability criteria approach areas in need of improvements can be pinpointed. However sustainability criteria are not very useful as a tool for work on improvements. For that a combination of developing goals, which are easy to evaluate on regular basis, and a careful evaluation of activities made for improvements are suggested.

All of the identified concepts for achieving a sustainable waste management are considered as applicable for Kavango. In fact today already some aspects of the concepts are incorporated in the waste management. One concept does not rule out another and actively working with the different concepts is a possible way to achieve a sustainable waste management.

9 Conclusions and recommendations for future work

The following conclusions are made from the literature review and the case study:

- Significant correlations between the average waste generation rates and the living standard, income level, urbanization and industrialization of countries could not be confirmed. Finding international solid waste data of high quality was proven to be difficult.

- A hypothesis exists that solid wastes in developing countries consist of higher proportions of organic waste than in developed countries. This could not be confirmed neither in the literature nor the case study.

- Solid waste management affect the three pillars of sustainable development; social development, economical development and environmental protection. It is therefore functional to use the term sustainability in the field of solid waste management.

- The waste management in Kavango are not sustainable today, according to existing predetermined sustainability criteria. A combination of poor efficiency, unable to cover it owns cost and severe environmental impacts are some examples of why the current system is not considered as sustainable.

- Relatively low amounts of waste are generated from the households in Kavango. Previously studies assume much higher amounts. This has to be considered when deciding how to improve the system. The waste consists of relatively low amounts of organic waste (26 %) and relatively high amounts of recyclable waste (> 50 %).

- Interviewed people directly connected to the waste management have a moderate awareness level. Most of the people are able to define waste, however the knowledge about certain negative impacts of current waste management are low. The people do not agree upon how the waste management should be improved. However most people agree that insufficient funds and lack of capacity is the biggest barriers for improvement.

- Waste is generated across all of Kavango and no significant differences could be found between people living in urban areas and people living in rural areas. However due to the high population density in Rundu and its vicinity, it is likely that the negative impacts of the waste management are largest there.

- The low standard of the disposal methods as well as insufficient waste collection in the informal areas of the Kavango region are seen as the two largest technical challenges in the current waste management. The barriers for improving these areas are lack of resources and knowledge about how to build safe dumping sites.

- Several concepts for improving the solid waste management exist; *integrated solid waste management*, *public private partnerships*, *integration of the informal sector* and *decentralization*. The concepts address different technical and non-technical issues and can be used together to improve the waste management.

9.1 Recommendations for future work: The process of improving solid waste management in Kavango

Improvement work in solid waste management should be regarded as continuous. The improvement process in **Figure 28** is based on the experiences and results from this study and is one example of how the Kavango region can work to improve the most important challenges in their solid waste management.

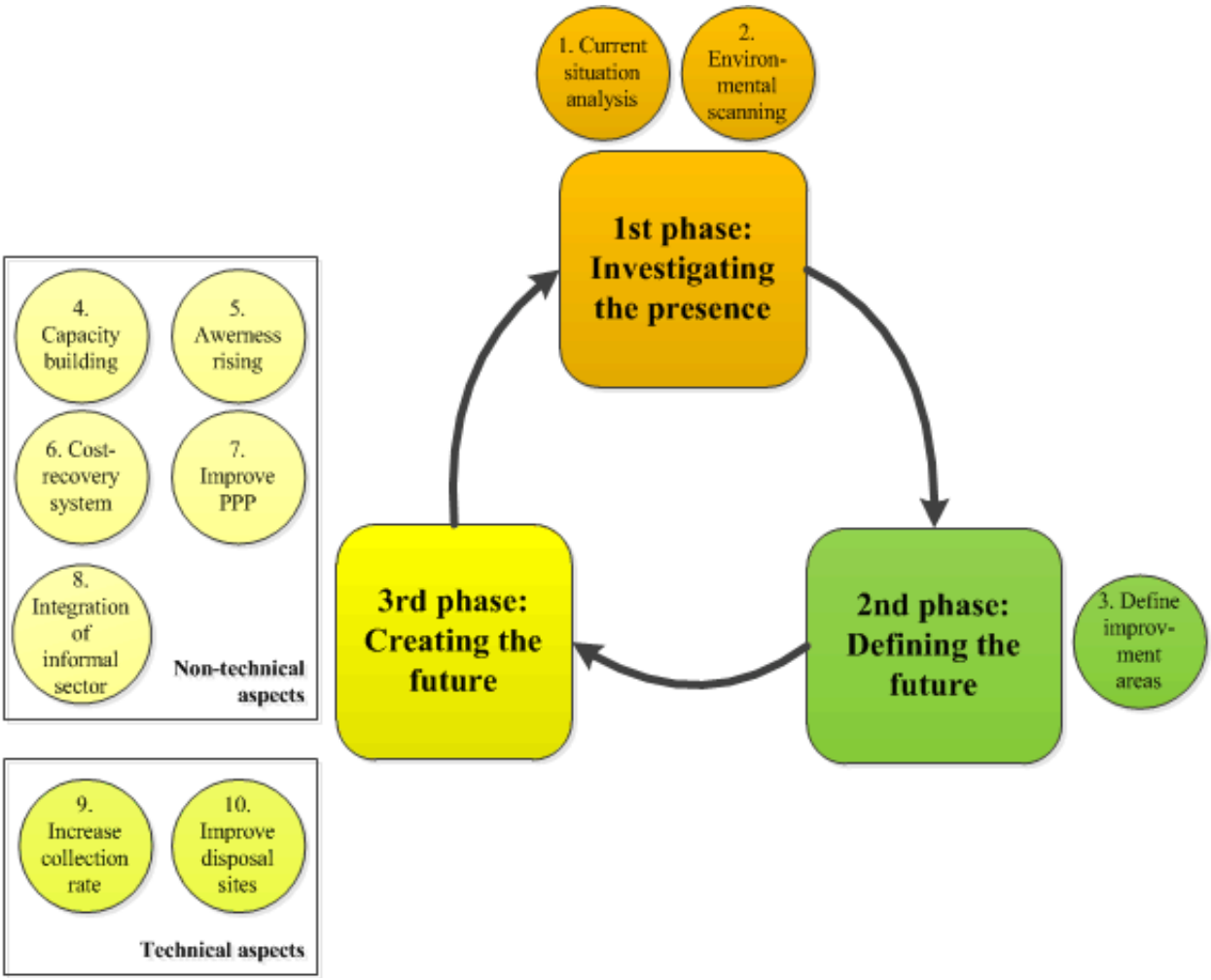


Figure 28. Example of improvement process for the Kavango region. The ten activities are divided into the three phases, *investigating the presence, defining the future and creating the future.* The activities 1-3, or the first and second phase are partly performed in this study, however repeating these steps are necessary to maintain the improvement work up-to-date.

1st phase: Investigating the future:

1. Investigate and map the current situation, introduce regular measurement (waste characterization studies)

2. Investigate top-down incitements from a national level (legislation, national solid waste management planning and private recycling businesses) and collaboration possibilities with other regions.

2nd phase: Defining the future

3. Define aims for the solid waste management and the necessary improvements to reach them.

3rd phase: Creating the future

Non-technical improvements

4. Capacity building at local authorities. The main responsibility for improving the waste management should be clarified and limited to a single institution or working group

5. Awareness rising amongst the public about the impacts of inadequate solid waste management

6. Investigate the possibilities for a cost-recovery system. This activity should start by clarify the costs of solid waste management in budget processes.

7. Improve the existing private public partnerships, better communication with contractors and incorporate backup plans to limit disturbances in collection services

8. Integrate the informal sector in the waste management system

Technical improvements

9. Decentralised technical solutions to increase the collection rate.

10. Improve the disposal sites (fencing, decrease the spreading of waste, issue of burning and leachates, increase recycling).

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Appendix A: Open ended interviews

Two different interview plans were used depending on which category of supplier and user of waste services the interviewee belonged to.

Interview plan, supplier

Introduction question
What is waste? Exemplify

Topic 1: Waste as a problem for development
In what way is waste a problem for Rundu/Nkurenkuru/Kavngo region?
Why does this problem exist?
What are the environmental impacts of the current waste management

What are the social impacts of the current waste management?

What are the economical impacts of the current waste management?

Topic 2: Waste generation and characteristics
What activities here in Rundu/Nkurenkuru/the Kavango region generate Waste?
What kind of waste is generated from the activites?
Which activities produce waste harmful for the public health and environment, i.e. hazardous waste?

Topic 3: Waste Collection and treatment
Which services do Rundu/Nkurenkuru/the Kavango region, offer its citizens when it comes to waste?

How is waste collected in Rundu/Nkurenkuru/the Kavango region?
In which areas are waste not collected?
Who collect?
Formal/Informal?

Topic 4: Possible improvements of waste management
How could the waste management be improved in the future?

What are the barriers for such a development?

Ending
This was all my prepared questions for this interview, do you have anything you want to add about the waste management in Rundu/Nkurenkuru/Kavango region?
Thank you!

Interview plan, user

Introduction question
What is waste?
Exemplify

Topic 1: Waste as a problem for development
How is waste a problem for you?
Why does this problem exist?

Topic 2: Waste generation and characteristics
What kind of waste do you generate here?
Exemplify
Do you produce any waste which is harmful for people or the environment?

Topic 3: Waste Collection and treatment
How do you get rid of your waste?

Which services do Rundu TC/Nkurenkuru TC/the Kavango region, offer you when it comes to waste?

Do you pay anything to get rid of the waste today?
How much would you be willing to pay for waste collection?

Topic 4: Possible improvements of waste management
How could the waste management be improved in the future?

Ending
This was all my prepared questions for this interview, do you have anything you want to add about your waste management or the general waste management in Rundu/Nkurenkuru/Kavango region?
Thank you!

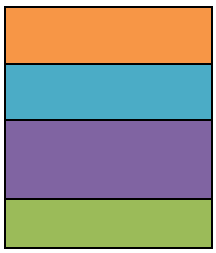
Data analysis

The interview answers were transcript and categorized into the following categories:

- Waste generation
- Waste collection, treatment and disposal
- Waste characteristics
- Informal worker
- Other

To be able to quantify the results, further analysis was necessary. Relevant information for the following topics were identified and made available for quantification:

- What is waste?
- Waste as a problem for development
- Possible improvements of waste management
- Barriers for improvement



Waste generation	Interview ID	Relevance
Waste is just to do with dispose of products that have less economic value. They can be disposed of, some can be recycled. Normally it is things that just have to be isolated from the other environment to insure that people maintain a healthy and clean environment.	I3	
Things that have lost value, the usage time the lifecycle time is over. Things become absolute you cannot use it again, and it becomes waste	I4	
Waste is the disposal of material which is not in use.	I13	
Waste to my own understanding is everything which is in no use to humans. It cannot be used otherwise, maybe recycled to be reused.	I14	
Waste in my own understanding is any unwanted materials or any unuseful things which needs to be disposed of is part of waste perspective	I15	
In my own understanding waste are products no longer useful, offspring of the original products. It needs to be carried away where it can be disposed.	I16	
Waste is normally like something which is not usable again or which has been used already and it cannot be used again. Then it is a waste product.	I17	
The refuses and waste products you see at our houses.	I17	
Waste is something which is no more in use,	U18	
Waste is like bad thing likes paper tins and bottles that paper throwing on the roads or on the houses of the people.	I19	
Normally what we use to do is to get people to do stock rotation.	U21	
Most of the waste is just ignored. People take things which will expire 2-3 years instead of the one which expire in a couple of months.	U21	
The expiring dates are very important. We are happy with the system.	U21	

A place like this, Rundu, the people are there. If you have stock they will buy.	U21	
You found various type waste. Some might only affect the environment, some might even affect the environment. Even properly even uncontrolled waste can in settlements were people lives the animals can come and consume which can cause deaths.	I1	
I live in a community just south of this town in an informal settlement. We struggle to cope with waste. Everywhere it is just waste. It might be a problem here in town, but is more of a problem in the informal settlements.	I3	
The waste is a result of the residents. There is a lot of littering going on. People just throw waste where they want.	I14	
I cannot say waste is a problem, it depends on the costumers. When you have costumers you don't have waste.	U21	
There are a number of things generating waste. One is people and toilets. One is people buying bottles which they throw as they go.	I1	
Shops, business buy in bulk, the plastic they might just throw them away. And also the plastics, when people go and buy an put items in the plastics. When people go they wouldn't dispose them well. They just leave them there. And also the schools, they just books. When the books become absolute they must dispose them in the waste.	I1	
The biggest waste generation is coming from the commodities that we are buying, in the forms of food items, cans, plastic, paper. It is mostly coming from the shops. So the households are buying these items. After usage we have a lot of waste that needs to be disposed. Those are mainly where it is coming from, from the household as well of shops. If you see on a weekly basis the collection of waste, there are larger amounts that are coming from the shops. Larger amounts of bottles, of empty liquor that has been used, that is mostly coming from bottle store. I think in this region that is how it is being produced.	I2	
Particularly from the clinics and the hospital that is from where these type of waste is coming from (ref. to hazardous waste), even though I cannot classify the exact items	I2	
The activities range from various factors. Some of them includes households products that we consume. It has to do with things that you buy from the shop. You use plastic bags, caned products, bottled products, including packaging of some sort. At the end of the day this things that are used on a regular, high rate, you have them only monthly weekly daily bases you have to discard them after use.	I3	
Other waste has to do with commercial waste from offices, work places, hospitals, shops. The shops are always shipping or bringing in a lot of volumes of boxes/containers which thay have to pile and stock in the shop. In the end of the day they have to discard the packaging material.	I3	
Other products have to do with old clothing, hair products, beauty products for those use makeup. It is just a lot. These things that people find difficult to deal with when it comes to dispose it at sites where it can not affect the environment.	I3	
Other has also to do with byproducts, cycles from material like wood. If people is doing something with three/timber there is always byproducts which you need to dispose of. The sources is endless.	I3	

We use a lot of chemicals, in cartridges, for printers, fluoresce bulbs some of them contain mercury. Also batteries for small electronic gadgets, cellphones for example. You use it for maybe 2 or 3 years then the battery is of and you have to discard it. Also some of the beauty products. Not a lot of people know what goes in to it when it comes to the content. In the end this is harmful things. One needs to see how to manage the dispose of such kinds. We just don't have the means of capacity to do that.	I3	
In times like this waste emirates from the health sector. You have a lot of chemicals, medical products, injections, needles	I3	
Household consumption produces a lot of waste. We do not have a lot large factories, but maybe on a minimal way would could say that industries and businesses produces waste. The market produces waste. Also the woodworkening also produce waste. The markets our stores definitely produces waste but we don't have large parts from manufacturing.	I5	
The waste comes from the residents themselves, like plastic and food. Even when they cut a tree. Even businesses also, boxes in the industrial areas you get some oils and so on.	I7	
Normally the most of the waste that we collect is generated from domestic use, it's in the form of bottles, plastics, paper you name it. In terms of industrial waste our town is still growing. We don't have a big industry. But in the near future I see the need to look into this aspect. If you could also consider parts of our town that accommodate a large number of people, you could also see that there also are visitors that needs to use our business areas.	I8	
The industrial sector is still small. What we have is mechanical shops. They use drums and containers were they contain used oil or fuel. These fuels are normally collected by scrap dealer. I **believe** the dealer is located in another town.	I8	
Mostly household and businesses, building rubble.	I9	
Things that we buy and after using it, maybe after drinking a cool drink and throw the container. That's how the waste is created.	I10	
This business that makes wood, they get the timber and cut the timber into pieces. They creating a bit of waste when they shaving the woods. Because we don't have a company that producing cars, so we get a lot of parts, so maybe garages. So maybe old cars they remove parts and parts and the car becomes a waste if nobody want the parts. And then shops. The most one that create a lot of waste is just the hospitals. Because of the equipment and everything they just.	I10	
We have many lodges, we have something like 13 lodges. For now we do not have many businesses producing waste. The only business I am aware of is the two shops in Divundu. But it is not so much. The most waste is from the houses. We have a high number of consumption of alcohol. This produce waste, people don't know what to do with the bottles. Most of the Shibi..ns ("bars") started before the settlements. They were not investigated from a health inspector then. We want to make sure that illegal occupancy is approached and must apply in the official way so a health inspector could come. If they are up to standards they could continue.	I12	
When people buy things from the shop for eating. After eating they throw the plastic or any waste anywhere on the ground. In Divundu we don't have any manufacturing companies. We only have business like shops. Whereby when they come and deliver material from the supplier to the shops. So now the boxes they throw out. Here we don't have any activities which produce harmful waste. Here in Divundu we have one clinic for the ministry.	I13	
The most waste come from shops, and the so called coca shops. If we take bottles, tins, plastic this is 99% coming from the shops. From the community there are the urgent to spreading this waste around the area.	I14	

We have industrial waste when construction companies producing waste like the left overs of the building materials, rubbers etc. Domestic waste like grass and trees they want to be disposed of and also the food leftovers. The paperwork like the offices, unwanted paper we also need to manage this kind of waste. We have also business complex were they also various kind of waste, papers, bottles, tins etc. That is the bulk in our town. They are producing a lot.	I15	
At the moment Nkurenkuru is a newly established town. We have some activities producing hazardous waste but not very much. But since the industries are coming we will have that problem. Here and there you could look at the health centre we have some hazardous waste they produce. But they have their managing that waste. In the future when will have industrial areas I think we will have that kind of problem.	I15	
The waste normally comes from households, hospitals and other institutions. Government institutions, schools, churches and so on. We don't have industries here yet.	I16	
For now there are no activities which produce hazardous waste. The only thing I could think of is the hospital. They are having some medical disposal goods that can be harmful. Appart from that I don't know about any other.	I16	
Normally the waste comes from the shops; some is coming from the people who uses the plastic or bottles and they use throw it there.	I17	
Normally since up to now we don't have any business which produces hazardous waste.	I17	
The dust waste comes from come from like the fabrics if they are burning and car gas.	I19	
Only shops, industries we don't have here.	I19	
It come from if people burning something. If you go to the bush people are burning the bush, the gases from there is dangerous.	I19	
We generate food stuff, which are not used, tins, bottles and cardboard boxes. Basically anything which you can find in the kitchen and the bar.	U20	
Over the weekend you have a tremendous amount of waste.	U20	
Sometimes you think this is end of the month I need to make more, but you don't get more costumers, so It is where you end up with more waste.	U21	
Waste is something uncontrollable most of the time	U21	
Waste is a normal thing, no waste = no business.	U21	
Normally things have expiring dates, so when it is expired, it is waste. Then you remove it, procedure follow and you call for the town council to come and collect.	U21	
The amounts depends, it is just up, down, down sometimes.	U21	
The metal we don't throw away unless it is rubbish, caboxes and those things in paper, but the metal we put on the scrap yard. We have our own scrap yard. We sell things, chokes, brakes etc. It is easy to sell.	U22	
We are not throwing anyway from the cars, just like maybe broken cables.	U22	

Those things we cannot repair or sell we can just throw away in the dustbin together with the rags. The town council come and collects.	U22	

Waste collection, treatment and disposal	Interview ID	Relevance quantified
The barriers could be if we get the people to collect the waste in one place the question is do we have the capcity to take all the waste in the area to the dumping site. You would ne adequate transport, you would need more regular pickups of the waste from the households.	I14	
When it economical aspects we still are having that idea that once you have used it you cannot use it again. We don't have the thing of recycling and reuse it again.	I17	
Normally we are having one which just a cleaning campaign. That was just for schools and the people in the town itself. Within the office our self we have the youth who collect the waste like plastics and cans and so on. Normally they start on Monday, Wednesday and Friday.	I17	
In newspaper for example there is a lot of other byproducts you can get from it. There is a lot of waste going on here, but turning waste to other byproducts we don't have knowledge for that. I believe that research have showed during a number of years that if the waste is managed properly a number of useful products could be derived from waste. And there is an opportunity for employment creation and level of income could also be enhanced in one way or another. There is a lot of waste lying around which could be turned to products. The challenge is the technology to do that. We do not have the technology to do that. I do not know if we have some studies in these areas. Otherwise we need to maybe identify one or two persons that could be able to be enlightening more in the recycle area.	I5	
Also maybe the recycling of this waste. I think the recycling is the best. Apparently currently there is nothing.	I1	
The dumping site is important to fence of the area. Some of the dumpsites is not fenced of which make it easy for animals to go to dumping sites and even children to access to some of this dumping sites. That requires an improvement.	I2	
For us at the regional council we have a difficulty to manage and control the waste management in the two settlements. The service delivery of the contracts, because you don't have means of transports. For this you need to have all the logistics requirements.	I3	
There is no resources to allow us maybe once a week or so to check , the invoice just go to us to make payment whether the service have been rendered or not.	I3	
In the communities there are certain place where they can put it and town council can collect it. Not for you to put it at the house where they can get it	I4	
Also cleaning campaign. You could found it only once a year perhaps. It is not enough. Why don't they do it weekly. Maybe youth when they have long weekends. Certain schools maybe. Perhaps competitions between schools were they say you collect more you get a price. Especially the riverside	I4	
I have seen good initiatives by some parastates. Some have also walked alongside the town council. They have acquired empty drums for us. We just modify them a little bit and put them in the central areas. This drums are for cater for general litter which is just scattered. To this time it has been very successful We write the name of RTC and the name of the company. The RTC approached companies. They feel they contribute to the social development. I think if we can get more of such companies to take ownership of the town I belive we can seriously improve. But we still have to involve a lot of stakeholders.	I8	
The only way they could improve this is like having bigger dust bins. In the future people would have a lot thing, so the dust bins are too small. You could dump things in it for a month. People would not to come every to pick it and pick it. But of course	I10	

it is dangerous as well because you could not have waste for a long time.		
The people themselves and the house they need to be advised how waste can be dangerous for their lives. They need another dust bin where they could put different glasses. They have provided a lot of places for dumping; At least there have to be a place, like a dust bin where they put certain waste, like glasses. The people who would come and pick up glasses would glasses. The people would be different. It is dangerous when you pick up all waste in the same time when you don't know what it is in the waste.	I10	
The truck parks and there is one person who pull the dust bin. The person and a assistant empty the waste in the truck and there people on the truck to push the waste forward. The work condition could be improved if the waste was separated waste in the houses it would be ok. Then all people don't need masks and so on. Like the waste that has to be recycled. They could collect waste and perhaps boils the waste.	I10	
They should also have different dumping sites for different types of things. It is risky for the contractors when everything is dumped on one site.	I10	
We have talked about fencing of the area and also to make sure the contractor burn of the waste immediately in order not to leave them to be exposed, to fly. We have compiled a report to the deputy director and are waiting for response, are they going to consider fence of the area? And are they going to assist us digging the hole. But even if we fence the area of there are no security there. We should expect the fence to disappear. Hopefully if it would be possible we need to allocate somebody, even only daytime security to look after the place.	I12	
Apart from that we also should consider how to approach a recycling system. It will not help if you only dump and dump and things are pilling. In the end you will not have any land. Right now that is what you are seeing. The waste is already being pilling in the dug hole in the dumping site so now we need to dig another hole, but we will not have enough area to dig every now and then. So the best option is to start what we are doing already and se have the place can be secured. You now even kids have access to the waste. You now if kids go there they would even use items from the hospital.	I12	
I think we should start from the national level with recycling.	I12	
The only way to improve the waste management in the future is to procuring a truck in Divundu settlement and employs a driver for the truck and also to fence the dumping area so that this truck would be working on daily bases from Monday to Friday. Then it would be no way for the animals or children enter the dumping area because it would be fenced with a gate. That is how the waste management in Divundu could be improved.	I13	
Normally as we are speaking now our dumping site is getting full. In top of that again it is good if we start separating the waste. Bottles might be aside and the boxes might be set aside.	I17	
Another thing again it would be good to cover the place with a fence, even though it is very far. There are people who would attempt to go there. To avoid disease it would be very good to keep people from the dumping site. Fence and separating that would be very good.	I17	
Just to keep it working all the time. We also need an incinerator here in the future so it is not needed to ship the waste to the district hospital.	U18	
If the waste is not properly disposed it would of course probelrbly cause diseases which will affect the productivity level of the people. Also their health.	I 1	
It is becoming a health hazard because we have problem in terms of waste management. I have been lucky to see how it is done elsewhere, but for us we just have an area identified and then it becomes a dumping side. With our dumping sites you would find a lot of flies. These areas are smelly, the areas becoming too small because af the amounts of waste.	I2	
Another problem is if you travel around in Rundu town you se a lot of littering. That is becoming a problem in the sense that the town is becoming dirty. So it has a financially implication because insuring the town is clean it becomes costly by the end of the day. That is how it becoming a problem for us because it require money for use to maintain or manage the waste. In this of what we are not do probably because of	I2	

lack of machinery and other things.		
Even the environment is becoming affected. In a regional level it is not yet that significant, except for what I have mentioned. In terms of finding dumping sites, that has become a problem already. You go to our river where most of our people go, it becomes a environmental problem because even the river becomes polluted with waste. The areas have becoming polluted with most of the waste. The carrying capacity on a daily there are large amounts of waste being produced. The waste areas are limited.	I2	
One thing is also people can try to manage waste in a household level, but where do you dispose it? It is one of the biggest challenges. The town council cannot coup with the demand of it. Even if you are able to manage it in refuse bin but the end of the day where are you going to dispose it? IF there was maybe some equipment, materials that can be used to take this thing away by the town council and take it away to certain disposal sites it would be better, but you just have to coup with it. In the end of the day it is also affecting the neighborhood and environment.	I3	
We are involved in waste management in that way that refuses removal is function that is done by the regional council itself. So we having contracts to remove waste from our settlements areas. Not much is been done in that area, the waste is just taken to identified dumping areas. What do we do with the waste that we collect to recycle or maybe produce some byproducts from that? What we at the regional council thinking now is that area is taking away from us. The one we are getting (Money??) for the dust bin removal is limited. Maybe we can turn that into more diversified way of merging it I think it will be okay.	I5	
That is her primary business (ref. to person recycling bottles). She have bought herself a small truck and she will go to the lands in every part of Kavango and pack it, and then it comes people from Windhoek to collect it, big trucks. That is just how she makes her money, it is really lucrative.	I5	
We need more recycling things that can be reused again instead of it be throw away, to save more and keep the town clean.	I6	
We are using overalls and gloves and the moth protection and boots. But we have medically checkup. This year we did not go. It is the same for the contractors.	I7	
Here in Rundu it is difficult, you see people burning there, and it is too close to the people it is not good.	I7	
The impact on the environment is quite negative in a sense that even the dumping site is not up to standards. I feel that we can do more to have a proper dumping site. Then we can also maybe bring in measures that can allow us to sort or arrange the waste into different categories. And then we could also maybe consider the possibility to recycle some waste. Since we don't have a proper dumping site what we are doing is not acceptable.	I8	
We don't have a proper way to store the waste. And how to recycle it, just dump it and nothing really happens to it, it just piles up	I9	
Some of the things are supposed to be recycled. We won't get enough things to be recycled to make another production and another job. When the waste is there you need to recruit or get people to collect it. So the waste is good for people that are unemployed, so the money stays with them. So it s utilized, its benefits for everyone as it well create job creations.	I10	
Roads and dumping site. The roads are not so nice, but we do it.	I11	
We burn the waste out, but there are no people staying close to the dumping site. We dig holes, than we dump it and after dumping we burn it out. We stand and look after the fire, sometime the wind is to strong and can take the fire out. When the blow it can take the fire out to the grass so we monitor. The lodges do it by their own. Then they came with the tractor and trailer. They dumped it and burned it but they never stay. The whole area was burning. It was good that the government put in that the tender is now responsible if something happens. We had a problem a few months ago. The chief of the area came to us and asked what happened and say that you people where responsible. We asked him when the fire started and he said it started on Sunday. It was too far from when we where there. The people don't put it in the whole, they just do it on the sides and then they just burn it.	I11	

Some of the private people dumped it on the road. If they don't have a 4x4 they can't reach the dumping site. I don't think there is a good control over the transport used when a tender either. They should inspect the vehicle. It is not a problem even if you have a 2x4 if you the work proper. But everybody doesn't do that.	I11	
If you go to the dumping site just look at what happens with the tree. They are just everywhere and they have no concern. They just cut down trees on the road.	I11	
In case of Nkurenkuru I believe there is a challenge for us in terms of waste management, particularly in terms of we don't have a proper dumping site. As a result every type of waste is disposed or thrown in one site. That alone I believe is a challenge for Nkurenkuru town council.	I16	
In terms of the management itself from the councils perspectives there are costs involved. They are making use of vehicles which are making use of manpower, fuel and maintenance. Even though the return is necessary based on a cost-recovery because most of the people the council is charging lives in town. But the waste coming in the town is not necersary only from the residents of the town, because the town is a center for all the area. So most people come to town for shopping and so on, they throw the waste. As a result we spend money and time for collecting waste and keeping the town clean. That money we collect from refuse removal is only based on the number of property owners in town while the waste is not only generated from the residents. The money we collect does not cover all of the operation. The people might not pay all the money on monthly bases. They might have some problem to pay us, as a result of these operations are subsidized by the council.	I16	
We need to have the waste removed twice a week. And irreverable we need to phone for them to come here. If it was not for miss Muyo I think rubbish would have been right through our door really. The town council are not up to it, but if I phone her they will inventible come.	U20	
They are suppose to come twice a week but they don't. They are suppose to come on Monday and Friday. But then they don't come on the Friday and then we have rubbish where we don't want rubbish.	U20	
Ever since a while we have had this problem because they don't have enough removal transport and as far as I am concerned they don't have fixed schedules. Because if I phone on a Friday and ask them please remove the waste they will come here but not anywhere around.	U20	
The economical impact of waste is that what we are reading it might be if properly managed waste can be an asset. It might even sell to those who want to use it for gardens. It might also generate an income.	I 1	
In Rundu the town Council probably have a program were they have distributed waste bins were people can throw papers were they can be collected and disposed.	I1	
In our case of the settlements, we have two settlements that were we have recently procured dust bins also that can be distributed to schools and so on. We have contracted somebody to go and remove those and disposal them.	I1	
I think in each of the two settlements we have identified a site were the waste is disposed	I1	
The Kavango regions itself is very big. Our services are just limited to proclaimed settlements. Other villages were people lives there is no such services.	I1	
. I know that they are required to use special methods or procedures in terms of disposing them. Unlike the ordinary waste that they just collect and then dumped at the dumping sites, the waste coming from the hospital and clinics I think it is classified in terms of their hazards and some is required to be burnet. Other is also disposed in special matters to avoid risk for the community.	I2	
Starting with the Kavango regional council, we are responsible as a regional council, for some of the areas we call settlements areas. These are small towns at a very very low level. We are point contractors on a one year basis, and then they collect the wastes which are normally dumped at dumpsites identified by the regional council. The same principal applies to the Rundu town council as well as the Nkurenkuru town council. They equally appoint small contractors and then they given sites and schedules for the collection fo the waste. And then they transport it to dumping sites. Of course some of the house owners including myself, there are times when we can	I2	

also dispose of our own waste. We load in our cars and dispose at the dumpsite. Others they burn they waste. They dig some holes and then burns. This becomes a problem. I remember when I was digging our swimming pool. Digging was a problem; it was just full of bottles. It was amount and amounts of waste it was just terrible. Maybe that is also another way we damaging the environmental. I never thought I would be able to overcome that.		
In Rundu we have two options. The one option some of the households were provided by the town council with bins. I do not know how many numbers. They are those who are provided by the town council. The people are paying a fee on monthly bases; it comes with their water bills. Other households do not have that. They would put in plastics or bags and on weekly bases as per the town council schedule they would then take up the items to be collected for collection by the contractors.	I2	
For Rundu it is a petty that it is that way. It was not implemented to long back, maybe six years or so. The problem the community has the fee was extremely to high. I think it is almost 100 N$. Some of the people felt that buying a bin of that nature would be less than 300. So why spend so much just for the bin. So therefore people did not go for that option. The town council also made a mistake, they did not make it compulsory.	I2	
I am not very sure about that (areas not collected). The collection is supposed to be at all different sites households, business that is within the town jurisdiction and even the settlements. The collection is supposed to be done at all places. My experience is that sometimes the contractors don't follow their schedule. The contractors also only collect waste which is in bins or plastics at these houses. Now if you look at other areas like the stadium, nobody is putting these items in plastic, unless the employees of the town council go there. If people have littered there is nobody to pick that up until the council takes their own employees or get people to do a cleanup. Cleaning in general public places that are not done on regular bases.	I2	
Those are things that they may incinerate. But the volume is just to much. If you go to the hospital the surroundings and even inside the hospital you found piles of these used things. It is also a challenge of condoms these days. How do you dispose such things? People just want to throw it in the bin or somewhere. Where it ends up is a concern. Sometimes children can take such things and start playing with it. It could become a big health risk.	I3	
I don't think really it is such a structured kind of operation. I say it is a sporadic exercise. It is more like crises management than a program or structured activity. It is a challenge because it is not nearly close to what you would expect. I don't know whether there is a certain issue with capacity. It also has to do with management, whether people is empowered to be able to manage and control the operations. It is not really a program that you can say is predictable.	I3	
They brought big containers they put in several sites within the informal settlement. But the demand is quite huge. The container can fill in a day or two, but yet it could take a month for them to come and empty. By the time when they would come and empty that the whole surrounding is filled with garbage or waste.	I3	
I can identify one activity at the riverside, mostly things have been thrown at the riverside as a waste dumping site. Especially at a community level. People and animals still use the same water as where there are dumping.	I4	
Sometime someone have for instance a bar and at the end you don't know where to throw it bins of waste and you end up dumping it by the side of the river, which is wrong. It is a large problem, especially here in Rundu it is a big big problem. Sometimes the town council can't afford picking or getting all the waste in one place due to the transporting or something like that. People think it is easy when they dump in the backyard.	I4	
Mostly I remember when bottles were thrown in the river and people going there for swimming and so on hurt in the river when there is glass there which are dirty.	I4	
Currently I only know one which is the town council. Sometimes a big challenge, because they can say an allocation is only one a week. For example here in the Kavango council we have a lot of meeting. We prefer it daily. When there is a lot of meetings and you reach Friday when they come and collect it is to much. Sometimes we put it aside were people come and take it or dogs, or people who are in need of	I4	

them come. I wish there were other companies taken part and come and collect. Maybe schools weekly to assist the town council.		
They (ref. to town council) hire constructor. That constructor may have a small buggy. Sometimes the buggy during the process it brakes. It can stay in the garage for one or two weeks, that is also a big challenge.	I4	
Households it is the same. It is not always they are on time to pick it. Maybe there is one day or week when they have problems. If for example they are schedule to pick up at Mondays. If they jump that Monday you have to wait for the other Monday. And the Monday there is something and at the end you have to wait whole month no picking which is challenge.	I4	
. Sometime you put things in the black plastics where town council advises us. But that is not always right because there might be food things inside in there which dogs come and just break things. At the end you just have to do it yourself. But you are paying monthly. For instance I pay 5 N$ /month whether they pick it up or not. But they are also limited	I4	
Just refuse collection. That is just it basically. They have scheduled times for collection.	I5	
I believe in large parts of the region especially where there is no government institution the waste may not be managed or controlled. In the town it is more controlled. The large parts of the areas is part of rural communities, or communal land. Their waste is not managed properly, except if maybe the owners themselves take initiative.	I5	
Contractors, cleaning campaigns.	I6	
Supermarkets and big business, we need to collect at least two or three times a week, they receive a lot of unwanted things.	I6	
The industries, the one manufacture madrasses, it could also pollute the air. The Chinese produce madrasses and the industry could pollute the air.	I6	
We do have contractors separated according to locations. Just at least to help us collecting once a week at each location to keep the town clean. So far we are not having enough transport so we are able to manage all the location once a week and hard working men's are not enough. We are not able to manage the town which is growing step by step. And there is a lot of shops also receiving a lot of things. We couldn't be able to manage, that's why we hire some contractors on those different locations.	I6	
So far we don't have enough bins and the bins are too small. We have managed to pick some businesses in informal areas.	I6	
The only areas we don't collect is the informal settlements. We only collect were they have our bins. Clinics and schools in the informal areas we use to pick. WE don't pick from each house. We put a big container on the location, when it is full we just go offload it and emptying and bring it back again.	I6	
We are having a program; we are dealing with schools, hospital and the lodges. The school we have to clean them every Monday and Friday, open market every Friday. The shops the contractor collects from Monday to Friday. The residents twice per week. The collection has been given dust bins. The collection is individually. For the open areas we use containers. We have eight containers which we collect when they are full. We only have one container truck, which is broken. The gravel roads are not good for the truck. Now the containers are full but we cannot empty them.	I7	
Waste from the hospitals we sort it separately. The town council has a very old compactor truck for this type of waste. We trust our team to burn it to protect animals and people to come in contact with the waste.	I8	
We have a program which involves about nine contractors. These contractors are outsourced to provide equipment or fleet that could collect the refuse. We allocate and are that we name a zone. We have eight zones. For the zone we have specific contractor to collect from the zone. What we have done is provided refuse bins in every zone. In the main street we have a different contractor. I entrust this contractor to give a good impression to our visitors. The fees are quite high to involve these contractors. The monthly payment range from 20000 to 30000 N$ per month. This is a quit massive amount for the TC to pay out. But since we don't have enough	I8	

equipment our staff it is the only way for us to provide the operation.		
The informal areas and newly formalized areas are unfortunate not catered for, simply due to lack of access. The roads have been surveyed but are still quite sandy. It is not easy for a vehicle without four wheel drive.	I8	
We have already acquired a skipper load truck. This truck can randomly just pick refuse within the newly formalized areas. And especially in the areas where we opening the new roads. With refuse containers we still have not a budget that allows us to cater for all households. We still have a few containers in storage so we could distribute them to newly formalized areas. I see better on the operations in the near future in terms of assisting newly formalized areas.	I8	
The large container is eight or nine in total. Since we acquired in 2011, but we are not able to empty them and some of them are filling up to the brim and the waste is just spilling over. That is because the truck have been design in south Africa to move on road that are propery surfaced. In our gravle roads they did not give provision to proper dumping. It has been under repair in a few months now. We hope that it will be repaired so we can give service to the newly formalized areas.	I8	
A weekly collection of waste from every house and business I think. They can also come and collect building rubble. RTC and contractors pick up waste.	I9	
Sometimes the trucks are broken and the waste is not collected.	I9	
Mostly it is common that the builders dispose the waste themselves by load it on a truck and dump it at the disposal site.	I9	
The good part is that they know how to manage the waste now. They put things in are plastic bags which are very infectious, in green they put something which are soiled in for example feases and in yellow they put something like the food remains, so at least they classify the waste. There is also one container where they keep everything sharps. Like needles. Those one they cannot really be taking some place to be dumped because it is dangerous. They put it in a machine that burns everything out. An incineration that makes sure that everything melts. Such waste that are not harmful they take somewhere out from Rundu (to disposal site??).	I10	
What they do is they offer people that have most of the equipment. First of you need a truck or something big enough to collect the waste. So if that person or candidate has the truck, they also need other things like 10-15 people that collect the waste. They all need uniforms, and some gloves. They have to get that. They also need helmets. They also need safety boots. At least nothing can penetrate the boost. They of you a tender. They have a lot of people. They have choose a lot of people and different them in different location. An every Monday and Tuesday and Wednesday they collect. There is a lot of people they have given job to do that. They at least offer that jobs. We have twelve people working. For this collecting of waste we have one bigger truck. It goes and can collect the hole so it only needs to dump ones.	I10	
Residential, but we only do the things on our list. The people need to register on the regional council if they want to have their refuse to be removed. They are all put into a list and are charged monthly. I don't think it is whole of Divundu on our list but the hospitals, and schools are all there, the shopings. The lodges we don't have. Mostly residential and the governmental offices and big shops	I11	
The waste is collected house by house and office by office according to our list with an ordinary truck. We have workers riding the truck just jump of and throw on the waste. Then we unload the waste by hand at the dumping site. There is a problem with gloves. But every second month we need to buy another one. We must always buy masks, the smell is terrible.	I11	
Because we are not allowed to drive the waste to Rundu we cannot transport bottles to Rundu were they can be sold.	I11	
Our dumpsite currently is totally in a mess. Plastic is scattered, bottles are exposed and there are no security of the area, so everybody have access to it, even animals. I received a complaint from the local authority. They asked me, what are the plans?	I12	
I can only remember on local woman from Divundu which intending to come up with this project with this waste disposal. She is still in the process to be applied. If she will be accepted she will do the recycling collection of all kinds of waste within the settlements. But it might be difficult for since she is a full time teacher and not	I12	

exposed in that field. She is just someone trying.		
We have these plastic refusal bins.	I12	
It is only this guy who is contracted. He follows a list where to pick up the waste. In the case of those local operators who have the time to put their waste together at one point, the contractor goes and collects at these points. The local people only point some only put in their sites. Some don't even bother.	I12	
Sometimes the contractor has to put the things together when collecting. We noticed the contractor to approach us when the people is not put their waste together.	I12	
The waste collection in Divundu we only do it once a week which is on Wednesday only**.** What happens is that the Regional council lease out a tender and the contractor applies, and the contractor reach the acquirements get the tender. Then he starts now with the collection on a weekly basis. Then the regional council pays to the contractor on the ends of the month.	I13	
We have some areas, especially some residential who does not have any dust bins. Now those ones are very difficult for the contractor to go to the house where there are no dustbins. But hence we have dust bins at the office, but we have a challenge because in Divundu settlement itself we don't have a transport or vehicle to take the dust bin to each and every household and also inform them to throw the waste in the dustbins. We have the dust bins to be supplied but not the means to supply them. It is compulsory that you should have a dustbin and pay at the end of the month for households. But is not expensive, only 11$ per month.	I13	
The lodges collect the waste themselves and dump it at the dumping area, but sometimes they dump anywhere else because the distance is a problem.	I13	
The only thing I want to add is to say to you institution to help us of capacity building, like informing us what are the negative impacts, especially for the regional council so they could put on the strategic plan of the waste management for the Kavango region.	I13	
The settlement committee through the regional council, we have realized that there is a lot of pollution going on in Divundu. At least you have seen this morning there is a dumping site.	I14	
But our challenge is that all waste is being collected. For now it is only lodges and schools and some of the business communities are using the dumping site. But most of the houses is waste not collected. There is no central place in each homestead where to put waste in order to be collected. That's why you see there are a lot of bins here that were supposed to be delivered to the people	I14	
The dustbins I was informed is not for free. If you get one you need to contribute 30 $ /month which include the waste collection. People is still struggling. Some might say it is to expensive, some might say they are not willing. They need to be educated so they are willing to take the bins so they can put their waste there.	I14	
Wastes differ, so we cannot classify waste in one category. We need to separate the waste. Bottles could be recycled and tins or they could be compressed so that the volume becomes small. If we also could supply plastic bags so that bottles could be kept in one bag, the plastics in one bag and the food waste in one bag. We have food waste which could be decompose and disappear,	I14	
The medical centre treats their waste according to the health standard. They put them into categories and don't mix them. The hazardous one they have a place where they burn.	I15	
The town council provides only a transport to the youth group which decided to take over the management over the waste. Actually the council outsourced the function to this youth group to collect the waste while the council provides the transport to the provisional dumping site. At the moment the council does not have a dumping site because of finance implications but we are optimistic that we need urgent a dumping site, a proper one.	I15	
The youth groups get some founds from the town council on monthly bases. It is up to the youth group to see how will participate. The council just makes sure that the waste collection is done.	I15	
The council provides refuse bins to all the houses, residential houses and business	I15	

places included a bulk skipper in business shops. It is compulsory to have the bins. All the built up areas the council charge them for this service a minimal amount for collect the refuse from their premises. It is a must that they must have. Except from the (någonting) townlands. Because they are just their temporarily, they must move. The town is still new, when they get the area planned they must moved to that site so they could get town services.			
The collection is done three times a week. We have outsourced this service to a youth group, just for the purpose of creating employment, but it is in partnership with the council. The council provides machineries and equipments and skippers and then the youthgroup provide the manpower so they do the physical collection. They pick up papers or bottles all around and they empty the plastic bins and put it in the car. Even though we have outsourced it is still a public private partnership with the council.		I16	
Within the town the collection is supposed to be based on cost recover. It is only the area where service is provided. Because the refuse removal have to be cost recovery. If we collect at other sites where there are no proper ….services… we cannot collect any fees.		I16	
They don't have the idée this is a town. But probably the town council has provided the drums, whereby when you are done with you cool drink you can just throw it there		I17	
The council is providing by a tender to the youth. They collect the waste products. The house owner doesn't need to get the waste to the dumping site. Just to keep the youth busy by collecting the waste from houses instead. Normally they are using our council cars. Normally they put on safety clothes and gloves before getting the waste.		I17	
Within town we do collect. Even in open spaces they do collect.		I17	
I don't know about any recycling.		I17	
The disposal site is very far 9 or 10 km. It is expensive with fuel. And by separating bottles it would be very easy to recycle.		I17	
We have sewage. According to the equipment we wash it and sterilization it in a machine. If we have blood bandages we put it a red plastic and burn it. We have a big whole where we put it and burn it there. And when it comes to needles we have a safety box. We put it in the safety box and when it is half full then we put it in a red plastic. We don't have an incinerator here but we do have in the district hospital. It is the same for all clinics in the region.		U18	
We don't pay anything for the incineration since we are in the same ministry. The incineration is done by the government *and* they make sure that the equipment works.		U18	
We are having youth that have volunteer to collect the waste, they work three days a week. The town council car collect.		I19	
The people who volunteer get something but not so much. The person if you having a house cannot afford to survive on that money.		I19	
Some of our youth collect waste here at Kahengi which is part of town. But they don't get anything. The people are unemployed. Starting from 18 to 25 years old. They don't go to school. Some are failing the grades, some are go up to grade twelve but the points are not good.		I19	
We put it in black plastic bags. When they come they just load the black bags and take it to the dumping site.		U20	
We store the bags in a room behind the kitchen.		U20	
We pay about 900 N $ / month. I think it is a reasonable figure.		U20	
We are working differently. Used oil as the one we empty from cars, that oil we have a dem. In our region here they use to come and take the oil out to use it for private "…." For insector killers. They use the oil for gardens and so on.		U22	

Waste characteristics	Interview ID	Relevance quantified
waste is the thing people don't won't to have in his or her environment, our houses. That's include the sewage tank, the disposal of it. Normally associated with litter.	I 1	
For instance waste can be like food items, leftovers which I no longer going to eat it can become waste. Things like you by tins of soft drink, you not going to use the tins, unless you have no use for it, it will become waste. You could have a very old chair, if I am no longer interested and I don't want to keep the chair, there are times when you either can give it to somebody which is interested, If you not give it to somebody you could also throw it away. It becomes waste to you, but the next person who picks it up it is not waste.	I2	
There is a lot of examples it can be paper, plastic it can be materials like containers of bottled things, cans, it can also be industrial waste like body parts for cars, engine parts. It can also include rubble for buildings.	I3	
Different types of waste are lake papers, unfinished food, trees etc.	I6	
Cans, bottles, food remains, perfume containers that are not good for the ozone; you could anything like a broken fridge or television.	I10	
Waste that can be recycled, like plastic things, glass waste, papers. The kitchen at the hostel mostly removes food as leftovers	I11	
We have waste like plastic, the bottles, and other article from the garden and also from the sewage.	I13	
Maybe I would place them in two major categories, we have natural waste and then we have waste coming from the human made activities such as glass, paper, food waste. Mostly of the waste coming from manufacturing, beverages, plastic bags and mostly it is coming from the manufacturing activities.	I14	
We have domestic waste, industrial waste, air pollution.	I15	
Different types of waste it would be difficult for me. The few information of waste I have we have garden waste, chemical waste, medical waste and paper waste I guess.	I16	
it can be urine, it can be left over food or some soiled items.	U18	
Everything unuseful, bottles, tins, plastic and paper for example.	U20	
Waste is a lot of different things.	U21	
Normally deli-food, when they slip one there is already waste. (Margarine?)	U21	
Waste is like old papers, dry leaves, clothes and all old things. Apart from warn and damaged items. The items must be taken to the scrap yard.	U21	
Bottles and cans are very common. I asked myself the other day these people did not get food to eat and get an empty milk package? It is just bottles. In the hostels we get food leftovers. In the residential is very few food. From the residential we often have sand and diapers. The sand is a big problem since it is so heavy. The bins are not so strong so the wheels get broken.	I11	
Blood of course, fluids from human bodies, those which come from toilets.	U18	
Normally what we use to do with waste; we have a storage where we keep the waste and then the town council come and collect twice a week.	U21	
The service is good, 100%. I use to communicate with miss Muyo. I am happy with the service.	U21	

Informal Workers	Interview ID	Relevance quantified
some of the people who are extremely very very poor, they are trying to find their ways to getting access or lay their hands on some of the items that are disposed. In that way people are contracting some deceases that are health hazard related.	I2	
For we actually have some people scavenging the dumping site now and then. Somehow we have in some extent taking care of that problem by fencing of the dumping site and a security personal to control their movement.	I8	
They make holes that they dig. Theese holes are then filled with garden waste and trees that could be composted over time. These holes are then covered. With the bottles and other litter they discard it somewhere else. This type of waste can also be seen on main roads. They don't have access of refuse bins or bigger container where they can dump this waste.	I8	
Sometimes I need to get people from the street looking for job for putting aside or digging a hole to wait for the town council.	I4	
Most people from informal areas they help it to do it themselves. They dig a hole, they put it there and burn it there, and they cover the hole. After two or three months they same again.	I4	
There are values in some of the waste. There are people on the other side that separate the waste. If we would do it would take much longer times and we would need more people. But if the waste is separated in the homes it would be better. As far as I know there are places like behind bars bottles are crashed and put in a big big sack. What they do with that there are certain companies that buy it and take it to recycle it. You get the bottles here and also in the disposal site. Later it would be and truck that would come and pick up the broken bottle and take it for recycle in Windhoek. One place where they break the bottles is behind these shops called fish-market. They are just two big big sacks. This area is circulated by two bars. Those peoples work is to collect the bottles and breaks it. Some of them do it for themselves. When it started it was self-employed, so you talked with the person that picked it up and him pay for his work. I don't know if they have made it officially.	I10	
The people working in the disposal site don't have any equipment and that is a big problem. At least if they could have any equipment.	I10	
Maybee boxes are also collected. Like behind shops, they collect from the shops. When they collect the boxes they kept outside and is burned, no recycling.	I10	
Informal recycle is when other people or companies are coming in and collect bottles on their own, and other waste like iron. But not in big numbers because they are still doing it on their own without the council.	I15	

Other	Interview ID	Relevance quantified
It is a big problem, one is that it is not really considered as a concern to most of the people in the general public one thing also is also it is a problem because a lack of awareness and also the lack of a capacity to be able to manage waste disposal. Also the elements of the education part of it, what impact it can have on people when they live round to waste. And more to it has to do with the authorities not being able to manage waste because of incapacity.	I3	
Maybe the barriers are the insufficient founds at the Kavango regional council that prevents us to have those services. Maybe also the capacity of the people in those areas.	I1	
The barriers would be the financial resources, another is because the absence of policies to guide people. But the biggest one I think is the mindset of the will to	I2	

do it. Those who are in charge need to drive this process. But again for driving a process you need to be competent you need to understand how to drive. The Ministry of environment and tourism need to have people who are trained and have some education in waste management, so that when they drive the process they know exactly what they want and they know exactly how to do it.		
The barriers are quite a lot. There is also a challenge with people being settled with the accepted norms. When you have a system when people are just so comfortable with current status quo. It becomes a hindrance to suggestion and recommendation for improvement. The people tend to accept the current situation. You want to come with suggestions but in times the decision makers just tend not to listen to people on the ground.	I3	
Another thing in the setup of the government there is so much of the region structure based on old laws that does not seem to coup with the current reality. What we have, does it serve with our current needs? We are just sticking to the old updated law regulation.	I3	
Generally it has also to deal with limited resources, but with little resources can coup with the demand.	I3	
I am not sure about what the law itself says. Also the founds maybe. Transport is always a cost. It can be a challenge transportation thing.	I4	
The barriers I believe could result from budgeting aspect. Even if it is a priority from our side we have limited budget to only for collect and remove and take to dumping site. To now develop the byproducts that should be on industries own, whereby investors could take that as a potential business venture.	I5	
Another barrier is limited knowledge. People don't have the skills of turning the waste materials into valuable products. Maybe if private investors come in maybe you to train one or two people and you get the fund for it.	I5	
We don't have the place; the one in Rundu is full. The problem is the money. We are struggling with money.	I7	
It is actually in two parts. One Is capacity building or human reasource. We need a lot of people to be trained to plan and manage these operations. The second being the maintanace of the equipments. Once we have operational equipment bet bets all new equipment if we have people to can really take proper care of this equipment. Then I think we will be …??...to conduct effective operation	I8	
No barriers, just time	I9	
The only thing is now if they have a lot more women than man employed. Because women are high risks because they have to breast feed and so. You have to have a lot of workers, because if you have a few workers and some of they are sick you could not collect the waste. The workers health is a problem. The barrier is people are resisted to change. You could say that the person paying for the dust bin so you could not say to separate different waste. They are resistant to change. They are not seeing that these people are helping you with the waste and you need to help back.	I10	
If the changes start at homes it is easy outside. People don't know about their health. As long as you feeling okay they think they are ok. Where is the smoke from burning waste heading, it could come to a problem having problem with their health.	I10	
If they would rent us to clean the whole town the people would see that the town is clean. Then they would not throw so much. Now there is always waste, people just continue throwing waste in the streets. The dumping site is actually in town. The main problem is actually inside. Everybody should be involved in cleaning of the town. Making compulsory would also be good so everyone could take responsibility. Because of the unemployment it would be a problem for them with payment and so on.	I11	
The barriers for improvement will be a lack of resources. These things we are planning to do only if we would have assistance from somewhere, somehow it is possible to realize. We should try to ask for finance everywhere where it is possible. If the road to the dump site is to be maintained which is necessary. The current road stops some private people from reaching the dump site and offload the waste along the road. You are required to have a 4x4. We just need a gravel	I12	

road.		
We may initiate these good ideas we are talking about, but at the end the dumping site is nearly already in the vicinity where the town is intended to grow, so we might end up with no site.	I12	
But the main thing is the resources. The Regional council did not receive enough founds for the budget.	I12	
The barrier we have no is the budget. I remember we put a request to buy the fence, which is 800m but it was not budgetated for. Now at the truck for the regional can't afford. The other barrier we also have is the capacity building. Our people are not capacitated on what are the negative effects of the waste, and also the management at the regional council needs to be capacitated on what is the positive impacts and what are the negative impacts on the waste. Through that when it comes to budgeting they could make a provision one day for budget for a truck or a fence.	I13	
The other challenge is also our business communities. They are doing business but in the same you should not pose danger to the people you are serving. They must also see a way of how do they participate in waste management. For example I rather have a shop encouraging my plans to have carry bags that you reuse. Because the plastics just becoming a danger. The shops must also think of the community itself. If you have a community where pollution is a health hazard your business would not prosper.	I14	
The country the revolution manufacturing, rules and policies that regulate manufacturing. Some of the waste could be stopped right at the manufactory rather than reaching. Which material do we use for packaging etc. I have seen in some countries they sell less bottles and more tins. Then you have limited types of waste with a program how to recycle it, rather than having the variety and in the end you don't have the capacity to recycle them.	I14	
Another one is regulations. In a settlement we must regulate that if you throw something you would be fined. If you would be fined you would be afraid of throwing things away.	I14	
The barriers for the improvement of proper waste management are funding. Funding is a problem since this is a newly established town. Also it emanate from communal land to move from rural to a town. It is a bit difficult because the income will not be that big, because most of the people are unemployed, and also culture place a role. Now we are trying the people from that concept from being from rural to a town. Now we need to start telling them to adapt to the town norms. Which mean funding is one of the struggle apart from the social issues. Then we could realize proper waste management.	I15	
The barriers are number one knowledge and information. Number two is the economy, the living standard of the people. You might have a plan to set up even a recyclingplant but now there are costs involved.	I16	
The problem is the financing. It is the thing keeping us still behind. That idée have already been brought up but the finance can just not allow us.	I17	
Central government need to come in. The way we manage our waste should be done perhaps as in the city Windhoek were they have proper machines, proper structures and proper systems to do waste management. In most towns of Namibia, they do not even have a structure or people who are qualified and have studied waste management. Waste management is just seen as a extra responsibility, it is not a dedicated function.	I2	
The second one is perhaps to benchmark with the developed countries to see how they are doing it to see what are the thing we are not doing right and then those things can become the areas for our improvements.	I2	
Another area I have said, even though we have not proper system in place, in the meantime we are doing these responsibilities, people must receive training so that we can within our limited resources and capacity we can improve that.	I2	
Maybe also policies and laws which can help us with littering. Because at this stage people can just throw a can without concerning about the consequence. Besides of the law, mobilizing people, educating is very important and we are not doing that.	I2	

First of all it has to start with empowering people in terms of awareness, capacity building. Because I always tend to think that if you could not tell the people to understand the harm or the danger of doing things one would be regard it as normal.	I3	
It has to do with a lot of awareness rising, education in order to inform people. How they can be able to understand the problem. In addition to that it has to be passed on to the next level which would be what to do with it, how to coup with the waste management? Because understanding would then facilitate the process of managing the waste.	I3	
Secondly it would also have to do with how to inform town council or the local authorities and the regional council how to sort and manage it. In terms of waste that can be recycled and waste that must be disposed in certain ways and waste that totally take away from the surroundings. That is key.	I3	
It also has to do with the empowerment how to build the capacity of the local authorities in terms of trying to make studies, what best would be needed. First to understand the magnitude. The local authorities need to understand how big the problem is. Then certain recommendations can be made as to where to excess capital and things like that in order to deal with the problem. If all just looks at it as a problem and there is nothing one can do then it will just be there.	I3	
The procurement section does not have an independent fleet. I need to turn to other sections to get transport. It is some of the things that really I would say gaps in the systems.	I3	
Maybe that town council gives authority to the community like the way they are fighting crimes. Mostly you fight a group of crime in the community. Maybe collection of bins in certain areas, maybe 4 or 5 youth that could do that.	I4	
Think about those people themselves what they have to do. They have to find funds for maybe helping those people. Voluntary they can do that part time, maybe students.	I4	
I believe for KRC the twinning agreement with Vetlanda, is one of the areas we look in to. We look in terms on the waste management technologies from the expertise. Even during my visit in Sweden we saw there is an opportunity in waste management and we would like to see if we could develop that part. And maybe leverage on the technology and platforms it is possible for people to those areas. The opportunities in those areas could be exploiting. The KRC and RTC have indicated very high interest in getting more technologies and knowledge in waste management.	I5	
As well as we should have enough transport and more employees that could do their job we would not have any problem and we could collect at least once a week.	I6	
We should just at least give information on our people in town how to use things, they should be a recycle bin and start recycle things, and they should know more about the environment and educate them. Some of them just know about the effects, they just throw things away.	I6	
If we had a lot of transports it would be better. If we would have a lot of transports its better.	I7	
We need some signs in Rundu. The sign is better to show the people that this is not a dumping area, you cannot dump here. An also to put some fine, when something is dumped illegal you get some fine. The fine could be paid to the town council. Also we need training and we should also communicate to other municipalities to share some ideas.	I7	
If the RTC could reach them halfway hopefully we could in the near future a compactor truck. We have a lot of old veichels. The idé is to auction them and with the revenue secure a shipment of a compactor truck that can step in and improve the operations.	I8	
More staff and more equipment.	I9	
In some city the use the big trucks that pick up the bin and empty it itself, but I would not recommend that because then we wouldn't have any job. They are giving the tenders to local contractors which creates job. The settlements are very very dirty. Before we started it was even worse. I tried to pick up bottles from the	I11	

shops. But it is still a big problem. The road to the dumping site needs to be better. A gravel road is enough. The dumping site is also a problem, they made it wrong. The put all sand they dug up so it is hard to get in. The disposal site at diona is squared and better. I was there when they prepared it and told them what to do. We had problem with tire cutting. With the new disposal it is better. The disposal site needs to be controlled better, with fence and so on. We get a lot of dead things in the drums, for example snakes. Once we got a living snake. The lack of knowledge is also a problem. Once we delivered letters warning them that they would be fined if they messed up the town, however the letter did not do any good.		
The way I think it should be improved are a bit by bit. We need to insure that the dump site it secured.	I12	
The only thing I want to add is to say to you institution to help us of capacity building, like informing us what are the negative impacts, especially for the regional council so they could put on the strategic plan of the waste management for the Kavango region.	I13	
If the ministry of the local and regional government would be informed they could also push the regions when it comes to the waste management.	I13	
To improve I think priority number one is I think we need to have community meetings to educate our community about waste management. We can do it in schools, we can do it in communities hand in hand with the traditional authorities so people exactly know what do we mean by waste management. The people can hear us talking about it but they must know what they should do.	I14	
Secondly it is also important that everyone, we must make every community member to be part of waste management. Because one way or the other everybody holds waste in their hands on a daily basis.	I14	
I remember when I was at school littering was prohibited. If you were caught you were fired. So up to now when I eat sweets for examples I put the waste in my pockets. I am used. Even if you go to my car you could find tins, everything I consume I keep it and don't throw it away. You must put it in the right place. In order for them to know, especially for them to know what is the danger, then they would start realizing something needs to be done.	I14	
We want to see to it to that the management of waste in Nkurenkuru complies with the general standard of the country and also international.	I15	
In my own opinion it would be good if we could have an identification of separation of these waste products. Things that can be recycled it would save us more. Those things that we cannot recycle we could dispose. If we could recycle we could create employments and so on. In the same time we create a healthy environment. There is no recycling right now, not informal either.	I16	
In the future we could continue what we do with our youth but at our regional council we are asking for doing something for the youth collecting without getting something. It would be good if the youth could get more money, maybe to buy at the shop. Perhaps some could continue with further study. Some want to go to Namco but they don't have the money to go to Namco.	I19	
If the people were absolutely organized so I don't have to phone.	U20	
They should have a schuedle. This is Omashare on Monday, and them some other companies and then on Fridat it is Omashare again.	U20	
If they have a brakedown they must have a standby. Even if it is only a small bukky which could get rid of most of the waste. This has miss Muyo organized for us in the past. She is pretty good.	U20	
I don't know how to improve the waste management.	U22	
Sometimes people from the town council come late to pick up.	U22	
Normally waste can be a problem to Kavango region, in the sense that if the waste is not properly managed. One is that visitors that would come would not like to stay or in the environment not hygiene	I1	
If not properly managed it would definitely pollute the environment.	I1	
It could lead to polluting the environment and soils. It could affect the children playing in the environment. It could also cause a lot of health hazard. Because	I3	

sometimes they have only one mean people have to burn. There is a lot of toxic in the material disposed. When you burn the gases, the fume of that kind of burning it can also affect people when inhaling the gas.		
It never reaches the right people who are in need. It can also cause health problem. Sometimes we throw the waste, but in the end kids or poor people they take it and use it which might be dangerous.	I4	
It is just thrown there, in the environment which is not good for the animals who just come and eat it. Or the place might end up being dead.	I4	
There is money involved, somebody maybe work hard at getting that and at the end it might up being waste.	I4	
For Kavango region the waste could become a problem is the waste is not management, especially pollution. Waste effect pollution as well. It might affect different hygienic conditions or the environment, including our useful resources as the river. If the waste is not management it ends up in the river. People can be affected or pick up diseases from that. People can pick up diseases if the environment is not clean.	I5	
Waste is a problem because it is very harmful; it can cause injuries on kids. It can contain mosquitoes and spread malaria. Many diseases is surrounded there.	I6	
There also air pollution, water pollution.	I6	
Currently Rundu have a big challenge to manage waste. The technical services are quite determined to see to it that the services are conducted effectively. But we have shortcomings and massive challenges to overcome. These come from a lack of resources and a lack of capacity within our structure at the department. We actually have our people doing the administrating as well as general worker. As you can see the planning of these operations require at least someone that conduct effective administrative task. Then in our case we only have two people to do that. Considering the town with a size of Rundu it is a quite massive task. You have one heading the division and one to supervise the operations. There have been some considerable efforts to expand this structure and fill as many vacancies as possible.	I8	
On another front you also need proper facilities. In our case it comes in the shape of equipment and safe fleet. In our case we have very old equipment. It breaks frequently, is not reliable and most of the equipment have been inherited. The maintenance cost is very excessive. You have a lot of things to deal with, in the end of the day the reasources I simply not big enough.	I8	
Unfortunately for the limited resources and that is the best we can do right now. That does not mean we stop looking for effective solutions. We are trying with the few staff we have, but we are still handicapped with the finances and we can only take small steps every time. Hopefully in the future the ministry of local and regional government, I feel that they are also making major strides to assist local authorities. I hope that they give us some sort of a motivation that we somehow can conduct effective operation in the near future.	I8	
But overall we have so many newly formalized areas; I think there are five in total. The access to these areas is quite limited. In terms of roads infrastructure the roads is not that proper. Improper meaning that they are to sandy. You could not simply go with any time of vehicle. If you don't have a four-wheel driven vehicle you cannot access these areas. And this is now where the biggest population resides in the city. If we cannot attend or address the refuse removal in these areas we have a serious impact on the environment. In terms of sanitation you could already imagine what tragic possibilities may arise. For now I believe our resident also tries on their part.	I8	
Solid waste ends up in the river. When there is rain season it is pushed out in the water.	I9	
In Rundu it does not affect the public health very much	I9	
It is a problem when it becomes too much and is not taken care. This can lead, because we are close to the river side, to too much mosquitoes. A lot of people would encounter a lot of problem like malaria diseases. It can pollute the environment leading to an unhiengenic environment, so it is not really good for health.	I10	

I am seeing it as a health risk. Apart from the waste which is not properly managed at the dump site, you have this item came from the hospital. They are not incinerated and dumped there. They are some dangerous waste which should not be thrown.	I12	
This waste in a dumpsite is eaten by our cattle. And the cattle is the same to be slaughter and sold. So you could see that any infection could be taken through that way.	I12	
The environment itself we could also see problem in the local vicinity. Disposing refuse just being scattered throughout the settlement. I see it as a hazard because if you talk about malaria we need to maintain the environment clean. In our case we leave it close to the river. We use the swamps as a dump site which invites the mosquitoes to breed in those swamps.	I12	
We are not using purified water, so the water we use is pumped directly from the river. It is a problem for now. NAMWATER is working with that now, they will construct a plant. It is a problem If waste end up in the water. We got a report from one of our hospital. They have a sewerage system which is leaking to the river. They are working on that but that is a well known fact.	I12	
We are not using purified water, so the water we use is pumped directly from the river. It is a problem for now. NAMWATER is working with that now, they will construct a plant. It is a problem If waste end up in the water. We got a report from one of our hospital. They have a sewerage system which is leaking to the river. They are working on that but that is a well known fact.	I12	
Divundu we have a problem when it comes to the rain season. We don't have the toilets so the people use the bushes as a toilet. When it comes to the rain season the rain water wash it to the river and the people drink from the river, that's the problem we have.	I13	
The plastic and bottles is also problems. Plastics our children, if they find something like bread in the plastic which have been thrown out they just take that one and eat. And the animals also eat the plastic which sometimes cause a problem. When it comes to bottles sometime when the children plays there they injure themselves. At the end they needs to be hospitalized and the children cannot go back to school again.	I13	
Here in the Divundu we don't have any environmental impact. The only problem is the plastic. When visitors come they see now plastic scattered everywhere which is not a good image when it comes to tourists.	I13	
We have now an economical impact if the tourist does not come and invest here, they just pass through where there is a clean area.	I13	
In the long run I think it is going to have a negative impact to human s and animals. Even the river may be polluted. The diversity of the river and ecology could be affected.	I14	
Public health for example. Say that we have a lot of waste and we have rain and the waste flowing down with the rain water to the river and mostly the people in this are depending on river water for drinking and cooking. Once it is spoiled it definitely becomes a health hazard. And other animals, I have seen cattle, goats consuming plastics. This now is dangerous to animals. Mostly it is also a hazard for the young ones. Because mostly wherever waste is kept together the kids want to play around. Some of them might be injured from broken bottles. Some of them might find waste food and consume it which is too dangerous for them. I mean waste can definitely cause a dangerous hazard for the community and environment.	I14	
Economical impact one is maybe no one wants to work in a polluted environment. We try to convince investors to invest in our area but then if Divundu pollution is such high the investors would not be able to come and invest, because investors need a clean environment to operate in. From their side it is one of their conditions. They would like to operate in clean environment. Also tourists. People who are coming to Namibia for example. In the process it could lead to an economical viability of the area itself.	I14	
Waste is a problem for the community in terms of health, and also the environment. Like if waste is not managed properly the town will not appear good and cause a health hazard for the community and also the animals. Also it is	I15	

not good for visitors and tourist passing the town will not happy because their health will be at stake		
Economically it also impacts the economy of the town and the region, simply if not managed properly the investors would not like to invest in such a town. Clean environment attract investors which would improve the local economy.	I15	
The environmental impact, currently it is now difficult for do in the assessment, some of us think we need research and so on. From a theoretical perspective it is important that a proper dumping site needs to be put in place. We do not know any immediate knowledge what impact the waste might have. Even without that immediate knowledge it is good to do it in a proper way. My personal view particulary from the environmental impact is: number one the site where we dispose the waste might have impact in groundwater and so on. That is way the identification of the dumping site needs to be done in a proper way. The disposal method must also be environmental friendly. What we currently do is to take the waste to the dumping site we put it on fire. When we burn it there is some implications. Some of the waste might not burn. And it can have implication on the surrounding environmental.	I16	
For the public health it could be that kids can have access to the dumping site, as a result there is a health risk already. People who are herding cattle might also be tempted to spend some time there and look for things and be infected and so on. Even the animals can go on the site trying to eat things and some might be affected. When the animals are slaughtered it would pass on to the consumers.	I16	
The economical impact it is linked to the health issue. If people are affected throw the waste management and there health condition could be affected it would translate into productivity even at home or at work. The immediate economical implication is that the waste must be managed properly so the health risk could be avoided.	I16	
Normally it is a problem especially here in town the people still have the village manors they are not used to how a town should be. They are just throwing anything which is dirtyfying the town. And then they would not see it as a problem. They would just throw everything in the areas which is not good for the view of the town.	I17	
The environmental impact, it really can destroy the environmental. The challenge of the impression. If you can see the town is very dirty and the impression you can see it looks not very nice. And even especially like the bottles it want even look nice to get all over the place is full of the waste products.	I17	
The waste products are all over, and the health is in danger. Especially in the summertime we have a lot of rain. The mosquitoes spread diseases; the mosquitoes would just spread malaria due to the waste products which is all over. Whereby go and get it and spread it to the people in town. Therefore it is good if we place it very far from the town.	I17	
The waste is a problem because is not supposed to be where the people are, it is supposed to be far so it could not harm the people. The waste for example blood there is bacteria there which can harm people. It need proper handling so it can not cause diseases.	U18	
It is a problem with people, if people throwing the waste, throw the shops, if the people come and visit the places, they see this town is very dirty.	I19	
If the damage something like threes they damage the environmental.	I19	
Public health, if the people burning something, in the air it affects people.	I19	
Waste to me is any items or goods that will no longer be used by a particular person, but it could be useable to the next person. When one is on the opinion that you no longer need the particular item and you don't want it anymore and you want to dispose it it qualifies as waste.	I2	
My own understanding of waste is sometime for the community itself it might be the waste for food items they donate, maybe the food is not properly stored it end up as waste. Maybe rats or rain can make the food to waste.	I4	
To use waste is now the materials you get after you have used that articles, materials or products. Usually it comes in the form of containers, things like plastic containers.	I5	

Waste is something like unwanted things that is thrown either by house or anyway.	I6	
We are doing these bottles, but we don't have recycling machines.	I7	
It is too high, we have a lot of illegal dumping. If you go down by the river you can find a lot of illegal dumping. Actually we don't give them any fine, it is better if we give them some fines. It is a problem; it is no program that if you dump illegal you are judged.	I7	
In my opinion waste would be anything. That is a product which has been used and is in no relevance in terms of usage. Actually it has an undesired affect of environment in terms of discarding. Waste is unwanted for the general public, which need to be contained to avoid diseases.	I8	
The result of a product not needed anymore. Mostly solid waste, metal waste	I9	
Waste is something that is used and not needed now. Its need to be taken somewhere else or just disposed. Waste is something that is not really needed around.	I10	
Waste is the things you don't use anymore, rubbish.	I11	
I regard it as anything sort of disposal that is not taking in a proper manner. Be it the littering taking place in our settlement. Be it the sewage system It can also be linked to waste. Any kind of refuse or disposal that is just not maintained in a proper way I will regard it as waste.	I12	
It is the first time I have been given the opportunity of giving my opinion. We never give that opportunity. The communities itself are very import to include.	I4	
Prevention is better than cure; we still have a chance in Kavango.	I4	
Yeah of course that is other ones, broken bottles around town for example. That for me is highly hazardous. Maybe to those villages nearby town the animals could eat the waste and it s effect their systems. Sometimes people wants to use the river to wash the cars. That may also be hazardous polluting the river	I5	
It is also a big problem provided that we only have two people in the division. The head of the division delegate the monitoring of the contractors as well as our own operation. When I refer to our own operation I mean I our team composed of general workor that accompany our own trucks. It is quite challenge for one person. But we do manage, however in difficult circumstances from time to time.	I8	
The town council doesn't have any four wheel drive trucks, so we have to compromise, by opening a few roads depending on the availability of founds. For now we our making process. We have allocated a quite significant amount of money with the curtsey of the inland ministry. They have allocated an amount of which we have taking a large portion to survey roads in newly formalized areas. So in the future we will have at least adequate access to assign more contractors to these areas. We could also use larger container to provide service for more household.	I8	
I think we could seriously get assistant that can also help us in the planning of the dumping site as we really don't have expertise in the structure right now. If we could also get short workshops, maybe to visit nearby town councils or municipalities. I think that could also help us to plan the dumping site properly. I believe the expertise will do a lot of justice in our case, as the capacity building is the biggest problem we experience right now.	I8	
I have seen like in the school where I am. The sewerage system was not working properly. The human waste was flowing to the river direction. We had to run down and rescue the river. And I have also seen people who are consuming bottles they throw the broken bottles, especially on the tire roads. This is dangerous to the road users, it might cause accidents.	I14	
. The people do not have the understanding, they need education. When Divundu is waste free we can say we have done our homework, but there is a lot that needs to be done.	I14	
but bottles don't disappear. It will remain in the environment for millions and millions of years and I don't know if anything will happen to it. But we need to educate people	I14	
Just a bit of not understanding the way of a town. The council soon will use their	I17	

power. Once you have been seen throwing something the fine would be distribution to the person. Maybe they will get the idée that if they throw something they get a fine and should use the drum instead. Still there are not yet any fines.		
Some are uneducated, so they not get employed. Some don't have higher grades. Some are out of school grade 8 9 or 10 perhaps. It is difficult for them to get jobs. (Fick inte svar på frågan!!)	I19	
If food goes rotten, they don't remove it in time, it can be pretty dangerous. Flies brings it in, you can't prevent the flies how hard you try and it can spread.	U20	

Appendix B: Household surveys, Willingness to pay

The household survey was filled in by people participating in the waste charactarization study. Most of the questions were necessary for the waste characterization, however a willingness to pay assessment were also made. The following question were included.

House ID: RF ( ), RI ( ), RUR ( ) Number_____ Adress /description:
_____
_____

People living in house?: Children_____ Adults_____

How do you get rid of waste today? Individual collection ( ), Communal collection ( ), Informal collection ( ), Own dumping ( ), Other ( )

Do you pay someone for that? Yes, how much? _____ No ( )

How much would you be willing to pay per month for someone to take care of the waste for you?
_____

Willingness to pay household in Informal areas.

ID-tag	Size of household	How much would you be willing to pay per month for someone to take care of the waste for you?
RI 1	6	50
RI 2	11	0
RI 3	16	500
RI 4	7	125
RI 5	7	0
RI 6	18	450
RI 7	11	300
RI 8	4	200
RI 9	5	300
RI 10	6	0
RI 11	6	200
RI 12		
RI 13	3	500
RI 14	15	50
RI 15	23	0
RI 16	10	300
RI 17	8	200
RI 18	9	400
RI 19	2	50
RI 20	4	200

Average values	**9**	**201**
	Standard deviation	155,8960276

Willingness to pay, household in Formal areas.

ID-tag	Size of household	How much do you pay for solid waste services?	How much would you be willing to pay per month for someone to take care of the waste for you?
RF 1	2	0	300
RF 2	6	0	0
RF 3	4	0	50
RF 4	1	0	0
RF 5	1	45	
RF 6	2	45	
RF 7	1	0	0
RF 8	4	0	0
RF 9	4	45	
RF 10	3	0	15
RF 11	6	40	
RF 12		45	100
RF 13	5	40	
RF 14	7	40	
RF 15		0	0
RF 16	2	40	
RF 17	4	45	
RF 18	7	30	300
RF 19	7	0	450
RF 20	6	0	50
Average values	**4**	**42**	**105**
		Standard deviation	**179,73359**

Appendix C: Waste characterization study

The waste characterization study aims for two different resutls, composisition of waste and waste generation rates.

The composition of waste have been calculated according to the following equation:

$$C_x = \frac{W_x}{W_t} * 100$$

C= composition of the material x in percent.
W_x = The total weight of the collected material x
Wt = The total weight of all collected waste

The waste genereation rate were calculated for each household. To calculate the waste genaration rate the following equation were used:

$$Waste\ generation\ rate = \frac{W_H}{P * D}$$

Waste generation rate = amount of waste generated per person and day in an household
W_H = Total amount of sorted waste from one household
P = number of people living in the housheold
D = number of waste generated days for the sample

The result of the waste characterization study can be seen in the table below

	id	Organic	Paper	Plastic	Glass	Metall	Hazardous	People	Days	Generation rate (kg/p/d)
RI	3	4,25	4,35	5,35	5,25	1,55	0,2	16	7	0,3026
RI	4	0	0,05	0,25	0	0,1	0,1	7	8	0,0089
RI	5	0,3	0,4	0,15	0	0	0,05	7	8	0,0321
RI	6	8,55	0,3	0,4	1,55	0,4	0	18	2	0,3125
RI	7	0,4	0,4	1,05	0,7	0,2	0	13	7	0,0324
RI	10	0,85	0,3	0,2	0	0,3	0,45	6	7	0,05
RI	14	0,15	0,35	0,3	0,5	1	0,05	15	7	0,0238
RI	15	1,45	0,65	1,2	0,4	4,1	0,3	22	8	0,0875
RI	18	0,15	0,05	0,05	0,7	0	0,1	9	5	0,0311
RI	20	0	0,05	0,35	0,45	0,8	0	4	7	0,0714
TOT RI		**16,1**	**6,9**	**9,3**	**9,55**	**8,45**	**1,25**	**117**		**0,0952**
Procent		**0,22**	**0,09**	**0,13**	**0,13**	**0,11**	**0,017**			
RF	1	0,45	0,65	0,2	0	0,3	0	2	7	0,1142
RF	10	0,1	0,15	0,25	0,15	0,2	0	3	7	0,0404
RF	11	1,2	0	0,1	0	0,1	0	5	9	0,0311
RF	12	2,1	0,2	0,3	0	0,1	0	1	9	0,3222
RF	14	0,15	0,6	0,6	0,35	0,05	0	7	3	0,0833

RF	18	0	1,15	0	0,4	0,5	0	7	8	0,0401
TOT RF		**4**	**2,75**	**1,45**	**0,9**	**1,25**	**0**	**25**		**0,1052**
Procent		**0,37**	**0,25**	**0,13**	**0,083**	**0,12**	**0**			
RUR	1	3,6	1,55	1,9	1,9	1,85	0	8	7	0,1928
RUR	3	3,1	0,55	3,1	1,75	0,65	0	3	7	0,4357
RUR	6	0,3	0,4	1,4	1,2	2,4	0	10	7	0,0814
RUR	7	0	0,55	0,4	0	0,6	0	8	7	0,0276
RUR	9	1,4	0,4	0,6	0	0,2	0	3	7	0,1428
RUR	12	0,7	0,5	0,7	0,4	0,5	0	15	7	0,0267
RUR	13	0	0,2	0,3	0	0,1	0,2	4	7	0,0321
TOT RUR		**10,8**	**4,15**	**8,4**	**5,25**	**6,3**	**0,2**	**51**		**0,1341**
Procent		**0,32**	**0,12**	**0,25**	**0,15**	**0,19**	**0,01**			

Appendix D: Field observation

Time	Place	Summary	Category
28-aug	Technical office Rundu	Oilbarrels are repainted in blue and white and placed along different roads at Rundu. They are emptied and collected daily by contractors.	waste collection, disposal and treatment
28-aug	Technical office Rundu	A supply of 120 l plastics waste containers. They are placed by contractors in diiferent places in town. The technical office should have a register of them.	waste collection, disposal and treatment
28-aug	Along the roads	Many dumping sites can be spotted along the roads, specially in the informal areas. Needs to be investigated and controlled.	waste collection, disposal and treatment
28-aug	Near SWAPO House Rundu	A group of people sits near several large white plastic bags. They seems to collect or have collecting mixed waste in the plastic bags. The plastic bags where rented from a company.	waste collection, disposal and treatment
28-aug	Rundu Waste disposal Site	Outside the disposal site are large areas of open dumping, the waste smokes from uncontrolled incineration.	waste collection, disposal and treatment
28-aug	Rundu Waste disposal Site	The disposal sites are fenced, but the guard is not present. Everyone can enter the disposal site. The disposal site have one machine to deal with the waste, however it is broken.	waste collection, disposal and treatment
28-aug	Rundu Waste disposal Site	The waste at the disposal site mostly compiles of packaging. Papper, glass, metall etc. Very few organic wast can be seen.	waste characteristics
28-aug	Rundu Waste disposal Site	At the disposal site several womens (10-20) are collecting glass and metall into plastic bags with different colors. The womens are not alowed to bring children and most sign when they enter the area. It is unclear who buy the waste.	informal workers
29-aug	Outskirts of Rundu	Relativly large open dumping site along the road. Two conteiners with RTC (Rundu town council) marked on the side stands at the dumping sites. They are full. A lot of incineration at the site.	waste collection, disposal and treatment
29-aug	Outskirts of Rundu	At a large open dumping site two women sort out tin cans and other packaging in to black plastic bags. A children without shoes came with a 120l plastic container with waste from nearby informal area.	informal workers
30-aug	Nkurenkuru	Around houses there often plastic waste (bags etc) however very little else waste	waste characteristics
30-aug	Nkurenkuru dumping site	Nkurenkuru has a temporary dumping site. The waste are stacked up prety nicely in a pile. Much of the waste seems to be glass bottles. NTC pays the transport of waste from the town to the dumping site.	waste collection, disposal and treatment
06-sep	Outside SAREP office	Large pile of gardening wate. Some plastic and paper aswell. Size of a smal "majbrasa". Have been present during a couples of weeks	waste collection, disposal and treatment
10-sep	Greenhouse guesthouse	A wagon with no wheels is used as a waste depo. When the wagon is full wheels are put on and the wagon is emptied somewhere.	waste collection, disposal and treatment
10-sep	Greenhouse guesthouse	Contractors emptying the communal collection barrels (Keep Rundu clean). A small truck were used. ~ 5 people worked on the truck. The barrells were turned upside down and the waste was put on a fabric beneeth the barrel. The fabric was then lifted up on the truck by hand. Same piece of fabric for all barrells. Heavy lifting!	waste collection, disposal and treatment

15-sep	Road from Rundu Beach	Dumping sites of waste, many boxes. Regular dumping since different piles of dumping were found.	waste collection, disposal and treatment
15-sep	General visit Rundu Beach	Visit a Saturday evening. Many people. There are some waste bins, but the need for more exist. Waste existed scattered over the area, in trees and so on. During festive seasone there are very many people which generate even more waste.	Waste generation
17-sep	Road bend, next to kavango river lodge	Dumping site with various waste. One tractor wheel. The day before a herd of cows were in the very same spot.	waste collection, disposal and treatment
18-sep	Divundu	Open dumping next to houses. Two goats were walking around and probebly also eating waste.	waste collection, disposal and treatment
18-sep	Divundu dumping site.	The road to the dumping site was 4 km with sand from the main road. Several times new routs were needed to go around trees cut down. A lot of waste just at the entry of the dumping side, former contractor used to dump there. At the digged hole a lot of burned can and bottles (metall and glass) Around the hole were some plastic bags scattered in trees.	waste collection, disposal and treatment
18-sep	Divundu dumping site.	Two kids ran away when we came. Boys between 4 and 10 years old. Playing, och try to find food, valueble waste?	informal workers
21-sep	Backstreet of Rundu	Just behing the shops at the main street there were a sign said "No dumping" from RTC. However the are were filled with boxes and plastics	waste collection, disposal and treatment
21-sep	Behind Sarep office	In a large are wihtout houses signs of frequent burning existed. The paths in area lead to an dumping site behind the big the sarep office and shops. Possible that this are were used as a frequently site for burning waste.	waste collection, disposal and treatment
22-sep	Streets of kehem	In the streets of kehem open dumping and burning of waste during the evening. The waste was dumped just outside the houses. Dogs and other animals was looking for something to eat in the waste pile.	waste collection, disposal and treatment
26-sep	Village at Vundu-Vundu	Village participating in waste characterization. The village located close to the vundu-vundu irrigation farm. The peope living there cultivated mahonga, which is their main source of food. Only a few people had an income, most of them from the irrigation projects. The normal waste management consited of a mix between digging hole which were filled and covered, open dumping and burning and just open dumping around the area. No communal management.	other
08-okt	Omashare river lodge	The waste is stored in a sall room at the backyard, The room is about 2x4x2,5 m. Over the weekend about 2/3 of the room is full. Th ewaste is stored in black plastics or freely (cardboards)	waste collection, disposal and treatment
10-okt	Shoprite	The distributers have agreements with the supermarkets which allow the supermarkets to return unselled goods. The distributors come and collect things when needed. Things which are normally collected as waste are packages and some items which distributors not collect. There are problems with power loss. Frozen values (eg. chicken) gets rotten and has to be thrown away.	waste generation

Appendix E: Statistical analyses of waste generation rates

In this appendix the details of the statistical analysis of factors for waste generation rates are presented.

In the report *What a waste* published by the World Bank in March 2012 waste data for a high number of cities and countries have been compiled in a much more complete way than in any previously sources. The report thereby offers a brand new opportunity to statistical analyses of waste generation data. The report however recommends a certain amount of precaution when using the data since the data quality in some cases can be low due to inconsistencies in definitions, data collection methodologies, and completeness. (The World Bank, 2012). Some information on waste generation data in the report can be found below.

	Waste generation	**Waste collection**	**Waste disposal**	**Composition**
Number of countries with data	164	95	89	109
Type of data source	National ministries, Scientific journals, International organisation reports	Scientific journals, International organisation reports	National ministries, Scientific journals, International organisation reports	National ministries, Scientific journals, International organisation reports
Year of data	1994-2008	1996-2007	1996-2007	1994-2008

Several factors which try to explain the waste generation rates, have been found in literature. The factors itself are in most cases subjective and cannot be used as a statistical tool. However for some factors, indicators have been identified.

Factor	**Indicator**	**Source**
Living standard	Human development index	UNDP 2011
Natural resources	N/A	
Income level	GNI per capita	World bank 2012
Public habits	N/A	
Industrialisation	% of GNI from Industry	CIA 2012 a
Local climate	N/A	
Urbanisation	% of people living in urban areas	CIA 2012 b

The amount of available data differs for each indicator. The total number of countries with data for the waste generation rate as well as for all of the four factors is 132.

Land	Income level	Waste gen [kg/cap/day]	Gin per cap [US dollar]	HDI	Urbanization [% of pop.]	Industry (% of GNI)
Brunei	High income: nonOECD	0,87	31800	0,84	76	67
Croatia	High income: nonOECD	0,29	13850	0,80	58	26
Cyprus	High income: nonOECD	2,07	29450	0,84	70	17
Kuwait	High income: nonOECD	5,72	48910	0,76	98	47
Oman	High income: nonOECD	0,70	19260	0,71	73	50
Qatar	High income: nonOECD	1,33	80440	0,83	96	73
Saudi Arabia	High income: nonOECD	1,30	17820	0,46	82	69
The Bahamas	High income: nonOECD	3,25	21960	0,73	84	7
United Arab Emirates	High income: nonOECD	1,66	40760	0,73	84	54
Australia	High income: OECD	2,23	46200	0,93	89	25
Austria	High income: OECD	2,40	48300	0,89	68	29
Belgium	High income: OECD	1,33	46160	0,89	97	22
Canada	High income: OECD	2,33	45560	0,91	81	27
Czech Republic	High income: OECD	1,10	18520	0,86	74	38
Denmark	High income: OECD	2,34	60390	0,89	87	19
Estonia	High income: OECD	1,47	15200	0,83	69	29
Finland	High income: OECD	2,13	48420	0,88	85	29
France	High income: OECD	1,92	42420	0,88	85	19
Germany	High income: OECD	2,11	43980	0,91	74	29
Greece	High income: OECD	2,00	25030	0,86	61	18
Hungary	High income: OECD	1,92	12730	0,82	68	31
Iceland	High income: OECD	1,56	35020	0,90	93	25
Ireland	High income: OECD	3,58	38580	0,91	62	29
Israel	High income: OECD	2,12	28930	0,89	92	31
Italy	High income: OECD	2,23	35330	0,87	68	25
Japan	High income: OECD	1,71	45180	0,90	67	27
Luxembourg	High income: OECD	2,31	78130	0,87	85	14

Netherlands	High income: OECD	2,12	49730	0,91	83	24
New Zealand	High income: OECD	3,68	29350	0,91	86	25
Norway	High income: OECD	2,80	88890	0,94	79	40
Poland	High income: OECD	0,88	12480	0,81	61	34
Portugal	High income: OECD	2,21	21250	0,81	61	23
Slovakia	High income: OECD	1,37	16070	0,88	55	36
Slovenia	High income: OECD	1,21	23610	0,51	50	7
South Korea	High income: OECD	1,24	20870	0,90	83	39
Spain	High income: OECD	2,13	30990	0,88	77	26
Sweden	High income: OECD	1,61	53230	0,90	85	27
Switzerland	High income: OECD	2,61	76380	0,90	74	28
United Kingdom	High income: OECD	1,79	37780	0,86	80	21
United States of America	High income: OECD	2,58	48450	0,68	82	19
Bangladesh	Low income	0,43	770	0,50	28	29
Benin	Low income	0,54	780	0,43	42	6
Burundi	Low income	0,55	250	0,32	11	21
Central African Republic	Low income	0,50	470	0,34	39	15
Chad	Low income	0,50	690	0,33	28	7
Eritrea	Low income	0,50	430	0,35	22	34
Ethiopia	Low income	0,30	400	0,36	17	13
Gambia	Low income	0,53	610	0,42	58	17
Haiti	Low income	1,00	700	0,45	52	16
Kenya	Low income	0,30	820	0,51	22	16
Madagascar	Low income	0,80	430	0,48	30	16
Malawi	Low income	0,50	340	0,40	20	17
Mali	Low income	0,65	610	0,36	36	22
Mauritania	**Low income**	0,50	1000	0,45	41	38
Mozambique	Low income	0,14	470	0,32	38	24
Nepal	Low income	0,12	540	0,46	19	15
Niger	Low income	0,49	360	0,30	17	16
Rwanda	Low income	0,52	570	0,74	19	14
Sierra Leone	Low income	0,45	340	0,87	38	22
Togo	Low income	0,52	560	0,77	43	23
United Republic of Tanzania	Low income	0,26	540	0,91	26	24
Zimbabwe	Low income	0,53	640	0,38	38	25
Albania	**Lower middle income**	0,77	3980	0,74	52	20

Armenia	Lower middle income	0,68	3360	0,72	64	41
Belize	Lower middle income	2,37	3690	0,70	52	20
Bhutan	Lower middle income	1,46	2070	0,52	35	45
Bolivia	Lower middle income	0,33	2040	0,66	67	40
Cameroon	Lower middle income	0,77	1210	0,48	58	31
Egypt	Lower middle income	1,37	2600	0,64	43	38
El Salvador	Lower middle income	1,13	3480	0,67	64	30
Fiji	Lower middle income	2,10	3680	0,69	52	20
Georgia	Lower middle income	1,69	2860	0,73	53	23
Ghana	Lower middle income	0,09	1410	0,54	51	21
Guatemala	Lower middle income	2,00	2870	0,57	49	24
Honduras	Lower middle income	1,45	1970	0,62	52	26
India	Lower middle income	0,34	1410	0,55	30	26
Indonesia	Lower middle income	0,52	2940	0,62	44	47
Ivory Coast	Lower middle income	0,48	1100	0,40	51	21
Laos	Lower middle income	0,70	1130	0,52	33	35
Lesotho	Lower middle income	0,50	1220	0,45	27	33
Mongolia	Lower middle income	0,66	2320	0,65	62	33
Morocco	Lower middle income	1,46	2970	0,58	58	32
Nicaragua	Lower middle income	1,10	1170	0,59	57	26
Nigeria	Lower middle income	0,56	1200	0,46	50	34
Pakistan	Lower middle income	0,84	1120	0,50	36	26
Paraguay	Lower middle income	0,21	2970	0,66	61	19
Philippines	Lower middle income	0,50	2210	0,64	49	32
Republic of the Congo	Lower middle income	0,53	2270	0,29	62	71
Senegal	Lower middle income	0,52	1070	0,77	42	23
Sudan	Lower middle income	0,79	1300	0,41	40	29
Swaziland	Lower middle income	0,51	3300	0,52	21	47
Syria	Lower middle income	1,37	2750	0,63	56	27
Vanuatu	Lower middle	3,28	2870	0,64	26	10

	income					
Vietnam	Lower middle income	1,46	1260	0,59	30	40
Zambia	Lower middle income	0,21	1160	0,46	36	35
Algeria	Upper middle income	1,21	4470	0,70	66	57
Angola	**Upper middle income**	0,48	4060	0,49	59	66
Argentina	Upper middle income	1,22	9740	0,80	92	31
Belarus	Upper middle income	0,78	5830	0,76	75	46
Botswana	Upper middle income	1,03	7480	0,63	61	45
Brazil	Upper middle income	1,03	10720	0,72	87	28
Bulgaria	Upper middle income	1,28	6550	0,77	71	31
Chile	Upper middle income	1,08	12280	0,80	89	42
China	Upper middle income	1,02	4940	0,69	47	47
Colombia	Upper middle income	0,95	6110	0,71	75	38
Costa Rica	Upper middle income	1,36	7660	0,74	64	22
Cuba	Upper middle income	0,81	5460	0,78	75	21
Dominican Republic	Upper middle income	1,18	5240	0,69	69	26
Ecuador	Upper middle income	1,13	4140	0,72	67	35
Gabon	Upper middle income	0,45	7980	0,67	86	54
Iran	Upper middle income	0,16	4520	0,71	71	38
Jamaica	Upper middle income	0,18	4980	0,73	52	30
Jordan	Upper middle income	1,04	4380	0,70	79	31
Latvia	Upper middle income	1,03	12350	0,81	68	22
Lebanon	Upper middle income	1,18	9110	0,74	87	20
Lithuania	Upper middle income	1,10	12280	0,81	67	28
Macedonia	Upper middle income	1,06	4730	0,49	59	27
Malaysia	Upper middle income	1,52	8420	0,76	72	40
Mexico	Upper middle income	1,24	9240	0,77	78	34
Namibia	Upper middle income	0,50	4700	0,63	38	33
Panama	Upper middle income	1,21	7910	0,77	75	17
Peru	Upper middle income	1,00	5500	0,72	77	38

Republic of Serbia	Upper middle income	2,98	5680	0,77	56	19
Romania	Upper middle income	1,04	7910	0,76	57	33
Russia	Upper middle income	0,93	10400	0,43	73	37
Suriname	Upper middle income	1,36	7630	0,68	69	24
Thailand	Upper middle income	1,76	4420	0,61	34	34
Tunisia	Upper middle income	0,81	4070	0,70	67	35
Turkey	Upper middle income	1,77	10410	0,70	70	28
Turkmenistan	**Upper middle income**	0,98	4110	0,69	50	25
Uruguay	Upper middle income	0,11	11860	0,78	92	22
Venezuela	Upper middle income	1,14	11920	0,74	93	36

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By using the identified indicators for the different factors the correlation between the waste generation rate and the suggested factors can be analyzed.

To test the correlation a multiregression analysis, with waste generation as the dependent variable and indicators as independent variables have been used. Only linear relashonship between the waste generation rate and the independent variables is tested.

For this to be possible the following assumptions have been made; the method assumes used data to be normally distributed. Furthermore the all variables except the waste generation rate are assumed to be independent of each other. Both these assumption might in this case contribute to sources of error.

The waste generation rate is the result of one or several factors according to the following equation:

$$y = k_1 * x_1 + k_2 * x_2 + k_3 * x_3 + \cdots + m \qquad \text{equation (1)}$$

Where y is the waste generation rate
k1,k2,k3 ... is the correlation coefficients for variable, or indicator 1,2 and 3
x1,x2,x3 is the value of the different indicators
m is the intersection with the y-axis
The equation is an extension of the more common single linear regression equation

$$y = kx + m. \qquad \text{equation (2)}$$

The first step of the analysis is to test the correlation between the waste generation rate, and each of the independent variables individually according to equation 2.

To measure the strength of the relationship between the waste generation rate and the variable the correlation coefficient *r* can be used. The correlation coefficient describes how well the actual values fit to the linear function.

Another way of measuring is the coefficient of determination, R^2. This coefficient expresses the amount of variance on one dimension that can be explained by the variance on another variable. The R^2 values achieved in the linear regression indicates that variance in waste generation rate best can be explained by variation in Income level since the R^2 value is the highest. The correlation between the waste generation rate and Living standards and Urbanization respectively are similar when it comes to the R^2 value. The Industrialization is however very poor at explaining variances in the waste generation rate.

Living standard	0.2702
Urbanization	0.2214
Income level	0.3835
Industrialization	0.0051

What happens if the variables are combined into a multiple regression? With equation 1 a linear regression are computed. The result can be found in below.

Regression Statistics	
Multiple R	0,657326609
R Square	0,43207827
Adjusted R Square	0,414190972
Standard Error	0,668426489
Observations	132

The combined R^2 value of 0,432 should be compared to the individual R^2 values. It is slightly higher than the highest individual R^2 value, but it can still only explain 43 % of the variances in the waste generation rate.