



**SOLID WASTE DUMPING AND BURNING
PRACTICES IN THE LESOTHO LOWLANDS**

By

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DECLARATION OF INDEPENDENT WORK

I, Mamello Agnes Motaung, student number _____ ,
hereby declare that this research document submitted to
the Central University of Technology, Free State is my
own independent work and has not been submitted
before to any institution by myself or any other person to
any other institution in fulfilment of any requirement for
the attainment of any qualification.

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ABSTRACT

Poor and inappropriate municipal waste management practices have become a universal problem and have led to adverse impacts on the environment and human health, especially in developing countries. In the lowlands of Lesotho, problems related to over population, changing consumption patterns and limited waste management services have been escalating, and these have exacerbated the impacts of inappropriate waste management methods. All activities in solid waste management involve risks that either impact workers who are directly involved or members of the community. It is for this reason that municipal solid waste management has recently been identified as a priority area for research.

This study reports on the identification and assessment of waste dumping and burning and the determination of waste management factors that cause such practices, with specific focus on the Lesotho lowlands. The impact of waste disposal sites on the environment as well as those communities living in their vicinity was assessed. This was achieved by locating sites where open dumping and burning occurred and by reviewing their status with respect to their compliance with South African waste legislation as well as international and national guidelines.

The study employed a descriptive cross-sectional design. Data were collected by using checklists when visiting the sites while two sets of questionnaires were also presented to 150 residents living in the vicinity of dumpsites or landfills and five waste management officials from five areas, namely Botha-Bothe, Hlotse, Maputsoe, Berea and Maseru. To administer the questionnaires to the residents, a direct door stepping approach was applied. The questionnaires were delivered by hand to respondents and returned to the researcher upon completion. The data were analysed using descriptive statistics and the results are presented in tables and graphs in this dissertation.

The results indicate that the majority of the study population did not receive waste collection services and that most disposal sites were non-compliant with the minimum requirements for dumpsites or landfills. Waste burning was identified as a frequently used solid waste management method followed by backyard burying at residences. All five the councils (100%) under study had open dumpsites and the majority (76%; 1) of the residents mentioned that waste was burned on site, while 76.7% (84) of the residents mentioned that this was practised on a daily basis. Almost half (46.7%; 70) of the residents perceived that they were susceptible to health risks and it was revealed that gastrointestinal and respiratory diseases were prevalent at a rate of 44.1% (30) in these areas.

In light of the emergence of new waste streams due to industrialization, the establishment of comprehensive legislation that is in line with globally accepted waste disposal norms is a major requirement in Lesotho. All the official disposal dumpsites under study need to be upgraded to functional landfills and they should be properly managed. Health and safety promotion interventions and sustainable waste projects need to be introduced for the benefit of the relatively young population of Lesotho. Risk awareness also needs to be enhanced among the communities in these councils and therefore local governments should prioritise municipal solid waste management and encourage public involvement in appropriate and sustainable waste management practices.

LIST OF ACRONYMS

DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
EU	European Union
GHG	Green House Gas
HM	Heavy Metal
ISWA	International Solid Waste Association
LDC	Least Developed Countries
MAHB	Millennium Alliance for Humanity and the Biosphere
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEMWA	National Environment Management Waste Act No. 58 of 2009
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
RSA	Republic of South Africa, Constitution of the Republic of South Africa, Act No. 106 of 1996
TB	Tuberculosis
UN	United Nations
UNCTD	United Nations Conference on Trade and Development
UN DESA	United Nations Department of Economic and Social Affairs
USA	United States of America
EPA	Environmental Protection Agency
WHO	World Health Organization

TABLE OF CONTENTS

COVER PAGE.....	0
ACKNOWLEDGEMENTS	i
DECLARATION.....	iii
ABSTRACT.....	iv
LIST OF ACRONYMS.....	vi
TABLE OF CONTENTS.....	vii
LIST OF TABLES.....	xii
LIST OF FIGURES.....	xiv
APPENDICES.....	xvii
CHAPTER 1: GENERAL	
1.1 Background.....	2
1.2 Introduction.....	3
1.3 Problem statement.....	8
1.3.1 Waste collection.....	9
1.3.2 International agreements/ Waste legislation.....	10
1.3.2.1 Waste legislation in South Africa.....	10
1.3.2.2 Waste legislation in Lesotho.....	11
1.4 Aim and Objectives.....	12
1.4.1 Aim.....	12
1.4.2 Objectives.....	12
1.5 Solid waste management strategy.....	13
1.6 Delimitations of the study.....	13
1.7 Structure of the thesis.....	14
1.8 Conclusion.....	15
REFERENCES.....	17

CHAPTER 2: WASTE LEGISLATION AND MANAGEMENT PRACTICES

2.1 Introduction.....	24
2.2 Definitions.....	25
2.2.1 Solid waste	25
2.2.2 Open waste dumps.....	26
2.2.3 Open waste burning.....	27
2.3 Solid waste management.....	29
2.3.1 Type and sources of solid waste.....	30
2.3.2 Solid waste management processes.....	31
2.3.2.1 <i>The waste management hierarchy</i>	31
2.3.2.2 <i>Waste generation</i>	33
2.3.2.3 <i>Waste storage</i>	34
2.3.2.4 <i>Waste collection</i>	35
2.3.2.5 <i>Waste transportation</i>	35
2.3.2.6 <i>Waste disposal</i>	36
2.3.2.7 <i>Energy and waste (recycling, non-thermal treatment, and waste-to-energy practices)</i>	38
2.3.3 Solid waste management systems.....	40
2.3.4 Integrated solid waste management planning (ISWMP).....	41
2.4 Solid waste management challenges.....	42
2.4.1 Financial constraints.....	43
2.4.2 Institutional constrains.....	43
2.4.3 Technical constrains.....	45
2.4.4 Educational constrains.....	45
2.5 Impacts of open dumping and waste burning on health and the environment.....	46
2.5.1 An international perspective.....	47
2.5.2 An African perspective.....	49
2.5.3 Lesotho.....	50
2.6 Solid waste management legislation.....	51

2.6.1 An international perspective.....	52
2.6.1.1 <i>European and American countries</i>	56
2.6.1.2 <i>Asian countries</i>	57
2.6.2 <i>An African perspective</i>	58
2.6.3 <i>Lesotho</i>	63
2.7 Conclusion.....	66
REFERENCES.....	67

CHAPTER 3: SOLID WASTE MANAGEMENT PRACTICES IN THE LESOTHO LOWLANDS

ABSTRACT.....	82
3.1 Introduction and Background.....	83
3.2 Aim and Objectives	87
3.3 Methodology.....	88
3.3.1 Ethical considerations.....	88
3.3.2 Description of the study area.....	88
3.3.3 Study design and data collection techniques.....	90
3.3.4 Statistical analysis.....	91
3.4 Results and Discussion.....	91
3.4.1 Municipal solid waste management (MSWM) process.....	91
3.4.1.1 <i>Waste collection</i>	92
3.4.1.2 <i>Waste storage and receptacles</i>	96
3.4.1.3 <i>Waste transportation</i>	103
3.4.1.4 <i>Waste segregation and recovery techniques</i>	108
3.4.1.5 <i>Waste disposal</i>	115
3.4.2 Residents awareness on MSWM issues.....	118
3.5 Conclusion.....	122
REFERENCES.....	124

CHAPTER 4: ENVIRONMENTAL IMPLICATIONS OF WASTE DISPOSAL SITES AND LEGAL COMPLIANCE IN THE LESOTHO LOWLANDS

ABSTRACT	132
4.1 Introduction and Background.....	133
4.2 Aim and Objectives	138
4.3 Methodology.....	138
4.3.1 Ethical considerations.....	139
4.3.2 Description of the study area.....	139
4.3.3 Study design and data collection techniques.....	140
4.3.4 Statistical analysis.....	141
4.4 Results and Discussion.....	141
4.4.1 Biological information.....	141
4.4.2 Description of waste disposal sites and characteristics.....	145
4.4.3 Environmental implications associated with poor waste disposal practices.....	149
4.5 Waste legislation, international agreements and domesticated waste legislations.....	174
4.6 Conclusion.....	175
REFERENCES.....	177

CHAPTER 5: GENERAL DISCUSSION

5.1 Introduction.....	186
5.2 Municipal solid waste management process.....	186
5.3 Residents' awareness on MSWM issues.....	188
5.4 Environmental implications of poor waste disposal practices.....	188
5.5 Waste legislation, international agreements and compliance in Lesotho.....	190
REFERENCES.....	192

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction.....	195
6.2 Conclusion.....	195

6.2.1 Identification and assessment of open waste dumping and burning practices	195
6.2.2 Factors leading to dumping and burning of solid waste	196
6.2.3 Environmental impacts of solid waste dumping and burning practices	197
6.2.4 Review of the current legislation and legal compliance	198
6.3 Recommendations	199
6.3.1 Sustainable MSWM	199
6.3.2 Improvement of waste legislation, amendment of regulations and compliance enforcement	199
6.3.3 Improvement of resource allocation for MSWM	200
6.3.4 Development of waste management strategy and the evaluation of MSWM systems	200
6.3.5 Appointment of waste management officers and occupational health and safety officers in the councils	201
6.3.6 Training and monitoring of waste management teams	201
6.3.7 Establishment of a trade union for informal waste worker	202
6.3.8 Improvement and upgrading of waste disposal sites	202
6.3.9 Rehabilitation plans for disposal sites	203
6.3.10 Health education and promotion	203
6.3.11 Need for further research	203

LIST OF TABLES

CHAPTER 2

Table 2.1	Waste management Legislations applicable to European Union, American and Asian countries	52
Table 2.2	Waste legislations used in Southern African countries	58
Table 2.3	Solid waste legislations and international waste conventions used in Lesotho.	64

CHAPTER 3

Table 3.1	Waste collection methods, frequency of waste collection and periods when waste was left uncollected	94
Table 3.2	Types of waste receptacles provided to residents	97
Table 3.3	Vehicles used by councils to transport waste from source to disposal sites	104
Table 3.4	Waste segregation and recovery techniques used in the Lesotho lowlands	108
Table 3.5	Methods used by councils to communicate with residents	119

Table 3.6	Knowledge regarding open waste dumping and waste burning practices	120
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CHAPTER 4

Table 4.1	Biological information of study respondents	142
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Table 4.2	Distance of waste disposal sites from human settlements, institutions, agricultural activities and water sources	145
------------------	---	------------

Table 4.3	Description of the disposal sites	146
------------------	--	------------

Table 4.4	Summary of training of waste management workers and safety measures to protect them	149
------------------	--	------------

Table 4.5	Waste dumping and burning in residential areas	153
------------------	---	------------

Table 4.6	Exposure to environmental risks and residents' suggestions for health risk management	162
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LIST OF FIGURES

CHAPTER 1

Figure 1.1	Open waste dump life cycle	7
Figure 1.2	Waste piles awaiting collection in Maputsoe, Leribe district	10

CHAPTER 3

Figure 3.1	Lesotho administrative districts and livelihood zones map	89
Figure 3.2	Waste collection in councils	95
Figure 3.3	Photo of a waste bin being used in the Maputsoe Urban Council area	98
Figure 3.4	Street sweeping and waste collected in refuse plastic bags collected in the Hlotse Urban Council area	100
Figure 3.5	Municipal plastic bags dumped in an open space of the Maputsoe Urban Council area	101
Figure 3.6	Waste collection cage receptacle in the Maputsoe Urban Council area	102
Figure 3.7	Waste collection trucks used by the Maputsoe Urban Council	105
Figure 3.8	A bakkie used as a waste collection vehicle by the Botha-Bothe Urban Council	106
Figure 3.9	Tractor-drawn loader used by the Botha-Bothe Urban Council	106
Figure 3.10	Skip loader truck used by the Maseru City Council	107
Figure 3.11	Waste separated in bags (sacks) at the Tsosane landfill, Maseru City	110

Figure 3.12	Onsite diesel waste compacting machinery used at the Mokota-koti dumpsite, Maputsoe Urban Council area	110
Figure 3.13	Cardboard and textile recycling at Mokota-koti dumpsite, Maputsoe Urban Council area	111
Figure 3.14	Plastic and glass waste separated for recycling at Mokota-koti, Maputsoe Urban Council area	113
Figure 3.15	Plastic and glass waste separated for recycling at the Hlotse dumpsite in the Hlotse Urban Council area	113
Figure 3.16	Disposal methods used by the five councils	116
Figure 3.17	Spontaneous fires at Tsosane landfill in the Maseru City Council area	117
CHAPTER 4		
Figure 4.1	Personal Protective Equipment [PPE] used by waste workers in the Maseru City Council	152
Figure 4.2	Waste burning at the Botha–Bothe dumpsite	155
Figure 4.3	Waste burning in an open trench dumpsite in the Hlotse Urban Council area	155
Figure 4.4	Waste burning at the Maputsoe dumpsite in the Maputsoe Urban Council area	156
Figure 4.5	Waste burning at the Berea Urban Council dumpsite	157
Figure 4.6	Waste tyres at the Maputsoe Dumpsite in the Maputsoe Urban Council area	157
Figure 4.7	Health and environmental hazards in the vicinity of dumpsites in the Lesotho lowlands as perceived by residents	159

Figure 4.8	Leachate trickling from waste at the Tsosane landfill of the Maseru City Council	160
Figure 4.9	Water stabilisation ponds near the Caledon (Mohokare) River at the Maputsoe dumpsite of the Maputsoe Urban Council	161
Figure 4.10	Pigs scavenging on waste at the Hlotse dumpsite of the Hlotse Urban Council	165
Figure 4.11	Poorly separated glass and other waste at the Berea Urban Council dumpsite	166
Figure 4.12	Dilapidated fencing at the Berea Urban Council dumpsite	167
Figure 4.13	Inadequate fencing at Maputsoe dumpsite in the Maputsoe Urban Council area	167
Figure 4.14	Disposable nappies and pharmaceutical waste at Berea dumpsite	168
Figure 4.15	Controlled entrance to and concrete fence of the Tsosane landfill in Maseru City	169
Figure 4.16	Houses less than 50 m from Tsosane landfill in Maseru City. The sturdily constructed concrete fence was the only one of its kind in the lowlands	169
Figure 4.17	Agricultural activity in close proximity to the Maputsoe dumpsite in the Maputsoe Urban Council area	173

APPENDICES

- 1. Resident's questionnaire**
- 2. Waste management official's questionnaire**
- 3. Checklist**
- 4. Letters of approval from the Ethical committees**
- 5. Letters of approval to conduct study in councils**

CHAPTER 1

GENERAL BACKGROUND

1.1 Background

Solid waste is defined as any material that no longer has any value for its original owner and which is discarded (Ashenafi, 2011; Mbiba, 2014). Prior to the industrial revolution, humans did not care much about waste and open dumping and waste burning practices did not pose a significant problem for them due to smaller population groups and the availability of sufficient land for the disposal of waste (Tsega, 2013). However, the introduction of more complex products into the waste stream due to increased urbanization and population growth has resulted in an increase in waste generation which, in turn, has negatively impacted open dumps (New Hampshire Department of Environmental Services, 2013; Department of Environmental Affairs, 2013).

In developing countries such as South Africa and Lesotho, open dumpsites are more common than engineered landfills for the disposal of solid waste (Oluranti & Omosalewa, 2012). In Lesotho in particular urban waste, including medical waste, is dumped and sometimes burned on these sites without any treatment or the application of specific techniques for managing residues and smoke during burning, and this has negatively impacted health, safety and environmental quality (Government of Lesotho, 2005; Ali *et al.*, 2013).

The environment is the primary source that sustains the global economy and must therefore be protected and managed sustainably. Although the majority of people perceive solid waste as an environmental nuisance that is worthy only for disposal on landfills and dumpsites, there are some people who perceive it as a business opportunity, and thus waste recovery centres have been established in Lesotho. For instance, waste pickers harvest waste from open dumpsites, kerbsides and public waste receptacles to sell to waste buy-back agents (UNEP, 2008; Filho *et al.*, 2016). However, the prominent challenge facing developing countries is that recycling is done mainly by these waste pickers, while waste dealers are still making use of out-

dated and hazardous waste recovery techniques. The use of these inappropriate techniques is exacerbated by the lack of a specific recycling infrastructure that separates waste from source to enable easy deviation to waste recovery facilities, unlike in developed countries where resource recovery is done mechanically and is institutionalized by governments (Department of Environmental Affairs and Tourism, 2013).

1.2 Introduction

Increasing population growth in cities presents more major implications for municipal waste management than any other services required by urban communities (Dotoli & Epicoco, 2017). Lesotho is facing increasing environmental hazards that occur in the milieu of rapid urbanization, high population growth, a decline in formal job opportunities, unplanned settlements, and the proliferation of informal businesses, and these cause severe pressure on the government, especially in terms of the provision of multiple urban basic services that include solid waste management (Mvuma, 2010; Tshabalala, 2012; Ramaiah *et al.*, 2017). Large amounts of municipal solid waste are dumped indiscriminately on open spaces and in streets, storm water drains, rivers and streams (Dladla *et al.*, 2016). In the Mophale's Hoek district in Lesotho, a major water supply river was found to be polluted by people living close to it and working at a nearby taxi rank. Local businesses and residents openly dumped waste in the stream that was conveniently close. Due to inadequate sanitary facilities, these people also relieved themselves directly into the stream, thus heavily polluting it (World Health Organization, 2013). Ayininuola and Muibi (2008) and Government of Lesotho (2012) state that, over the next several decades, globalization, rapid urbanization and economic growth in developing countries will deteriorate further if remedial actions to preserve the environment and curb irrational dumping are not taken.

There is a link between environmental pollution arising from waste dumps and the implications for public health (Oluranti & Omosalewa, 2012; Mavropoulos *et al.*, 2014). In developing countries, the burning of combustible municipal solid waste at open dump sites is a common practice to reduce waste volumes at locations without centralized waste collection and treatment services (Bhavannrayana *et al.*, 2003; Roberts, 2013). Wang *et al.* (2016) indicate that the dumping and burning of waste are often preferred because they are simple, convenient and inexpensive methods. However, waste burning has embedded health and environmental consequences, as indiscriminate waste dumping and combustion cause the release of powerful greenhouse gases that lead to climate change (Wang *et al.*, 2016). Furans and dioxins are pollutants released from burning of waste that are carcinogenic and associated with birth defects in children. If smoke is inhaled directly or deposited on soil, water and crops, the dioxins and pollutants become part of the food chain (Mavropoulos *et al.*, 2014). Moreover, open waste dumps do not only emit harmful odours but also attract rodents and vectors that are carriers of diseases and have become major causes of respiratory illnesses and communicable disease outbreaks among residents living in the vicinity of dumps (Tshega, 2013; Mavropoulos *et al.*, 2014). Dumping of waste on riverbanks and in forests can have severe consequences for wild animals and aquatic life, especially through the ingestion of micro-plastics (Malinowski *et al.*, 2015). In developing countries, these problems are exacerbated by the scarcity of waste management facilities.

Open dumping and burning of waste are age-old challenges in Lesotho and other countries where certain locations have become routine disposal sites and existing dump piles have attracted further dumping (Lakshmikantha, 2006; Malinowski *et al.*, 2015). Very few developing countries have properly engineered compliant landfills, which means that dumpsites are prevalent in these countries (Filho *et al.*, 2016; Roberts, 2013). Open dumping occurs on land disposal sites where the indiscriminate disposal of solid waste takes place with either no or at best very limited measures to control the operations and to protect the surrounding

environment (Mavropolous *et al.*, 2015). In South Africa, a number of old landfills are unregistered. Although the city councils or private companies service them, waste disposed at dumpsites is not carefully monitored like in the case of sanitary landfills. Sanitary landfills differ from these dump sites in that waste is disposed of according to a categorically designed infrastructure and operational practices and waste control is conscientiously implemented (Finlay, 2005; Mavropolous *et al.*, 2014). Ts'osane is the only existing sanitary landfill in Lesotho and serves the urban areas of Maseru City, while other districts have only official disposal sites that are selected by the district councils. These disposal sites are often selected with little or no consideration of site selection indicators such as distance from natural resources, distance from infrastructure facilities and residential areas, land morphology, hydrological and geological factors and the degradation of land (Josimovic & Maric, 2012; Mavropoulos & Newman, 2015).

In Lesotho, like in many other developing countries, ineffective municipal solid waste collection has been a problem for decades and has been the fundamental cause of open waste dumping and burning practices. Open dumping and burning are in turn related to a lack of solid waste management efforts that are implemented and residents' low standard of living (Lakshmikantha, 2006; Malinowski *et al.*, 2015). Moreover, municipal waste collection in Lesotho is limited to high-income and some middle-income areas, while poor areas receive virtually no services. In Maseru City, one quarter of the suburban areas known to be occupied by members of the country's cabinet, high-ranking officials and the wealthy are receiving better service delivery than other areas such as better roads, good water systems and sanitation as well as solid waste collection. These areas include Matsoatlareng, Moshoeshoe 2, Maseru East, Mohalalitoe, Thamae, Tsautse, Katlehong, Lower Thetsane, Hills View, Europa, Ha Hoohlo and Lecop in Khubetsoana. Generally, however, the waste collection system in Maseru is irregular even in the wealthy areas, and it has been described as so unreliable that even the collection vehicles do not have specific schedules (Bulane, 2009; Matope, 2013). Moreover, efficient refuse

collection is compromised by poor roads and general access problems that make house-to-house collection difficult and expensive (Okot-Okumu, 2012). Communities without access to transfer stations resort to open disposal methods which include burning, burying, using of waste as animal feed and indiscriminate disposal. Crofts *et al.* (2010) and Filho *et al.* (2016) argue that residents opt for such practices because legal disposal of waste is expensive, whilst open dumping is essentially free. Such poor waste management practices are unsatisfactory as various other strategies to manage solid waste are available, such as recycling that forms part of the effective implementation of the waste management hierarchy.

Solid waste management comprises any of the procedures and programs that eradicate, reduce, re-use, recycle or landfill waste. Compared to municipalities in low-income and middle-income countries, high income countries allocate the majority of their solid waste management budget to collection and transportation services, whereas in low-income countries final disposal costs are minimal because disposal is usually accomplished by means of open dumping (Tsega, 2013; Guerrero *et al.*, 2013). Guerrero *et al.* (2013) report that most municipal authorities in the latter countries render poor waste disposal services as the systems applied are unscientific, out-dated and non-efficient and because government environmental policies, where they exist, are poorly documented and implemented. The lack of funding and equipment hinders efficient waste management operations and exacerbates erratic solid waste management in developing countries. According to Bhavannrayana *et al.* (2003) and Mavropoulous *et al.* (2015), municipal solid waste management, particularly in developing countries, has emerged as a dominant urban environmental issue that has attracted academic, economic and media debates and has developed into an independent discipline over the years. It is argued that the growth in awareness, publicity, support and educational presentations about required change has not been enough and that more effective waste management implementations are necessary (Bhavannrayana

et al., 2003; and Mavropoulos *et al.* (2015). It is against this background that the open waste dump life cycle in the Lesotho lowlands is illustrated in Figure 1.1.

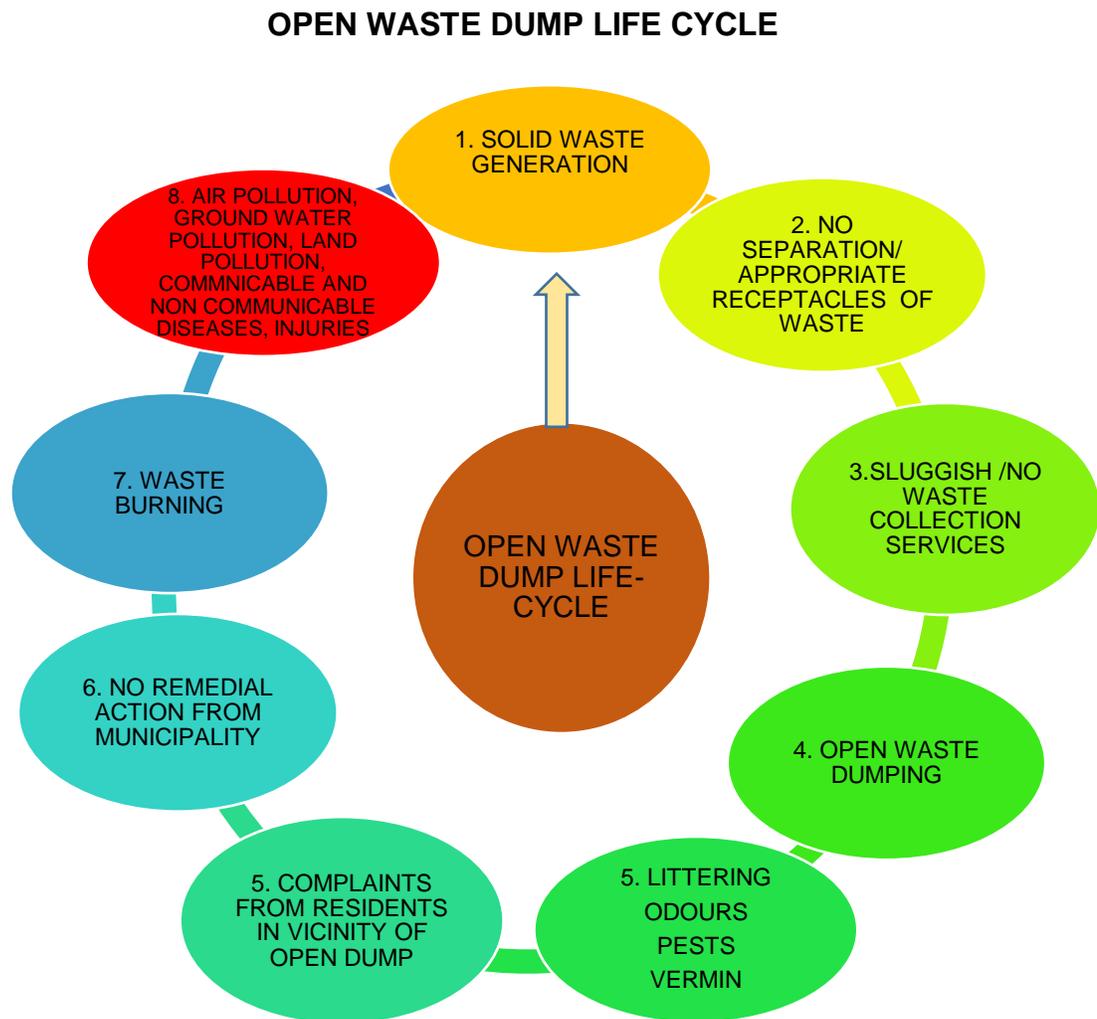


Figure 1.1: Open waste dump life cycle in the Lesotho lowlands

1.3 Problem Statement

Financially poor countries are generally more susceptible to the dangers associated with waste dumping and burning practices than their more affluent counterparts (Ali *et al.*, 2013). For instance, a lack of the most basic services such as solid waste management in low-income areas is a major contributor to the high morbidity and mortality rates among the urban vulnerable groups living close to waste dumps (Zewdie, 2007; Nkosi, 2014). Lesotho has been categorised as one of the 'least developed countries' and has recently been fraught with extreme development challenges compared to the time of independence in 1966. Even with enhanced financial management capacity at both municipal or ministerial levels, Lesotho is still economically challenged and councils do not generate enough income to sustain general waste management expenses. Due to the increasing unemployment rate and general poverty, most citizens cannot afford waste collection fees (Government of Lesotho, 2005 & 2012; Matope, 2013). In developing countries such as Lesotho, the incapacity of municipalities to manage waste and to provide safe water and sanitation facilities is a main area of concern that requires careful monitoring, especially at household level (Mvuma, 2010; Ali *et al.*, 2013).

Even though the poor performance of towns to manage solid waste is impacted by various contextual factors, financial, technical and institutional constraints are mutual in most developing countries (Dotoli & Epicoco, 2017). Unplanned urban development and poor access roads hinder effective management of waste, especially in the waste collection process. This leads to slow services that eventually cease altogether. The lack of statistical reports on open waste dumping and burning can be explained by the tendency to regard this problem as local and non-criminal (Crofts *et al.*, 2010; Newman, 2013). The absence of a formal waste management system, the lack of law enforcement and non-existent realistic penalties regarding littering in streets and any other form of offensive waste disposal behaviour by

community members and businesses influence the continuance of these practices (Abel, 2014).

1.3.1 Waste collection

The rapid growth of urban areas outweighs the ability of urban authorities to provide adequate housing, roads, water, and sewerage and solid waste collection for all their communities. In most developing countries, including Lesotho, most cities are unplanned and characterized by disorganized construction of extensive slums with narrow roads that are inaccessible to collection vehicles (Awosusi, 2010; Department of Environmental Affairs, 2013). This causes district councils to struggle with the collection of all domestic and industrial solid waste. The shortage and frequent breakdowns of vehicles also lead to irregular service provision and it is estimated that an average of only 10 to 15% of urban households receive regular waste collection in these countries (Bulane, 2009; Simelane & Mohee, 2012; Matope, 2013). The waste collection process includes the removal and transportation of waste from the source of generation to the disposal site. This service is often quite expensive as it involves specialised equipment and a large number of personnel. Industrial premises and institutions such as hospitals are usually provided with big containers for refuse disposal. These are supposed to be emptied regularly but remain unattended because of inadequate and unsuitable transport. The haulage distances between the waste sources and disposal sites are usually primary determinants of the choice of a disposal method. This is why, regardless of the presence of an official disposal site, waste continues to be dumped indiscriminately on open spaces and in rivers and dongas, or is sometimes burned in an inappropriate area when it has not been collected or has been disposed of infrequently (Seholoholo, 1998; Bulane, 2009; Mvuma, 2010; Lemaire & Kerr, 2016).



Figure 1.2: Waste piles awaiting collection in Maputsoe, Leribe district

1.3.2 International agreements

The acts and principles that will be referred to below highlight the challenges that were identified in the solid waste management sector in the Lesotho lowland districts. They reveal that there is a very limited legal and institutional framework concerning solid waste and expose that almost no solid waste management system exists to steer and coordinate recycling. The collection system is limited and random and open dumpsites are used for disposal. According to the United Nations environment Programme (UNEP), these factors are exacerbated by limited community awareness that causes increased littering (UNEP, 2008; Matope, 2013). These limitations also suggest a lack of law enforcement, compliance failure, and discrepancies in current legislations. The main principles of waste legislation in South Africa and Lesotho are mentioned.

1.3.2.1 Waste legislation in South Africa

The following principles are included in Chapter 7, Section 28 of the National Environmental Management Act No. 107 of 1998 (Republic of South Africa, 1998).

- The '**equitable access**' principle implies that environmental resources, benefits and services should meet basic human needs and ensure human well-being. Special measures may be taken to ensure access to categories of persons disadvantaged by unfair discrimination (Department of Environmental Affairs, 2013).
- The '**polluter pays**' principle implies that all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste they produce. This principle indicates that polluters are responsible for the cost of remedying pollution that has resulted in environmental degradation and adverse health effects (Republic of South Africa, 2008).
- The '**precautionary**' principle implies that, where there is absence of scientific evidence of potential environmental risk or where its magnitude is unknown, it should be assumed that the risk is significant and protection measures should be designed accordingly (Terblanche, 2007; Abel, 2014).
- The '**sustainable development**' principle seeks to balance economic and social development so that it meets the challenges of protecting environmental resources for future generations (Department of Environmental Affairs, 2013).
- The '**waste is avoided**' principle states that, where waste cannot be altogether avoided, it should be minimised and re-used or recycled where possible or otherwise disposed of in a responsible manner. The waste management hierarchy provides a systematic and hierarchical approach to integrated waste management. It addresses waste avoidance, reduction, re-use, recycling, recovery, treatment and safe disposal as a last resort (Republic of South Africa, 2011).

1.3.2.1 Waste legislation in Lesotho

The following legislations are currently used for solid waste management in Lesotho:

- The Constitution of Lesotho (1993)
- National Environmental Policy (1998)
- Environment Act no.10 of 2008
- Public Health Order no.12 of 1970
- Sanitary Services and Refuse Removal Regulations (1972) and
- Town and Country Planning Act no. 11 of 1980.

1.4 Aim and objectives of the study

1.4.1 Aim

The aim of the study was to identify and assess open waste dumping and burning in the Lesotho lowlands and to determine which waste management factors cause such practices.

1.4.2 Objectives

The objectives of the study were to:

- Locate and record open dumping sites and sites where open burning takes place using a Global Positioning System (GPS);
- Determine social, environmental and economic factors leading to open dumping and burning of solid waste;
- Assess the environmental impacts of open solid waste dumping and burning practices;
- Review current legislation that prohibits the open dumping and burning of solid waste; and
- Evaluate public compliance with waste management legislation.

1.5 Solid Waste Management Strategy

A solid waste management strategy coordinates waste management issues in the country and incorporates resources and skills by relevant stakeholders, including community members, to achieve a common goal in the waste management industry. This common goal focuses on waste avoidance, waste reduction and waste recovery as well as sound waste disposal methods. By locating, identifying and recording open waste dumps and sites where burning is practised in the Lesotho Lowlands, a mini waste map can be established. The need to improve current solid waste management practices was analysed and available resources were assessed to determine their relevance and efficacy. A review of existing waste legislations and their suitability for current waste management problems could assist in refining the solid waste strategy in Lesotho.

1.6 Delimitations of the Study

The study was limited to the Lowlands of Lesotho and focused on the Northern Lowland areas of Botha-Bothe, Leribe and Berea. Only Maseru represented the Southern Lowlands. Thus, the perceptions and the study results will not be a reflection of all the urban areas in the country and the findings of the study could thus not be generalized to the entire Kingdom of Lesotho.

The second limitation was that Lesotho lacks a national database on the volumes of generated municipal solid waste (MSW) and the waste disposed due to a lack of equipment such as weigh bridges at disposal sites. Most waste disposal data were derived from non-governmental organisations (NGOs) and interested stakeholders' reports but were over ten years old and covered Maseru city only.

A frustrating challenge was experienced because the data collection process was influenced by who was in authority in the Council at the time of the study. In most

Councils the workers felt that the only person who had the right to give permission to conduct the study or participate in it by completing the questionnaire was the Town Clerk. This caused delays in responses and resulted in repeated journeys because, due to the countless duties assigned to the Town Clerks, they were rarely in the office as they had to attend meetings, workshops and public gatherings within and outside the council. However, the data collection process could resume regardless of this issue.

1.7 Structure of the Thesis

The format followed in this document includes a general background and a literature review. However, Chapter 3 and 4 are written in article format which leads to duplication in some abstracts and introductions. Discussions, recommendations, conclusions and references are included in each chapter. This study report follows the following format:

Chapter 1: General Background

This chapter provides the background to the study and presents an introduction to the phenomena of open waste dumps and waste burning practices, with specific reference to the Lesotho lowland districts. The challenges and problems associated with waste disposal sites that residents and municipalities face are highlighted. The aims and objectives of the study are presented while the most important delimitation that impacted the study is explained.

Chapter 2: Literature Review

Key concepts and definitions are discussed in the literature review. Global health and the environmental implications of open dumpsites and waste burning are a specific focus of this review. International and national legislations and the solid waste management hierarchy are discussed in detail.

Chapter 3: First Article – Solid Waste Management Practices in the Lesotho Lowlands

This chapter includes an assessment of public perceptions, the environmental status and economic activities associated with open dumps. The research methodology is outlined and the analysed results and conclusion of the first article are presented.

Chapter 4: Second Article – Environmental Implications of Waste Disposal Sites and Compliance in the Lesotho Lowlands

This chapter provides an assessment of the environmental and health impacts of open waste dumpsites and burning practices on nearby human settlements in the Lesotho lowlands. It evaluates public nuisances as well as the injuries and diseases contracted from living in the vicinity of dumpsites. The research methodology is outlined and the analysed results and conclusions are presented.

Chapter 5: General Discussion

Based on the findings presented in Chapter 3 and Chapter 4, the discussion summarises and describes their meaning in this study.

Chapter 6: Conclusion and Recommendations

This is the final part of the research report. Conclusions are drawn based on the findings pertaining to the objectives of the study and recommendations to address the causes of waste dumping and burning in the Lesotho Lowlands are offered.

1.8 Conclusion

The question whether solid waste dumps should be closed or, alternatively, upgraded is a key issue that needs to be considered, particularly in developing countries. The upgrading of these dumps will be an essential step in reducing future

environmental impacts and curbing public health hazards and economic constraints caused by the ongoing disposal and burning of solid waste on open dumps.

REFERENCES

- Abel, D.J. 2014. *Perceptions of illegal dumping in EThekweni Municipality*. Master's thesis, University of the Free State, Bloemfontein.
- Ali, M.S., Pervaiz, A., Afzal, B., Hamid, N., & Yazmin, A. 2013. Open dumping of municipal solid waste and its hazardous impacts on soil and vegetation diversity at waste dumping sites of Islamabad City. *Journal of King Saud University–Science*, 1, 1018–3647.
- Ashenafi, H. 2011. *Determinants of effective household solid waste management practices: the case of Ambo Town-West*. Master's thesis, Mikelle University, Ethiopia.
- Awosusi, A.O. Assessment of environmental problems and methods of waste management in Ado- Ekidi, Nigeria. *An International Multi-Disciplinary Journal, Ethiopia*, 4(3), 331–343.
- Ayininuola, G.M., & Muibi, M.A. 2008. An engineering approach to solid waste collection system: Ibadan North as case study. *Waste Management*, 28, 1681–1687.
- Bhavannarayana, C., Prakash K.S., & Saritha, V. 2003. Estimation of municipal solid waste generation: a case study. *International Journal of Research and Reviews in Pharmacy and Applied Sciences (IJRRPAS)*, 2(3), 473-481.
- Bulane, I. 2009. *The selection of transfer locations for Maseru Municipality*. Master's thesis, University of Witwatersrand, South Africa.
- Chatsiwa, J. 2015. *Land pollution and population density: the case of Kwekwe City residential areas, Zimbabwe*. Master's thesis, University of South Africa, Pretoria, South Africa.
- Crofts, P., Morris, T., Wells, K., & Powell, A. 2010. Illegal dumping and crime prevention: a case study of Ash Road, Liverpool Council. *Public Space*, 5(4), 1–23.

- Department of Environmental Affairs. 2013. Waste Management Chapter 13. Available from: http://www.environment.gov.zaa/sites/.../reports/environmentoutlook_chapter_13.pdf [Accessed 05 February 2018].
- Dladla, I., Machete, F., & Shale, K. 2016. A review of factors associated with indiscriminate dumping of waste in eleven African countries. *African Journal of Science, Technology, Innovation and Development*, 8(5-6), 475–481.
- Dotoli, M., & Epicoco, N. 2017. A vehicle routing technique for hazardous waste collection. *IFAC Papers Online*, 50(1), 9694–9699.
- Filho, L.W., Brandli, L., Moora, H., Kruopiene, J., & Stenmarck, A. 2016. Benchmarking approaches and methods in the field of urban waste management. *Journal of Cleaner Production*, 112, 4377–4386.
- Finlay, A. 2005. E-waste challenges in developing countries: A South African case study. *Association for Progressive Communications (APC) Issue Papers*.
- Garfi, M., & Bonoli, A. 2009. Waste disposal in developing countries and emergency situations: the case of Saharawi refugee camps. *International Solid Waste Association (ISWA) World Congress*, 1–7.
- Government of Lesotho. 1970. *Public Health Order: Order No 12 of 1970*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 1972. *Sanitary Service and Refuse Removal Regulations*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 1980. *Town and Country Planning Act: Act 10 of 1980*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 1993. *The Constitution of Lesotho with Amendments*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 1998. *National Environmental Policy for Lesotho*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2005. *National Health Care Waste Management Plan Maseru*. Synergy Holdings. *The World Bank and National Workshop*, Maseru: Ministry of Health and Social Welfare.

- Government of Lesotho. 2008. Environmental Act: Act 10 of 2008. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2012. Poverty reduction strategy paper: National strategic development plan. *International Monetary Fund Country Report No.12*, 102.
- Guerrero, L.A., Maas, G., & Hogland, W. 2013. Environmental and health impact of solid waste disposal in developing cities: a case study of Granville Brook dumpsite. *Journal of Environmental Protection*, (4), 665–670.
- Josimovic, B., & Maric, I. 2012. Methodology for the regional landfill site selection. Chapter 22. *INTECH*, 22, 514–538.
- LakshmiKantha, H. 2006. Report on waste dumpsites around Bangalore. *Waste Management*, 26, 640–650.
- Lemaire, X., & Kerr, D. 2016. Waste management: innovative solutions for African municipalities. *Supporting Sub-Saharan Africa's Municipalities with sustainable energy Transitions (SAMSET)*. <http://samsetproject.net/>.
- Malinowski, M., Wolny-Koladka, K., & Jastrzebski, B. 2015. Characteristics of illegal dumping sites case study: watercourses. *Infrastructure and Ecology of Rural Areas*, 4(4), 1475–1484.
- Matope, T. 2013. Maseru City Council plans makeover. *Lesotho Times*, 26 September.
- Mavropoulos, A., Mavropoulos, A., Koukosia, I., Tsakona, M., Mavropoulou, N., Rigas, N., & Andredakis, T. 2014. *Waste atlas: the world's 50 biggest dumpsites*. D-Waste Reports, D-Waste Environmental Consultants.
- Mavropoulos, A., Marinheiro, L., Cohen, P., Law, J., Greedy, D., Loureiro, A., Plimakis, S., & Bouldry, T. 2015. A roadmap for closing waste dumpsites: the world's most polluted places. International Solid Waste Association report, Vienna, Austria.
- Mavropoulos, A., & Newman, D. 2015. Waste health: the tragic case of dumpsites. International Solid Waste Association report, Vienna, Austria.
- Mbiba, B. 2014. Urban solid waste characteristics and household appetite for separation at source in Eastern and Southern Africa. *Habitat Int.* 43, 152–162.

- Mvuma, G. 2010. Waste a necessary evil for economically impoverished communities in least developed countries (LCDs): a case of Lesotho. 20th Waste Conference and Exhibition 4–8 October. Emperor's Palace, Gauteng, South Africa. Waste Con 2010.
- New Hampshire Department of Environmental Services. 2013. Open burning of residential trash: environmental impacts and safer alternatives. *Environmental Fact Sheet*, 603, 271–3503.
- Newman, D. 2013. World waste report. International Solid Waste Association Report, Vienna, Austria.
- Nkosi, L.F. 2014. *An evaluation of the municipal solid waste management system within City of Tshwane Metropolitan Municipality, in Mamelodi Township, Gauteng Province, South Africa*. Master's thesis, University of Pretoria, South Africa.
- Okot-Okumu, J. 2012. Solid waste management in African cities: East Africa. *INTECH* 10, 5772/50241.
- Oluranti, O.I., & Omosalewa, A.E. 2012. Health and economic implications in cities: the case of Lagos, Nigeria. *International Journal of Economics and Finance* 4 (4), 231–259.
- Ramabitsa-Siimane, T. 2005. *The identification of environmentally sound technologies for healthcare waste management in Lesotho*. Master's thesis, University of Pretoria, South Africa.
- Ramaiah, B.J., Ramana, G.V & Datta, M. 2017. Mechanical characterization of municipal solid waste from two waste dumps at Delhi, India. *Waste Management*, 68, 275–291.
- Republic of South Africa. 2008. National Environment Management Act, Waste Act. No. 59 of 2008. *Government Gazette No. 32000*. Pretoria: Government Printers.
- Republic of South Africa. 2011. Environmental Management: Waste Management Strategy. Pretoria: Government Printers.

- Roberts, H.A. 2013. Landfills or dump sites? Status of landfill sites in the Free State Province, South Africa. INTERIM.
- Roberts, H.A. 2016. Impact of abattoirs and landfills in the Free State Province, South Africa on climate change. Paper delivered at the Sixth International Symposium on Energy from Biomass and Waste, 27 July 2016. Free State: Central University of Technology, INTECH.
- Seholoholo, M. 1998. *Solid waste management in low and high income residential areas of Maseru: a comparative study of Maseru West and Sea Point*. Master's thesis, University of Natal, South Africa.
- Simelane, T., & Mohee, R. 2012. Future directions of municipal solid waste management in Africa. *Africa Policy of South Africa Policy Brief No. 81*.
- Terblanche, F.J. 2007. *A legal framework for the trans boundary movement of hazardous waste in South Africa and Lesotho*. Master's thesis, North-West University, South Africa.
- Tsega, A.F. 2013. *Institutional and community awareness on the environmental impact of solid waste management practice: the case of Shambu Town, Horo Guduru Wellega Zone, and Oromia Regional State*. Master's Thesis, Haramaya University, Ethiopia.
- Tshabalala, M. 2012. Innovation partnerships for a solid waste management project in Lesotho (2009–2012). *Project Evaluation Report*. Maseru; Ministry of Health, Lesotho.
- United Nations Environment Programme (UNEP). 2008. *Policy and Regulations: Maseru (Lesotho)*. Final Baseline Report on Waste in Maseru City. Maseru.
- Wang, Y., Cheng, K., Wu, W., Tian, H., Yi P., Zhi, G., Fan, J., & Liu, S. 2016. Atmospheric emissions of typical toxic heavy metals from open burning of municipal solid waste in China. *Science Direct*, 152, 6–15.
- World Health Organization. 2013. *A multi-sectoral response to water sanitation and hygiene issues in Lesotho: the Mohale's Hoek experience*. Geneva: WHO/AFRO Library.

Zewdie, T. 2007. *Ground water pollution and public health risk analysis in the vicinity of Reppi solid waste dumping site*. Bachelor's thesis, Addis Ababa University.

CHAPTER TWO

WASTE LEGISLATION AND MANAGEMENT PRACTICES

2.1 Introduction

The most appropriate literature related to this study is discussed in this chapter. The discourse illuminates key definitions and urban solid waste management, waste dumps and burning practices are discussed. The chapter will also focus on the solid waste management hierarchy by illuminating waste collection and waste reclamation interventions as well as solid waste disposal methods. Waste management legislations that are effective in Europe, North America, Asia, Southern Africa and Lesotho are reviewed, with specific reference to the health and environmental impacts of waste dumps and burning practices.

Increasing urbanization as people have flocked to cities in search of employment has resulted in increased population movement to Maseru and major towns in Lesotho (Thoso, 2007; Government of Lesotho, 2016a). Due to the country's topography, economic activities are largely confined to the Lowlands while the mountainous region of the country is only suitable for grazing, water resource development and hydro-power production (Government of Lesotho, 2000a & 2014; Morake, 2010). Urban areas such as Maseru and Maputsoe are suitable for industrial activities. Urban invasion and a decline in formal job opportunities have accounted for a growing population, with about 64% of the population entering the informal sector (Mvuma, 2010; Khoeshe, 2018). In general, solid waste management has very low priority in developing countries such as Malaysia and Nigeria, except in their capital cities (Igbinomwanhia & Ohwovoriole, 2012; Permana, 2015). In Lesotho, urban migration has caused increased pressure to provide basic waste management services. Domestic waste often remains uncollected on the streets, on kerbs and along major roads and residents now usually dump it or burn it anywhere they consider convenient, which contributes greatly to environmental pollution (Thoso, 2007; Mvuma, 2010; Khoeshe, 2018).

Many governments have resorted to decentralisation in an attempt to provide and maintain public service infrastructure (Lebentlele, 2002; Government of Lesotho, 2018). Lesotho adopted a national decentralisation policy in 2014 and, as a consequence, eleven urban councils operating as part of local governments were selected and given independence to manage and govern urban areas (Government of Lesotho, 2018). Thus, these local authorities are responsible for the control of natural resources, environmental protection, public health, water supply, education, agricultural services and the promotion of economic development as required in their by-laws (Government of Lesotho, 2016b).

2.2 Definitions

There are various definitions in the waste management field. The most relevant definitions pertain to solid waste, open waste dumps, and open waste burning.

2.2.1 Solid waste

Globally the description of 'solid waste' is basically the same because the common constituents referred to in most definitions include similar words and phrases such as 'unwanted', 'unavoidable', 'human activities' and 'disposal'. Countries such as the United States of America, Ghana, Pakistan and India describe municipal solid waste (MSW) as inevitable by-products produced from several sources where variable human activities are encountered (MAHB, 2002; Raman & Narayanan, 2008; Ali *et al.*, 2013; Miezah & Mensah, 2015; Srigirisetty, 2017). According to Ally *et al.* (2014), urban municipal solid waste is usually generated in human settlements and small industries and is produced by domestic and commercial activities. In most countries, legal definitions of waste can often be confusing as they may be dependent on factors other than the composition or possible after-use of various materials (Oelofse & Godfrey, 2008). Tsega (2013) argues that it is difficult to define waste because countries perceive waste differently, have different views on what

resorts under waste categories, and have different ways of reporting waste statistics. However, many countries have a comprehensive definition of waste yet no specific definition of 'solid waste' in their legislations. Lesotho's Ministry of the Environment, Culture and Tourism describes waste in its Environment Act No.10 of 2008 as "any substance that may be prescribed as waste or any matter, whether liquid, solid, gaseous or radio-active which is discharged, emitted or deposited in the environment in such volume, composition or manner which can cause an alteration of the environment" (Government of Lesotho, 2008). South Africa's National Environmental Management: Waste Act No. 59 of 2008 (Republic of South Africa, 2008) describe waste as "any substance that can be reduced, reused, recycled or recovered: that is surplus, unwanted, rejected, discarded, abandoned or disposed of which the generator has no further use of for the purpose of production, and must be treated or disposed". The New Zealand Waste Strategy defines waste as "...any material, solid, liquid or gas that is unwanted and/or unvalued and discarded or discharged" (Department of Environmental Affairs, 2012b). It is noteworthy that New Zealand and South Africa consider waste a renewable resource and not merely useless material (Oelofse & Godfrey, 2008; Department of Environmental Affairs, 2012b).

2.2.2 Open waste dumps

Various authors define open dumpsites using relatively similar wording. Studies conducted in India, Turkey, and the world's most polluted cities define an open waste dump as a land disposal site where the indiscriminate depositing of solid waste takes place with either no, or very limited, measures to control the operation or to protect the surrounding environment (Raman & Narayanan, 2008; Turan *et al.*, 2009; Mavropoulos *et al.*, 2014). Open dumps are characterized visually by an extensive spread of uncovered waste, open fires or occasional burning of waste, no records or inspection of incoming waste, no control of waste location, no covering nor compaction of waste, no minimal waste cover, unmanaged leachate discharged

into the surrounding environment, unmanaged odours, unorganized scavenging at site, no security, unrestrained waste management practices, visible rodents and vectors, open service policy, and complaints from residents (Mavropoulos *et al.*, 2015).

In the distant past when waste streams were simple, few environmental laws and land restrictions existed and open dumping was used as an economical and appropriate solution in most developing countries (Tsega, 2013). Currently, dump sites receive approximately 40% of the world's waste and serve about three and half to four billion people worldwide (Mavropoulos *et al.*, 2015). Open dumping is thus commonly practised in both low-income and upper- to middle-income countries (Mavropoulos *et al.*, 2015). Although strict regulations on the management of solid waste are in place in many developed countries, there are still reports of this primitive disposal method being used in countries such as Turkey and parts of South America (Turan *et al.*, 2009; Mavropoulos *et al.*, 2015; Srigirisetty *et al.*, 2017). Selecting and developing landfill sites have become extremely difficult operations in developing countries such as Lesotho, and this inability has led to the increased use of open dumpsites which are associated with several negative effects (Thoso, 2007; Khoetle, 2018).

2.2.3 Open waste burning

Open waste burning is also commonly practised to manage and dispose of waste, especially in developing countries and economies in transition such as China despite its deleterious effects on the environment and health (Zhang *et al.*, 2017). The Central Pollution Control Board in India defines open burning as “the combustion of any matter in such a manner that releases by-products directly into ambient air without passing through an adequate vent” (Kumari *et al.*, 2017, p. 1). Zhang *et al.* (2017, p. 543) describe open burning as “the unenclosed and uncontrolled combustion of flammable materials in an ambient environment”.

According to the United States Environmental Protection Agency (US EPA, 2012b), the open burning of waste is characterized by a form of low temperature combustion with high contaminant emissions, particularly of carbon black. A study in the United Kingdom (UK) revealed that black carbon is a component of particulate matter and the most effective component for absorption of solar energy (Reyna-Bensusan *et al.*, 2018).

Open burning of municipal solid waste contributes significantly to urban air pollution (Ali *et al.*, 2013; Srigirisetty *et al.*, 2017). According to the European Commission, the combustion of domestic waste and burning of waste at dumpsites are potential sources of high emissions of dioxins (Boman *et al.*, 2011; Ali *et al.*, 2013). The burning of waste is often associated with by-products caused incomplete burning. These emitted by-products include persistent organic pollutants, volatile organic compounds and heavy metals such as mercury, cadmium, lead and arsenic (Lundin *et al.*, 2013; Mavropoulos *et al.*, 2015; Wang *et al.*, 2017). China is documented as the country where the largest volumes of municipal waste are burnt, yet 30% of urban residents depend on this process (Wiedinmyer *et al.*, 2014; Zhang *et al.*, 2017). Mexico also has one of the highest rates of open dump burning and is considered a possible main emitter of 'black carbon' (Wiedinmyer *et al.*, 2014; Reyna-Bensusan *et al.*, 2018). In Lesotho, some of the waste pickers working on the dumpsites do not only collect waste for selling purposes, but they also use it as a source of biomass energy in residential areas (Mvuma, 2010). According to Candice-Joy (2011), satellite observations have identified Africa as a region where open fires are most persistent.

The determination of the amount of waste deposited on open dumps or in open areas is the most important information required for estimating emissions from open burning of waste (Kumari *et al.*, 2017). Even though it can be an important organic source of harmful emissions, waste burning is seldom included in current emission inventories used for chemistry and climate modelling applications (Wiedinmyer *et*

al., 2014). In South Africa, while urban areas may dispose of waste to managed landfill sites, there is a significant use of unmanaged sites, open dumps and open burning in urban informal, tribal and rural areas (Department of Environmental Affairs, 2014). Most countries, especially developing countries, usually lack statistics on waste burning activities, and this results in inadequate population and economic data that can be used as drivers to estimate the extent of waste burning practices (Candice-Joy, 2011; Kumari *et al.*, 2017). According to Zhang *et al.* (2017), such data are highly reliant on waste composition and burning conditions rather than on the prevalence of the act.

2.3 Solid Waste Management (SWM)

Waste management is the most important duty of municipalities even though different approaches are followed by country, region (urban or rural) and by type of waste managed (Filho *et al.*, 2016). Waste management is defined as “a sequence of activities that include collecting, transporting, processing, recycling and finally the disposal of waste” (Department of Environmental Affairs, 2012b). It is important that solid waste is collected efficiently from all sources, minimized and disposed of in controlled disposal facilities because, when left uncontrolled, commercial or residential waste is not only an aesthetic problem, but also poses serious health menaces (Wang *et al.*, 2017). Providing global access to adequate, safe and affordable municipal solid waste collection services and eliminating uncontrolled dumping and burning of waste are international strategic objectives which are an integral part of the United Nation’s Sustainable Development Goals to be achieved in all countries (United Nations, 2015).

The next section focuses on the types of solid waste, solid waste management processes, preferred waste disposal methods and waste recovery approaches in the developed and developing countries in Europe, America, Asia and Africa. Waste management systems and strategies in these countries were reviewed to align with

the objective to recommend safe and effective solid waste management approaches for Lesotho.

2.3.1 Types and sources of solid waste

The composition of municipal solid waste varies frequently and erratically (Zhang *et al.*, 2017). Studies conducted in the USA and China have identified the main constituents of solid waste as: food waste, paper, plastic, textiles, rubber, metal and glass, small quantities of hazardous waste such as electronics, automotive parts and discarded medicines and chemicals, and sometimes demolition and construction waste (MAHB, 2002; Zhang *et al.*, 2017). According to Ali *et al.* (2013), an additional source of waste that enters municipal solid waste stream is health care risk waste (HCRW) generated at hospitals, veterinary clinics, tattoo parlours and clinics. Electrical and electronic waste known as e-waste is also a type of waste that increases at a rapid rate. This waste has its own treatment principles and developing countries such as Lesotho are experiencing collection, handling, disposal and recycling challenges with these products (Sello, 2015; Liu *et al.*, 2015). A Canadian study revealed that, besides the increasing growth in weight and volume, the composition of municipal solid waste is becoming more complex (Ma & Hipel, 2016). The complexity of the waste stream directly complicates and affects its management, especially when hazardous waste is mixed with general waste (Department of Environmental Affairs, 2012b; Eberhard, 2018).

A consideration of the quantities and characteristics of the waste being generated is a key component in the development of sustainable, cost-effective solid waste management strategies (MAHB, 2002). The high organic content of a waste stream is influenced by the economy as well as the living standards and habits of residents (Othman *et al.*, 2013; Ally *et al.*, 2014). Solid waste in most developing Asian and African countries is characterized by large densities, high moisture content and greater composition of more degradable organic matter (Othman *et al.*, 2013) as

well as the odours that attract rodents and vectors that are common due to irregular waste collection (Ally *et al.*, 2014). Kolekar *et al.* (2016) observe that the relative percentage of organic waste in municipal solid waste in India generally increases with a decrease in socio-economic status. This could also explain why the proportion of recyclables is high in developed countries while degradable organic matter is high in developing countries (Ali & Sion, 2014).

2.3.2 Solid waste management processes

2.3.2.1 The waste management hierarchy

The successful implementation of the waste management hierarchy should be achieved sustainably. The waste management hierarchy is a globally accepted principle underlying waste policy which arranges waste management options in the following order: **waste avoidance and reduction, re-use, recycling, recovery, treatment, and disposal**. This ranges from the most preferred option to the least preferred option (Department of Environmental Affairs, 2012a; Filho *et al.*, 2016). The effective execution of the waste hierarchy largely depends on its translation into policy and legislation (Hoorweg & Bhada-Tata, 2012). The basis of management of waste is that it must be consistent from the point of generation to the point of final disposal by following a clear waste stream which is standard and acceptable (Government of Lesotho, 2016b). Therefore, municipal solid waste managers are mandated to collect waste from residents and urban centres in the most economic, socially acceptable, and environmentally optimal manner possible (Hoorweg & Bhada-Tata, 2012).

However, municipal solid waste management is still in its infancy in many low economic countries and this constitutes a serious problem as urban populations are growing (Ayninuola & Muibi, 2008; Filho *et al.*, 2016). In these countries institutional and policy frameworks, where they exist, are not in line with global best practices

(Ezeah & Roberts, 2012). Solid waste management is arguably the most important municipal service and should have preference to other services municipalities provide (Hoornweg & Bhada-Tata, 2012), but in developing countries such as Nigeria urban centres do not receive municipal waste disposal services (Babs-Shomoye & Kabir, 2016). According to Gurrero *et al.* (2013), collection and transportation of waste in Africa are the most important and costly aspects of the waste disposal process because of the labour intensity of the work and the extensive use of vehicles for collection and transportation. Urban centres in Lesotho are confronted with a chronic problem and only a fraction of the population receives waste collection and proper disposal services (Thoso, 2007). It is common to see refuse being dumped along major roads and highways where it becomes a nuisance (Babs-Shomoye & Kabir, 2016).

Another challenge associated with solid waste management is that waste management solutions in one region might not be appropriate elsewhere. For example, incineration and anaerobic digestion used in many developed countries are used to a limited extent in developing countries because of their high costs and stringent operating requirements. Moreover, the development of an advanced waste management infrastructure is and will only be viable for a short period of time as most developing countries cannot afford the operation, running and maintenance of such equipment (Marshall & Farahbakhsh, 2013; Filho *et al.*, 2016). In the USA, most MSW is handled in one of three ways: landfilling (53.8%), recycling (34.5%), and incineration (11.7%) (US EPA, 2012a; Liu *et al.*, 2015), while many developing countries rely mostly on the less preferred waste management option in the waste hierarchy which is waste landfilling. Moreover, waste dumping and burning are still continuing problems in developing countries (Filho *et al.*, 2016).

2.3.2.2 Waste generation

The increased generation of waste in the Lesotho Lowlands has occurred as a result of rural-urban migration (Filho *et al.*, 2016). Several studies have identified that an increasing population, economic growth, increased well-being, and rapid urbanization are significant factors that exacerbate waste generation in urban areas. This is a common development challenge which has been identified by studies in South Africa, Europe, Malaysia and India (Department of Environmental Affairs, 2012a; Maasikmets *et al.*, 2015; Permana & Ho, 2015; Srigirisetty, 2017). In contrast, Lesotho has been challenged with increasing poverty and a declining formal labour force of up to 24%. These challenges have been caused by subsiding job opportunities and an extensive return of ex-miners from South African mines that have encouraged the growth of informal businesses. The latter sector tends to cluster entrepreneurs in commercial areas and at transport hubs in urban areas where waste generation seems to increase at an alarming rate which, in turn, puts pressure on waste management facilities that are already in short supply and under pressure in urban areas (Department of Environmental Affairs, 2012a; Government of Lesotho, 2014 & 2016b).

Many countries have witnessed an explosive population growth accompanied by rising urbanization and diversifying, growing consumption for the last two centuries (Zhang *et al.*, 2017). As a result, current global municipal solid waste generation levels are between 1.3 and 1.9 billion tonnes per year. These figures are expected to increase to approximately 2.2 billion tonnes per year by 2025 in developing and transitional countries (Miezah *et al.*, 2015; Mavropoulos *et al.*, 2015; Filho *et al.*, 2016). Hoornweg and Bhada-Tata (2012) predicted in 2012 that waste generation rates would more than double over the following twenty years in lower income countries. High-income countries such as Australia, Japan, Hong Kong, China, the Republic of Korea and Singapore produce between 1.1 and 5.0 kg of waste per capita/day. These are estimated figures as, despite the importance of planning,

reliable global municipal solid waste information is not always available or reliable. Data are often inconsistent, incomparable and incomplete. However, it was stated in a study conducted in Pakistan that there was enough municipal solid waste information available to estimate global amounts and trends (Ali *et al.*, 2013). In Africa, data on municipal solid waste generation and composition are available for only a few selected cities, most of which are over a decade old (Miezah *et al.*, 2015).

2.3.2.3 Waste storage

Most developing countries have no regulations pertaining to the type of containers to be used for packaging household waste, therefore many countries resort to whatever they find useful or convenient (Mavropoulos *et al.*, 2015). According to Bulane (2009), there are inadequate and inaccessible waste receptacles in Lesotho, therefore transfer stations or depots must be established in urban areas for effective collection and disposal of waste (Bulane, 2009). Industrial concerns are provided with bigger containers for refuse disposal that are supposed to be emptied regularly, while industries and institutions such as hospitals and government complexes are provided with separate waste collection receptacles (Thoso, 2007; Bulane, 2009; Hapazari *et al.*, 2015). Other developing African countries such as Mozambique use the least expensive type of disposal receptacles such as plastic bags and buckets of various sizes, cans and cardboard boxes. These various shapes and sizes of receptacles complicate waste collection and contribute to unsanitary conditions in urban centres where the collection of municipal solid waste is concentrated (Mavropoulos *et al.*, 2015). Guerrero *et al.* (2013) indicate that the inadequate supply of waste containers and lengthy distances to these containers increase the probability of waste dumping in open spaces and along roadsides in Africa. In South Africa, the disposal of waste at landfill sites can be done directly from source or from temporary community collection point storage areas such as skips, bunkers, trailers and open lots (Rasmeni & Madyira, 2019).

2.3.2.4 Waste collection

Lesotho's urban councils are mandated to provide waste collection services; however, these services are fraught with challenges (Thoso, 2007; Bulane, 2009; Government of Lesotho, 2016b). Efficient refuse collection is mostly complicated by poor access roads which make door-to-door collection difficult. This problem is exacerbated by the long distances travelled for each trip to disposal sites, a shortage of collection vehicles, increasing labour inefficiency, and other technical problems experienced in many cities in developing countries (Guerrero *et al.*, 2013; Mavropoulos *et al.*, 2015). In Nigeria and Zimbabwe collection may not be carried out in slums due to a lack of space for waste containers, narrow roadways, steep gradients, and unsurfaced roads that standard collection vehicles cannot manage. Therefore, collection systems for urban and peri-urban areas in developing countries must be designed to accommodate the particular conditions of the community (Ayininuola & Muibi, 2008; Jerie, 2013; Gumbi, 2015).

Many metropolitan municipalities collect less than half the waste that is generated which is usually blamed on the cost of collection (Filho *et al.*, 2016). In these areas collection services usually cover the central, built-up inner-city areas and sometimes suburban areas, but peri-urban areas are rarely serviced (Mavropoulos *et al.*, 2015). Filho *et al.* (2016) indicate that, in European countries, the average collection coverage is estimated at 41% in lower-income countries and 85% in upper-middle income countries. In most African countries and India, collection costs represent 80 to 90% and 50 to 80% of municipal solid waste management budgets in low-income and middle-income countries respectively (Das & Bhattachannya, 2015).

2.3.2.5 Waste transportation

Transportation of waste is an important aspect of municipal solid waste management and is usually linked with waste collection (Bulane, 2009). In Peru,

decisions pertaining to municipal solid waste management can typically be classified into three levels: strategic, technical and operational (McAllister, 2015). In China, waste management is focused on collection, planning, transport routes and internal logistics. Transportation problems have been identified as some of the most difficult operational problems to manage in an integrated waste management system (Bing *et al.*, 2016). Waste collection in South Africa is typically carried out using a conventional motorised collection vehicle-based system that usually utilizes compactor vehicles. However, despite most municipalities' efficiency in waste collection, many experiences a shortage of vehicles and equipment. Those that operate with fifteen or more vehicles perform better in terms of vehicle productivity and utilization (Department of Environmental Affairs, 2012a; Gumbi, 2015). Conversely, in Lesotho waste remains generally unattended because of transport problems and this results in solid waste usually being dumped illegally in open spaces. It is also burnt, which causes widespread pollution (Bulane, 2009; Khoeshe, 2018).

2.3.2.6 Waste disposal

There are several methods of waste disposal, but landfilling remains the most preferred method in most developing countries such as Ethiopia and transiting countries such as China (Ebistu & Minale, 2013; Zhang *et al.*, 2017). A study that was conducted in the UK by Filho *et al.* (2016) found that landfilling was not the best method as it was associated with the production of leachate, the emission of pollutants, and land scarcity due to development, urbanization and population increase. However, a study that was conducted in Delhi, India, confirms that, although landfilling of solid waste is the least preferred option in the waste management hierarchy, it remains the primary method of managing municipal solid waste in this region and may continue to do so for a foreseeable time in other developing economies as well (Ramaiah *et al.*, 2017). This is true because the efforts of municipal waste management sectors in these nations have focused

mainly on waste disposal alternatives and not on waste minimization (Department of Environmental Affairs, 2009; Department of Environmental Affairs, 2012a). In fact, it is argued that sanitary landfilling is an ideal disposal method despite the disadvantages associated with it (Tchobanoglous *et al.*, 1993; Filho *et al.*, 2016). Therefore, whenever environmental and ecological solutions are provided or modelled, landfilling needs to be one of those vital options (Filho *et al.*, 2016).

Waste in developing countries is rarely landfilled as it is discarded on dumps (Nyarai, 2016). Since ancient times, open dumpsites have been a commonly used solid waste disposal method in many parts of the world (Sankoh, 2013). Currently many African countries, except South Africa, have a limited number of engineered landfills and therefore these nations rely on open dumping for waste disposal (Ebistu & Minale, 2013). In South Africa there are about 2 000 waste facilities. Of these, 27% is licensed and only 44% (350) is recognised as private and public landfill sites (Department of Environmental Affairs, 2009). It has been documented that most of the unlicensed disposal sites operate like waste dumps as they are not maintained or operated in accordance with established Minimum Standards (Department of Environmental Affairs, 2009 & 2012a; Roberts, 2013). Open dumping in an area symbolises deterioration, disorder and poorly rendered services by municipal authorities as these practices are unscientific, outdated and associated with serious health and environmental effects (Sankoh, 2013; Department of Environmental Affairs and Development Planning [DEADP], 2017). Open dumping is usually caused by the higher cost of landfilling as it is virtually free but generally regarded illegal (Ramaiah *et al.*, 2017), hence it is vital to embark on waste recovery strategies to minimize this practice.

2.3.2.7 Energy and waste (recycling, non-thermal treatment, and waste-to-energy practices)

Resource recovery is described as a positive outcome from waste disposal (Garnett *et al.*, 2017). According to the National Environmental Management: Waste Amendment Act No. 26 of 2014 (Republic of South Africa, 2014), waste recovery is “the controlled extraction of a material or the retrieval of energy or any substance, material or object from waste to produce a product”. In Lesotho, the Ministry of Tourism, Environment and Culture has called for more intensive efforts to convert waste management into business opportunities in order to alleviate unemployment and boost economic growth while improving environmental conditions (Sello, 2015). It is undeniable that environmental conditions can be improved by the recycling of waste.

Waste recycling is essential for the reduction of waste volumes deposited on landfills, environmental pollution, and the creation of informal employment opportunities (Scheinberg *et al.*, 2010; Ali & Sion, 2014). Recently, the role of the informal sector in municipal solid waste management has been widely recognized (Abba *et al.*, 2013). Waste picking by the informal sector is common in Asian and Latin American cities where 2% of the population depends on waste picking for their livelihood (Gutberlet, 2013). In urban China, this number is approximately 3.3 to 5.6 million which is 0.56 to 0.93% of the urban population (Linzner & Salhofer, 2014). Waste pickers recover recyclables from the streets, waste receptacles, open dumps and landfill sites and in thus paper, glass and metals are the main recyclables that are sold to waste recovery companies (Abba *et al.*, 2013). However, in China it has been shown that, despite the huge benefits of recycling, the costs associated with recycling are significantly high as waste collection, transfer and transport comprise the major parts of the total cost, reaching as high as 70% of the overall management expenses (Naustdalslid, 2014). This could be one of the reasons for low recycling rates in developing countries, especially in Africa (Ferreira *et al.*, 2017). Recycling

is not always the best option to reduce waste, and thus an alternative disposal strategy is non-thermal treatment or composting.

Non-thermal treatment such as anaerobic digestion and composting has become a highly acceptable option for waste management, especially in terms of the reduction of landfill waste. This is true especially in European countries such as the UK (Garnet *et al.*, 2017). Composting is described as “the biological process of breaking up organic waste such as food waste, manure, leaves, grass trimmings, paper worms and general house hold wastes into an extremely useful humus-like substance by various micro-organisms including bacteria, fungi and actinomycetes in the presence of oxygen” (Ladan, 2014, p.11). However, it has been reported that urban managed composting programmes have not been very successful in most developing countries due to the high operation and management costs, high transportation costs, poor understanding of the composting process, the poor quality of end product and their low market value that is greatly affected by competition from chemical fertilizers (Nyarai *et al.*, 2016; Garnet *et al.*, 2017). A few Asian countries such as China and countries in eastern Asia have successfully utilised composting activities on a large scale, whereas composting projects have not been successful in Africa and Latin America (Pandyaswargo & Premakumara, 2014; Garnet *et al.*, 2017).

In industrialized countries, **waste-to-energy recovery** to reduce waste volumes is very common. There are more than 200 energy recovery plants in fourteen European countries that manage about 23% of MSW, while 89 waste-to-energy plants operate in 27 states in the USA (Liu *et al.*, 2015). Incineration technology is the most commonly used method for municipal solid waste management in cities such as Tokyo for heat and power production (Laohalidanond *et al.*, 2015). Liu *et al.* (2015) argue that one of the benefits of incineration is waste volume reduction; however, incineration fly ashes and bottom ash quantities are suitable for only a few selected countries. In Sweden, which is a highly developed country, approximately

48 to 51% of municipal waste is incinerated and these incineration plants produce about 14.7 terawatt-hour (TWh) of district heating and 2.3 TWh of electricity, which makes incineration of waste an important waste management method in this region (Sundqvist & Miljoinstitutet, 2017). In the UK, emerging advanced thermal treatment technologies are being considered by some local authorities as their impact appears to be less invasive (Garnett *et al.*, 2017).

2.3.3 Solid waste management systems

Globally, most countries where solid waste management systems exist are facing challenges with it, while other countries have only drafted and not implemented such systems. Tchobanoglous *et al.* (1993) describe six functional elements of a solid waste management system: waste generation, processing at the source, collection, transformation of solid waste, transfer and transport, and finally disposal. Solid waste management is not only a challenge for underdeveloped nations, but often also fails even in developed countries (Scheinberg *et al.*, 2010). Many municipal waste management systems and existing technologies or amenities in European countries are ageing and need to be upgraded to meet demands (Filho *et al.*, 2016). The reason for the failure of waste management systems is that they are not financially sustainable, particularly because of high collection costs (Republic of South Africa, 2014). Currently, the Maseru City Council in Lesotho assigns staff members by electoral wards to work in association with District Councillors to assist community members so set up ward specific solid waste management systems (UNEP, 2008; Government of Lesotho, 2012). In order for municipalities to change from unsustainable waste management systems to more environmentally friendly alternative waste management technologies, they need to have an integrated solid waste management plan (ISWMP).

2.3.4 Integrated solid waste management planning (ISWMP)

It is essential that municipal solid waste management planning should be done by following an integrated approach (Scheinberg *et al.*, 2010). Several studies have described and stipulated the constituents of such an approach. For instance, according to Tchobanoglous *et al.* (1993), an Integrated Solid Waste Management Plan (ISWMP) constitutes the selection and application of suitable techniques, technologies and management programmes to achieve sound solid waste management objectives and goals. Such a plan needs to consider the nature of wastes, waste generation realities, as well as current treatment and disposal methods. It should also determine priorities for improvement, adhere to legislation and regulations, consider waste minimization, consider effective waste treatment and disposal techniques, and aim at economic sustainability (Republic of Botswana, 1998). Ayininuola and Muibi (2008) argue that urban solid waste management planning has to address several inter-reliant issues such as public health, the environment, the impact on society, and incentives for those participating in the recycling sector in developing countries. Lederer *et al.* (2015), who conducted their study in Uganda, state that such a strategy or plan requires some level of knowledge among all stakeholders involved, and therefore cooperation with the public is crucial when this plan is devised.

The implementation of an integrated waste management plan is recommended for all municipalities to ensure efficient waste management (Fayez, 2012). In South Africa, most municipalities have an IWMP, but there are still some challenges, particularly with regards to shifting from waste disposal to waste reduction as 90% of the waste generated in South Africa is still ending up in landfills (Department of Environmental Affairs and Tourism, 2007; Department of Environmental Affairs, 2012b; Department of Science and Technology, 2014; Sango *et al.*, 2016). This has been linked to the lack of capacity and knowledge to efficiently carry out an integrated waste management strategy (Fayez, 2012). Even though training

manuals for municipal solid waste management planning exist, a feasibility study still needs to be carried out as a form of knowledge creation for integrated planning (Ahsan *et al.*, 2014; Lederer *et al.*, 2015).

2.4 Solid Waste Management Challenges

Various waste management challenges exist that hamper the efficient handling of solid waste. The aspects that will be discussed include financial, institutional, educational and technical constraints.

Managing municipal solid waste is a labour-intensive service and most councils are struggling to develop adequate means to cope with the solid waste that is generated in both urban and rural areas (Hoorweg & Bhada-Tata, 2012). Several studies that were conducted in African, Asian and some European states have identified variables that exacerbate these challenges. Authors have categorized these challenges as financial, institutional, legislative, educational, technical and operational constraints that hamper effective solid waste management, particularly in developing countries (Igbinomwanhia & Ohwovoriole, 2012; Hoorweg & Bhada-Tata, 2012; Abba *et al.*, 2013; Gurrero *et al.*, 2013; Lohri *et al.*, 2014; Permana & Ho, 2015; Filho *et al.*, 2016). The Government of Lesotho (2012) also indicates that developmental constraints that impact waste management in this country are negatively associated with the incapacity of urban councils and the Ministry of Local Government and Chieftainship to manage urban development. An associated problem is their inability to keep track of the growing population and industrialization. This section will focus on the main challenges in relation to MSW management in developed and developing countries in Europe, South America, Asia, and Africa, with specific reference to Lesotho. The reviewed articles assisted the researcher in meeting the objective of assessing social, environmental and economic factors that encourage open dumping and the burning of solid waste.

2.4.1 Financial constraints

Financial sustainability to fund municipal solid waste management continues to be a major challenge in cities in developing countries (Lohri *et al.*, 2014) where there is lack of proper use of economic instruments to support waste management (Guerrero *et al.*, 2013; Government of Lesotho, 2016a). Governments in many African countries provide inadequate financial support to municipalities (Guerrero *et al.*, 2013). In these countries an estimated of 20 to 40% of municipal funds spent to manage waste is barely enough to handle escalating volumes of solid waste (Othman *et al.*, 2013; Filho *et al.*, 2016). It has been reported that urban councils, in particular the Maseru City Council in Lesotho, are not financially independent which is due to the fact that the Council lacks the ability to generate adequate payment of rates charged for services (Lebentlele, 2002; Government of Lesotho, 2016a). Financial constraints that cause poor and ineffective waste management in many developing African countries is partly linked to the economic development status of specific countries such as Zimbabwe (Muswere & Rodic-Wiersma, 2017). Most African governments are embarking on strategies to fight poverty, but unfortunately the gap between the rich and the poor is large and growing inequality is escalating, which impacts the provision of basic services to the poor (Likotsi, 2013). In African countries such as Nigeria, Ghana and Lesotho, higher and middle-income earning residents are receiving better services than poor residents who, due to limited income, either avoid paying for services or their needs are overlooked by municipalities due to low budgets available for waste disposal. This is one of the reasons why solid waste is dumped in urban areas (Igbinomwanhia & Ohwovoriole, 2012; Likotsi, 2013; Miezah *et al.*, 2015).

2.4.2 Institutional constraints

Solid waste management is usually the responsibility of local governments and often consumes over half of municipal budgets, particularly in developing countries

(Hoorweg & Bhada-Tata, 2012). In Nigeria, several departments have been created at state level so partially be involved in solid waste management. One such department is the Environmental Health Department (Igbinomwanhia & Ohwovoriole, 2012). Solid waste management involving street sweeping is also often the single largest source of employment in developing cities (Hoorweg & Bhada-Tata, 2012) because local governments' environmental departments have the responsibility to pick up and transport solid waste from public places to dumpsites (Igbinomwanhia & Ohwovoriole, 2012). In this context McAllister (2015) advises that appropriate distribution of responsibilities, authority and revenues between national, regional and local governments be determined so that waste management programs may succeed and be effective.

However, various common problems prevent institutions from providing effective waste management services (Garnett *et al.*, 2017). For instance, Lesotho's councils are given a huge scope of responsibilities despite them facing a significant shortage of staff, and these challenges hinder them from achieving their goals (Lebentlele, 2002). The absence of effective legislation for solid waste management is also to some extent related to unclear definitions of functions in local municipalities (Igbinomwanhia & Ohwovoriole, 2012). There is a persistent lack of control of land use through legislature which has led to conflict of land use. This has impacted the selection of suitable disposal sites over settlements in Lesotho in particular because land in this kingdom is communal and is controlled by chiefs (Morake, 2010). The lack of total independence is another factor that has negatively impacted the performance of councils as, in most cases, they do not have the authority to make decisions. This is a common challenge in Lesotho (Lebentlele, 2002; Government of Lesotho, 2016a). Another challenge is the lack of coordination of resources by municipalities which often results in repetition of work, wastage of resources, and unsustainable solid waste management programs (Garnett *et al.*, 2017).

2.4.3 Technical constraints

Many studies have indicated that the majority of developing countries such as Nigeria and Lesotho still use outdated systems and have not embarked on the latest technologies to combat solid waste management with strategies like those used in developed countries. It seems that human resources in charge of solid waste management are not equipped with the necessary technical skills for solid waste management planning and operation and, in particular, they lack the technical background and training in engineering and management (Ogawa, 1996; Iyeke & Nena, 2012). In most developing countries, including Lesotho, there is no formal training program to capacitate people in any position, from administrators to general waste workers. Moreover, communication is poor and this hinders sustainable solid waste management planning and implementation (Government of Lesotho, 2014; Tello-Espinoza *et al.*, 2010; Filho *et al.*, 2016). Poorly designed infrastructure as well as steep gradients and unsurfaced roads, combined with inadequate equipment and ageing vehicle fleets, also hamper the development and effectiveness of waste management programs (Iyeke & Nena, 2012; Guerrero *et al.*, 2013; Filho *et al.*, 2016).

2.4.4 Educational constraints

A major constraint that is prevalent throughout the developing world is the lack of education which results in limited awareness of effective waste-management practices (McAllister, 2015). Sensitisation and awareness are key concepts in the initiation, development and implementation of any activity (Government of Lesotho, 2012). According to Lohri *et al.* (2014), the role of communities in solid waste management must be acknowledged and actively sought as citizens are great agents of change. Unfortunately, the public has often either been excluded from waste management decision-making or involved too late (Garnett *et al.*, 2017), and thus people's apathetic behaviour has become a norm and they refrain from taking

part in any decision-making processes or waste reduction initiatives due to a lack of interest (Lohri *et al.*, 2014). Khoeshe (2018) reports that the Maseru City Council is battling to create environmental awareness and influence behavioural change among residents. Urban councils are urged to cooperate with the Ministry of Tourism, Environment and Culture and to run awareness campaigns that focus on solid waste management by using suitable multimedia strategies (Government of Lesotho, 2012). To date, such programmes have either not come off the ground or have been ineffective.

Environmental awareness and conservation are positively affected by the public's supportive attitude, but this can only be achieved if knowledge about waste management is sound (Filho *et al.*, 2016). The social status of solid waste management workers in developing countries such as Nigeria, Peru and Lesotho is normally low, and waste management is negatively impacted by societies who believe that only a certain social class is accountable for solid waste management (Agunwamba, 1998; McAllister, 2015). These perceptions have led to a low self-esteem among ordinary workers, especially among general waste workers, which in turn have resulted in low work ethics, inadequate labour, and poor quality of work (Filho *et al.*, 2016). It is therefore crucial that authorities take steps to align the information presented to the public with the knowledge these individuals already have (McAllister, 2015) in order to combat the negative perceptions of society regarding work that involves the handling of solid waste (Filho *et al.*, 2016).

2.5 Impacts of Open Dumping and Waste Burning on Health and the Environment

This section will focus on global environmental impacts that are experienced in the vicinity of landfills and dumpsites. Studies have revealed a variety of adverse environmental impacts of solid waste dumping and burning practices in developed and developing countries in Europe, the Americas, Asia and Africa.

Globally, dumpsites have contributed significantly to air, land and groundwater pollution. As a consequence, dumps have attracted a lot of attention because of the devastating health and environmental impacts associated with them. Moreover, open dumping on the outskirts of many cities has resulted in the degradation of the chemical and geotechnical properties of land resources that would otherwise have been suitable for development (MAHB, 2002; Sriririsetty *et al.*, 2017). After a couple of years, a dumpsite undergoes biologically, chemically and hydrologically facilitated changes that result in a break-down process of solid waste (Oyelami *et al.*, 2013). Studies conducted in Nigeria and India have confirmed that leachate trickles from waste sites or landfills and releases pollutants from sediments that contaminate groundwater resources (Oyelami *et al.*, 2013; Sriririsetty *et al.*, 2017). According to Zhang *et al.* (2017), open burning of municipal and industrial waste is a major source of dioxins and accounts for about 48% of the total dioxin emission in China. Uncontrolled disposal of hazardous and healthcare waste, as well as manual on-site treatment by informal workers and the disposal of e-waste, results in public health impacts such as respiratory ailments and infectious diseases like dengue fever in highly populated cities in the world (Hoornweg & Bhada-Tata, 2012; Mavropoulos *et al.*, 2015).

2.5.1 An international perspective

Globally, open dumping and burning practices have resulted in various issues of concern such as air pollution, deforestation, and desertification (Wang *et al.*, 2017). Open waste burning releases harmful aerosols, but this threat has been largely disregarded until recently (Wiedinmyer *et al.*, 2014). Open dumpsites accumulate landfill gases (mainly methane) that often cause fire outbreaks. This contributes to the degradation of air quality and climate alteration (MAHB, 2002; Wang *et al.*, 2017). Zhang *et al.* (2017) illustrated that depletion of the ozone layer due to East Asian forest fires reached into the stratosphere. Countries that rank high in open

burning gaseous emissions include China, India, Brazil, Mexico, Pakistan and Turkey (Wiedinmyer *et al.*, 2014). The World Health Organization (WHO) (2016) indicates that, of the 50% of the world's most polluted cities, 20 are in India, which is a clear testament to the intensity of the air pollution problem in this country (Kumari *et al.*, 2017). It is noteworthy that, during the lockdown period in India due to the Corona (Covid-19) pandemic outbreak in 2020, significant reductions of visible air pollution in India's largest cities occurred as vehicles stayed off the road, construction activities were on hold, factories halted production, levels of harmful microscopic particulate matter decreased (PM 2.5), and nitrogen dioxide (N₂O) levels dropped (Davidson, 2020).

Waste dumps in urban areas are not only an aesthetic problem, but also pose serious implications for those living in their vicinity (Wang *et al.*, 2017). Although there is a lack of systematic long-term epidemiological studies that have fully documented the health implications caused by dumpsites, existing scientific evidence has revealed very important health risks associated with these dumps (Mavropoulos *et al.*, 2015). For instance, the collapse of a seven-storey high open dump in July 2000 near Quezon City, Manila, caused the death of hundreds of people. This was evidence of the direct hazard posed by uncontrolled dumping (MAHB, 2002). In a study conducted in 3 000 human settlements globally by WHO to determine exposure to ambient air pollution and to estimate disease burden and resultant deaths, it was found that Western Pacific, South East Asian, and European regions bore most of the burden with 1.1 million, 799 000 and 269 000 deaths respectively (WHO, 2016). Mavropoulos *et al.* (2015) suggests that stakeholders worldwide should work together to speed up programs, initiatives and investments needed to eradicate dumpsites globally.

2.5.2 An African perspective

Waste that is generated in African countries is mostly organic. It therefore decomposes and releases a bad odour which causes major problems in the environment, especially when the air that people inhale reek (Sankoh *et al.*, 2013). After a couple of years dumpsites undergo biological, chemical and hydro-mediated modifications due to the weathering process of the refuse and, consequently, the dumps become a source of pollutants (Oyelami *et al.*, 2013). Dumpsites emit obnoxious odours and smoke that cause illnesses in people who live in their proximity (Sankoh *et al.*, 2013). Moreover, biomass burning emissions contribute to the increasing degradation of air quality due to elevated levels of aerosols and trace gases, and this has significant health effects for humans and even animals (Candice-Joy, 2011). These dumps are often in a state of combustion and thus pollute the surrounding atmosphere with trace gas and aerosol emissions that have a significant effect on health and on the climate and may even result in climate variability (Harley, 1990; Candice-Joy, 2011; Friedrich, 2013).

Many studies have revealed that waste dumps are associated with communicable diseases in African countries (Gouveia & Ruscitto, 2010; WHO, 2016). Inappropriate disposal of solid waste can be detected by contamination of surface and ground water through leachate and soil contamination (Ebistu & Mainale, 2013). A study that was conducted at Dandora Waste Dump in Kenya evaluated the link between this dump site and public health effects and evidence was found of microbial contamination (Mberu *et al.*, 2019). Similarly, Yongsi *et al.* (2008) conducted an epidemiological study to examine the health risks associated with different waste disposal systems in Cameroon. The study found a 14% diarrheic prevalence among the respondents and a strong statistical association between household waste management methods and incidences of diarrhoea among the respondents (Sankoh *et al.*, 2013). It is a fact that organic municipal waste degrades and that this creates favourable conditions for microbes to survive and for microbial

pathogens to grow. Direct and unprotected handling of solid waste can result in various types of infectious and chronic diseases that affect especially waste workers and children living in the vicinity of dumps (Sankoh *et al.*, 2013). Gouveia and Ruscitto (2010) state that a wide range of health problems associated with waste dumps are respiratory problems; irritation of the skin, eyes and nose; gastrointestinal problems; psychological disorders; and allergies. Pollutants deposited on land usually enter the human body through the medium of contaminated crops, animals, food products, or water (Sankoh *et al.*, 2013). Air ambient pollution caused by waste burning was a major factor that caused disease burden among and the mortality of 211 000 people in Sub-Saharan Africa (WHO, 2016).

2.5.3 Lesotho

In Lesotho, marginalized and poverty-stricken communities are highly prevalent and this has hindered the distribution of basic services to thousands of people. It is particularly in the areas of safe water supply and proper sanitation that major issues are experienced (Motsoene, 2014). Due to the stagnant nature of urban development in the country, most waste management operations are limited to urban (administrative) centres where production and commercial activities are prominent. This has negatively impacted the health of people and the environment in urban areas in general (Government of Lesotho, 2000b; Motsoene, 2014). There are some human health risks associated with solid waste handling and disposal in all countries (Bulane, 2009), but in Lesotho these risks are particularly evident. Cointreau (1982), Bulane (2009) and the World Health Organization (2013) have classified the threats into four main categories: (1) the presence of human faecal matter; (2) the presence of potentially hazardous industrial waste; (3) the decomposition of solids into constituent chemicals that contaminate air and water systems; and (4) air pollution caused by constantly burning dumps and methane gas emission. At a recent solid waste management forum organised by the Maseru

City Council at Manthabiseng Convention Centre, the Council's Health and Environment Director, Maseitshiro Khooe, stated that strategies were required to control littering, illegal dumping, the burning of diapers, public urinating, and open defaecation (Khoeshe, 2018). In 2014, the Maseru City Council embarked on the Hlabahlabane Community Day program during which staff visited communities to collaboratively clean up their residential areas. However, in the end all the cleaning was done by the employees and not by the residents, which defeated the purpose of reducing the risk of disease outbreaks in a sustainable manner (Khoeshe, 2018).

2.6 Solid Waste Management Legislation

Waste management is guided by specific legislation that may differ from country to country. This section discusses waste management related legislations that are employed internationally, in African countries, and in Lesotho.

Globally, most countries have formulated legislation that guides solid waste management. These legislations are often diverse in terms of how they exercise and regulate laws in their respective countries. According to Liu *et al.* (2015), countries do not share identical circumstances as they differ in terms of political systems, industrial policies, major commercial activities, topography, and solid waste problems. For these reasons they also differ in environmental standards. An important purpose of environmental regulations is to regulate the use of resources to ensure minimal impact on the environment and human health (Liu *et al.*, 2015). Thus, the aims of any legislation will not be achieved if it is not properly implemented and enforced (Chinwe, 2010; Jerie, 2013).

Waste legislations, and solid waste legislation in particular, is applied in European, American, Asian and African countries. A review of the various waste legislations is presented to meet the objective of assessing current waste management legislation

that prohibits open dumping and burning practices, with specific attention to an evaluation of public compliance with these waste management legislations.

2.6.1 An international perspective

Tables 2.1, 2.2 and 2.3 summarise current international waste legislations with specific attention to Lesotho.

Table 2.1: Waste management legislations applicable to European Union, North and South American and Asian countries

COUNTRY	LEGISLATION	SOURCE
EUROPE		
The European Union	Waste Framework Directive (1970) Hazardous Waste Directive (1970) Landfill Directive (1999/2001) Waste Shipment Regulation (2006) Directive 1999/31/EC (Landfill of Waste) Directive 2006/21/EC (Management of Waste from Extractive Industries) Decision 2000/532/EC amended by the Framework Directive 2008/98/EC (List of Waste and Hazardous Properties)	Liu <i>et al.</i> , 2015; European Commission, 2005
Ireland	Waste Management Act of 1996	Lown, 2003
Russia	Federal Law No. 458 of 2014 Federal Law No. 89 of 1998; amended (29 th December 2000, 10 th January 2003, 18 th December 2006 and 8 th November 2007.	Shaposhnikova, 2015; Yelsin, 1998
Turkey	Law on Environment No. 2872 of 1983 and amendment into Law on Environment No. 5491 Solid Waste Control Regulation (1991) Law on Metropolitan Municipalities No. 5216	Turan <i>et al.</i> , 2009; Goren and Ozdemir, 2011

	<p>Municipal Law No. 5393</p> <p>Law on Municipal Revenues No. 2464 (CTV)</p> <p>Turkish Penal Code No. 5237</p> <p>Waste Management Regulation (26739th Official Gazette) of 2008</p> <p>Regulation of Solid Waste (20834th Official Gazette).</p>	
NORTH AND SOUTH AMERICA		
The United States of America	<p>The US EPA</p> <p>The Solid Waste Disposal of 1965</p> <p>The Resource Conservation and Recovery Act 1976</p> <p>Federal Facility Compliance Act of 1992</p> <p>Land Disposal Program Flexibility Act of 1996</p>	<p>Lown, 2003;</p> <p>Jay, 2010</p>
Brazil	<p>Law 6.938 of 1981</p> <p>Law 7,347 of 1985</p> <p>Law 9,605 of 1998. Amended by Law 12,305; 2 August 2010 when the Brazilian National Policy on Solid Waste was established.</p> <p>Law 9,795 of 27 April 1999</p> <p>Law 9,966 of 28 April 2000</p> <p>Law 9,974 of 6 June 2000</p> <p>Law 10,650 of 16 April 2003</p> <p>Law 11,107 of 6 April 2005</p> <p>Law 11,445 of 5 January 2007</p> <p>Law 12.305 of 2010</p>	<p>Pereira <i>et al.</i>, 2010;</p> <p>Bellan <i>et al.</i>, 2012</p>
ASIA		
Thailand	<p>Enhancement and Conservation of National Environmental Quality Act, B.E. 2535</p>	<p>Ali & Sion, 2014</p>

Taiwan	Waste Disposal Act of (July) 1974; amended March 1997 Recycling Regulations of 1988	Taiwan Environmental Protection Administration, 2002
Japan	National Government develops the Fundamental Policy for Waste Reduction; The Development Plan of Waste Treatment Facilities <u>Programs for Recycling</u> ; Laws on solid waste minimisation: 1. Waste Reduction Law of 1997 2. Law for the Effective Utilization of Resources of 2000 <u>Laws for Recycling</u> 1. Containers and Packaging Recycling Act of 1995 2. Green Purchasing Act of 2000	Ali & Sion, 2014
Korea	Water Environment Conservation Act No. 14532 of (January) 2017. Amendment No. 15194 (December) of 2017. Natural Environment Preservation Act No. 13724 of 1992 Comprehensive Plan for the Resourcification of Food Waste of 1998 Act on the Promotion of Saving and Recycling of Resources: Act No 6632 (February) 2002; amended to Act No. 15101 (November) of 2017.	Ali & Sion, 2014; Lee, n.d
Malaysia	Local Government Act of 1976 Site, Drainage and Building Act No. 133 of 1974 Town and Country Planning Act No. 172 of 1976 <u>Strategies</u> National Strategic Plan for Solid Waste Management 2002 National Solid Waste Management Policy of 2006	Manaf <i>et al.</i> , 2009; Ali & Sion, 2014; Agamuthu & Dennis, 2011

	Solid Waste and Public Cleansing Management Act No. 673 of 2007	
Vietnam	<p>Action Plan - Green Aid Plan</p> <p><u>Programs of Recycling</u></p> <p>Laws of Solid Waste Minimisation:</p> <p>1. Environmental Protection 1989, amended 1994</p> <p>Directive on Urgent Measures on Solid Waste Management in Urban & Industrial Areas, 1997</p>	Ali & Sion, 2014
Singapore	<p><u>Recycling:</u></p> <p>Environmental Public Health Act (Public Cleansing) of 1970</p> <p><u>Programs of Recycling:</u></p> <p>1. Licensing Solid-Waste Collectors, 1989</p> <p><u>Guidelines and Handbooks on Recycling</u></p> <p>Educational Materials and Milieu</p>	Oelofse & Godfrey, 2008; Ali & Sion, 2014
India	<p><u>Policies on Solid Waste Management</u></p> <p>The National Environment Policy of 2006;</p> <p>The National Action Plan for Climate Change of 2009;</p> <p>The Waste Prevention and Control of Pollution Act No.6 of 1974. Amendment (1988) and Amendment (2003)</p> <p>Environmental Protection Act of 1986. Amendment (1991);</p> <p>The Recycled Plastics Manufacture and Usage Rule of 1989. Amendment: The Recycled Plastic Manufacture, Sale and Usage Rule of 1999;</p> <p>Municipal Solid Waste (Management and Handling) Rule 2000. Draft Notification for Amendment (2013), Draft Notification for Amendment (2015).</p>	Chintan Environmental Research and Action Plan of 2013; Gupta, 2015
New Zealand	Waste Minimization Bill	Boyle, 2000

2.6.1.1 European and American countries

Most countries in Europe have issued effective solid waste regulations and directives to manage waste minimization through restricting its generation (Abba *et al.*, 2013). European Union (EU) legislation emanates from the European Economic Community treaty. The EU is a multinational body to which member states have submitted their administrative and legislative powers. Waste regulations, among others, apply to Member States and aim to protect the environment and human health across the European Community (European Commission, 2005; Ma & Hipel, 2016). Over the last 30 years, the European Commission has adopted the Circular Economy Package aimed at changing outdated perceptions about waste from regarding it as an unwanted liability to regarding it as a valuable resource (Liu *et al.*, 2015; Ma & Hipel, 2016). The Circular Economy Package entails new waste legislations and incentives to promote adherence to the waste hierarchy, boost global competitiveness, foster sustainable economic growth, and generate new jobs (Abba *et al.*, 2013; Mavropoulos *et al.*, 2015).

The European Union also formulated some directives to guide waste management procedures, programs and facilities (Filho *et al.*, 2016). For instance, the Landfill Directive of 2001 was adopted to address the problem of pollution emanating from incinerators, landfills and recycling plants (European Commission, 2005; Liu *et al.*, 2015). The Waste Framework Directive, the Hazardous Waste Directive and the Waste Shipment Regulation of 2006 form the basis of efforts to control and manage waste in EU countries that have really committed to encouraging integrated waste management for the systematic and sustainable management of waste (European Commission, 2005; Liu *et al.*, 2015; Filho *et al.*, 2016).

The European Union proposes three targets to meet the objectives of the directives, namely recycling 65% of municipal waste, recycling 75% of packaging

waste, and reducing landfill to a maximum of 10% of all waste by 2030 (Abba *et al.*, 2013). In order to meet these targets, taxation is commonly used as an incentive in many countries for promoting waste recycling and covering the cost of waste collection and treatments (European Commission, 2014; Bing *et al.*, 2016). England introduced a compulsory five pence minimum charge for single use plastic bags and Hong Kong implemented a 50 cents charge that reduced the use of plastic bags by 90%. Several United States municipalities, for example Dallas, Sacramento, Honolulu, Chicago and Portland, also implemented similar measures (Mavropoulos *et al.*, 2015). To attain a higher recycling rate, the Netherlands introduced a so-called differentiated tariff system to distinguish separated from non-separated waste. Householders pay 10 euros tax for 240 litres of mixed waste versus 2 euros for 240 litres of separated waste, which is a workable system that promotes waste recovery (Filho *et al.*, 2016). In response to the need to solve the problem of minimizing and reclaiming waste, environmental legislation in the Russian Federation has undergone huge changes since 2014. These changes have affected practically all aspects of the waste treatment process and also opened the door to licensing waste treatment activities and professional training for waste treatment workers (Berezyuk *et al.*, 2016).

2.6.1.2 Asian countries

The management of municipal solid waste in Asian countries still experiences many challenges related to development (Othman *et al.*, 2013). Since the 1970s, countries such as Korea, Singapore and China have achieved great success in economic growth and urbanization due to viable agricultural programmes, strong manufacturing industries and the successful development of policies, while India, Malaysia and Thailand are still upcoming (Othman *et al.*, 2013; Zeng *et al.*, 2015). However, despite some achievements in Asian countries, the sustainable development of their societies has been compromised by the heavy price paid by the environment and ecology for development, and they have subsequently made

adjustments to their laws and policies (Permana & Ho, 2015). China for instance has devoted far-reaching initiatives towards environmental protection (Zeng *et al.*, 2015). In Malaysia, amendments were also made to the Local Government Act of 1976, the Site, Drainage and Building Act of 1974, and the Town and Country Planning Act of 1976, and penalties have been introduced for breaches of these Acts. Harsh penalties are also imposed on those caught illegally dumping or inadequately storing and treating waste. Fines range between RM 10,000 (EUR, 1980) and RM 100 000 (EUR 19,802) and a jail sentence of up to five years may be imposed for infringements (Manaf *et al.*, 2009). With the aim of attaining the status of a developed country in 2020, India’s Ministry of the Environment, Forest and Climate Change outlined new solid waste management rules in 2016. These rules highlight restrictions on landfill disposal and impose a levy on service fees and the right to issue on-spot fines for littering in public (Ministry of Urban Development (India), 2016; Gupta *et al.*, 2016; Kamari *et al.*, 2017).

Some Asian countries have successfully adopted the waste recovery trend of European countries. According to Ali and Sion (2014), the waste hierarchy minimization strategy is one of the finest and latest ways to decrease detrimental effects on the environment and human health. Hong Kong and Japan are the two most active countries in waste recovery and this was achievable through enforcing legislation, education and licensing of residents and stakeholders as responsible bodies for municipal waste management (Ali & Sion, 2014).

2.6.2 An African perspective

Table 2.2: Waste legislations used in different Southern African countries

Country	Legislation	Source
Republic of South Africa	Constitution of the Republic of South Africa Act No.108 of 1996	South Africa, 2011

	<p>National Environmental Management Act No. 107 of 1998</p> <p>Department of Water Affairs and Forestry: Minimum requirements for waste disposal by landfill, second edition, 1998</p> <p>Municipal Systems Act No. 32 of 2000</p> <p>Municipal Finance Management Act of 2003</p> <p>National Environmental Management, Air Quality Act No. 39 of 2004</p> <p>National Environmental Management Waste Act No. 59 of 2008</p> <p>National Waste Management Strategy of 2011</p>	
Swaziland	<p>Waste Regulations Act of 2000</p> <p>Environment Management Act of 2002</p> <p>National Environmental Policy</p> <p>National Solid Waste Management Strategy for Swaziland of 2002</p>	<p>Salam, 2010;</p> <p>Rantlo, 2015</p>
Botswana	<p>Botswana Waste Management Strategy of 1998</p> <p>Waste Management Act No. 15 of 1998.</p>	<p>Republic of Botswana, 1998;</p> <p>Kgosiele & Zhaohui, 2010</p>
Nigeria	<p>Nigerian Constitution of 1979, amended into Constitution 1999, Section 20 (focuses on environmental protection)</p> <p>Federal Environmental Protection Agency Act of 1988, Section 38</p> <p>The Environmental Impact Assessment Act of 1992</p> <p>The Harmful Waste Act of 1988</p>	<p>(Nwufu, 2010)</p>
Namibia	<p>Namibian Constitution of 1989</p> <p>Environmental Management Act No.7 of 2007</p> <p>Namibia's Green Plan Vision 2030 and the National Development Plan</p>	<p>Ruppel & Ruppel-Schichting, 2016</p>

	<p>Environmental Policies in Namibia</p> <p>Pollution Control and Waste Management Bill</p> <p>Public and Environmental Health Bill of 2014</p> <p>Namibia's Climate Change Strategy and Action Plan</p> <p>International Laws and Conventions</p>	
Zimbabwe	<p>Salisbury Sanitary and Refuse Removal Act of 1948, amended 1953 and 1978</p> <p>Public Health By-Laws (1962)</p> <p>Harare Waste Management By-Laws (1979)</p> <p>Environmental Management Act of 2002, 20:27</p> <p>Urban Councils Act No.5 of 2017</p> <p>Public Health Act No. 899 of 1972</p>	<p>Jerie, 2013;</p> <p>Muswere & Rodic-Wiersma, 2017</p>
Zambia	<p>Constitution of Zambia</p> <p>National Conservation Strategy (1985)</p> <p>Environmental Protection and Pollution Control Act No.2 of 1990; amended Act No.12 of 1999</p> <p>National Environmental Action Plan (1994)</p> <p>Local Government Act No. 22 of 1991 and Council By-Laws</p> <p>Public Health Act No. 34 of 1930; amended Act No. 22 of 1995</p> <p>Waste Management Regulations</p> <p>Hazardous Waste Management Regulations of 2001</p> <p>National Solid Waste Management Strategy for Zambia of 2004</p> <p>Endorsement of International Conventions related to waste management.</p>	<p>Environmental Council of Zambia, 2004</p>
Malawi	<p>National Environmental Action Plan (NEAP) of Malawi (1994)</p> <p>Environmental Management Act No. 23 of 1996</p>	<p>(Barre, 2014)</p>

	National Environmental Policy	
Kenya	Constitution of Kenya The Environmental Management and Coordination Act No. 8 of 1999 Environmental (Impact Assessment and Audit) Regulations of 2003 Environmental Management and Coordination (Waste Management) Regulations (2006) Occupational Safety and Health Act No.15 of 2007 Public Health Act No 12 of 2012 County Governments Act No. 17 of 2012 National Solid Waste Management Strategy	(National Environment Management Authority, 2015)
Mozambique	Law of Local Government (Law 2/97 of 18 February) The Environment Act: Law 20/97 (1 October 1997) Constitution of Mozambique (2004) Solid Waste Management Regulations (Decree 13/2006 of 15 June) National Environment Policy (2008) Finance Act and Municipal Heritage (Law 11/97 of 31 May) Strategy for Integrated Municipal Solid Waste Management in Mozambique	(Tas & Belon, 2014)
Tanzania	Environmental Management Act No. 20 of 2004 Solid Waste Management Regulations (2009)	(Palfreman, 2014)

It is estimated that about 70% of environmental legislation that applies in third world countries, including Lesotho and Nigeria, is based on international laws in the form of treaties, conventions, customary international law, protocols and other agreements that are mandatory for signatories. The interest in environmental

protection began in the 1970s when developed countries started implementing and enforcing laws to create healthy environments (Nwufo, 2010). A few exceptions are countries such as Zambia and Zimbabwe where legislations aiming at the protection of public health and the environment were available as early as the 1930s and 1950s respectively (Environmental Council of Zambia, 2004; Muswere & Rodic-Wiersma, 2017).

In most African countries, particularly in the Southern Africa Development region, the core of waste management emanates from environmental management guidelines that make provision for the protection of human and environmental health in the constitutional laws of their respective countries (Government of Lesotho, 2016a; South Africa, 1996; Environmental Council of Zambia, 2004; Nwufo, 2010; Tas & Belon, 2014; National Environment Management Authority of Kenya, 2015). Countries such as South Africa, Botswana, Swaziland, Kenya and Mozambique have successfully preceded the formulation of acts and regulations specific for waste management in their fundamental laws. In South Africa, the National Environmental Management Waste Act No. 59 of 2008 (Republic of South Africa, 2008) provides a holistic approach to regulating waste. The processing, treatment and disposal of waste must take place in accordance with the principles expounded in this Act (Department of Environmental Affairs, 2012b). The Republic of Botswana also has a Waste Management Act (Act 15 of 1998) that aims at regulating the management of controlled waste (Republic of Botswana, 1998). Swaziland has a Waste Regulation Act to combat the waste problem in the country (Salam, 2010) while Mozambique has Solid Waste Management Regulations (Decree 13/2006 of June 15th) that specifically aim at the management of solid waste (Tas & Belon, 2014).

Over the past two decades, many developing nations such as Zambia, Botswana, Mozambique, South Africa and Kenya have formulated national waste management strategies to facilitate and coordinate waste management issues in their respective

countries. They have also merged initial achievements with proposals by relevant stakeholders in the waste management industry to ensure a coordinated approach to sound solid waste management (Environmental Council of Zambia, 2004; Salam, 2010; Kgosiesele & Zhaohui, 2010; Department of Environmental Affairs, 2012a; Tas & Belon, 2014; National Environment Management Authority of Kenya, 2015). National waste management strategies in Africa have adopted the internationally recognised waste management hierarchy. Salam (2010) and Department of Environmental Affairs (2009) also indicate that one of the priorities of the National Waste Management Strategy is to comply with the set objectives of waste Acts and regulations.

Many African countries are signatories to international conventions based on their status in the United Nations. These countries have undertaken to address the global problem of uncontrolled illegal dumping of hazardous waste in developing countries and are committed to controlling transboundary movement and the management of hazardous wastes on the African continent by automatically writing this issue into their national laws or by legally transforming elements of international conventions into national laws (Environmental Council of Zambia, 2004; Kgosiesele & Zhaohui, 2010; Ruppel & Ruppel-Schichting, 2016).

2.6.3 Lesotho

Different national and international waste conventions are applicable to waste management in Lesotho (Table 2.3).

Table 2.3: Solid waste legislations and international waste conventions that apply in Lesotho

COUNTRY	LEGISLATION	SOURCE
Lesotho	Constitution of Lesotho Public Health Order No. 12 of 1970, amended to Lesotho Public Health Act No. 10 of 1991, later Public Health Bill Draft 3 of 2012 Sanitary Services and Waste Removal Regulations (1972) Town & Country Planning Act No. 11 of 1980 Environment Act No. 15 of 2001, amended Environment Act No. 10 of 2008 Labour Code Order No. 24 of 1992, amended to Labour Code Act No. 3 of 2000. Signatory to International Conventions (Basel and Stockholm Convention on Persistent Organic Pollutants; Bamako Convention; Rotterdam Convention; Convention on Hazardous Chemicals and Pesticides in International Trade).	UNEP, 2008; Kingdom of Lesotho, 2016a

After gaining its independence in 1966, successive governments in Lesotho have introduced various policies and programmes to improve the state of health of the people (UNEP, 2008). In 1970, the Public Health Order came into operation for the protection of public health. It defines what constitutes a nuisance and provides for corrective measures that Health Officers need to follow (Government of Lesotho, 2005). The Sanitary Service and Refuse Removal Regulation came into force in 1972, although services were limited to government institutions and premises and a few selected residential areas (UNEP, 2008). Some health indicators have

significantly improved over time (Government of Lesotho, 2016a). These improvements have only begun to be sluggish fifteen years later due to the AIDS pandemic, economic decline and unhealthy lifestyles (Government of Lesotho, 2016a). Since urban expansion began in the 1980s, waste became a recognized problem and a broad environmental concern (UNEP, 2008). This triggered the “Keep Lesotho Clean” campaign that was formulated by the National Environment Secretariat (NES), the promulgation of new laws, and the amendment of existing laws in the 1980s and early 1990s. The Acts and regulations were established to control pollution in Lesotho’s bustling towns. However, these Acts and regulations were not supported by any waste management policy, strategy or even guidelines (Von Blottntz & Nissing, 2007). As a consequence, the Constitution of Lesotho was amended in 1993 to establish a mandate for the protection of the environment. Section 36 of the Act states:

“Lesotho shall adopt policies designed to protect and enhance the natural and cultural environment of Lesotho for the benefit of both present and future generations and shall endeavour to assure to all its citizens a sound and safe environment adequate for their health and well-being.”

Subsequently, there was a formulation of new-fangled Acts and amendments of existing laws and the adaptation of international laws to protect the lives of people and the environment. The Environment Act No.15 was established in 2001. This Act aimed to assure that every individual living in Lesotho had the fundamental right to a clean and healthy environment (Government of Lesotho, 2001). The Act was not fully functional by 2007 (Von Blottntz & Nissing, 2007), and hence it did not fulfil its purpose of protecting the environment and the wellbeing of the Basotho people. It was then replaced by the Environment Act No.10 of 2008 which currently makes provisions for the protection of the environment against hazardous waste and the management of waste in general. It also provides penalties for offences in section 30 and lists the functions of councils for the protection of the environment in section 8 (Government of Lesotho, 2008; Government of Lesotho, 2016a). The Environment

Act generalises the management of all wastes causing deleterious impact on the environment; hence it includes a comprehensive municipal solid waste management strategy that has not existed to date but is necessary for efficient waste management services provision. In order to prevent various adversities that might happen in high risks jobs such as MSW management, the Labour Code Amendment Act No.3 of 2000 states that employers should ensure the safety, health and welfare of their employees and that ordinary people should not be exposed to risks involving their safety and health (Government of Lesotho, 2000b & 2016a). Lesotho is also a signatory to various international conventions, treaties and protocols to prevent transboundary movement of hazardous waste, environmental exposure to persistent organic pollutants (POPs), and the impacts of waste on health. It also aims to promote sustainable development (UNEP, 2008; Government of Lesotho, 2016a).

2.7 Conclusion

The literature review revealed that many countries use a general definition for waste and have no specific legislated definition for 'solid waste'. This has implications in terms of classifying and reporting waste generation. MSW practices differ from one country to the other, but when developed and developing economies are compared, open dumping and burning are still commonly practised. However, this phenomenon seems to be more prevalent in developing countries, particularly in Asia and Africa. High numbers of waste dumps in a country seem to symbolise poor provision of services by municipal authorities whose primary responsibility should be to provide a clean environment for all citizens. It is therefore noteworthy that MSW management in African countries, including Lesotho, is still in its infancy and that only a fraction of their population receives waste collection services. This implies that residents in these countries are highly exposed to environmental and health risks as they do not receive adequate waste removal and treatment services.

REFERENCES

- Abba, A.H., Noor, Z.Z., Yusuf, R.O., Din, M.F., & Hassan, M.A.A. 2013. Assessing environmental impacts of municipal solid waste of Johor by analytical hierarchy process. *Resources. Conservation and Recycling*, 73, 188–196.
- Agunwamba, J.C. 1998. Solid waste management in Nigeria: problems and issues. *Environ Manage*, 22(6), 849–856.
- Agamuthu, P & Dennis, V. 2011. Policy Evaluation of Solid Waste Management in Malaysia. Malaysia: University of Malaya. *ResearchGate*, 916–924.
- Ahsan, A., Alamgir, M., El-Sergany, M.M., Shams, S., Rowshon, M.K., & Nik Daud, N.N. 2014. Assessment of municipal solid waste in a developing country. *Hindawi Publishing Corporation*, Art. ID 561935, 1–11.
- Ali, M.S., Pervaiz, A., Afzal, B., Hamid, N., & Yazmin, A. 2013. Open dumping of municipal solid waste and its hazardous impacts on soil and vegetation diversity at waste dumping sites of Islamabad City. *Journal of King Saud University–Science*, 1, 1018–3647.
- Ali, N.E., & Sion, H.C. 2014. Solid waste management in Asian countries: a review of solid waste minimisation (3Rs) towards low carbon. 8th International Symposium of the Digital Earth. IOP Conference Series: Earth and Environmental Science, 18 (2014) 012152.
- Ally, B., Ismail, S.N.S., & Rasdi, I. 2014. Municipal solid waste management of Zanzibar: current practice, the challenges and the future. *International Journal of Current Research and Academic Review*, SSN: 2347-3215 Special Issue, 1 October, 5–9.
- Ayinuola, G.M., & Muibi, M.A. 2008. An engineering approach to solid waste collection system: Ibadan North as case study. *Waste Management*, 28, 1681–1687.
- Babs-Shomoye, F., & Kabir, R. 2016. Health effects of solid waste disposal at a dumpsite on the surrounding human settlements. *Journal of Public Health in Developing Countries*, 2(3), 268–275.

- Barre, J. 2014. *Waste market in urban Malawi*. Master's thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Bellan, N., Pinto, T.J.A., Kaneko, T.M., Moretto, L.D., & Junior, D.S. 2012. Critical analysis of the regulations regarding the disposal of medication waste. *Bazillian Journal of Pharmaceutical Sciences*, 48(3), 508–518.
- Berezyuk, M., Rumyantseva, A., & Lapina, A. 2016. Municipal solid waste management in a new legislation: a comprehensive approach. ICSC E3S Web of Conferences 6, 01006.
- Bing, X., Bloemhof, J.M., Ramos, T.R.P., Barbosa-Povoa, A., Wong, C.Y., & Van der Vorst, J.G.A.J. 2016. Research challenges in municipal solid waste logistics management. *Waste Management*, 48, 584–592.
- Boman, C., Pettersson, E., Westerholm, R., Boström, D., & Nordin, A. 2011. Stove performance and emission characteristics in residential wood log and pellet combustion, part 1: pellet stoves. *Energy & Fuels*, 25(1), 307–314.
- Bond, T.C., Doherty, S.J., Fahey, D.W., Forster, P.M., Berntsen, T., DeAngelo, B.J., ... & Zender, C.S. 2013. Bounding the role of black carbon in the climate system: a scientific assessment. *Res: Atmos*, 118, 5380–5552.
- Boyle, C. 2000. Solid waste management in New Zealand. *Waste Management*, 20, 517–526.
- Bulane, I. 2009. *The selection of transfer locations for Maseru Municipality*. Master's thesis, University of Witwatersrand, South Africa.
- Candice-Joy, M. 2011. *Monitoring biomass burning emissions using satellite imagery for Southern Africa*. Master's thesis, University of Witwatersrand, Johannesburg.
- Chintan Environmental Research and Action Plan. 2013. Draft municipal solid waste (MSW) rules 2013 are a missed opportunity. *GlobalRec*, India.
- Chinwe, O.U., Obinna, C.N., Akeem, A., & Alo, B.I. 2010. Assessment of heavy metals in urban highway runoff from Ikorodu Expressway, Lagos, Nigeria. *Journal of Environmental Chemistry and Ecotoxicology*, 2(3), 34–37.

- Cointreau, S.J. 1982. Environmental management of urban solid waste in developing countries. *Urban Development Technical Paper No. 5*. Washington, DC: World Bank.
- Das, S., & Bhattachannya, B.K. 2015. Optimization of municipal solid waste collection and transportation routes. *Waste Management*, 43, July.
- Davidson, J. 2020. 'India's pollutions plummets in COVID-19 lockdown'. EcoWatch: 02 April.
- Department of Environmental Affairs (DEA). 2009. *National waste management strategy phase 2 research: macro-economic trends, targets and economic instruments*. Pretoria: DEA.
- Department of Environmental Affairs (DEA). 2012a. *National waste management strategy*. Pretoria: DEA.
- Department of Environmental Affairs (DEA). 2012b. *Chapter 13: waste management*. Pretoria: DEA.
- Department of Environmental Affairs (DEA). 2014. South Africa's greenhouse gas (GHG) mitigation potential analysis. Pretoria, South Africa: DEA.
- Department of Environmental Affairs and Development Planning (DEADP). 2017. State of the environment outlook report for the Western Cape Province: waste management, Western Cape. Cape Town: DEADP.
- Department of Environmental Affairs and Tourism (DEAT). 2007. *Assessment of the status of waste service delivery and capacity at local government level*. Pretoria: DEAT.
- Eberhard, R. 2018. Waste management in South Africa's cities: Discussion paper. Pretoria, National Treasury, Government Printer.
- Ebistu, T.A., & Minale, A.S. 2013. Solid waste dumping site suitability analysis using the Geographic Information System (GIS) and Remote Sensing for Bahir Dar Town, North Western Ethiopia. *African Journal of Environmental Science and Technology*, 7(11).
- Environmental Council of Zambia. 2004. National Solid Waste Management Strategy for Zambia. Zambia, Zambian Government publication.

- Envitech. 2013. Landfill gas monitoring for Motse Miya Trading and Projects: Ts'osane Landfill, Maseru, Lesotho. *Envitech Technical Reports*, South Africa.
- European Commission. 2005. The story behind the strategy: EU waste policy. Retrieved from: <http://ec.europa.eu/environment/waste/pdf/storybook.pdf> [Accessed 20/06/2017].
- European Commission. 2014. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the region. Towards a circular economy: a zero-waste programme for Europe. European Commission, Belgium: Brussels.
- Ezeah, C., & Roberts, C.L. 2012. Analysis of barrier and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria. *Journal of Environmental Management*, 103, 9–14.
- Fayez, T.M.N. 2012. *Evaluation of the gaps and barriers in implementing the National Waste Management Policy and its implementation in formal and informal urban areas in Ekurhuleni Municipality, South Africa*. Master's thesis, Master of Arts, University of South Africa, Pretoria.
- Ferreira, F., Avelino, C., Bentes, I., Matos, C., & Teixeira, C.A. 2017. Assessment strategies for municipal selection waste collection scheme. *Waste Management*, 59, 3–13.
- Filho, L.W., Brandli, L., Moora, H., Kruopiene, J., & Stenmarck, A. 2016. Benchmarking approaches and methods in the field of urban waste management. *Journal of Cleaner Production*, 112, 4377–4386.
- Friedrich, E. 2013. *An investigation into the emissions of greenhouse gases with the disposal of solid waste in EThekweni Municipality*. Doctorate of Philosophy thesis, Department of Civil Engineering, University of KwaZulu-Natal, Durban.
- Garnett, K., Cooper, T., Longhurst, P., Jude, S., & Tyrrel, S. 2017. A conceptual framework for negotiating public involvement in municipal waste management decision-making in the UK. *Waste Management*, 66, 210–221.

- Goren, S., & Ozdemir, F. 2011. Regulation of waste and waste management in Turkey. *Waste Management Research*, 29, 433–441.
- Gouveia, N., & Ruscitto, R. 2010. Health risks in areas close to urban solid waste landfill sites. *Rev Saude Publica*, 44(5), 1–8.
- Government of Lesotho. 1992. *Labour Code Act: Act No.24 of 2000*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 1993. *The Constitution of Lesotho*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2000a. *National report on climate change*. Ministry of Natural Resources. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2000b. *Labour Code Act: Act No.3 of 2000*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2001. *Environmental Act: Act No. 15 of 2001*. Maseru, Lesotho: Government Printer.
- Government of Lesotho, 2005. *National Health Care Waste Management Plan Maseru*, Ministry of Health and Social Welfare. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2008. *Environmental Act: Act No. 10 of 2008*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2012. *Innovative partnerships for a solid waste management project in Lesotho (2009–2012)*. Project evaluation report. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2014. *2013 Solid waste, water and sanitation report*. Statistical Report No.15 of 2014. Maseru: Bureau of Statistics.
- Government of Lesotho. 2016a. *Infection control and waste management plan (ICWMP) Vol. 1. SFG1928 V1*. Maseru: Government Printer.
- Government of Lesotho. 2016b. *National Health Strategic Plan NHSP 2017 – 2022 (Final Draft)*. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2018. *Country profile 2017-18: the local government system in Lesotho*. Maseru, Lesotho: Government Printer.

- Gumbi, S.E. 2015. *Current waste management and minimisation patterns and practices: an exploratory study on the Ekurhuleni Metropolitan Municipality in South Africa*. Master's thesis, University of South Africa, Pretoria.
- Gupta, V., Goel, S., & Rupa, T.G. 2016. Good governance and solid waste management: an overview of legislative regulations in India. *Journal of Business and Management Studies*, 2(1), 1–9.
- Gurrero, L.A., Maas, G., & Hogland, W. 2013. Solid waste management challenges for cities in developing countries. *Waste Management*, 33, 220–232.
- Harley, A.C. 1990. Energy recovery from burning municipal solid wastes: a review. *Resources, Conservation and Recycling*, 4, 77–103.
- Hoorweg, D & Bhada-Tata, P. 2012. What a waste: a global review of solid waste management. *Urban Development Series Knowledge Papers*, March, No.15. World Bank: Urban Development & Local Government Unit, Washington, DC, United States of America.
- Iyeke, I.D., & Nena, O.E. 2012. A study of the constraints to residential solid waste management in Benin Metropolis, Nigeria. *Journal of Emerging Trends in Engineering and Applied Sciences*, 3(1), 103–107.
- Jay, N.A. 2010. History of United States waste management: urban planning 260 12/ 11/ 10. Los Angeles: University of California. *ResearchGate*, 1–40.
- Jerie, S. 2013. Quo vadis? Solid waste management legislation in the informal sector of Harare. *The Dyke*, 7(1).
- Kgosiele, E., & Zhaohui, L. 2010. An evaluation of waste management in Botswana: achievements and challenges. *Journal of American Science*, 6(9), 144–150.
- Khoeshe, N. 2018. Maseru City Council (MCC) struggles with littering. *Lesotho Times*, August.
- Kolekar, K.A., Hazra, T., & Chakrabarty, S.N. 2016. A review on prediction of municipal solid waste generation models. *Procedia Environmental Sciences*, 35, 238–244.

- Kumari, K., Kumar, S., Rajogopal, V., Khare, A., & Kumaar, R. 2017. Emission from open burning of municipal solid waste in India. *Environmental Technology*. DOI: 10.1080/09593330.2017.1351489. ISSN: 0959-3330.
- Ladan, S.I. 2014. Composting as a sustainable waste management method in Katsina Metropolis, Northern Nigeria. *International Journal of Bioscience, Biochemistry and Bioinformatics*, 4(1), 11–13.
- Laohalidanond, K., Chaiyawong, P., & Kerdsuwan, S. 2015. Municipal solid waste characteristics and green clean energy recovery in Asian megacities. *Energy Procedia*, 2015, 391–396.
- Lebentlele, N.T. 2002. An evaluation of the problems facing the Maseru City Council in the process of urban management in Maseru. Master's thesis. South Africa: University of Natal.
- Lederer, J., Ongatai, A., Odeda, D., Rashid, H., Otim, S., & Nabaasa, M. 2015. The generation of stakeholders' knowledge for solid waste management planning through action research: a case study from Busia, Uganda. *Habitat International*, 50 (December), 99–109.
- Lee, S.H. n.d. Policies for sustainable resources management in the Republic of Korea. Korea, Korea Environment & Resources Corporation.
- Likotsi, T.E. 2013. *Poverty reduction and public security in Lesotho*. Master's thesis, University of Witwatersrand, South Africa.
- Liu, A., Ren, F., Lin, W.Y & Wang, J.Y. 2015. A review of municipal solid waste environmental standards with a focus on incinerator residues. *International Journal of Suitable Built Environment*, 4, 165–188.
- Lizner, R., & Salhofer, S. 2014. Municipal solid waste recycling and the significance of the informal sector in urban China. *WasteManagRes*, Sep, 32(9), 896–907.
- Lohri, C.R., Camenzind, E.J., & Zurbrugg, C. 2014. Financial sustainability in municipal solid waste management: costs and revenues in Bahir Dar, Ethiopia. *Waste Management*, 34, 542–552.

- Lown, J.J. 2003. Eco-industrial Development and the Resource Conservation and Recovery Act: examining the barrier presumption. *Boston College Environmental Affairs Law Review*, 30(2), 275–314.
- Lundin, L., Gullet, B., Carroll Jr, W.F., Touati, A., Marklund, S., & Fiedler, H. 2013. The effect of developing nations' municipal waste composition on PCDD/PCDF emissions from open burning. *Atmospheric Environment*, 79, 433–441.
- Ma, J., & Hipel, K.W. 2016. Exploring social dimensions of municipal solid waste management around the globe: a systematic literature review. *Waste Management*, 56, 3–12.
- Maasikmets, M., Kupri, H.L., Tienemaa, E., Vainumae, K., Arumae, T., Roots, O., & Kimmel, V. 2015. Emissions from burning municipal solid waste and wood in domestic heaters. *Atmospheric Pollution Research*, 7, 438–440.
- Matope, T. 2013. Maseru City Council plans makeover. *Lesotho Times*, 26 September.
- Mavropoulos, A., Marinheiro, L., Cohen, P., Law, J., Greedy, D., Loureiro, A., Plimakis, S., & Bouldry, T. 2015. A roadmap for closing waste dumpsites: the world's most polluted places. International Solid Waste Association report, Vienna, Austria.
- Mavropoulos, A., Mavropoulos, A., Koukosa, I., Tsakona, M., Mavropoulou, N., Rigas, N., & Andredakis, T. 2014. *Waste atlas: the world's 50 biggest dumpsites*. D-Waste Reports, D-Waste Environmental Consultants.
- Mberu, B., Ziraba, A.K., Amugsi, D., Chumu, I & Muidi, K. Impact of solid waste management on health: a biomedical study of solid waste workers at Dandora dumpsite, Nairobi, Kenya. *Urban Africa Risk Knowledge*, 1–78.
- McAllister, J. 2015. *Factors influencing solid waste management in the developing world*. Master's thesis, Utah State University, United States: Logan.

- Miezah, K., Obiri-Danso, K., Kadar, Z., Fei-Baffoe, B., & Mensah, M.Y. 2015. Municipal solid waste characterization and quantification as a measure towards effective waste management in Ghana. *Waste Management*, 40, 15–27.
- Millennium Alliance for Humanity and the Biosphere (MAHB). 2002. Solid waste management: chapter 8. Available at: www.masslocalinstitute.info/solidwaste/08%20Solid%20Waste.pdf [Accessed 22/07/2017].
- Ministry of Urban Development (India). 2016. *Municipal Solid Waste Management Manual*. Available from: <http://moud.gov.in/pdf/57f1e55834489Book03.pdf> [Accessed 06/06/2017].
- Morake, P. 2010. *Documenting historical faunal change in Lesotho and the adjoining Eastern Free State of Southern Africa*. Master's thesis, University of the Witwatersrand, South Africa.
- Muswere, G.K., & Rodic-Wiersma, L. 2017. Municipal solid waste management in Greater Harare, Zimbabwe. Available at: <https://www.researchgate.net/publication/277954897> [Accessed 10/10/2018].
- Mvuma, G.G.K 2010. Waste a necessary evil for economically impoverished communities in least developed countries (LCDs): a case of Lesotho. The 20th WasteCon Conference and Exhibition 4-8 October 2010. Emperor's Palace, Gauteng, South Africa: WasteCon 2010.
- National Environmental Management Authority. 2015. *The National Solid Waste Management Strategy: Kenya Vision 2030*. Nairobi, Kenya, National Environmental Management Authority publication.
- Naustdalslid, J. 2014. Circular economy in China: the environmental dimension of the harmonious society. *International Journal of Sustainable Development & World Ecology*, 21, 303–313.
- Nwifo, C.C. 2010. Legal framework for the regulation of waste in Nigeria. *International Multi-Disciplinary Journal, Ethiopia*, 4(2), 491–501.

- Nyarai, M.P., Willard, Z., Moses, M., & Ngenzile, M. 2016. Challenges of solid waste management in Zimbabwe: a case study of Sakubva high density suburb. *Journal of Environment and Waste Management*, 3(2), 142–155.
- Oelofse, S.H.H., & Godfrey, L. 2008. Defining waste in South Africa: moving beyond the age of waste. *South African Journal of Science*, 104, 242–248.
- Ogawa, H. 1996. Sustainable solid waste management in developing countries: the 7th ISWA International Congress and Exhibition, Parallel Session 7, International Perspective, Malaysia.
- Othman, S.N., Noor, Z.Z., Abba, A.H., Yusuf, R.O., & Hassan, M.A.A. 2013. Review on life cycle assessment of integrated solid waste management in some Asian countries. *Journal of Cleaner Production*, 41, 251–262.
- Oyelami, A.C., Aladejana, J.A., & Agbhedo, O.O. 2013. Assessment of the impact of an open waste dumpsite on groundwater quality: a case of the Onibu-Eja dumpsite, Southwestern Nigeria. *Procedia Earth and Planetary Science*, 7, 648–651.
- Palfreman, J. 2014. Waste management and recycling in Dar es Salaam, Tanzania. DOI: 10.13140/2.1.3196.4482
- Pandyaswargo, A.D & Premakumara, G.D.J. 2014. Financial sustainability of modern composting: the economically optimal scale for municipal waste plant in developing Asia. *Int J Recycl Org Waste Agricult*, 3(66), 1–14.
- Pereira, A., Fortes de Almeida, M., Filho, J.R.S., Teixeira, I.M.V., Jorge, M., Temporao, J.G., Mantega, G., Favetti, R.T., & Silva, L.I.L. 2010. National solid waste policy of Brazil. *Brasilia*. http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm [Accessed 10/10/2018].
- Permana, A.S., Towolioe, S., Aziz, N.A., & Ho, C.S. 2015. Sustainable solid waste management practices and perceived cleanliness in a low-income city. *Habitat International*, 49, 197–205.
- Ramaiah, B.J., Ramana, G.V., & Datta, M. 2017. Mechanical characterization of municipal solid waste from two waste dumps at Delhi, India. *Waste Management*, 68, October, 275–291.

- Raman, N., & Narayanan, S. 2008. Impact of solid waste effect on ground water and soil quality nearer to Pallavaram solid waste landfill site in Chennai. *Rasayan J. Chem*, 1(4), 828–836.
- Rantlo, T.J. 2014. *Environmental impact assessment legislation in Lesotho, Swaziland and South Africa*. Master's thesis, North-West University, Potchefstroom.
- Rasmeni, Z.Z., & Madyira, D.M. 2019. A review of the current municipal solid waste management practices in Johannesburg City townships. *Procedia Manufacturing*, 35, 1025–1031.
- Republic of Botswana. 1998. *Botswana's strategy for waste management*. Gaborone, Government Printer.
- Republic of South Africa. 2008. National Environmental Management: Waste Act No. 59 of 2008. *Government Gazette No. 32000*. Pretoria: Government Printer.
- Republic of South Africa. 2011. *Environmental Management: Waste Management Strategy*. Pretoria: Government Printers.
- Republic of South Africa. 2014. National Environmental Management: Waste Amendment Act No. 26 of 2014. *Government Gazette*, 2 June, 588(449). Cape Town: Government Printer.
- Reyna-Bensusan, N., Wilson, D.C., & Smith, S.R. 2018. Uncontrolled burning of solid waste by households in Mexico is a significant contributor to climate change in the country. *Environmental Research*, 163, 280–288.
- Roberts, H.A. 2013. Landfills or dump sites? Status of landfill sites in the Free State Province, South Africa. *INTERIM*.
- Ruppel, O.C., & Ruppel-Schichting, K. 2016. *Environmental law and policy in Namibia towards making Africa the Tree of Life* (3rd ed.). Namibia: Hanns Seidel Foundation.
- Salam, A. 2010. Environmental and health impact of solid waste disposal at Mangwaneni dumpsite in Manzini, Swaziland. *Journal of Sustainable Development in Africa*, 12(7), 64–77.

- Sankoh, F.P., Yan, X., & Tran, Q. 2013. Environmental and health impact of solid waste disposal in developing cities: a case study of Granville Brook dumpsite, Freetown, Seirra Leone. *Journal of Environmental Protection*, 4, 665–670.
- Scheinberg, A., Wilson, D.C., & Rodic, L. 2010. Solid waste management in the world's cities: UN-Habitat's third global report on the state of water and sanitation in the world's cities. *Earth Scan*, Newcastle-upon-Tyne, UK.
- Sello, L. 2015. Waste management a business opportunity. *Lesotho Times*, 28 May.
- Srigirisetty, S., Jayasri, T., & Chitti, N. 2017. Open dumping of municipal solid waste -impact on groundwater and soil. *International Journal of Current Engineering and Scientific Research*, 4(6), 26–33.
- Sundqvist, J.O., & Miljoinstitutet, I.V.L.S. 2017. Energy from waste in Sweden: state art and possibilities for the future. *Draft Report 2017-11-21*, Northern European Energy Perspectives Project.
- Taiwan Environmental Protection Administration. 2002. *Resource Recycling Act*. Available at: <http://law.epa.gov.tw/en/laws/962396701.html> [Accessed 01/10/2018].
- Tas, A., & Belon, A. 2014. A comprehensive review of the municipal solid waste sector in Mozambique. *Carbon Africa Limited*, Nairobi, Kenya.
- Tchobanoglous, G., Theisen, H., & Vigil, S.A. 1993. Integrated solid waste management: engineering principle and management issue. New York: McGraw Hill.
- Tello Espinoza, P., Martinez Arce, E., Daza, D., Soulier Faure, M., & Terraza, H. 2010. Regional evaluation on urban solid waste management in Latin America and the Caribbean. *UN-HABITAT*.
- Thoso, M. 2007. *The construction of a geographical information system (GIS) model for landfill site selection*. Master's thesis, University of the Free State, Bloemfontein, South Africa.

- Tsega, A.F. 2013. *Institutional and community awareness on the environmental impact of solid waste management practice: the case of Shambu Town, in Horo Guduru Wellega Zone, Oromia Regional State*. Master's thesis, Haramaya University, Oromia Regional State, Ethiopia.
- Turan, N.G., Coruh, S., Akdemir, A., & Ergun, O.N. 2009. Municipal solid waste management strategies in Turkey. *Waste Management*, 29, 465–469.
- United Nations. 2015. Transforming our world: the 2030 agenda for sustainable development. Resolution adopted by the General Assembly on 25 September 2015. Available at:
http://www.un.org/ga/search/view_doc.asp?Symbol=A/RES/70/1&Lang=E.
[Accessed 6/03/2017].
- United Nations Environment Programme (UNEP). 2008. Policy and regulations: Maseru, Lesotho. Available at:
www.unep.or.jp/ietc/spc/activities/GPWM/data?T2/IS_3_P_PolicyAndRegulation.pdf [Accessed 20/ 11/ 2018].
- United Nations Environment Programme (UNEP). 2013. III. Waste management. Available at:
www.un.org/esa/dsd/resorces/res_pdfs/...waste/ch4_waste_management.pdf
[Accessed 20/06/2018].
- United States Environmental Protection Agency (US EPA). 2012a. Municipal solid waste (MSW) in the United States: facts and figures. Available at:
<http://www.epa.gov/solidwaste/nonhaz/municipal/msw99.html> [Accessed 2/10/2018].
- United States Environmental Protection Agency (US EPA). 2012b. Report to Congress on black carbon. Agency, US EPA. Available at:
<http://www3.epa.gov/blackcarbon/2012report/fullreport.pdf> [Accessed 20/06/2017].
- Von Blottntz, H., & Nissing, C. 2007. Policy framework for an integrated waste management plan in Maseru. Environmental & Process Systems Engineering Group report, December 2007.

- Wang, Y., Cheng, K., Wu, W., Tian, H., Yi, P., Zhi, G., Fan, J., & Liu, S. 2017. Atmospheric emissions of typical toxic heavy metals from open burning of municipal solid waste in China. *Atmospheric Environment*, 152, 6–15.
- Wiedinmyer, C., Yokelson, R.J., & Gullett, B.K. 2014. Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste. *Environ. Sci. Technol*, 48, 9523–9530.
- Wolpert, V.M. 1994. Incineration of municipal solid waste combined with energy production: latest development. *Renewable Energy*, 5, 782–785.
- World Health Organization (WHO). 2013. *A multi-sectoral response to water sanitation and hygiene issues in Lesotho: the Mohale's Hoek experience*. Geneva: WHO/ AFRO Library.
- World Health Organization (WHO). 2016. WHO global urban ambient air pollution database. Available at:
http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/.
[Assessed 10/09/2018].
- Yongsi, H.B.N., Hermann, T.M., Ntetu, A.L., Sietchiping, R., & Bryant, C. 2008. Environmental sanitation and health risks in tropical urban settings: case study of household refuse and diarrhoea in Yaounde, Cameroon. *International Journal of Biomedical and Biological Engineering*, 2(8), 158–166.
- Zeng, C., Niu, D., & Zhao, Y. 2015. A comprehensive overview of rural solid waste management in China. *Environ. Sci. Eng.*, 9(6), 949–961.
- Zhang, M., Buekens, A., & Li, X. 2017. Open burning as a source of dioxins. *Critical Reviews in Environmental Science and Technology*, 47(8), 543–620.

CHAPTER THREE

SOLID WASTE MANAGEMENT PRACTICES IN THE LESOTHO LOWLANDS

SOLID WASTE MANAGEMENT PRACTICES IN THE LESOTHO LOWLANDS

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ABSTRACT

Solid waste management has become a global dilemma, especially in countries that are categorised as 'least developed'. The lowlands of Lesotho encounter problems related to over population, changing consumption patterns and limited waste management services which have led to poor waste management practices. The study aimed to identify and assess waste dumping and burning practices and to determine waste management factors that cause waste management challenges in the Lesotho lowlands.

The study utilised a descriptive cross-sectional design and relevant methodology. Data were collected by means of on-site checklists and two sets of questionnaires that were administered to 150 residents living in the vicinity of dumpsites or landfills and five waste management officials, one from each municipal council in the lowlands (Botha-Bothe, Hlotse, Maputsoe, Berea and Maseru). A direct door stepping approach was applied to survey the residents and questionnaires were delivered to them by hand. The completed questionnaires were returned to the researcher directly after completion. The questionnaires were administered to the five council members after they had been identified and recruited with the permission of relevant gatekeepers. The data were analysed using descriptive statistics and the numerical results are presented in tables and graphs in this paper.

The results indicate that the majority of the study population did not receive waste collection services and that most disposal sites were non-compliant with the minimum requirements for landfills. Waste burning was identified as a frequently used solid waste management method. Other methods were backyard burying and open dumping upon which this waste was intermittently collected by municipality

waste workers. The study revealed a lack of awareness of the implications of open waste dumping and burning practices, which highlights an urgent need to increase the public's knowledge of waste implications in order to improve waste management practices.

The improvement of waste disposal sites and law enforcement as well as public awareness campaigns will enhance the management of solid waste in Lesotho. Moreover, the implementation of safe and effective solid waste management approaches such as composting and recycling are not only crucial but will also benefit communities economically.

Keywords: solid waste, waste services, management practices, dumping, burning, awareness

3.1 Introduction and Background

Solid waste management is one of many basic services that are managed by municipal authorities to improve and maintain sanitation in any country, especially in metropolises (Parvez *et al.*, 2019). Waste is any material that has been discarded and that needs to be disposed of in an environmentally safe manner (Department of Environmental Affairs and Tourism of South Africa, 2013). Waste management aims to protect human health and the environment and is necessary to conserve natural resources (Cervantes *et al.*, 2018). The principles of environmental management are expounded in Environment Act 2008 of Lesotho (Government of Lesotho, 2008). This Act emphasizes that every person living in Lesotho has the fundamental right to a clean and healthy environment. It further states that the environment and the natural resources of Lesotho should be used and conserved for the benefit of both present and future generations by taking into account the rate of population growth and the productivity of available resources (Government of Lesotho, 2008). Municipalities are responsible for managing development and the

delivery of essential services to all their citizens. A successful solid waste management system thus depends on their efforts and adherence to policies and the law (Department of Environmental Affairs and Tourism, 2013; Sinthumule & Mkumbuzi, 2019).

Solid waste management is a complex process that relies on various appropriate practices (Melare *et al.*, 2017). The concept of a waste management hierarchy is recognized globally as its main functional elements are waste reduction from source, reuse, recycling or composting, recovery of energy from waste, and the disposal of solid waste in an acceptable and sustainable manner (Mian *et al.*, 2017). The main functional elements of municipal solid waste management (MSWM) are waste generation and separation, storage, collection, transportation, processing, recycling and disposal in an aesthetically acceptable and economical manner (Gilpin, 1996; Khan & Samadder, 2014; Olaniyi & Hezekiah, 2016). More particularly, waste composition, annual waste generation data and suitable interventions for waste reduction are associated with sorting at source, separation, and accurate data records, but these functions are rare in developing countries such as Lesotho. The latter country has limited records of waste generation data and, where such data are available, they are usually outdated or derived from invalidated sources that use assumptions and not scientific measurements (Ranjith, 2012; Miezah *et al.*, 2015). The literature reveals that municipal solid waste management methods vary from country to country in terms of the prioritisation of solid waste management problems which differ according to standards of living and the settings where waste management is implemented (Cervantes *et al.*, 2018).

Poor solid waste management is a global dilemma and various challenges are experienced, especially in countries that are categorized as 'least developed', such as Lesotho. Further to this argument, it is an undeniable fact that rural-to-urban migration has caused the accumulation of informal businesses and population density in urban areas, and cities in developing countries in particular lack the

capacity to successfully handle waste management services due to financial constraints (Wilson, 2007; Mvuma, 2010; Ogola *et al.*, 2011; Oteng-Ababio *et al.*, 2013; Melare *et al.*, 2017). An increase in municipal solid waste is thus closely associated with escalating population growth and increased limitations associated with waste management (Ogola *et al.*, 2011; Amasuomo & Baird, 2016). It is estimated that about 54% of the world's population lives in urban areas, and this figure is expected to increase to 66% in 2050 (United Nations Department of Economic and Social Affairs [UN DESA], 2014). In Lesotho, population growth rose from 1996 to 2006 in urban areas by an estimated 43.8%, and it increased from 2006 to 2016 by a massive 62.7% (Government of Lesotho, 2016). This population escalation in urban areas has resulted in the fact that a significant number of people do not have access to a waste collection service which, in turn, encourages inefficient treatment and disposal of solid waste. This situation is prevalent in most developing countries across the globe (Schubeler, 1996; Gundupalli *et al.*, 2017) and research has indicated that many communities living in metropolises are excluded from municipal solid waste management services (Kinobe *et al.*, 2015; Babs-Shomoye & Kabir, 2016; Matope, 2013). It is also argued that two billion people globally lack access to MSW collection services and that they thus typically dispose of municipal solid waste by indiscriminate dumping, open burning, or discarding it into watercourses (United Nations Environment Programme & International Solid Waste Association [UNEP & ISWA], 2015; Reyna-Bensusan *et al.*, 2018). Erratic waste collection undoubtedly influences the prevalence of poor waste management practices.

The many socio-economic challenges that are experienced in developing countries have led to poor waste management service provision (Ogola *et al.*, 2011; Amasuomo & Baird, 2016). When comparing waste management to other needs such as a clean water supply, food availability, cash reserves and access to electricity, waste management is generally viewed as the least important of all these basic necessities (Palfreman, 2014). In most developing countries, particularly in

marginalized African countries such as Lesotho, the limited budget for waste management is partly due to the concentration on more fundamental needs such as food, health service mobilization, the provision of safe water, and the eradication of the unemployment rate (Zurbrugg, 2002; Government of Lesotho, 2012; Kinobe *et al.*, 2015). Most developing countries thus fail to effectively manage solid waste due to limited available resources and competing priorities over resources (Abdel-Shafy & Mansour, 2018). This prioritisation, coupled with a lack of knowledge and awareness of solid waste realities among the public (Melare *et al.*, 2017; Sinthumule & Mkumbuzi, 2019), forces citizens in developing countries to rely on ancient waste treatment technologies and disposal methods such open dumping and burning without any management of smoke or leachate control (Mmereki *et al.*, 2016). These methods are associated with public health risks, diminish the aesthetic value of the environment, and contaminate natural resources (Ayuba *et al.*, 2013; Amasuomo & Baird, 2016).

Melare *et al.* (2017) argue that there is a severe breach in the management of waste from source to its final destination in several countries because most collected solid waste still ends up in landfills. The informal waste sector has capitalized on this by recovering recyclables such as metal, glass, paper and plastic from municipal solid waste dumps, but this is usually done manually and without safety equipment, and this in turn means that waste pickers are exposed to possible injuries and pathogenic infections (Ayuba *et al.*, 2013; Gundupalli *et al.*, 2017). Conversely, developed countries have met most solid waste management challenges by successfully implementing and operating policy frameworks and well-engineered waste management technologies to ensure efficient and sustainable waste management approaches (Mmereki *et al.*, 2016). According to the South African Department of Environmental Affairs and Tourism (2013), it is not possible to avoid waste completely, and thus more focus should be placed on ways to reduce, reuse or recycle unwanted material. This requires a shift away from current ineffective and potentially hazardous waste storage, collection and disposal methods. There is

therefore an urgent call on developing countries to move away from the throw-away approach and to adopt more sustainable waste disposal and reusable approaches.

Municipal solid waste (MSW) is an important waste category and also an area of grave concern (Amasuomo & Baird, 2016). With reference to Lesotho, only a very few publications on waste management related topics could be located. The publications that could be traced focused on the selection of transfer stations for Maseru Municipality (Bulane, 2009), an evaluation of the problems facing the Maseru City Council (MCC) and processes of urban management in Maseru (Lebentlele, 2000), the construction of a geographic information system (GIS) model for landfill site selection (Thoso, 2007), waste generation and management in Lesotho and waste-to-clay brick recycling (Hapazari *et al.*, 2015), urban poverty reduction through municipal solid waste management (MSWM) (Mvuma, 2002), and waste as a necessary evil for economically impoverished communities in least developed countries (Mvuma, 2010).

3.2 Aim and Objectives

The focus of the study was to evaluate municipal solid waste management practices in the Lesotho Lowlands. This was achieved by assessing constraints leading to the choice of practices.

The objectives to achieve this aim were therefore to:

- Administer a questionnaire to residents living in the vicinity of dumps and landfill sites to assess their waste disposal practices and determine waste management services that they receive in their councils;
- Administer a questionnaire to council officials to assess their waste management process and determine their challenges in waste services provision;

- Assess waste recovery interventions in councils; and
- Review residents' awareness of municipal solid waste management (MSWM) issues.

3.3 Methodology

The following aspects will be discussed as components of the study methodology:

- Ethical considerations;
- Description of the study area;
- Study design and data collection techniques; and
- Data analysis (i.e., statistical techniques).

3.3.1 Ethical considerations

Ethical approval for this study was sought and obtained from the Health Science Research Ethics Committee (HSREC) of the University of the Free State and the Ministry of Health Research Coordinating Unit. All ethical requirements were rigorously adhered to and thus validity and appropriateness were foci of the study and participants' identities were safeguarded. The respondents were informed of their rights and they were all given informed consent forms to sign prior to their participation in the study. They were at liberty to withdraw whenever they wanted to (Chatsiwa, 2015). Care was taken to ensure that the respondents were 18 years or older (Ezeah & Roberts, 2012).

3.3.2 Description of the study area

Lesotho is a small country that is mountainous and lies high above sea level. This has earned it the name of 'The Kingdom in the Sky'. It is landlocked and has a surface area of 30 350 km². It is entirely surrounded by the Republic of South Africa and most districts are bordered by the Free State Province (Government of Lesotho,

2012; Kabi *et al.*, 2014; Government of Lesotho, 2018). It is divided into four physiographic regions based on elevation and agro-climate, namely the mountainous area, the foothills, the Senqu River Valley, and the Lowlands (Kingdom of Lesotho, 2018). All ten administrative districts in Lesotho have district councils (Hoolo, 2016). The current study was conducted in the Lowlands. The Northern Lowlands comprise of Botha-Bothe urban council in the Botha-Bothe district, Maputsoe Urban Council and Hlotse Urban Council in the Leribe district and Berea Urban Council in the Berea district. In the Southern Lowlands, only the Maseru City Council in the Maseru district was included (Figure 1). The sample of five councils was a 45.5% representation of the total sum of 11 urban councils.

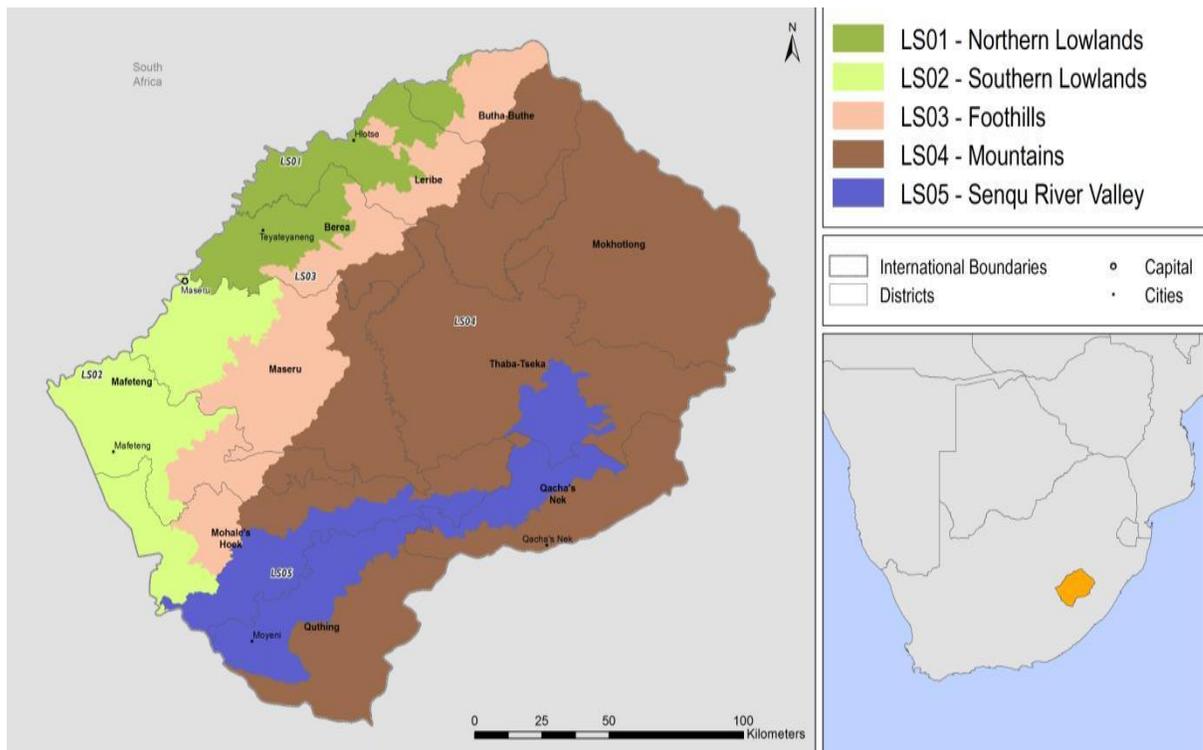


Figure 3.1: Map of Lesotho's administrative districts and livelihood zones

Source: Famine Early Warning Systems Network, 2011

3.3.3 Study design and data collection techniques

This study utilized a descriptive cross-sectional survey design. Two types of structured questionnaires were formulated in both English and Sesotho (the home language of the majority of citizens). The two questionnaires were distinctly designed and worded to draw out the required information from target respondents. Open-ended questions were used to allow the respondents to express themselves in their own words without undue influence (Sinthumule & Mkumbuzi, 2019). The first questionnaire was administered by the researcher to waste management officials in the five councils during working hours. The second questionnaire was administered to a convenient sample of one hundred and fifty residents (thirty residents per council) living in the vicinity of the selected dump sites. A direct door-stepping approach was used to administer the questionnaires to the resident respondents who returned them to the researcher immediately upon completion (Ezeah & Roberts, 2012). A time when potential respondents would be home was identified to avoid unsuccessful data collection. The questionnaires were designed for self or guided completion and worded as to be easy to read and understood in their native language. Most respondents completed questionnaires in the presence of the researcher and therefore had the opportunity to inquire for clarification whenever needed. Respondents who chose to answer questions in their own time left out questions they did not understand and there was be a meeting before collection to clarify those questions and subsequently complete. Questionnaires were checked upon submission. As another data collection method, selected waste disposal sites were visited to observe human behaviour and activities and to record the environmental appearance of the sites. These observations were recorded by means of a checklist while various photographs were also taken.

3.3.4 Statistical analysis

The data provided by the respondents in the questionnaires were coded and captured in Microsoft Excel by the researcher. Descriptive statistics namely frequencies and percentages were calculated for categorical data. Means and standard deviations or medians and percentiles were calculated for numerical data. The data are presented in a convenient and informative manner by using tables and graphs.

3.4 Results and Discussion

The results emanating from the data provided by the respondents are reported under the following categories:

- Municipal solid waste management processes;
- Waste collection;
- Waste storage and receptacles;
- Waste transportation;
- Waste segregation and recovery techniques;
- Waste disposal; and
- Residents' awareness of municipal solid waste management (MSWM) issues.

3.4.1 Municipal solid waste management (MSWM) processes

Municipal solid waste management implies the 'cradle to grave' stages of solid waste handling. The activities associated with solid waste management can be classified as waste generation, storage, collection, processing, transportation and disposal (Tchobanoglous *et al.* 1993; Rasmeni & Madyira, 2019). However, the collection, storage, transportation and final disposal of solid waste pose major

problems in urban cities and achieving the desired goals of solid waste management has been fraught with challenges, particularly in developing countries (Ahsan *et al.*, 2014). Abdel-Shafy and Mansour (2018) suggest that cities in East and North Africa as well as most developing countries are facing severe problems in waste management. These problems are arguably attributed to poor economies that account for low waste collection rates and consequent poor solid waste management. This situation is experienced in various sub-Saharan countries, particularly in Lesotho, where residents are often compelled to manage their own waste which often leads to illegal dumping and open burning. Van Niekerk and Wegmann (2019) propose that waste recovery through source reduction, reuse, recycling and composting can deplete significant quantities of municipal solid waste, but they argue that large quantities of waste still need to be deposited at landfills as a last resort to waste management in areas where population growth is escalating in an unchecked manner.

3.4.1.1 Waste collection

Existing waste collection services in residential areas are discussed in this section. Methods of collection, waste collection periods and frequencies are highlighted. The data refer to the responses of the residents who were surveyed. Figure 3.2 presents waste collection in councils.



Figure 3.2: Waste collection in the councils under study

Figure 3.2 illustrates that 60% of the residents in the areas under study, or the populations of three councils, did not receive any waste collection services, whereas only 40% (2) of the councils provided waste collection services. Collection mostly occurred during evening hours.

Similar studies have also revealed that waste remains uncollected in the municipal areas of most African countries such as Ethiopia, Uganda and Nigeria at rates of 30 to 65% collection, while generally less than 50% of the population receives waste collection services (Kampala City Council [KCC], 2006; Ogwueleka, 2009; Memon, 2010; Lohri *et al.*, 2014; Hapazari *et al.*, 2015; Kinobe *et al.*, 2015; Nnaji, 2015; Olaniyi & Hezekiah, 2016). Data based on a 2012 survey revealed that the total volume of waste collected in Africa was only 55% of the total volume of waste generated on this continent. In sub-Saharan Africa, the collection rate is even lower at 44% (Van Niekerk & Wegmann, 2019). The problem is particularly acute in poor areas where limited or non-existent waste collection services are available, which amounts to about two billion people globally lacking access to MSW collection services. In 2012, the average MSW collection rate was 55% in Africa and 44% in sub-Saharan Africa (UNEP & ISWA, 2015; Reyna-Bensusan *et al.*, 2018). Similarly,

in developing areas in Asia such as Bangladesh, 40 to 60% of waste is left uncollected (Ahsan *et al.*, 2014).

Table 3.1 presents information on the waste collection methods used in different councils, the frequency of waste collection services provided, whether there were periods when waste was uncollected and the reasons for their unsuccessful waste collections.

Table 3.1: Waste collection methods, frequency of waste collection and periods when waste was left uncollected

Characteristics	Class	Percentage per council (%)	Number of councils (n)
Types of collection methods used in councils	Kerbside collection	60	3
	Central collection point	80	4
	Door-to-door collection	40	2
	Other: waste cages	40	2
<i>n = +/- 5, more than one option was selected</i>			
Waste collection frequency	Once a week	20	1
	Five days (Monday to Friday)	80	4
<i>n = 5</i>			
Periods of uncollected waste	Yes	60	3
	No	40	2
<i>n = 5</i>			
Periods	Beginning of fiscal year	33	1
	During shortage of funds	67	2
	Weekends	33	1
	Rainy days	33	1
<i>n = 3, councils that mentioned there were periods when was not collected</i>			

Table 3.1 indicates that waste collection methods were dominated by central collection points which was a commonly used method of solid waste collection by 80% (4) of the councils, followed by kerbside waste collection by 60% (3) of the councils. The least used methods were door-to-door and waste cages collection as only 40% (2) of the councils used these. Four of the councils (80%) collected waste during five working days (Monday to Friday) and only 20% (1) of the councils collected waste once per week. It is noteworthy that 60% (3) of the councils admitted to having had periods in which solid waste was left uncollected. Table 3.1 indicates periods in which 3 (60%) of the councils did not collect solid waste. Two Councils indicated that they did not collect waste when they ran out of funds and waste was also not collected at the beginning of a fiscal year, on weekends and during rainy days by one (60%) of the three councils.

Local municipalities or councils are charged with the huge responsibility of managing waste in their operational areas. In Lesotho, the Maseru City Council and other urban councils are mandated to collect and dispose of solid municipal waste (Bulane, 2009; Government of Lesotho, 2014). A fraction of the generated waste is actually collected by means of a door-to-door collection system. This usually occurs in higher income areas and at government complexes and institutions. Where door-to-door collection systems are not available, waste is also collected from kerbsides along main roads (Government of Lesotho, 2014), but the efficiency of the waste collection methods in Lesotho is affected predominantly by financial constraints as waste is apparently not collected when funds are low (i.e., by 67% or 2 councils) and at the beginning of the fiscal year when local government is waiting for the allocation of funds from the Lesotho Ministry of Finance. Waste is also not collected on rainy days and on weekends. This seems to depend on the functionality of the relevant council as well as the accessibility of collection areas and waste collection frequencies, as 80% (4) of the councils collected waste only during the five working days. Waste seemed to be voluntarily taken to central collection points by residents

but this would depend on residents' motivation, awareness and commitment to contribute to the management of their waste. If they are not committed, residents still resort to non-recommended practices such as open dumping and burning (Government of Lesotho, 2014; Ahsan *et al.*, 2014). Sinhumule and Mkumbuzi (2019) reveal that the Bulawayo City Council in Zimbabwe collects waste once a week in the central business district (CBD) and in low density suburbs, whilst in high-density areas it is collected once every two to three weeks. Likewise, waste collection in some residential areas of Abuja in Nigeria is sometimes consistent while in other areas it is not. This is influenced by factors such as insufficient collection vehicles, inadequate staff, unplanned settlements and high costs (Ayuba *et al.*, 2013). A study that was conducted in Mexico revealed that approximately 25% of the metropolitan area could be categorised as an urban housing area and that this area was exposed to a daily waste collection service. The peri-urban community that is located between the urban and rural areas received waste collection at a reduced frequency of once per week (Reyna-Bensusan *et al.*, 2018).

As waste is collected by municipalities, provision must be made for waste storage until collection, and for this purpose different types of waste receptacles are found in different areas. These receptacles are discussed in the next section.

3.4.1.2 Waste storage and receptacles

This section indicates the number of councils that provided waste receptacles as well as the types of waste receptacles they provided.

Table 3.2 indicates the types of waste storage receptacles that 80% (4) of the councils said they provided. All four these councils that claimed to provide waste receptacles made waste bins available. Moreover, 75% (3) of the councils stated that they provided residents with plastic bags, which was the second most

commonly used receptacle, while one council (25%) indicated that it provided bulk containers, which was the least preferred receptacle.

Table 3.2: Types of waste receptacles provided to residents

Characteristics	Class	Percentage (%)	Frequency (n)
Does the council provide receptacles for waste storage?	Yes	80	4
	No	20	1
<i>n = 5 councils</i>			
If yes, types of waste storage receptacles provided.	Plastic bags	75	3
	Waste bins	100	4
	Bulk containers	25	1
<i>n = +/- 5 councils that provided receptacles</i>			

The type and conditions of waste bins provided in the Maputsoe Urban Council area are as depicted in Figure 3.3.



Figure 3.3: Photo of a waste bin provided in the Maputsoe Urban Council area (Photograph: Motaung, 27th October 2019).

Observation showed that only a few waste bins were placed by the councils in commercial areas such as along Sir Seretse Khama main road leading to the Maputsoe border, as shown in Figure 3.3. The bins were made of metal and raised from the ground to last longer and to allow easy tipping of waste into waste transport vehicles. However, the bins were clearly inadequate as none had a cover which made them easily accessible to humans and scavenging animals or for litter to be blown away by the wind. The waste bins seemed dilapidated and rusty which could have been reasons for the public's unwillingness or lethargic attitude to deposit waste in these bins, especially during periods of unsuccessful collection, as is evident in Figure 3.3. Solid waste, mainly paper, plastic and boxes which are recyclable, was observed around the bins. Clearly, the capacity of the bins was inadequate for the daily waste generation in the area. This contributed to waste scattering and the visibly diminished aesthetic appeal of the area.

In commercial areas, waste bins were placed several metres from one another which is a method that was used by 100% (5) of the councils. A study that was conducted in Lagos in Nigeria also found an inadequate number of waste collection bins (Olaniyi & Hezekiah, 2016). According to the National Domestic Waste Collection Standards of South Africa (October 2010), waste receptacles for non-reusable waste should be:

- distinguishable from recyclable waste;
- fit for storage to avoid pollution of the environment and causing harm to health;
- intact and not tarnished or worn; and
- covered to keep away animals and insects.

The waste collection bins in Figure 3.3 were not in line with any of these specifications. Kinobe *et al.* (2015) argue that scattered waste such as is evident in Figure 3.3 contributes to delays in loading waste into collection vehicles as well as lower collection rates. To achieve the best waste collection efficiency when using waste bins, it is essential to estimate waste generation volumes and the storage capacity required, to plan routes, and to determine suitable placement locations and the number and type of bins to be provided (Vilay *et al.*, 2008; Abel-Shafy & Mansour, 2018).

Street cleaning (sweeping and litter picking) was performed by waste collectors. Waste was collected in refuse bags in the Hlotse Urban Council area as shown in Figure 3.4.



Figure 3.4: Street sweeping and waste collected in refuse plastic bags in the Hlotse Urban Council area (Photograph: Motaung, 5th March 2019).

It was observed that the councils provided plastic bags for waste collection by street sweepers in central business areas, along main roads, and in front of chain stores and government complexes. Waste sweepers are depicted in Figure 3.4. In most areas the work of street sweepers is done manually. Workers with grass brooms and plastic bags walk through the streets of various parts of the city and sweep and pick up waste and litter. It is a physically demanding job and has specific health and safety challenges. On the other hand, should street sweeping vehicles be used as in European countries, employment and earning opportunities will be reduced. Such vehicles may also be unsuitable and expensive in areas with a poor infrastructure such as a lack of tarred roads (Van Niekerk & Wegmann, 2019).

Waste generated from different sources was stored in municipal plastic bags and dumped in secluded areas in the Maputsoe Urban Council area (Figure 3.5).



Figure 3.5: Municipal plastic bags dumped in an open space in the Maputsoe Urban Council area (Photograph: Motaung, 27th October 2019).

Open spaces next to main roads and near unoccupied land or areas not yet used for any development seemed to be used as temporary storage sites before collection by the responsible council or contractor. Both general waste and hazardous wastes were stored at these sites as black and red municipal plastic bags were observed and photographed, as can be seen in Figure 3.5. It can be deduced that the waste dumped in this manner was generated by various sources such as residences, commercial enterprises and health care centres. This caused potential environmental pollution and compromised the health of waste collectors.

When used as receptacles for waste collection, plastic bags are less durable than other waste receptacles and therefore they require proper use and handling. In some African cities such as Kampala, waste storage is more appropriate as it is predominantly managed by private waste operators (Kinobe *et al.*, 2015) and it thus does not end up in open sites such as the one depicted in Figure 3.5. Waste that is collected by means of street sweeping may be mainly organic (leaves and dust) and is likely to be returned to the environment in one way or another (Olaniyi & Hezekiah,

2016). However, leaves and dust are mixed with litter when the streets are swept and, when placed out in the open (i.e., the waste is not protected by a container), the plastic bags can be damaged by animals searching for food. This causes unsightly waste and creates an additional source of pollution by waste that is unsuitable for re-use and/or recycling.

In some councils, residents were provided with a waste receptacle cage located at a central collection point as depicted in Figure 3.6.



Figure 3.6: Waste receptacle cage in the Maputsoe Urban Council area
(Photograph: Motaung, 21st February 2019).

In most countries, municipal authorities in urban areas are responsible for organising municipal solid waste collection or for delegating private contractors to collect waste on their behalf. This is also the case in Lesotho. The municipalities are responsible for the selection of routes, the location of waste pickup points and the type of waste receptacles provided (Vilay *et al.*, 2008; Republic of South Africa, 2011; Government of Lesotho, 2014). According to Ayuba *et al.* (2013), waste

containers vary in type and size and they are procured based on their suitability for the task in hand. Some central collection points are provided with bulk containers for waste storage. Figure 3.6 depicts waste collection cages that are used by the Maputsoe Urban Council for the storage of residential waste. The cages are constructed of metal and wire, are movable, and are 1 m to 1.5 m high. The cage depicted in the photograph was convenient for Nyenye village residents who lived between 100 m to 200 m away, but the distance other residents had to walk to this container could have discouraged them from utilising it. There was visible littering near the cage, which suggests that either the waste was not properly placed into the container or animals such as monkeys or birds could have scavenged in it to find food as the container did not have a cover. Fredrick *et al.* (2018) state that authorities should supply convenient waste receptacles to motivate residents to cooperate with this form of waste management. Thus, if receptacles are inconveniently constructed and inappropriately positioned, residents will avoid using them efficiently, as this photograph suggests. Moreover, if there is no easy way to reach the waste placed in such a cage, waste collectors may also not clear them on a regular basis.

3.4.1.3 Waste transportation

Waste stored in various containers (bags, bins and cages) should be removed from the storage areas at frequent and appropriate intervals. It was found that different types of vehicles were used by the councils to transport waste to the disposal sites.

Table 3.3: Vehicles used by the Councils to transport waste from source to disposal sites

Vehicle	Percentage (%)	Number of councils (n)
Compactor truck	20	1
Skip-loader truck	40	2
Tractor-drawn trailer	80	4
Small bakkie/Utility vehicle	80	4
Other: 4.0 ton to 8.0ton trucks	60	3

n = +/- 5; more than one option was selected

The table (3.3) shows that tractor-drawn trailers and small vans were the most commonly used waste collection vehicles as 80% (4) of the councils relied on them. This was followed by 4.0 to 8.0 ton trucks which were used by 60% (3) of the councils. A skip-loader truck and a compactor truck were the least preferred waste collection vehicles as only 40% (2) and 20% (1) used them respectively.

It was stated by the respondents that the councils, service providers and private companies such as textile manufacturers relied on the type of truck depicted in Figure 3.7. Even though the beds of these trucks were observed not to be covered, they were bordered by metal mesh fencing to minimise litter falling from the sides of the vehicles during transportation to the disposal sites. This type of utility vehicle was generally used.



Figure 3.7: Waste collection truck used in the Maputsoe Urban Council area
(Photograph: Motaung, 21st February 2019).

Smaller waste collection vehicles referred to as 'bakkies' (a type of pick-up truck) were the preferred type of vehicle used by 80% (4) of the councils. These waste collection vehicles were also not covered but the back was usually bordered by metal mesh fencing to minimise waste falling off or being blown from the vehicle during transportation to the disposal site. Such a bakkie is depicted in Figure 3.8. These vehicles are known for low maintenance and reasonable fuel costs.



Figure 3.8: Waste collection bakkie used in the Botha-Bothe Urban Council area (Photograph: Motaung, 6th March 2019).

A tractor-drawn loader was also a favourite collection vehicle as 80% (4) of the councils relied on this form of waste transportation. Tractors are suitable for use on tarred roads but are particularly useful in harsh terrain. Figure 3.9 shows a tractor-drawn loader off-loading waste at dumpsite in the Botha-Bothe Urban Council area.



Figure 3.9: Tractor-drawn loader used in the Botha-Bothe Urban Council area (Photograph: Motaung, 6th March 2019).

The use of skip-loader trucks was limited to only a few councils such as the Maseru City Council area as shown in Figure 3.10.



Figure 3.10: Skip loader truck used in the Maseru City Council area
(Photograph: Motaung, 19th February 2019).

They were reportedly used by councils to collect skips from education or government complexes and commercial areas such as malls and factories. After certain time intervals, these vehicles would deliver empty skips to the collection sites and pick up full skips that would be taken to waste disposal sites.

An efficient waste collection system requires adequate, suitable and well-maintained transport equipment. Most urban municipalities in African countries such as Nigeria are struggling with an inadequate number of vehicles, a lack of spare parts for those available, poor maintenance practices, and unskilled personnel

(Olaniyi & Hezekiah, 2016). According to Lorhi *et al.* (2014), limited suitable equipment in Bahir Dar in Ethiopia contributes to a decline in the number of serviced areas in this region. In Kampala, Ghana, the trucks that are used are not recommended for the collection of waste and are in many cases overloaded, which compromises the health and safety of waste loader handlers who transport waste to disposal sites (Kinobe *et al.*, 2015). The data thus suggest that, as long as improvements are not made in terms of waste transportation practices, waste collection will continue to be limited and compromised.

3.4.1.4 Waste segregation and recovery techniques

The data that are summarised in Table 3.4 were obtained from the residents and council members who participated in the survey.

Table 3.4: Waste segregation and recovery practices in the Lesotho lowlands

Characteristics	Class	Percentage (%)	Frequency (n)
Waste segregation at source	No	80	4
	Not specified	20	1
<i>n = 5 councils</i>			
Presence of waste pickers at disposal sites	Yes	84	126
	No	16	24
Frequency of waste picking on-site	Daily	79.4	100
	Every other day	11.9	15
	Weekly	7.1	9
	Every other week	1.6	2
<i>n = 126 residents who claimed they saw waste pickers on-site</i>			

Type of waste recycled	Plastic	80	4
	Glass	80	2
	Cardboard	100	5
	Paper	60	3
	Scrap metal	40	2
	Electronics	20	1
	Other: Textiles	40	2
Availability of transfer stations	Yes	20	1
	No	80	4
<i>n = 5 councils</i>			

Table 3.4 indicates that waste was not separated at source in 80% (4) of the Councils. Only one council did not specify whether there was any separation done at source, which could be linked to uncertainty due to limited or no waste records in Lesotho. The majority of the council members (84%; 126) mentioned that they were aware of waste pickers on site while 79.4% (100) said they saw them every day. Cardboard was the most preferred recycled product in all five the councils (100%). Plastic and glass were recycled by 80% or 4 of the councils. However, 4 of the 5 councils (80%) did not have a transfer station.

Figure 3.11 shows recyclable waste separated and stored in bags by waste pickers at Tsosane landfill in the Maseru City Council area.



Figure 3.11: Waste separated in bags at the Tsosane landfill site in the Maseru City Council area (Photograph: Motaung, 19 February 2019).

Waste was separated and compacted by waste pickers using a diesel driven machinery onsite at the Mokota-koti dumpsite in the Maputsoe Urban Council area as shown in Figure 3.12.



Figure 3.12: On-site diesel driven waste compacting machinery at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

Cardboards and textiles were some of the common recyclables which were separated onsite by waste pickers at Makota-koti dumpsite in the Maputsoe Urban Council area as shown in Figure 3.13.



Figure 3.13: Cardboard and textile recycling at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

Figure 3.14 shows that plastics and glass were also common recyclables which were separated onsite by waste pickers at Makota-koti dumpsite in the Maputsoe Urban Council area.



Figure 3.14: Plastic and glass waste separated for recycling at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

Plastic and glass were common recyclables which were separated onsite by waste pickers at the Hlotse dumpsite in the Hlotse Urban Council area as shown in Figure 3.15.



Figure 3.15: Plastic and glass waste separated for recycling at the Hlotse dumpsite in the Hlotse Urban Council area (Photograph: Motaung, 27th February 2019).

Developing countries seldom practise waste segregation at source (Gundupalli *et al.*, 2017). Studies conducted in developing African countries such as Nigeria, South Africa, Uganda and Lesotho found that the practice of separating certain solid waste at household level for direct re-use or for monetary value through recycling was very rare and was thus limited to institutional level (Ogola *et al.*, 2011; Olaniyi & Hezekiah, 2016). However, researchers agree that it is very common to see waste pickers segregating solid waste for recycling purposes in streets and at disposal sites, and the majority of the resident participants agreed that they saw waste pickers on a daily basis at dumpsites (Table 3.4). In India and other developing countries where integrated solid waste management is still a challenge, waste pickers are often harassed by the police and bullied by municipal workers and residents as they are suspected of theft or charged for trespassing and scattering waste which causes a nuisance (Bhaskar & Chikarmane, 2012). However, waste pickers in the Lesotho Lowlands appeared not to be deterred in any way as a large percentage of respondents (84%; 126) claimed that they saw waste pickers

separating and collecting recyclables at most disposal sites on a regular basis. Bulane (2009) mentions that waste is sorted and separated at transfer stations and transported to different end points such as recycling, composting, landfill or incineration sites. Such transfer stations were not available in all the surveyed councils, which is a pity as the existence of transfer stations in all councils will reduce the challenges associated with waste picking and optimize waste recycling.

Waste that is collected at source and transported to disposal sites is usually mixed in refuse bags or in the beds of waste trucks. This practice compromises the quality of recycled waste like cardboard and paper which were found to be the most preferred recycled waste categories (Table 3.4) (Ogola *et al.*, 2011; Miezah *et al.*, 2015; Kinobe *et al.*, 2015). Source separation and municipal solid waste collections result in higher percentages of waste recycling, especially in some European countries and Korea where source separation is strictly controlled and implemented (Mian *et al.*, 2017). In comparison with Ghana, scrap metal and electronic recycling seemed low in Lesotho as only 40% (2) of the councils recycled these products, while plastic waste was highly recycled by 80% (4) of the councils in the Lesotho Lowlands. A study conducted in Kiteezi, Ghana, revealed that 2% of plastic waste was recycled and the rest was thrown into the streets indiscriminately, while on the other hand scrap metal was recycled at a 100% rate due to its market value in the country (UNEP, 2018). Figure 3.12 shows that textile waste was also prevalent at the formal disposal sites and was recycled by 40% (2) of the councils, namely the Maseru City Council and the Maputsoe Urban Council. This waste form was prevalent due to an abundance of clothing manufacturers in these areas (Government of Lesotho, 2012). In South Africa, it is estimated that around 80 to 90% of paper and packaging waste is recovered by the informal sector (Van Niekerk & Wegmann, 2019). In Brazil, China and the United States, around twelve million people are employed in the waste management sector (UNEP, 2019).

Waste recycling businesses are viable in the Maputsoe Urban Council and the Maseru City Council areas. For instance, it was stated that contractors involved in such businesses organize waste pickers and waste segregation and even compacted recyclables on-site, as is depicted in Figure 3.11 and Figure 3.12. In the Hlotse Urban Council area, waste contractors or waste buyers reportedly came once or twice a week to buy waste recyclables, particularly cardboard boxes, plastic and glass waste. Through observations and inquiry of available dumpsite workers and waste contractors, it was estimated that waste pickers in the five councils numbered in the region of two hundred. Only the Maseru City Council and the Maputsoe Urban Council could provide recorded numbers of waste pickers at 138 and 19 respectively. The waste disposal sites in the Lesotho Lowlands that were initially earmarked for industrial, commercial, institutional and residential waste have thus evidently become a source of livelihood for poor urban populations who pick waste that they find useful for consumption or financial gain (Serabele, 2014; Hapazari *et al.*, 2015). The lower number of waste pickers in the councils other than the Maputsoe Urban Council and the Maseru City Council could be attributed to low economic activities and low generation of recyclable waste in these areas (Hapazari *et al.*, 2015; Miezah *et al.*, 2015).

3.4.1.5 Waste disposal

Various methods are used by residents and the municipalities in which they reside to dispose of waste. Figure 3.16 depicts the different waste disposal methods used in the Lesotho lowlands.

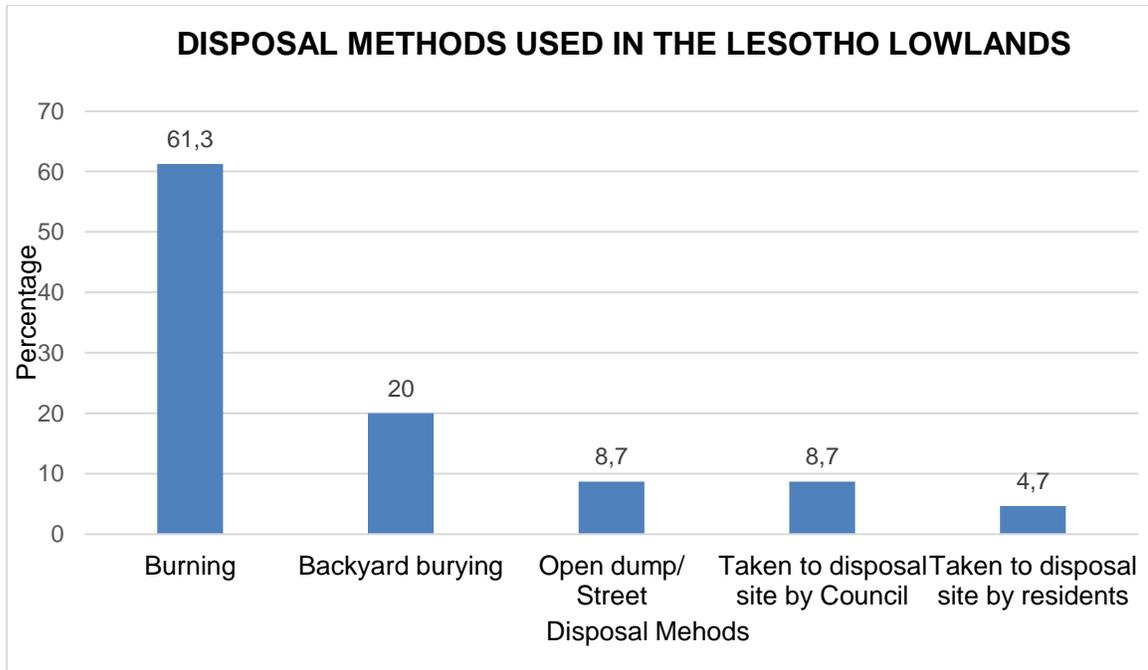


Figure 3.16: Disposal methods used in the five council areas under study

The data that are presented in Figure 3.16 were obtained from the residents who participated in the survey. The figures indicate that waste burning was the most frequently used solid waste disposal method as it was determined that more than half (61.3% or 92) of the residents burnt their waste. A lower percentage of residents (20% or 30) burnt their waste in their backyards. Only 4.7% (7) of the residents said that they carried their own waste to the landfill or dumpsite.

Figure 3.17 shows Tsosane landfill in the Maseru City Council area covered in smoke after breaking out of fire onsite.



Figure 3.17: Spontaneous fires at Tsosane landfill in the Maseru City Council area (Photograph: Motaung, 30th October 2019).

Various authors have confirmed that waste disposal methods in developing countries are outdated and fraught with challenges. For instance, in Tanzania more than 50% of the residents rely on waste burning, followed by waste burying and dumping while safer waste disposal methods are rarely used (Palfreman, 2014). Both students and teachers of a secondary school in Zimbabwe stated that waste burning was a suitable disposal method and they preferred this method over waste collection services despite being aware of the environmental implications of waste burning (Chatira-Muchopa *et al.*, 2019). This finding of the latter study was corroborated by the current study as the majority 61.3% (92) of the respondents living in the vicinity of disposal sites preferred waste burning compared to the 8.7% (13) who preferred waste collection services or taking waste to a disposal site or point. Similar to Lesotho, backyard dumping is still a challenge in Uganda in low income areas where residents cannot afford waste management services (Fredrick *et al.*, 2018). The current study also found that the second most used disposal method by residents in the Lesotho lowlands was backyard burning. Similarly, populations that receive little or no waste collection in Mexico rely on open burning,

burial, or open dumping into watercourses, all of which have a negative impact on health and the environment (UNEP & ISWA, 2015; Reyna-Bensusan *et al.*, 2018).

The current study found that collected waste was disposed of at uncontrolled open and partially lined landfills. None of the disposal sites were properly controlled or engineered. Some towns, excluding Maseru, had official disposal sites that had been selected by the Council and town clerks. Most were unprotected and inappropriately located. It was also found that waste was dumped and sometimes burned onsite. The Ts'osane landfill site had served Maseru since the early 1980s but, although it is regarded as a landfill, it does not meet the required standards of a landfill and has a history of poor operations. In fact, it is not clear how long the site may continue to receive waste. Installations for the control of landfill gas, particularly methane, were observed, but landfill waste burning was prevalent with smoke hovering over and in the vicinity of the site for over a month (see Figure 3.17). This fire outbreak was reported to the Maseru City Council by the contractor operating the site, but nothing had been done to contain the situation. This poses the question whether this council is effective in monitoring landfill gas emissions to protect citizens from any adverse effects. For over a decade, the Maseru City Council has been planning the construction of a sanitary landfill in Tsoeneng, 45 kilometres from Maseru city, as an environmentally safe disposal site for solid waste (Bulane, 2009; Envirotech, 2013), but at the time of this study nothing had been accomplished yet.

3.4.2 Residents' awareness of municipal solid waste management (MSWM) issues

The resident respondents were requested to provide information regarding their awareness of solid waste issues and the methods of communication between the Council and themselves. Table 3.5 summarises their responses.

Table 3.5: Methods used by the five councils to communicate with residents

Methods of Communication	Percentage	Number of councils
	(%)	(n)
Radio	40	2
Email/Social media blogs	0	0
Newspapers	20	1
Pamphlets	0	0
Notifications at community centres	60	3
Public gatherings by village chief or councillor	60	3

n = 5 councils

Table 3.5 highlights that notifications at community centres and public gatherings by the village chief or councillor were the main methods used by Councils to communicate with residents. Sixty percent of the councils seemed to rely on public gatherings and two councils (40%) used radio messages to communicate notifications to their residents. Only one council posted notifications in weekly newspapers.

Awareness campaigns can be launched through newspapers, community meetings, the Internet, radio and television. In Kampala, Uganda, 83% of the respondents participating in a survey reported that newspapers, television and radio were used to educate communities on waste management and they mentioned that these communications impacted positively on their attitude towards waste practices (Miezah *et al.*, 2015). Awareness campaigns are key to community based solid waste management practices and can have a positive impact on communities' attitude towards waste management (Sinthumule & Mkumbuzi, 2019). However, in economically poor residential areas, access to the mass media is limited, therefore public gatherings and educational programs should be used for information

dissemination (Mamady, 2016). Public gatherings called by the village chief or councillor and notifications at community centres are useful and effective strategies to inform the community. In fact, the current study identified these strategies as the most preferred methods of communicating information to communities. If the councils use this platform, they will capacitate residents with knowledge regarding the impact of open burning and the indiscriminate dumping of waste. Table 3.6 summarizes residents' knowledge regarding waste dumping and burning and lists the sources from which the knowledge was acquired.

Table 3.6: Knowledge of open waste dumping and waste burning

	Questions	Response	Percentage (%)	Number of respondents (n)	Sources
1.	Have you ever come across any form of information associated with waste dumping ?	Yes No Not specified	20 74 6	30 111 9	From elsewhere (media, educational programs, Non-Governmental campaigns)
2.	Have you ever come across any form of information associated with the burning of solid waste?	Yes No Not specified	28 64.7 7.3	42 97 11	From elsewhere (media, educational programs, Non-Governmental campaigns)

3.	Have you ever received any information or lessons from the council regarding waste dumping ?	Yes	6.7	10	Councils
		No	85.3	128	
		Not specified	6	12	
4.	Have you ever received any information or lessons from the council regarding waste burning ?	Yes	14.7	22	Councils
		No	78	117	
		Not specified	7.3	11	

The sources of information were limited, but some residents had received information from their councils, the media, educational programs, schools, and non-governmental organization (NGO) campaigns. Unfortunately, a very limited number of residents had received any kind of information or education on waste dumping from the councils (6.7%; 10) and elsewhere (20%; 30). Similarly, a significantly low number of residents had received any kind of information or education about waste burning from their councils (14.7%; 22) and elsewhere (28%; 42).

These low figures confirm that residents were not sensitized regarding vital environmental issues and that the relevant authorities neglected their mandate in this regard. This finding indicates that the municipalities did not communicate the principles of environmental management referred to in the Environment Act which aims to ensure that environmental awareness is treated as an integral part of education at all levels (Government of Lesotho, 2008). The role of communities in

the proper management of waste depends on the availability of information and the active participation of community leaders and a competent local authority (Sithumule & Mkumbuzi, 2018). A study that was conducted in Kampala City in Uganda revealed that, in areas where education on waste management was rare, the consequence was that the community indiscriminately dumped solid waste everywhere simply because it was convenient. This undeniably occurred as a result of a lack of waste education in the area (Fredrick *et al.*, 2018). The same reason may have provoked improper waste practices in the Lesotho Lowlands. Desa *et al.* (2012) argue that the relationship between people's attitude towards the environment and their behaviour is impacted by their levels of knowledge and awareness. Only if these levels are high will residents publicly voice their pledge to environmental health and demonstrate acceptance of their responsibility in this regard. According to Mamady (2016), the role of community residents, their attitudes, their waste management practices and their relations with other participants in the waste management system need to be emphasized because they are the main users of waste management facilities (Mamady, 2016).

3.5 Conclusion

Solid waste management services that are provided by local governments are often erratic in developing countries where waste collection services are available to only a small fraction of society. This was found to be the case in the study area in Lesotho as well. The most commonly used collection method for waste in Lesotho seemed to be central collection points, but these were convenient only for residents living along the main roads. Waste cages in central business areas were also prevalent, although not in sufficient numbers. It was found that waste was mostly transported from source to the disposal sites by vans (some were caged to prevent littering and some were not), four- or eight-ton trucks, and tractor-drawn skips. Waste was rarely transported in compactor or skip loader trucks. Waste segregation was not practised at source which impeded the quality of waste recyclables such as paper and

cardboard. Waste picker activities have a great potential for additional recycling, and it was found that waste pickers, as members of the informal waste sector, operated actively at dumpsites, particularly in the Maputsoe Urban Council and the Maseru City Council areas. For them this was a source of livelihood and survival. The data revealed that the majority of residents relied on waste burning to dispose of their waste, while burning was also practised at all the official dumpsites. This practice was unfortunately encouraged by poor waste collection coverage and a lack of public awareness of waste associated hazards which was caused by a lack of information dissemination by the councils. Spontaneous fire outbreaks at the Tsosane dumpsite posed questions regarding the efficacy and monitoring ability of landfill gas equipment. The findings suggest that local governments should prioritise effective municipal solid waste management and encourage public involvement by launching educational campaigns and programmes. Moreover, skilled private operators should be contracted in to manage solid waste disposal. This will ensure higher waste disposal efficiency as they will capitalize on the shortcomings of the councils and deliver improved services.

REFERENCES

- Abdel-Shafy, H., & Mansour, M.S.M. 2018. The solid waste issue: sources, composition, disposal, recycling and valorization. *Egyptian Journal of Petroleum*, 27, 1275–1290.
- Ahsan, A., Alamgir, M., El-Sergany, M.M., Shams, M.K., & Nik Daud, N.N. 2014. Assessment of a municipal solid waste management system in a developing country. *Chinese Journal of Engineering*, Article ID 561935, 1–11.
- Ayuba, K.A., Manaf, L.A., Sabrina, A.H., & Azmin, S.W.N. 2013. Current status of municipal solid waste management practice in FCT, Abuja. *Research Journal of Environmental and Earth Sciences*, 5(6), 295–304.
- Amasuomo, E., & Baird, J. 2016. The concept of waste and waste management. *Journal of Management and Sustainability*, 6(4), 88–96.
- Babs-Shomoye, F., & Kabir, R. 2016. Health effects of solid waste disposal at a dumpsite on the surrounding human settlements. *Journal of Public Health in Developing Countries*, 2(3), 268–275.
- Bhaskar, A., & Chikarmane, P. 2012. The story of waste and its reclaimers: organising waste collectors for better livelihoods. *The Indian Journal of Labour Economics*, 55(4), 595–619.
- Bulane, I. 2009. *The selection of transfer locations for Maseru Municipality*. Master's thesis, University of Witwatersrand, South Africa.
- Cervantes, D.E.T., Martinez, A.L., & Hernandez, M.C. 2018. Using indicators as a tool to evaluate municipal solid waste management: a critical review. *Waste Management*, 80, 51–63.
- Chatira-Muchopa, B., Chidarikire, M., & Tarisayi, K.S. Solid waste management practices in Zimbabwe: a case study of one secondary school. *Journal for Transdisciplinary Research in Southern Africa*, 15(1), 2–5.
- Chatsiwa, J. 2015. *Land pollution and population density: the case of Kwekwe City residential areas, Zimbabwe*. Master's thesis, University of South Africa, Pretoria, South Africa.

- Department of Environmental Affairs and Tourism of South Africa (DEAT). 2013. *Working with waste: guidelines on waste collection in high density and unserviced areas*. Available at: www.environment.gov.za. Tshwane: DEAT.
- Desa, A., Kadir, N.B.A., & Yusooff, F. 2012. Waste education and awareness strategy: towards a solid waste management (SWM) program in UKM. *Procedia Social and Behavioural*, 59, 47–50.
- Envirotech. 2013. *Landfill gas monitoring for Motse Miya trading and projects: Ts'osane landfill, Maseru-Lesotho*. South Africa: Envitech Technical Report.
- Ezeah, C., & Roberts, C. 2012. Analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria. *Journal of Environmental Management*, 103(9), 9–4.
- Fredrick, M., Oonyu, J.C & Sentongo, J. 2018. Influence of Education on the Solid Waste Management Practices of Communities in Kampala City. *Journal of Environment and Waste Management*, 5(1), 261–274.
- Gilpin, A. 1996. *Dictionary of environment and development*. Chester and New York: John Wiley and Sons.
- Government of Lesotho. 2008. Environmental Act: Act No.10 of 2008. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2012. Poverty reduction strategy paper: National Strategic Development Plan. *International Monetary Fund Country Report No.12, 102*. Maseru: Ministry of Finance.
- Government of Lesotho. 2014. Solid waste, water and sanitation report 2013. *Statistical Report No.15*. Maseru: Bureau of Statistics.
- Government of Lesotho. 2016. Census 2016: Bureau of Statistics report. Available at: www.bos.gov.ls>2016sum...pdf [Accessed 01/10/ 2019].
- Government of Lesotho. 2018. Country profile 2017-18: the local government system in Lesotho. Available at: www.clgf.org.uk/lesotho United Nations Economic Commission for Africa (UNECA) [Accessed 18/10/ 2018].

- Gundupalli, S.P., Hait, S., & Thakur, A. 2017. Multi-material classification of dry recyclables from municipal solid waste based on thermal imaging. *Waste Management*, 70, 13–21.
- Hapazari, I., Ntuli, V., & Taele, B.M. 2015. Waste generation and management in Lesotho and waste to clay brick recycling: a review. *British Journal of Applied Science & Technology*, 8(2), 148–161.
- Hoolo, N. 2016. Assignment of functions to local authorities in Lesotho. *Commonwealth Journal of Local Governance*. Do-105130/cjlg.v0i19.5449.
- Kabi, T., Kompi, B., & Twala, C. 2014. Challenges of local government in the community councils of the Maseru district in the Kingdom of Lesotho: a historical overview. *J Soc Sci*, 39(1), 51–57.
- Kampala City Council (KCC). 2006. Solid Waste Management Strategy Report. In city council of Kampala, edited by KCC. Kampala, Uganda: Republic of Uganda.
- Khan, D., & Samadder, S.R. 2014. Municipal solid waste management using geographical information system aided methods: a mini review. *Waste Management and Research*, 32(11), 1049–1062.
- Kinobe, J.R., Niwagaba, C.B., Gebresenbet, G., Komakech, A.J., & Vinneras, B. 2015. Mapping out the solid waste generation and collection models: the case of Kampala City. *Journal of the Air & Waste Management Association*, 65(2), 197–205.
- Lebentlele, N.K. 2000. *An evaluation of the problems facing the Maseru City Council (MCC) in the process of urban management in Maseru*. Master's thesis, University of Natal, Durban.
- Liu, A., Ren, F., Lin, W.Y & Wang, J.Y. 2015. A review of municipal solid waste environmental standards with a focus on incinerator residues. *International Journal of Suitable Built Environment*, 4, 165–188.
- Lohri, C.R., Camenzind, E.J., & Zurbrugg, C. 2014. Financial sustainability in municipal solid waste management: costs and revenues in Bahir Dar, Ethiopia. *Waste Management*, 34, 542–552.

- Mamady, K. 2016. Factors influencing attitude, safety behaviour, and knowledge regarding household waste management in Guinea: a cross-sectional study. *Journal of Environmental and Public Health*, 1–9.
- Matope, T. 2013. Maseru City Council plans makeover. *Lesotho Times*, 26 September.
- Melare, A.V., Gonzalez, S.M., Faceli, K., & Casadei, V. 2017. Technologies and decision support systems to aid solid waste management: a system review. *Waste Management*, 59, 567–584.
- Memon, M.A. 2010. Integrated solid waste management based on the 3R approach. *Journal of Material Cycles and Waste*, 12(1), 30–40.
- Mian, M.M., Zeng, M., Nasry, A.N.B., & Al-Hamadam, S.M.Z.F. 2017. Municipal solid waste management in China: a comparative analysis. *J Mater Cycles Waste Management*, 19, 1127–1135.
- Miezah, K., Obiri-Danso, K., Kadar, Z., Fei-Baffoe, B., & Mensah, M.Y. 2015. Municipal Solid waste characterization and quantification as a measure towards effective waste management in Ghana. *Waste Management*, 40, 15–27.
- Mmerekhi, D., Baldwin, A., & Li, B. 2016. A comparative analysis of solid waste management in developed, developing and lesser developed countries. *Environmental Technology Reviews*, 5(1), 120–141.
- Mvuma, G.G.K. 2002. *Urban poverty reduction through municipal solid waste management (MSWM): a case study of Maseru and Maputsoe in Lesotho*. PhD Thesis, Department of Civil Engineering, UW, RSA.
- Mvuma, G.G.K. 2010. Waste a necessary evil for economically impoverished communities in least developed countries: a case of Lesotho. The 20th WasteCon Conference and Exhibiion 4-8 October 2010. Emperor's Palace, Gauteng, South Africa. WasteCon 2010.
- Nnaji, C.C. 2015. Status of municipal solid waste generation and disposal in Nigeria. *Management of Environmental Quality: An International Journal*, 26(1), 53–71.

- Ogola, S.L., Chimuka, L., & Tshivhase, S. 2011. Management of municipal solid wastes: a case study in Limpopo Province, South Africa. In: S. Kumar (Ed.). *Integrated waste management Vol. 1*. ISBN: 978953-307-469-6, InTech.
- Ogwueleka, T. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health, Science and Engineering*, 6(3), 173–180.
- Olaniyi, A.A., & Hezekiah, O. 2016. Inventory analysis of solid waste management in Ikorodo Community. *Civil and Environmental Research*, 8(9), 26–38.
- Oteng-Ababio, M., J.E. Melara Arguello, & O. Gabbay. 2013. Solid Waste Management in African Cities: Sorting the Facts from the Fads in Accra, Ghana. *Habitat Int*, 39, 96–104.
- Palfreman, J. 2014. Waste management and recycling in Dar es Salaam, Tanzania. *Researchgate*. DOI: 10.13140/2.1.3196.4482
- Parvez, N., Agrawal, A., & Kumar, A. 2019. Solid waste management on a campus in a developing country: a study of the Indian Institute of Technology, Roorkee. *MDPI Recycling*, 4, 28.
- Rasmeni, Z.Z., & Madyira, D.M. 2019. A review of the current municipal solid waste management practices in Johannesburg City townships. *Procedia Manufacturing*, 35, 1025–1031.
- Republic of South Africa. 2011. *Environmental management: waste management strategy*. Pretoria. Government Printers.
- Reyna-Bensusan, N., Wilson, D.C., & Smith, S.R. 2018. Uncontrolled burning of solid waste by households in Mexico is a significant contributor to climate change in the country. *Environmental Research*, 163, 280–288.
- Schubeler, P. 1996. *A conceptual framework for municipal solid waste management in developing Countries*. St. Gallen, Switzerland: Swiss Centre for Development Cooperation in Technology and Management (SKAT).
- Serabele, M. 2014. Dumpsite Divides Maputsoe. *Lesotho Times*, 25 April.

- Sinthumule, N.I., & Mkumbuzi, S.H. 2019. Participation in community – based solid waste management in Nkulumane suburb, Bulawayo, Zimbabwe. *Resources*, 8(30), 1–16.
- South Africa. 2010. National Environmental Management Act (Act No.59 of 2008): National Domestic Waste Collection Standard. Gazette No. 33935.
- Tchobanoglous, G., Theisen, H., & Vigil, S.A. 1993. Integrated solid waste management: engineering principle and management issue. New York: McGraw Hill.
- Thoso, M. 2007. *The construction of a geographical information system (GIS) model for landfill site selection*. Master's thesis, University of the Free State, Bloemfontein, South Africa.
- United Nations Department of Economic and Social Affairs (UN DESA). 2014. World's population increasingly urban with more than half living in urban areas. Available at: <http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html> [Accessed 16/12/2019].
- United Nations Environment Programme (UNEP). 2019. Solid Waste Management. Available at: www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/cities/solid-waste-management [Accessed 16/12/2019].
- United Nations Environment Programme & International Solid Waste Association (UNEP & ISWA). 2015. Global waste management outlook: United Nations Development Programme. Available at: <http://www.unep.org/ietc/InformationResources/Events/GlobalWasteManagementOutlookGWMO/tabid/106373/Default.aspx> [Accessed 18-11-2018].
- Van Niekerk, S., & Wegmann, V. 2019. Municipal solid waste management services in Africa – Working Paper. *Public Services International*, 1–68.
- Vilay, R., Gautam, A., Kalamdhad, A., Gupta & Devotta, S. 2008. GIS locational analysis of collecting bins in municipal solid waste management system. NRC Canada, 39–43.

Wilson, D.C. 2007. Development divers for waste management. *Waste Manage Res*, 25, 1998–207.

Zurbrugg, C. 2002. Urban solid waste management in low-income countries of Asia: how to cope with the garbage crisis. Paper presented at the Scientific Committee on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session, Durban, South Africa.

CHAPTER 4

ENVIRONMENTAL IMPLICATIONS OF WASTE DISPOSAL SITES AND LEGAL COMPLIANCE IN THE LESOTHO LOWLANDS

ENVIRONMENTAL IMPLICATIONS OF WASTE DISPOSAL SITES AND LEGAL COMPLIANCE IN THE LESOTHO LOWLANDS

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ABSTRACT

The generation of waste is unavoidable. In recent years waste has been regarded as an economic resource but also as an environmental problem. All activities in solid waste management involve risks that either impact workers directly or affect communities. It is for this reason that investigations into sustainable methods and technologies for waste management have been launched on an increasing scale. The current study aimed to assess the impact of waste disposal sites on the environment and the lives of those living in their vicinity. This was achieved by locating sites where open dumping and burning occurred and reviewing their status with respect to their compliance with waste legislation and international and national waste disposal and management guidelines. The study utilised a descriptive design and employed an appropriate methodological approach. Two sets of cross-sectional survey questionnaires were used to respectively survey waste management officials and 150 residents living in the vicinity of dumpsites or a landfill site. Photographs were also taken and checklists were completed on site. The data were analysed using descriptive statistics and are presented in tables and graphs. The study revealed that less than half (40%; 2) of the five councils under study trained the waste management labourers in their employ. All the councils (100%; 5) utilised open dumpsites and the majority (76%;1) of the residents who were surveyed mentioned that waste was burned onsite. Of these, (76.7%; 84.) said that burning occurred on a daily basis. Almost half (46.7%; 70) of the residents perceived that they were exposed to health risks and it was revealed that gastrointestinal and respiratory diseases afflicted about (44.1%; 30) of the residents residing in the vicinity of these dumps. The diseases were associated with the consumption of condemned food, the prevalence of rodents and vectors, smoke inhalation and

nasty odours. Most of the residents (27.9%; 19) felt that it was the responsibility of their respective councils to mitigate the deleterious effects of dumpsites. Health and safety promotion interventions and sustainable waste projects are needed to enhance risk awareness among the communities affected by inappropriate waste practices by these urban councils.

Keywords: residents, waste workers, waste implications, health and safety, sustainable waste management

4.1 Introduction and Background

The generation of waste is inevitable, especially in the modern age of industrialization and urbanization. According to the United Nations Environment Programme (UNEP) (2015), waste can be viewed as a combination of four wrongs: a wrong substance, of a wrong quality, in a wrong place and at a wrong time. Godfrey *et al.* (2019) argue that the continent of Africa is facing growing waste management crises due to population growth coupled with people's migration to urban centres. Consumption trends have also accelerated the municipal solid waste generation rate in developing countries. These factors, among others, have led to either uncontrolled management or the mismanagement of the environment (Vergara & Tchobanoglous, 2012; Debnath *et al.*, 2015; Melare *et al.*, 2017).

Waste that originates from households, central business areas, open market places, institutions and residential areas are referred to as municipal solid waste (MSW) (Government of Lesotho, 2014; Ogundele *et al.*, 2018). While the volumes of waste generated in Africa are relatively small compared to those generated in developed regions, the mismanagement of waste in Africa is already impacting human and environmental health (Godfrey *et al.*, 2019). It is for this reason that municipal solid waste management, particularly in urban areas, has become a major concern in

developing cities as few efforts have been made by authorities to improve waste collection and disposal facilities (Ali *et al.*, 2014).

There have been growing concerns over the disposal of solid waste globally, as such waste may contain small amounts of hazardous components (Jerie, 2016). The quantity and varieties of hazardous waste have also been increasing, with little awareness of the nature or management of such waste, especially in high- or middle-income areas (Department of Environmental Affairs, 2018). Moreover, waste streams in Africa are escalating as consumer behaviour changes and as inexpensive, second-hand products are increasingly being imported by African countries. These products have caused new emerging hazardous waste streams that need to be managed efficiently and scientifically (Department of Environmental Affairs, 2018). According to the Environment Act of 2008 of Lesotho, hazardous waste means waste that is poisonous, corrosive, noxious, explosive, inflammable, radioactive, toxic or harmful to the environment (Government of Lesotho, 2008). The continuous accumulation of municipal solid waste is also associated with the disposal of heavy metals (HM), which is a common phenomenon in urban centres where accelerated industrial, agricultural and intensive economic activities prevail (Nwaogu *et al.*, 2017). Due to industrialization and the proliferation of affordable second-hand imports from more developed countries, there has been a stream of hazardous waste that contains electrical and electronic equipment (WEEE) as well as waste tyres. These materials end up in waste dumps and landfill sites where they often remain untreated as waste (Department of Environmental Affairs, 2018). In 2016, the Minister of Trade, Industry, Cooperatives and Marketing stated that Lesotho had become a convenient dumpsite for vehicles and tyres that were not roadworthy in their countries of origin, and therefore he stated that the Ministry was working towards decreasing the rate of import of these forms of waste (Minister wants to halt cheap car imports, 2016). Unfortunately, to date this plan has not been implemented. In 2018 the Department of Environmental Affairs (2018) stated that WEEE was produced without adequate end-of-life solutions for these products

(Department of Environmental Affairs, 2018), and therefore the organised and scientifically planned segregation of MSW, particularly if it contains WEEE, remains an urgent requirement in developing cities. This is because, when such waste is mixed with municipal solid waste, it poses a threat to human health and will have long-term effects on the environment (Ali *et al.*, 2014).

It has been stringently argued that developing countries are faced with rapid deterioration of environmental conditions due to out-dated systems of collection and the dumping of solid waste (Ali *et al.*, 2014). The indiscriminate disposal of waste on open areas and the burning of waste on a large scale at a centralised site were common practices until the emergence of global environmental protection movements in the 1960s and 1970s (UNEP, 2015). However, open dumps and landfills are still the first choice of waste management and disposal in developing countries, particularly in Lesotho (Chiemchaisri & Visvanathan, 2007; Ferronato & Torretta, 2019). According to the Environment Act (2008) of Lesotho, the environment means all physical factors surrounding human beings. Thus land, water, atmosphere, climate, sound, odour, taste, biological factors of animals and plants, and the aesthetics of both natural and built environments are included in this definition (Government of Lesotho, 2008). However, the proliferation of open waste dump sites in developing countries continues to cause a number of environmental and socio-economic impacts due to a lack of appropriate engineering and inadequate maintenance (Maheshi *et al.*, 2015).

There is a lack of appropriate disposal sites for the disposal of waste in developing cities and, unfortunately, where they are available, they are not well managed. Ferronato and Torretta (2019) associate the lack of sanitary landfills with inadequate economic resources and legislation. For instance, a sanitary landfill should have a waste containment liner to separate waste from the subsurface environment. Such a system supports the management of leachate and landfill gas until the placement of cover soil after waste deposition has been completed and waste has been

compacted (Halkos & Petrou, 2012; Laner *et al.*, 2012), but none of the disposal sites in the study areas were lined. A landfill liner or composite liner is a low permeable barrier that is used in engineered landfills to prevent percolation of leachate and contaminants into underground and surface water sources. It is imperative that the liners comprise of both clayey soils and geosynthetic membranes as clay prevents leakage from membrane layers (Rubinos & Spagnoli, 2018).

The Waste Atlas Partnership (2015) lists the fifty largest active dumpsites in the world, stating that they are situated in Africa, Asia and Latin America, with only two such dumpsites found in Europe. These dumpsites differ in size, volumes of waste received and the number of people either working at the dumps or living in their vicinity. Nonetheless, they have one thing in common which is the serious threat they pose to human health and the environment (UNEP, 2015). Hapazari *et al.* (2015) corroborate this view, arguing that there is a relationship between poor environmental conditions and long-term implications of waste for local communities.

Amasuomo and Baird (2016) state that dumpsites and landfills can have a negative impact on the well-being of the public and the environment if not properly managed. Unscientific handling of municipal solid waste degrades the urban environment and causes health hazards (Joshi & Ahmed, 2016). Moreover, a dumpsite is a suitable breeding ground for vectors and rodents that spread communicable diseases such as malaria, dengue fever, typhoid, tetanus, cholera, eczema and dysentery (Komolafe, 2011; Babs-Shomoye & Kabir, 2016). Feeding food waste to animals is a common practice in African and Asian countries, but this phenomenon has become less prevalent in developed countries due to effective education and concerns about animal health. People who handle and recycle waste or who live in close proximity to municipal solid waste dumpsites or landfills are also exposed to air pollutants that are emitted by landfill gas that contains methane, carbon dioxide, hydrogen sulphide, volatile organic compounds, particulate matter and bioaerosols

which are also diffused into soil as well as surface and underground water sources (Mataloni *et al.*, 2016). Such pollutants aggravate incidences of cancer, low birth weight, congenital abnormalities, unsightly conditions and infectious diseases (Ncube *et al.*, 2017; Amugsi *et al.*, 2019). These risks are particularly experienced by waste workers and pickers who are in contact with solid waste on a daily basis.

However, in many instances both formal and informal waste workers contribute significantly to the sanitation of the environment and economic growth even though their work is risky and they are often marginalised (Joshi & Ahmed, 2016). This is because they recycle waste and waste pickers in particular gain economic benefits from the products they sell. According to Ahmed and Sundaram (2012), Seok *et al.* (2012) and Melare *et al.* (2017), the economic performance of every state depends on its consideration of the value of the environment, its promotion of social responsibility, and its attention to the population's quality of life. In South Africa, the waste economy contributed up to R24.3 billion in 2016, provided 36 000 formal jobs, and supported 80 000 workers from the informal sector (Department of Environmental Affairs and Development Planning (DEADP), 2017; Green Cape, 2019). Thus, waste workers' and pickers' adherence to the waste hierarchy seems significant, but the risks that their work poses to their health are still prevalent. Such risks involve accidental cuts, biological and medical waste contamination, poisoning by chemical substances and HMs, bites from stray animals, rodents and vectors, musculoskeletal injuries, and stress due to the workload and abuse (Jerie, 2016; Cibrario, 2018). The principles of environmental management that are expounded in section 2(b) of the Environmental Act of 2008 of Lesotho seek to ensure that sustainable development is achieved through sound management of the environment. However, although these principles are noteworthy and commendable, their effective implementation at both national and municipal level in Lesotho is seriously questioned.

4.2 Aim and Objectives

The study aimed to assess the impact of waste disposal sites on the environment as well as on the lives of those living in their vicinity.

The objectives to achieve this aim were therefore to:

- locate sites in selected municipal areas where open dumping and burning occur;
- review the status of these dumps and landfill sites (by means of observations and photographs) to determine their compliance with waste legislation and international and national guidelines;
- administer a questionnaire to residents living in the vicinity of dumps and landfill sites to assess the levels of risk exposure they endured;
- administer a questionnaire to waste council officials to determine the most common waste disposal practices;
- determine the safety of waste workers when carrying out duties (both formal and informal); and
- utilise information pertaining to global waste practices to determine if the councils under study adhered to legislative and Convention requirements.

4.3 Methodology

The following aspects will be discussed as components of the study methodology:

- Ethical considerations;
- Description of the study area;
- Study design and data collection techniques; and
- Data analysis (i.e., statistical techniques).

4.3.1 Ethical considerations

Ethical approval to conduct this study was obtained from the Health Science Research Ethics Committee (HSREC) of the University of the Free State and the Ministry of Health – Research Coordinating Unit for Ethical Clearance in Lesotho to ensure adherence to ethical practices and to achieve validity and trustworthiness of the information that would be used in the study. To safeguard the respondents, they were informed of their rights and given informed consent forms to complete and sign before responding to the relevant questionnaire. Reliable citizens of both genders that were aged 18 years and above were recruited.

4.3.2 Description of the study area

The Kingdom of Lesotho is a small, mountainous country of 30 555 km². It is completely landlocked by the Republic of South Africa (United Nations Development Project [UNDP], 2015). The Highlands area (Maluti mountains) covers about two thirds of Lesotho. This is a mountainous region with steep cliffs, deep valleys and cool rivers, while the rest of the land on the western side comprises the foothills. A narrow strip of lower-lying land is known as the Lowlands (Lesotho Ministry of Environment, Tourism and Culture, 2010). The Lowlands area covers about 33% of the country but carries about 80% of the population (Government of Lesotho, 2012). In the Lowlands, the highest mean maximum temperatures range from 20^oC to 32^oC during the summer while in the winter the mean temperature drops to a range of -1^oC to -3^oC, while it ranges from 8.5^oC to -6^oC in the Highlands (Lesotho Meteorological Services, 2020). Lesotho is an ethnically homogenous country with 99% of the population being classified as Sotho (singular Mosotho, plural Basotho) (Workman, 2018). The country's population is in the region of 2.01 million of which 49% is male and 51% is female (Lesotho Ministry of Finance, 2018). Lesotho has a high rate of youths as approximately 40% of the population is aged between 15 and 35 years. The country is therefore experiencing a youth cluster (UNDP, 2015). The

country is divided into ten districts with ten district councils, sixty-five community councils and eleven urban councils and has one municipal (or city) council which forms the local government (UNDP, 2015). The study was conducted in the one city council and four urban councils, namely Maseru City Council, Berea Urban Council, Maputsoe Urban Council, Hlotse Urban Council, and Botha-Bothe Urban Council.

4.3.3 Study design and data collection techniques

The study employed a descriptive research design. The descriptive research approach is used to identify problems associated with current practices, to justify a current practice, to make judgments, or to determine what other professionals or academics in similar situations have done or what theories they have developed (Brink *et al.*, 2012). Two structured questionnaires were formulated in both English and Sesotho (the first language of the Basotho people) which was easier for respondents to assimilate. Considerations were taken in the wording of questions to avoid bias or ambiguity which leads to measurement error. The questionnaires were administered respectively to participants dwelling in the vicinity of open dumps and waste management officials. A time when residents would be at home was identified to administer the relevant questionnaire. All questionnaires were self-administered by the respondents as they were fairly literate (able to read and write). Most questionnaires were filled in the presence of the researcher to enhance the return rate and the effective completion of questionnaires by respondents as the researcher was present to provide guidance but without consciously or unconsciously influencing their responses. Respondents who preferred to fill their questionnaires in their own time left out questions that required clarification and a meeting was held before collection to clarify those questions before completion. Questionnaires were checked after being handed over by the respondents. The questionnaire for council employees was administered during working hours at the council offices where they worked to avoid unsuccessful data collection.

Observations were also used as a data collection method. This technique involved taking field trips to the selected disposal sites with the help of a Global Positioning System (GPS) to detect their locations. A mobile Garmin Etrex 10 was used. It was calibrated for 10 minutes and a waypoint was created for 90 minutes as recommended for good results in the guideline pamphlet. Human behaviour and activities at the sites and the environmental appearance of the sites were recorded by the researcher using a checklist while photographs were also taken of the sites for visual confirmation.

4.3.4 Statistical analyses

The data that were obtained were coded and captured on Microsoft Excel sheets by the researcher. Further analyses were conducted by a statistician using SAS Version 9.2. Descriptive statistics namely frequencies and percentages were calculated for categorical data. The data are presented in a convenient and informative way in this report using tables and graphs.

4.4 Results and Discussion

4.4.1 Biological information

Biological information of residents that includes their gender, age categories, educational level, employment status and duration of stay in their areas is presented in Table 4.1.

Table 4.1: Biographical information of the residents who participated in the study

Characteristics	Class	Percentage (%)	Frequency (n)
Gender	Male	29.3	44
	Female	70.7	106
Age	18 – 19	10	15
	20 – 29	24.7	37
	30 – 39	18.7	28
	40 – 49	10.7	16
	50 – 59	20.7	31
	60 – 69	11.3	17
	70+	4.0	6
Educational level	Primary	48.7	73
	Junior secondary	18.0	27
	High School	23.3	35
	Tertiary	10	15
Employment	Unemployed	30	45
	Self-employed	38	57
	Employed	20.7	34
	Unspecified	9.3	14
Duration of stay	0 – 2 years	12.7	19
	3 – 5 years	6	9
	6 – 10 years	13.3	20
	11 – 15 years	12.7	19
	Over 15 years	55.3	83
<i>n = 150 residents</i>			

Table 4.1 presents the biographical characteristics of the resident participants. The purpose of obtaining these data was to determine any contributing factors to the perceptions, behaviours and choices of the residents in terms of waste management. For instance, the researcher was curious whether age impacted waste management decisions and practices. The gender distribution was unequal for this group as the majority (70.7%; 106) was female and only 29.3% (44) was male. According to Babs-Shomoye and Kabir (2016), solid waste management has

no gender sensitivity, but the higher participation rate of women in this study was probably due to their better knowledge and awareness of the environmental issues that affect their children and other members of their households. Also, this was a door-to-door survey and it was generally the women who answered the door and agreed to participate by completing the questionnaire. Another factor that impacted the female slant of the resident respondents may have been that, in Lesotho, most women head their families as either single parents or widows or they hold this position in the absence of their husbands who are migrant workers.

The respondents' ages varied from 18 years to over 70. The predominant age group (24.67%; 37) was aged between 20 and 29, which is within the economically active age group. The youth is a broad and diverse group in Lesotho. The United Nations (UN) defines the youth as young people who are aged between 15 and 24, whereas in Lesotho the youth is deemed to be those residents who are between 15 and 35 years of age (UNDP, 2015). The group who had the lowest participation rate (4%; 6) comprised pensioners of 70 years and older.

Lesotho has a strong national commitment to investment in education. All the residents involved in the study were literate to a certain level but a significant percentage (48.7%) had only a primary school education. About 18% of the residents had completed their secondary school education, while 23.3% had completed their high school education and only 10% held a tertiary qualification. Lesotho has a high adult literacy level of 75.8%. When this is compared with other sub-Saharan African countries where the literacy rate is estimated at 59.3%, it is significantly higher in Lesotho. Nonetheless, primary school drop-out rates remain high in Lesotho and the transition to tertiary education is quite low, especially for low-income groups (United Nations Conference on Trade and Development [UNCTAD], 2010; UNDP, 2015; Lesotho Ministry of Health, 2016). The Lesotho Ministry of Health (2016) emphasises that women are more likely to be hired if they have a secondary education than men. A Nigerian study found that respondents

with a high level of education had a better knowledge of the impact of improper waste management on health than those with low education levels (Amugsi *et al.*, 2019). However, according to Sedova (2016), a higher education level does not make people more conscious of the environment, nor inclines people to act more responsibly in terms of waste management.

Income inequality in Lesotho is one of the highest in the world (Lesotho Ministry of Health 2016; Lesotho Ministry of Finance, 2018). The majority of the respondents (38%; 57) was self-employed, while only 20.67% (34) had formal employment. A significant number of the surveyed residents (30%; 45) was unemployed. This was probably because the breadwinners of the families were away due to work while women looked after their families, or it could have been due to the general scarcity of jobs in Lesotho. In 2008, a Labour Force Survey indicated that the rates of formally employed and informally employed were 18.6% and 71.7% respectively, and the overall working age of the population was 24% (Government of Lesotho, 2012). Four years ago, the Lesotho Ministry of Health (2016) also indicated that the overall unemployment rate in Lesotho had aggravated to 33% and that 32% of the unemployed was in the youth category.

A government old-age pension was introduced in Lesotho in 2005, but only citizens aged 70 and above have benefited from it. According to Sedova (2016), employment can be associated with higher levels of income and consumption that can contribute to higher levels of waste production, and therefore poverty can be determined by the rate of unemployment. According to Amugsi *et al.* (2019), a low household wealth index is more positively associated with solid waste dumpsite health risks than when people are more affluent. Thus, poor households who live in the vicinity of dumpsites are more exposed to the hazards associated with dumpsites.

4.4.2 Description of waste disposal sites and characteristics

The section below describes the location, physical appearance and activities which were observed in disposal sites.

Table 4.2: Distance of waste disposal sites from human settlements, institutions, agricultural activities and water sources

Characteristics	Class	Estimated distance	Percentage (%)	Frequency (n)
Human settlements	0 – 50 m	10m	20	1
	>50m<250m	70m 220m	40	2
	>250m<500m	300m	20	1
	>500m<1000m		0	0
	>1000m	1050m	20	1
Institutions	0 – 50 m	40m	20	1
	>50m<250m	80m 230m	40	2
	>250m<500m	220m	20	1
	>500m<1000m	650m	20	1
	>1000m		0	0
Agricultural fields	0 – 50 m	10m 30m 50m	60	3
	>50m<250m		0	0
	>250m<500m	230m	20	1
	>500m<1000m	800m	20	1
	>1000m		0	0
Water sources	0 – 50 m		0	0
	>50m<250m	80m 250m	40	2
	>250m<500m		0	0
	>500m<1000m	520m 600m 1000m	60	3

	>1000m		0	0
<i>n = 5 disposal sites</i>				

Table 4.2 shows that the disposal sites were very close to human settlements. One council (20%) was less than 50 m away from households, two (40%) disposal sites were more than 50 m away but less than 250 m away, and only one disposal site (20%) was more than 1 000 m (1 km) away. Similarly, the disposal sites were very close to institutions: one disposal site (20%) was less than 50 m, two (40%) disposal sites were more than 50 m but less than 250 m, and none was further than 1 000 m (1 km) from schools and governmental and non-governmental institutes offering essential services. Most disposal sites (60%; 3) were located less than 50 m away from agricultural fields and activities, one (20%) disposal site was more than 250 m away but less than 500 m away, and one (20%) disposal site was more than 500 m but less than 1 000 m (1 km) away. The majority of disposal sites (60%; 3) was more than 500 m but less than 1 000 m (1 km) away from water sources and two (40%) disposal sites were more than 50 m but less than 250 m away from water sources. Not one of the disposal sites was less than 50 m away from a water source.

Table 4.3 describes the physical appearance of the disposal sites and the activities that took place onsite.

Table 4.3: Description of the disposal sites

Characteristics and activities	Class	Percentage (%)	Frequency (n)
Access road	Track or soil road	60	3
	Gravel road	40	2
	Tared road	0	0
Signage boards	Yes	20	1
	No	80	4
Fencing	Cement slab fence	20	1
	Vector barbed wire fence	20	1

	Ranch barbed wire fence	20	1
	Devil fork fencing	20	1
	None	20	1
Lockable gates	Yes	40	2
	No	60	3
Controlled access	Yes	40	2
	No	60	3
Worker's equipment and amenities	Shelter and ablution facilities	40	2
	Sufficient equipment	20	1
	Personal Protective Equipment	20	1
Types of workers available at site	Contractor	20	1
	General workers	60	4
	Security guards	40	2
	Waste pickers	100	5
Type of waste disposed on the site	Government institutions	100	5
	Health care centres	80	1
	Central business areas	100	5
	Industrial areas	40	2
	Residential areas	40	2
Waste management practices at disposal sites	Waste dumping	80	4
	Waste burning	80	4
	Soil layer covering and waste compaction	20	1
	Waste separation and recycling	100	5
Types of vehicles used at disposal sites	Light vehicles (bakkie)	100	5
	4.0 to 8.0-ton trucks	100	5
	Heavy loader trucks	40	2
	Tractor-drawn loaders	40	2
	Compactors	20	1
	Excavators	20	1
	Forklifts	20	1
Human settlements onsite	Yes	0	0
	No	100	5

n = 5 disposal sites

Table 4.3 shows that majority (60%; 3) of the roads leading to the disposal sites were track roads and only 40% (2) was gravel roads. The latter type is prone to be muddy and slippery conditions during rainy seasons. Most disposal sites (80%; 4) did not have information or signage boards indicating whether this was a landfill or dumpsite. The types of fencing at the disposal sites varied: about 80% (4) was fenced while 20% (1) was an open trench with no fencing. Only 40% (2) of the disposal sites had lockable gates, controlled access, worker shelters, ablution facilities and security guards onsite which assured better security of facilities, convenience and protection of the employees from harsh weather. Most of the sites (60%; 3) had none of these facilities. The use of sufficient working equipment and adequate personal protective equipment (PPE) was noted at only one (20%) disposal site. Waste pickers were prevalent at all the disposal sites (100%; 5) and most (80%; 4) had general workers who directed traffic and checked waste and directed where and how to dispose the waste. They also ensured general maintenance of the site. Only one (20%) disposal was run by a contractor on behalf of the council. The site received a variety of wastes, both general and hazardous. All disposal sites received waste from government institutions and central business areas. Most (80%; 4) of the disposal sites received health care waste and only 40% (2) of them received waste from industrial areas and residential areas. Waste separation and recycling were practised actively at all the disposal sites. At most (80%; 4) of the disposal sites burning was practised and it was only at one disposal site where waste was covered with a soil layer and compacted at the end of the day. The types of vehicles that were observed offloading waste at all (100%; 5) of the disposal sites were light vehicles (bakkies), 4.0- to 8.0-ton trucks, heavy loader trucks and tractor-drawn loaders. The latter were used at two (40%) of the disposal sites and at only one (20%) of the site a compactor, excavator and forklift were used. There were no human settlements or squatter camps on any (100%; 5) of the disposal sites, although at some human settlements were nearby.

4.4.3 Environmental implications associated with poor waste disposal practices

It is undeniable that poorly managed waste has a negative impact on human health and the environment. Mavropoulos *et al.* (2015) indicates that the world's 50 largest dumpsites are generally located close to or within urban zones and near major natural resources. About 42 of the biggest dumpsites are less than two kilometres from human settlements, 44 dumpsites are less than ten kilometres from land, vegetation and mineral resources, while 38 dumpsites are close to water sources such as watercourses, lakes and seas. This proximity to water bodies poses the threat of aquatic and coastal pollution. According to UNEP (2015), dumpsites affect the daily lives of 64 million people globally, which is a number that is comparable to the population of France. Against this background, UNEP (2015) advises that the elimination of all dumpsites around the world should be a priority for the global community. However, attention should be placed on developing and transitioning countries where the unsustainable management of solid waste is common but seldom revealed in statistical reports (Ferronato & Torretta, 2019).

Council employees were questioned about the training of waste workers and the safety measures in place to protect them. Table 4.4 summarises the findings.

Table 4.4: Summary of training of waste management workers and safety measures to protect them

Characteristics	Class	Percentage (%)	Frequency (n)
Are the waste workers trained?	Yes	40	2
	No	60	3
<i>n = 5 councils</i>			
Type of training received by waste management workers	Waste management training	20	1
	Legislative training	0	0
	Safety training	40	2

	Health training	0	0
<i>n = +/-5 councils that received any training</i>			
Are the workers provided with personal protective equipment (PPE)?	Yes	100	5
	No	0	0
Types of personal protective equipment (PPE) provided to workers	Overalls	100	5
	Gloves	80	4
	Safety boots	20	1
	Nose masks	100	5
	Reflectors	60	3
<i>n = 5 councils</i>			

Table 4.4 indicates that only 40% (2) of the councils trained their waste management workers while the majority (60%; 3) did not. Various training aspects are required for waste workers, but the councils provided only safety and waste management training (40% [2] and 20% [1] respectively), while legal education and personal health training were neglected. All the councils (100%; 5) provided some protective clothing/equipment for their waste management workers. Overalls and nose masks were provided by 100% (5) while the majority (80%; 4) provided gloves and 60% (3) provided reflectors. Safety boots were provided by only 20% (1) of the councils. Figure 4.1 below (a photograph) illustrates some of the personal protective equipment that was provided by the councils.

Waste workers are some of the most vulnerable workers as they face serious health and safety risks. According to Cibrario (2018), personal protective equipment, sanitation facilities and occupational health and safety training for waste workers are often inadequate or non-existent, especially in the absence of trade union support and association. This study observed that only the Maseru City Council had Environmental Health or Safety and Health officials. This lack of appropriate staff appointments was possibly the reason why the four other councils were less conscious of prioritising essential worker training and providing adequate personal protective equipment for waste management workers. This seems to be a common

omission in developing countries. For instance, a study that was conducted in Bindura, Zimbabwe, revealed that health and safety issues were not prioritised because no Safety, Health and Environment practitioners had been appointed and because no Occupational Safety and Health (OSH) policy had been implemented due to financial constraints (Shuvai, 2017). According to UNEP (2018), corruption in municipalities is one of the factors that inhibit effectiveness in the waste management sector and impacts the sustainability of these services in Africa. Inadequate provisioning of personal protective equipment and little prioritization of workers' health and safety portray mismanagement and the exploitation of workers. A noteworthy point is that waste collection and disposal has historically been regarded as a man's job, but this has changed in developing countries where more and more women are now employed in this sector, although they are still a minority (Godfrey *et al.*, 2019). Another noteworthy point regarding the risks associated with waste management is that workers in the informal waste sector are the most neglected in this field.

Informal waste pickers are undoubtedly significant individuals whose jobs are risky despite their efforts to reduce and recycle waste. However, this study found that the informal waste pickers who operated at the dumps under study had no form of personal protective equipment and were prone to ergonomic related injuries, cuts and infections that would never be reported. Serabele (2014) also found that the Mokota-koti dumpsite managed by the Maputsoe Urban Council had initially been earmarked for industrial, commercial, institutional and residential waste. However, due to socio-economic factors that resulted in a lack of job opportunities, it became a source of livelihood for poor families who now utilize the site to pick money valued waste that can be recycled at buy-back centres. These pickers also source clothes for reuse, cloth off-cuts that can be used as fuel, and discarded foodstuffs for consumption. A study that was conducted at Onderstepoort in Pretoria revealed that waste risks were associated with limited use of safety boots and gloves and that the majority of injuries inflicted on waste workers and pickers were constant cuts on the

hands and legs (Nyathi *et al.*, 2018). According to Nyathi *et al.* (2018), the risks associated with the informal waste sector are aggravated by a lack of health information about personal hygiene and the activities of untrained and unprotected informal waste pickers.

Figure 4.1 depicts the personal protective equipment provided by the council and used by waste workers in the Maseru City Council.



Figure 4.1 Personal Protective Equipment [PPE] used by waste workers in the Maseru City Council (Photograph: Motaung, 19th February 2019).

Table 4.5 summarises information gathered from residents and council management officials on the waste dumping and burning practices in the council areas.

Table 4.5: Waste dumping and burning in residential areas

Questions	Responses	Percentage (%)	Frequency (n)
Are there any open dumpsites in the council area?	Yes	100	5
	No	0	0
What happens with the dumped waste?	Removed by the council	80	4
	Left there	40	2
	Burnt by waste management workers	20	1
	Burnt by residents	60	3
What are factors leading to open dumping and burning of solid waste decisions?	Lack of awareness in residents	40	2
	Insufficient collection frequency and coverage area	20	1
	Insufficient resources in councils	60	3
	Ignorance	40	2
	Lack of law enforcement	20	1
	Inadequate waste receptacles	20	1
<i>n = 5 councils</i>			
Is solid waste burnt at dumpsites?	Yes	76	111
	No	24	39
<i>n= 150 residents</i>			
How often does burning occur?	Daily	76.7	84
	Every other day	18	20
	Every week	3.6	4
	Every other week	1.8	2
	Every month	0.9	1
<i>n = +/- 150; number of residents who have seen waste burned</i>			
Do you know of any violators of waste regulations who were penalized?	Yes	24	36
	No	76	114

n = 150 residents

It was observed that there were open dumps in all the councils (100%; 5). The majority of the council representatives (80%; 4) mentioned that they removed openly dumped waste from streets and open spaces. Some council members (60%; 3) claimed that waste was burned by residents and about 40% (2) mentioned that waste was left in open spaces without any treatment measures being applied. Only one council member (20%; 1) stated that waste was burned by waste management workers at the dumpsite that was managed by the council.

When the residents were asked about waste burning at the dumpsites in their vicinity, the majority (74%; 111) affirmed that waste was burned at the dumpsites and 76.7% (84) indicated that this occurred on a daily basis, followed by those who stated that it occurred a few days per week (18%; 20) (see Figure 4.2, Figure 4.3, Figure 4.4, and Figure 4.5) (photographs). The burning of solid waste is more dangerous when it is mixed with heavy pollutants such as discarded tyres (Figure 4.6). The majority of the council members (60%; 3) felt that a lack of resources was the cause of open dumping and burning practices, followed by 40% (2) who stated that this practice was due to ignorance and a lack of public awareness. Other factors that were perceived as contributors to waste burning were insufficient collection frequencies, a too large coverage area, a lack of law enforcement, and inadequate waste receptacles. The majority of the residents (76%; 114) was unaware of any violators of waste regulations who had been penalised, while 24% (36) stated that they had heard of such penalties or had been involved in such a situation.

Figure 4.2 shows smoke emitted from open waste burning at the Botha-Bothe dumpsite in the Botha-Bothe Urban Council area.



Figure 4.2: Waste burning at the Botha-Bothe dumpsite (Photograph: Motaung, 6th March 2019).

Figure 4.3 shows smoke emitted from open waste burning in an open trench dumpsite in the Hlotse Urban Council area.



Figure 4.3: Waste burning in an open trench dumpsite in the Hlotse Urban Council area (Photograph: Motaung, 27th February 2019).

Figure 4.4 shows smoke emitted from open waste burning at the Mokota-koti dumpsite in the Maputsoe Urban Council area.



Figure 4.4: Waste burning at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

Figure 4.5 shows smoke emanating from open waste burning and children galivanting freely at the Berea Urban Council dumpsite



Figure 4.5: Waste burning at the Berea Urban Council dumpsite (Photograph: Motaung, 20th February 2019).

Waste tyres were dumped in heaps at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Figure 4.6).



Figure 4.6: Waste tyres at the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

Poor solid waste management practices can lead to significant environmental and health hazards (Babs-Shomoye & Kabir, 2016). Whenever urban waste services and management systems are inadequate or have failed, residents in underprivileged neighbourhoods or slums that are located near dumpsites or landfills suffer badly under hazardous living conditions (Cibrario, 2018). It is estimated that 56% of urban populations in sub-Saharan Africa live in slums where modern waste collection systems have not been implemented (UNEP, 2018). In the city of Johannesburg, South Africa, weekly waste collection from households contributes to the highest percentage of waste at 54.7%, while 16.5% of waste is cleared from dumping areas. This means that dumping is the second common waste management practice in this city and thus a serious matter of concern (Rasmeni & Madyira, 2019). Many cities in Africa have only one official landfill site for the whole city, which in many cases is overflowing and a serious health and safety concern (Van Niekerk & Wegmann, 2019). This is also the case in Lesotho where each town has an official dumpsite and or a landfill as is the case with the capital city, Maseru. Ziegler-Rodriguez *et al.* (2018) state that, between 2012 and 2013, there were approximately 105 open dumpsites in municipalities in Peru serving about as many as 10 000 inhabitants. Burning is generally practised at these dumpsites to reduce waste piles. In many African cities the burning of waste is also a frequent occurrence due to poor waste management services (Van Niekerk & Wegmann, 2019). For instance, in Accra in Ghana waste burning at disposal sites is a very common practice, just as it is in Lesotho (Yoada *et al.*, 2014). Waste burning is a major contributor of air pollution but quantifying the exact impact is complex as there are no emission inventories for most African cities (Wegmann, 2017). The Department of Environmental Affairs (2014) mentions that open waste burning occurs in South Africa, but it admits that the scale of this practice is unknown as the current inventory underestimates minor emissions while future projections are also likely to underestimate future emissions from the sector. Unfortunately, it is the

urban poor who live and work near solid waste disposal sites that are most at risk as they sometimes suffer acute health impacts (Babs-Shomoye & Kabir, 2016).

Figure 4.7 presents a graphic representation of the environmental and health risks associated with the dumpsites and the landfill that the residents of this study highlighted.

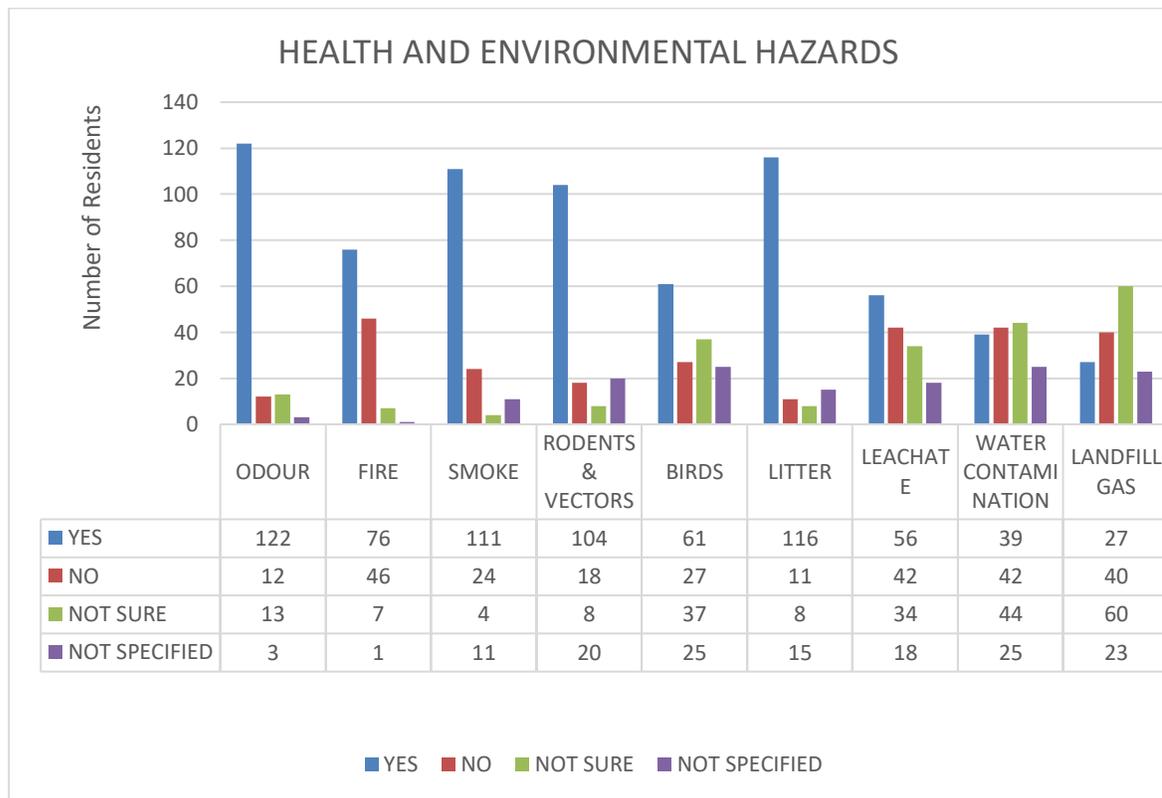


Figure 4.7: Health and environmental hazards in the vicinity of dumpsites in the Lesotho lowlands as perceived by residents

The results showed that there was generally a higher level of awareness of the existence of risks associated with exposure to solid waste than not. The majority of the residents (>75; >50% [number greater than 75 or half of the respondents]) admitted that they were affected by persistent odours, fire, smoke, rodents and vectors, birds, litter, and leachate, whereas a minority felt that they were affected by water contamination and landfill gas. The responses suggest that untreated waste

in fields and litter compromised the aesthetics of the areas where the residents lived. It is noteworthy that more residents were not bothered by leachate or were unaware of it than those who were. However, when Figure 4.8 is viewed the prevalence of leachate is quite evident. This lack of awareness may be attributed to the low levels of education about waste hazards that the communities had been exposed to, and they may have viewed the leachate simply as a water source and not considered its potential health hazard. Most of the residents mentioned that there was an invasion of birds, rodents and vectors, and they understood that these factors posed a real threat to their health.

The far end of the Tsosane landfill had a barrier which was constructed with heaps of waste tyres. Leachate trickled from the waste and formed a pool as depicted in Figure 4.8



Figure 4.8: Leachate trickling from waste at the Tsosane landfill of the Maseru City Council (Photograph: Motaung, 19th February 2019).

Most residents were not sure whether their nearest water sources were contaminated by the dumpsite in their vicinity, but Figure 4.9 reveals that a dumpsite was less than 50 m from water stabilization ponds near the Mohokare (Caledon) River. Moreover, when the researcher visited this site, the odour clearly indicated the presence of methane gas.



Figure 4.9: Water stabilisation ponds near the Caledon (Mohokare) River at the Maputsoe dumpsite of the Maputsoe Urban Council (Photograph: Motaung, 21st February 2019).

When the residents were asked whether they were exposed to health risks by living in close proximity to a dumpsite/landfill, the rates of those who felt that they were unsafe and those who felt that they were not exposed to hazards were very similar (46.7% and 53.3% respectively). However, more residents felt safe than threatened, but observations and photographic evidence confirmed that the conditions were undesirable and even hazardous at all the dumpsites as well as the landfill.

The residents were inquired about the environmental risks associated with living in the vicinity of dumpsites and implementations to minimize and manage the risks. Table 4.6 summarises the information.

Table 4.6: Exposure to environmental risks and residents' suggestions for health risk management

Characteristics	Class	Percentage (%)	Frequency (n)
Are you exposed to any type of risk living close to the dump site?	Yes	46.7	70
	No	53.3	80
<i>n=150 residents</i>			
Please state the type/s of risk/s you are exposed to.	Waste litter	20.6	14
	Road accidents	4.4	3
	Burning of properties and goods	10.3	7
	Gastrointestinal diseases	44.1	30
	Respiratory diseases	44.1	30
	Poisoning	11.8	8
	Injury	22.1	15
	Animals' and children's death	2.9	2
<i>n = +/- 150; number of residents exposed to hazards</i>			
What could be done to minimise or manage the risk/s?	Report to the responsible authorities	27.9	19
	Improvement of infrastructure	2.9	2
	Hire adequate waste personnel	2.9	2
	Health education	10.3	7
	Training of waste management teams	7.4	5
	Personal protective equipment (PPE)	10.3	7

	Fencing and security at dumpsites	2.9	2
	Hazardous waste not to be permitted on sites	17.7	12
	Prohibition of waste burning	4.4	3
	Dumpsite or landfill should be relocated away from residential areas	7.4	5
<i>n = +/-150; mitigation suggestions by residents exposed to hazards</i>			

Table 4.6 reveals that almost 50% (46.7%; 70) of the residents felt they were vulnerable to health and environmental risks associated with living in the vicinity of the landfill or the dumpsites, while a slightly larger percentage (53.3%; 80) felt that they were safe. However, the potential for gastrointestinal diseases (especially in children and the underprivileged) due to the consumption of contaminated water, condemned foodstuffs or contamination by decomposing and faecal matter was evident. Respiratory diseases associated with the constant inhalation of hazardous odours and smoke were indicated by 44.1% (30) of the residents. Although below 50%, this figure is still a reason for concern. Some residents (22.1%; 15) claimed that they had suffered injuries such as broken limbs or piercing and cuts by needles, surgical blades and other broken and sharp-edged waste objects. (see Figure 4.14). These injuries were encountered due to the unrestricted movement of waste pickers and residents at dumps that were not properly fenced or secured and that were thus easily accessible as depicted in Figure 4.3 and Figure 4.5. Sharp objects were a hazard. For instance, Figure 4.10 shows the indiscriminate dumping of sharp glass shards with other forms of waste. The prevalence of waste littering fields at/near homesteads (20%; 14) was reported and this type of secondary littering is associated with a lack of proper fencing, as can be seen in Figure 4.12, Figure 4.13 and Figure 4.17. Figure 4.10 shows how animals are exposed to waste

contamination and hazards as pigs were observed roaming freely at this poorly fenced dumpsite. These images show that even though a dumpsite might be fenced, if it is not litter proof if not well maintained, which is tantamount to a non-existent fence. The litter interferes with agricultural activities and plant growth and compromises the aesthetics of the environment where the community lives.

Figure 4.14 suggests the likelihood of chemical poisoning, which was mentioned by 11.8% (8) of the residents. This hazard was corroborated by the presence of hazardous chemical substances and pharmaceutical waste (discarded medication) which were detected and photographed. The burning of waste near residential properties was mentioned by 10.3% (7) of the residents. This occurred near houses and agricultural fields that were in close proximity to the disposal sites, as depicted in Figure 4.4, Figure 4.5, and Figure 4.17 and where waste burning was not practised. Figure 4.16 indicates the proximity of houses to the landfill and suggests the potential for health hazards should spontaneous fires occur. Another risk was road accidents (4.4%; 3) that may be associated with poorly maintained muddy roads leading to the dumpsites during the rainy season. The death of animals and children was mentioned by 2.9% (n = 2) of the residents who associated such tragedies with poorly maintained dumpsites.

To mitigate the many risks that they were exposed to, the residents made the following recommendations:

- Report poorly maintained dumpsites to the responsible authority (27.9%; 19). This was recorded as the most viable step to prevent the dumping of hazardous substances by 17.7% (12) of the residents.
- Provide personal protective equipment as mandatory when entering dumpsites (10.3%; 7).
- Train waste management teams (7.4%; 5).
- Prohibit waste burning and use safer methods of waste reduction (4.4%; 3).

- Improve the infrastructure of waste disposal sites and erect and maintain proper fences.
- Hire security and adequate waste management staff (2.9%; 2).

It is noteworthy that the rates of these positive recommendations were relatively low. This may again be attributed to uninformed communities who had become accustomed to conditions as they were, without questioning the hazards that they might be exposed to.

Domestic animals such as pigs were able to access the dumpsite and scavenge on any edible waste in the Hlotse Urban Council area as depicted in Figure 4.10.



Figure 4.10: Pigs scavenging on waste at the Hlotse dumpsite of the Hlotse Urban Council (Photograph: Motaung, 27th February 2019).

Demolition and construction debris including glass waste was mixed with other waste at the Berea dumpsite in the Berea Urban Council area (Figure 4.11).



Figure 4.11: Poorly separated glass and other waste at the Berea Urban Council dumpsite (Photograph: Motaung, 20th February 2019).

Figure 4.12 presents the type and conditions of the fencing provided at the Berea dumpsite in the Berea Urban Council area.



Figure 4.12: Dilapidated fencing at the Berea Urban Council dumpsite
(Photograph: Motaung, 20th February 2019).

The type and conditions of the fencing provided at the Mokota-koti dumpsite in the Maputsoe Urban Council area is shown in Figure 4.13.



Figure 4.13: Inadequate fencing at Mokota-koti dumpsite in the Maputsoe Urban Council area
(Photograph: Motaung, 21st February 2019).

Discarded pharmaceutical waste and soiled disposable nappies were disposed at Berea dumpsite without any further treatment (Figure 4.14).



Figure 4.14 Disposable nappies and pharmaceutical waste at Berea dumpsite
(Photograph: Motaung, 20th February 2019).

Figure 4.15 shows the general appearance of the entrance at the Tsosane landfill in the Maseru City.



Figure 4.15: Controlled entrance to and concrete fence of the Tsosane landfill in Maseru City (Photograph: Motaung, 19th February 2019).

Tsosane landfill in the Maseru City Council was located just a few metres from the residents' homes as shown in Figure 4.16.



Figure 4.16: Houses less than 50 m from Tsosane landfill in Maseru City Council. The sturdily constructed concrete fence was the only one of its kind in the Lowlands (Photograph: Motaung, 19th February 2019).

Both landfill and dumping sites have become pivotal sources of environmental and health hazards in the waste chain because of their poor management in Lesotho (Government of Lesotho, 2014). All the figures that have been presented as well as Table 4.4 provide evidence of the environmental hazards associated with living in the vicinity of disposal sites where waste is inappropriately managed. Studies conducted in developing and transitioning countries such as Nigeria, the Republic of South Africa, Ghana and China have identified various negative environmental impacts associated with inappropriate waste disposals practices. These studies have provided visuals and evidence of these impacts and have demonstrated soil contamination, air contamination, the effects of green-house gas (GHG) emissions, surface and ground water pollution, as well as rodent and vector disease risks (Salam, 2010; Hapazari *et al.*, 2015; Babs-Shomoye & Kabir, 2016; Mian *et al.*, 2017; Amugsi *et al.*, 2019; Ferronato & Torreta, 2019; Van Niekerk & Weghmann, 2019; Singh, 2019).

The impacts of solid waste on human health are varied and depend on numerous factors such as the nature of the waste, methods of disposal, distance from the disposal site, duration of exposure, population exposed, and mitigation intervention practices (UNEP, 2018). In 2013, the Organization for Economic Co-operation and Development (OECD, 2013) estimated that around 712 000 people in Africa had died due to the consequences of polluted air. According to Van Niekerk and Weghmann (2019), this risk has increased by 36% since 1990. They also state that most deaths due to air pollution occurred in urban areas. Accra in Ghana experiences high incidences of respiratory disease among families who burn their waste due to a lack of waste management services. Children and women are often the most affected as they are the ones responsible for the open burning of household waste (Weghmann, 2017; UNEP, 2018). An air quality impact assessment for large and general landfill sites in South Africa indicated that some health risks associated with improper waste management were generally restricted

to areas within 500 m from the boundary of these sites (Department of Environmental Affairs, 2016). The current study found that most households in the vicinity of the non-sanitary municipal dumpsites and Maseru City's landfill site were located within a 500 m radius of these sites. This finding justifies the argument that these communities were exposed to health and environmental threats. Moreover, a local newspaper found that the majority of residents, particularly children, who lived in close proximity to the Ts'osane landfill in Maseru were exposed to smoke inhalation which was suspected of causing respiratory diseases such as tuberculosis and sinusitis. It is undeniable that the proximity of residents to the Lesotho Lowlands waste disposal sites aggravates the risk of contracting various ailments (Rubbish dumping dejects residents, 2017).

A deleterious impact of living near a poorly managed waste disposal site is that chronic and infectious diseases may be contracted. For instance, a study that was conducted in Rome, Italy, suggests that a significant association exists between the exposure of residents to hydrogen sulphide (H_2S) that is emitted by the anaerobic decomposition of sulphur-containing organic matter in landfills and the mortality rate caused by lung cancer and respiratory diseases, especially in children. The risk of contracting non-Hodgkin lymphoma and liver, pancreas and kidney cancer is associated with male residents living close to waste disposal sites (Goldberg *et al.*, 1999; Mataloni *et al.*, 2016). Moreover, laryngeal and bladder cancer was found to be high in women who lived within 2 km from landfills (Michelozzi *et al.*, 1998; Mataloni *et al.*, 2016). These findings emphasize that residents who live very close to dumpsites where waste is heterogeneously mixed with hazardous wastes are highly susceptible to morbidity and mortality (Mataloni *et al.*, 2016). A study that was conducted in Ibadan, Nigeria, revealed an association between vomiting and food-borne diseases and this was in turn associated with the proliferation of flies, cockroaches and rats at dumpsites (Nyathi *et al.*, 2018; Ogundele *et al.*, 2018). Food-borne diseases are also associated with unsafe water supplies (Pandey *et al.*, 2014; Abdel-Shafy, 2018).

Africa's water resources have persistently been affected by droughts and the overuse of land whose effects have been exacerbated by the population boom in urban areas. This has increased the demand for already limited water supplies (UNEP, 2018). In South Africa, where very low levels of waste management are available in squatter settlements of the City of Johannesburg, communities are threatened by water-borne toxins as they depend on informal sources of water for survival (Rasmeni & Madyira, 2019). Ironically, water is Lesotho's primary natural resource yet many of this country's inhabitants, particularly in poor urban areas, remain severely water insecure. The availability of groundwater resources and safely managed sources is uneven and the Basotho people, particularly in the Lowlands, experience routine water insecurity and depend on unsafe water sources such as rivers and unprotected wells that are likely to be contaminated (Workman, 2018). Social dissatisfaction with this situation was reported in local newspapers and residents complained that waste was offloaded anywhere that was convenient, but it was then washed by storm water down the Mohokare (Caledon) River (Serabele, 2014). Moreover, the Maseru City Council seemed to take no action to curb waste leachate that flowed down a village donga into the Maqalika Dam, which caused water contamination and was an eyesore in the environment (Rubbish dumping dejects residents, 2017).

Open waste dumping is unsightly and can degrade land productivity and diminish the aesthetic value of an affected area (DEADP, 2017). Land that is used for crops is also likely to be polluted by open dumps as un-engineered embankments slide down the slope and contaminate and change soil structure (Abel, 2014). This is depicted in Figure 4.15 that shows the close proximity of a waste dump to crops. A study that was conducted in Nigeria revealed that the soil contents of chromium (Cr), zinc (Zn) and lead (Pb) at dump sites were far above the permissible limits for agricultural soil. Excessive concentrations of elements such as chromium (Cr) prevent the growth of nitrogen-fixing plants at dumpsites and cause atmospheric

deposition of waste (Nwaogu *et al.*, 2017). This causes problems for residents who depend on crop farming. The situation may be exacerbated by the presence of methane gas which is a by-product of the anaerobic decomposition of organic wastes (Ogundele *et al.*, 2018). When uncontrolled, this gas is likely to cause spontaneous fires on dumpsites and landfills which can extend to fields and nearby houses. As methane is one of the greenhouse gases, its emission and ignition contribute greatly to global warming (Maheshi *et al.*, 2015).

The distance between the land utilized for agricultural purposes and Mokota-koti dumpsite in the Maputsoe Urban Council was significantly close (Figure 4.17).



Figure 4.17: Agricultural activity in close proximity to the Mokota-koti dumpsite in the Maputsoe Urban Council area (Photograph: Motaung, 21st February 2019).

4.5 Compliance with International Agreements and Domesticated Waste Legislation

Many countries, including Lesotho, have pledged their commitment to protect the environment in their Constitutions as well as in environment related Acts and the regional or international agreements to which they are signatories. More particularly, Lesotho and many other African countries have signed an agreement to uphold international conventions that seek to protect human health and the environment from the adverse impacts of waste. These agreements include the Basel Convention of 1992 that addresses the control of the transboundary movement of hazardous wastes and their disposal, the Bamako Convention of 1991 on the banning of imports into Africa and the control of the transboundary movement and management of hazardous wastes within Africa, and the Stockholm Convention of 2001 that aims to curb persistent organic pollutants in Africa and other countries (Lesotho Ministry of Tourism, Environment and Culture, 2010; UNEP, 2018). These conventions require that countries manage their waste in a manner that does not cause harm to human health or the environment. It also requires signatories to report the efforts they made towards their implementation (UNEP, 2018). This is tricky for countries like Lesotho that do not have adequate data to determine how far they are from their target. The number one goal of the initiative *Agenda 2063: the Africa We Want* (African Union Commission [AUC], 2015) is a prosperous Africa based on inclusive growth and sustainable development. It aspires towards a high standard of living and a good quality of life and well-being for all citizens. It thus expects that cities will recycle 50% of the waste they generate by 2023. Member states are expected to develop strategies for the development and implementation of policies for the advancement of urban waste recycling methods and practices (African Union Commission, 2015). Being aware that open dumping of municipal solid waste and industrial waste is a serious dilemma in countries in the Southern African Development Community (SADC), member states have been required to promote sustainable environmental management by means of waste management,

environmental education, training, and the development of projects to prevent pollution and waste impacts (SADC, 2017). In 2000, Lesotho was one of the 189 countries that agreed to work toward meeting the Millennium Development Goals (MDGs) by 2015. The country was successful in achieving only two of these goals, namely the achievement of primary education (MDG 2) and the promotion of gender equality and the empowerment of women (MDG 3). However, Lesotho has been unable to eradicate poverty and hunger (MDG 1), reduce infant mortality (MDG 4), improve maternal health (MDG 5), combat HIV and tuberculosis (MDG 6), and ensure environmental sustainability (MDG 7) (UNDP, 2015; World Bank Group, 2015). Most African countries, including Lesotho, have a dearth of comprehensive solid waste management laws and most of the laws dealing with the environment are outdated (Lesotho Ministry of Tourism, Environment and Culture, 2010; Naha, 2015). South Africa is the only country in Africa with an integrated legislative framework that addresses all the steps in the waste management hierarchy through its National Environmental Management: Waste Act of 2008 (Republic of South Africa, 2008). The minimum requirements for landfill are presented as guidelines for controlling waste landfills. They classify landfills in terms of type of waste, size of waste stream and climatic conditions with a focus on the prevention of leachate and landfill gas emissions (DEA, 2011; Ogola *et al.*, 2011). The current study demonstrated adequately that the disposal sites in Lesotho do not comply with these minimum requirements and have not yet met the targets of the agreements it signed to prevent the adverse impacts of MSW on human life and the environment.

4.6 Conclusion

The findings of the study suggest unequivocally that the Kingdom of Lesotho needs to establish comprehensive legislation to adhere to the globally accepted waste hierarchy. This is necessary considering the emergence of new waste streams that comprise WEEEs and waste tyres that are currently not properly disposed of. Local governments (or councils) in Lesotho are seen as a gateway for all developmental

endeavours (Naha, 2015), therefore these structures should invest in employing skilled and suitable personnel such as environmental health practitioners (EHPs), properly trained waste management officers (WMOs), and safety, health and environment (SHE) officers who should be tasked to devise efficient waste management practices, document the proper management of disposal sites, train waste collectors, and take responsibility for health information dissemination to enhance public awareness. The youth makes up 40% of Lesotho's population and the majority of residents living in the vicinity of disposal sites are young and mostly unemployed, therefore involving them in sustainable waste projects such as recycling and composting may involve them in gainful employment or entrepreneurial endeavours. Moreover, the promotion of health and safety awareness and intervention campaigns will enhance awareness and will result in more appropriate waste management practices that will impact these communities positively.

REFERENCES

- Abdel-Shafy, H., & Mansour, M.S.M. 2018. The solid waste issue: sources, composition, disposal, recycling and valorization. *Egyptian Journal of Petroleum*, 27, 1275–1290.
- Abel, D.J. 2014. *Perceptions of illegal dumping in EThekweni Municipality*. Master's thesis, University of the Free State, Bloemfontein.
- Amugsi, D.A., Haregu, T.N., & Mberu, B.U. 2019. Levels and determinants of perceived health risks from solid wastes among communities living near dumpsites in Kenya. *International Journal of Environmental Health Research*. ISSN: 0960-3123 (Print), 1369–1619.
- Amasuomo, E., & Baird, J. 2016. The concept of waste and waste management. *Journal of Management and Sustainability*, 6(4), 88–96.
- African Union Commission (AUC). 2015. Agenda 2063: The Africa we want. Available at: https://au.int/sites/default/files/pages/3657fileagenda2063_popular_version_en.pdf [Accessed 14/02/2020].
- Bloomfeild, C., Bomarito, R.K., Borden, L.M., Brown, S., Butler, B., Hawkey, K.R., Kuhl, M.W., Rea, J., Rudi, J.H., Sheman, M.D & Shortrees, T. 2016. Public Awareness Campaigns. The Center for Research and Outreach (REACH), The University of Minnesota.
- Brink, H., Van de Walt C. & Van Rensburg, G. 2012. *Fundamentals of Research Methodology for Health Care Professionals*, Juta & Company Ltd. Cape Town.
- Chiemchaisri, C., & Visvanathan, C. 2007. Municipal solid waste management in Thailand and disposal emission. *Environ.*, 135, 13–20.
- Cibrario, D. 2018. SDG 11: To ensure sustainable waste services, we must value waste workers and make sure they are in decent jobs. Available at: https://www.2030spotlight.org/sites/default/files/spot2018/Spotlight_2018_web.pdf [Accessed 14/02/2020].

- Debnath, B., Baidya, R., & Ghosh, S.K. 2015. Simultaneous analysis of a WEEE management system focusing on the supply chain in India, the U.K. and Switzerland. Institute of Research Engineers and Doctors, ISBN: 978-1-63248-054-5 doi: 10.15224/ 978-1-63248-054-5-56, 85–89.
- Department of Environmental Affairs (DEA). 2011. *National Waste Management Strategy*. Department of Environmental Affairs.
- Department of Environmental Affairs (DEA). 2016. *Second South African environment outlook: a report on the state of the environment*. Pretoria: Department of Environmental Affairs.
- Department of Environmental Affairs (DEA). 2018. South Africa's state of waste report: a report on the state of waste. *First Draft Report*. Pretoria: Department of Environmental Affairs.
- Department of Environmental Affairs and Development Planning (DEADP). 2017. State of the environment outlook report for the Western Cape Province: waste management, Western Cape. Cape Town: Department of Environmental Affairs and Development Planning.
- Department of Science and Technology (DST). 2014. A waste research, development and innovation roadmap for South Africa (2015-2025). *Summary report*. Pretoria: Council for Scientific and Industrial Research.
- Ferronato, N., & Torretta, V. 2019. Waste management in developing countries: a review of global issues. *International Journal of Environmental Research and Public Health*,16, 1–28.
- Green Cape. 2019. Waste 2019 – market intelligence report. Green Cape, South Africa: Cape Town.
- Godfrey, L., Ahmed, M.T., Gebremedhin, K.G., Katima, J.H.Y., Oelofse, S., Osinbajo, O., Richter, U.H., & Yonli, A.H. 2019. Solid waste management in Africa: governance failure or development opportunity? DOI: <http://dx.doi.org/10.5772/intechopen.86974> [Accessed 14/02/2020].

- Goldberg M.S., Siemiatyek, J., De War,R., Desy, M & Riberdy, H. 1999. Risk of developing cancer relative to living near a municipal solid waste landfill site in Montreal, Quebec, Canada. *Arch Environ Health*, 54, 291–296.
- Government of Lesotho. 2008. Environmental Act: Act 10 of 2008. Maseru, Lesotho: Government Printer.
- Government of Lesotho. 2012. Poverty reduction strategy paper: National Strategic Development Plan. *International Monetary Fund Country Report*, 12(102).
- Government of Lesotho. 2014. *2013 Solid waste, water and sanitation report*. Statistical Report No.15 of 2014. Maseru: Bureau of Statistics.
- Hapazari, I., Ntuli, V & Taae, B.M. 2015. Waste Generation and Management in Lesotho and Waste to Clay Brick Recycling: A Review. *British Journal of Applied Science & Technology* 8(2),148–161.
- Halkos, G., & Petrou, K.N. 2016. Efficient waste management practices: a review. *Munich Personal RePEc Archive*, Paper no. 71518,1–35.
- Jerie, S. 2016. Occupational risks associated with solid waste management in the informal sector of Gweru, Zimbabwe. *Journal of Environmental and Public Health*, 2016, 1–14.
- Joshi, R., & Ahmed, S. (2016). Status and challenges of municipal solid waste management in India: a review. *Cogent Environmental Science*. Cogent, 28(1), 1–18. DOI: 10.1080/23311843.2016.1139434
- Komolafe, S.F. 2011. Sustainable solid waste management: a possible solution to environmental & sanitation problems in the ancient city of Ibadan, Nigeria. *Journal of Environmental Science & Technology*, 4, 119–122.
- Kota, Z. 2016. Realising the right to a healthy environment: an analysis of the policy efforts, budgeting and enjoyment of the right to a healthy environment in South Africa. Studies in Poverty and Inequality Institute (SPII), Working Paper 13. ISBN: 978-0-620-72995-6.
- Laner, D., Crest, M., Sharff, H., Morris, J.W.F., Barlaz, M.A. 2012. A review of approaches for the long-term management of municipal solid waste landfills. *Waste Management*, 32, 498–512.

- Lesotho Meteorological Services. 2020. Climate of Lesotho. Available at: www.lesmet.org.ls [Accessed 21/02/2020].
- Lesotho Ministry of Development Planning. 2012. *National strategic development plan 2012/13-2016/17: growth and strategic development framework*. Maseru: Government Printer.
- Lesotho Ministry of Health. 2016. *Lesotho demographic and health survey 2014*. Maseru: Government Printer.
- Lesotho Ministry of Tourism, Environment and Culture. 2010. *National profile of chemicals management*. Maseru: Ministry of Tourism, Environment and Culture.
- Lesotho Ministry of Finance. 2018. Lesotho national budget brief: fiscal year 2018/19. Maseru: Government of Lesotho and the United Nations Children's Fund.
- Lesotho News Agency. 2017. Rubbish dumping dejects residents. 2017. Lesotho News Agency: 20 February.
- Maheshi, D., Passel-Steven, V & Acker-Karel, V. 2015. Environmental and economic assessment of 'open waste dump' mining in Sri Lanka. *Resources, Conservation and Recycling*, 102, 67–79.
- Mataloni, F., Badaloni, C., Golini, M.N., Bolignano, A., Bucci, S., Sozzi, R., Francesco, F., Davoli, M., & Ancona, C. 2016. *Morbidity and mortality of people who live close to municipal waste landfills: a multisite cohort study*, 2016, 806–815.
- Mavropoulos, A., Marinheiro, L., Cohen, P., Law, J., Greedy, D., Loureiro, A., Plimakis, S., & Bouldry, T. 2015. A roadmap for closing waste dumpsites: the world's most polluted places. International Solid Waste Association report, Vienna, Austria.
- Melare, A.V., Gonzalez, S.M., Faceli, K., & Casadei, V. 2017. Technologies and decision support systems to aid solid waste management: a system review. *Waste Management*, 59, 567–584.

- Mian, M.M., Zeng, M., Nasry, A.N.B., & Al-Hamad, S.M.Z.F. 2017. Municipal solid waste management in China: a comparative analysis. *J Mater Cycles Waste Manag.*, 19, 1127–1135.
- Michelozzi, P., Fusco, D...& Forastiere. 1998. Small area of mortality among people living near multiple sources of air pollution. *Occu Environ Med*, 55, 611–615.
- Naha, I.M. 2015. *Full decentralisation of powers, resources and functions in the Kingdom of Lesotho: an evaluation from a developmental local government perspective*. Master's thesis, Stellenbosch University, South Africa.
- Ncube, F., Ncube E.J & Voyi, K. 2017. Bioaerosols, noise and ultraviolet radiation exposures for municipal solid waste handlers. *Journal of Environmental and Public Health*, 2017, 1–8.
- Njagi, E.N.M., Afullo, D., Ngugi, M.P., Mwanzo, I., & Njagi I.K. 2013. Knowledge, attitude and perceptions of village residents on the health risks posed by Kadhodeki dumpsite in Nairobi, Kenya. *Ethiopian Journal of Journal of Environmental Studies and Management*, 6(4), 427–434.
- Nwaogu, C., Ogbuagu, H.D., Abrakasa, S., Olawoyin, A.M., & Pavlu, V. 2017. Assessment of the impacts of municipal solid waste dumps on soil and plants. *Chemistry and Ecology*. DOI: 10.1080/02757540.2017.1337101
- Nyathi, S., Olowoyo, J., & Oludare, A. 2018. Perceptions of scavengers and occupational health hazards associated with scavenging from a waste dumpsite in Pretoria, South Africa. *Hindawi Journal of Environmental and Public Health*, Article ID 9458156, 1–7.
- Organization for Economic Co-operation and Development (OECD). 2013. OECD's work on sustainable materials and waste management. Available at: <http://www.oecd.org/environment/waste>. [Accessed 14/02/2020].
- Ogola, J.S., Chimuka, L & Tshivhase, S. 2011. Management of municipal solid wastes: a case study in Limpopo, South Africa. *Integrated Waste Management*, 1, 91–112.

- Ogundele, M.O., Rapheal, O.M., & Ablodun, A.M. 2018. Effects of municipal waste disposal methods on community health in Ibadan, Nigeria. *Polytechnia*, 1, 61–72.
- Pandey, P.K., Kass, P.H., Soupir, M.L., Biswas, S & Singh, V.P. 2014. Contamination of water resources by pathogenic bacteria. *AMB Express*, 4(51), 1–16.
- Rasmeni, Z.Z., & Madyira, D.M. 2019. A review of the current municipal solid waste management practices in Johannesburg City townships. *Procedia Manufacturing*, 35, 1025–1031.
- Republic of South Africa. 2008. National Environmental Management: Waste Act No. 59 of 2008. *Government Gazette No. 32000*. Pretoria: Government Printer.
- Republic of South Africa (RSA). 2011. National Environment Management: Waste Act No. 59 of 2008. National Domestic Waste Collection Standards. *Government Gazette No. 33935*, GNR, 21 January. Pretoria: Government Printer.
- Southern African Development Community (SADC). 2017. *Waste management*. Available at: <http://www.sadc.int/issues/environmentsustainabledevelopment/wastemanagement/> [Accessed 14/02/2020].
- Rubinos, D.A & Spagnoli, G. 2018. Utilization of waste products as alternative landfill liner and cover materials. *Critical Reviews in Environmental Science and Technology*, 48(4), 376–438.
- Salam, A. 2010. Environmental and health impact of solid waste disposal at Mangweneni dumpsite in Manzini: Swaziland. *Journal of Sustainable Development in Africa*, 12(7), 64–78.
- Sedova, B. 2016. On causes of illegal waste dumping in Slovakia. *Journal of Environmental Planning and Management*, 59(7), 1277–1303.
- Seok, H., Nof, S.Y., Filip, F.C. 2012. Sustainability Decision Support System Based on Collaborative Control Theory. *Ann. Rev. Control*, 36(1), 85–100.

- Shuvai, C. 2017. *Occupational safety and health hazards associated with solid waste management in Bindura, Zimbabwe*. Master's thesis, Midlands State University, Gweru: Zimbabwe.
- Singh, A. 2019. Managing the uncertainty problems of municipal solid waste disposal. *Journal of Environmental Management*, 240, 259–265.
- Tchobanoglous, G., Theisen, H., & Vigil, S. 1993. Integrated solid waste management: engineering principles and management issues. *Water Science & Technology Library*, 8(1), 63–90.
- The Post. 2016. Minister wants to halt cheap car imports. 2016. *The Post*, 17 June.
- Thoso, M. 2007. *The construction of a geographical information system (GIS) model for landfill site selection*. Master's thesis, University of the Free State, Bloemfontein, South Africa.
- United Nations Conference on Trade and Development (UNCTAD). 2010. *Science, technology & innovation policy review of Lesotho: an implementation strategy*. Geneva: United Nations Publication.
- United Nations Development Programme (UNDP). 2015. Lesotho national human development report: leveraging the power of youth to promote human development. Lesotho: United Nations Development Programme.
- United Nations Environment Programme (UNEP). 2015. Global waste management outlook. Available at: <http://web.unep.org/ourplanet/september-2015/unep-publications/global-waste-management-outlook> [Accessed 14/02/2020].
- United Nations Environmental Programme (UNEP). 2018. Africa waste management outlook. Nairobi, Kenya: UNEP.
- United Nations Environment Programme (UNEP). 2019. Solid Waste Management. Available at: www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/cities/solid-waste-management [Accessed 16-12-2019].
- Vergara, S.E., & Tchobanoglous, G. (2012). Municipal solid waste and the environment: a global perspective. *Environment and Resources*, 37(37), 277–309. <https://doi.org/10.1146/annurev-environ-050511-122532>.

- World Bank. 2015. World development indicators. The World Bank Group. Available at: <http://data.worldbank.org> [Accessed 14/02/2020].
- Yoda, R.M., Chirawurah, D., & Adongo, P.B. 2014. Domestic disposal practices and perceptions of private sector waste management in Urban Accra. *BMC Public Health*, 14, 697.
- Van Niekerk, S., & Wegmann, V. 2019. Municipal solid waste management services in Africa – Working Paper. *Public Services International*, 1–68.
- Wegmann, V. 2017. Waste management in Europe: good jobs in the circular economy. EPSU. Available at: <https://www.epsu.org/sites/default/files/article/files/Waste%20Management%20in%20Europe.%20Good%20Jobs%20in%20the%20Circular%20Economy%20for%20web> [Accessed 14/02/2020].
- Ziegler-Rodriguez, K., Margallo, M., Aldaco, R., Irabien, A., Vazque-Rowe, I., & Kahhat, R. 2018. Environmental performance of Peruvian waste management systems under a life cycle approach. *The Italian Association of Chemical Engineering*, 70, 1753–1758.

CHAPTER 5

GENERAL DISCUSSION

5.1 Introduction

This chapter provides a synopsis of the solid waste management concept and associated practices identified in the Lesotho Lowlands. The discourse forms the background for the conclusions and recommendations emanating from the study. The current waste management practices that were exposed and evaluated by the study are compared with those highlighted by other studies and reports.

The main concepts of the assessment that are discussed include:

- Municipal solid waste management processes;
- Residents' awareness of municipal solid waste management (MSWM) issues;
- Environmental implications of poor waste disposal practices; and
- Compliance with waste legislation and international agreements by the Lesotho national and local governments.

5.2 Municipal Solid Waste Management Processes

Waste management is an essential service that has been given recognition in recent years. It is particularly important in urban areas due to emerging megacities (UNEP, 2015). The world's population was estimated at 7.6 billion in mid-2017 and the most densely inhabited regions of the world are Asia and Africa (United Nations, 2017). Despite waste management services being a basic human need, collection of MSW is done according to the capacity of the resources and not according to the volumes of waste that needs to be collected (Aryampa *et al.*, 2019). Poor financing is a major constraint to the development of an effective waste sector in Africa (Godfrey *et al.*, 2019). It has been shown that Lesotho urban councils also lack the capacity to provide fully-fledged waste management services. Instead, councils seem to depend on obsolete and less preferred waste disposal methods such as landfilling and, even worse, waste dumping and burning. According to the United Nations Environment Programme (UNEP) (2018a), subcontracting landfill operations to the private sector can overcome municipal managerial challenges while still allowing

municipalities to impose strict minimum operating requirements on the private operator. This is one of the methods that urban councils can adopt to reduce problems caused by poor waste management.

It is illogical that most of the waste generated in Africa is still typically disposed of at landfill and uncontrolled/controlled dumpsites while 80 to 90% of the waste is recyclable (Godfrey *et al*, 2019). Efforts to separate waste at source increase recyclable material recovery and improve the cost value of the material recovered (Eberhard, 2018). The sorting of waste is generally performed manually in developing countries while it is often not required in developed countries due to the use of well-established source-segregation programs such as thermal imaging cameras (Gundupalli *et al.*,2017). Cardboard and plastic packaging and putrescible wastes are prominent types of waste being produced in large volumes in developing countries, particularly on the African continent (Lemaire & Kerr, 2016). These wastes can be recycled into valuable products such as compost or biogas, but these processes have not yet been explored on a large commercial scale in African countries (Godfrey *et al*, 2019). Electric and electronic equipment waste (WEEE) that is produced at a large scale in developing countries due to changing consumer behaviour usually has no end-of-life solutions and is either being scrapped and partly recycled or disposed of indiscriminately (Godfrey *et al*, 2019). In Lesotho, waste segregation and recycling are done mainly by waste pickers at disposal sites. However, the work of informal waste workers is mostly ignored and often actively prevented, but countries like Morocco have taken the initiative to integrate waste pickers into the formal waste sector (Uganda's plastic bags headache for Kenya, 2018). This procedure can also be adopted by the urban councils of Lesotho and thus work efficiency and health and safety problems associated with waste management may be better addressed and managed.

It is crucial that urban councils in Lesotho adopt the concept of a circular economy in their waste management plans. A circular economy maximises the value of resources and keeps it in the economy when a product has reached its end of life,

so that it can be re-processed and used again (Department of Environmental Affairs, 2017). Thus, the focus is shifted to reusing, repairing, renewing and recycling that are processes that minimize the costs of collection and disposal (Stahel, 2016; Aryampa *et al.*, 2019). Moreover, a circular economy adheres to the objectives of the waste hierarchy by encouraging processes of waste management that protect the environment from the most favourable to least favourable actions in order to promote sustainable economic growth and the generation of new jobs (UNEP, 2015).

5.3 Residents' Awareness of MSWM Issues

Public awareness plays a big role in the behavioural change and norms of residents towards MSW. According to the Republic of South Africa (RSA) (2011), municipal campaigns that are designed and implemented together with local stakeholders, labour, industry, civil society and NGOs should be the foundation of the creation of a waste awareness plan. Radio broadcasts still have the largest reach of all media as these devices are relatively cheap and many people listen to the radio even on their mobile phones (Aryampa *et al.*, 2019). It is imperative that councils follow up on awareness campaigns to evaluate whether they yielded positive results, particularly in terms of waste management sensitization.

5.4 Environmental Implications of Poor Waste Disposal Practices

The nature of waste received at dumpsites is complex and contributes to adverse health impacts. Some of the hazardous waste observed at the disposal sites in the urban councils of Lesotho that are banned in most countries were disposable nappies, tyres, and medical and pharmaceutical waste. Due to indiscriminate disposal at dumpsites, such wastes become a source of infection due to bacterial incubation and the proliferation of rodents (e.g., rats and mice) and vectors (e.g.,

flies and mosquitoes) that are carriers of gastrointestinal, dermatological and other infectious diseases (Salam, 2010). Gastrointestinal disease was the highest risks perceived by residents in the urban councils. In epidemiology, it is well established that all diarrhoeal diseases are regarded as environmental diseases (Mavropoulos *et al.*, 2015) and such infections should thus be prevented by city and local councils.

Air pollution represents one of the biggest environmental risks to health (WHO, 2016). The most prominent waste management practice at the disposal sites in the urban councils under study was open waste burning which obviously attributed to pollution and health impacts. According to the United Nations (2016), Africa is a small contributor to greenhouse gas (GHG) emission as it emits only 3.8% of the GHG compared to the 23% generated by China or the 19% by the United States of America. However, this estimation may be skewed due to a common lack of data to accurately quantify the contribution of for instance methane to greenhouse gas emissions in Africa. Respiratory diseases were also perceived as high risk factors by residents in the urban councils. According to Van Niekerk and Wegmann (2019), populations living in proximity to waste disposal sites are often more affected by waste impacts than the general population. Approximately three million deaths are caused by ambient outdoor air pollution with the major causes being respiratory, cardiovascular and genetic diseases (WHO, 2016). This is the reason why developing countries need to have interventions to abate this problem.

The persistent prevalence of dumpsites is a global health emergency issue that needs urgent and a coordinated response (Mavropoulos *et al.*, 2015). The operation of dumpsites damages health and violates the human rights of hundreds of millions of people (Mavropoulos *et al.*, 2015). Their prevalence causes the contamination of both ground and surface water resources which is a persistent threat to health in affected areas. This phenomenon was observed and deemed a matter of serious concern in the urban councils under study as these dumpsites were in close proximity to water and agricultural land resources. It is noteworthy that the environmental impacts of waste disposal leachate that seeps into land and water

sources and results in loss of water and soil productivity have not received full attention and have not been studied adequately in Africa (Aryampa *et al.*, 2019).

In light of the above, it is a matter of global concern that dumpsites are places where millions of informal recyclers are working. Closing dumpsites and delivering an alternative system that will involve informal recyclers will therefore be a step towards generating more inclusive and economic growth through appropriate and sustainable waste management practices (World Bank, 2016).

5.5 Waste Legislation, International Agreements and Compliance in Lesotho

Effective enforcement is essential to ensure compliance with legislations and minimum waste management standards (Eberhard, 2018). In the absence of waste regulations and their rigorous implementation and enforcement, a waste generator will opt for the cheapest available disposal method (UNEP, 2015), hence indiscriminate waste dumping and burying in the Lesotho Lowlands are common due to a lack of relevant regulations guiding MSW. In South Africa, important progress has been made in the implementation of policies and regulations for managing waste (Eberhad, 2018). However, even though legislation is strict, implementation is often weak. In South Africa this has improved since a few years ago after enforcement officers were appointed (UNEP, 2018a), but such personnel have still not been appointed in the urban councils of Lesotho. The reasons for a measure of successful implementation in South Africa are regulations against the single use of plastics, waste tyre disposal and regulations that guide the minimum requirements for landfill (UNEP, 2018b). Nigeria and Uganda also have by-laws in place to deal with waste in an environmentally sustainable manner, but in many areas they are not enforced, which encourages uncontrolled dumping and burning (UNEP, 2018a). Moreover, the disposal of used electronic devices is a growing concern as this has not been incorporated in the legislation of many countries. The problem is to determine at which point the equipment is still usable and from which point it

becomes disposable waste that is subject to control under the Basel Convention (UNEP, 2015).

Developing countries, including Lesotho, need to follow sustainable development practices in the implementation of their waste strategies to meet international targets. The UN Sustainable Development Goals seek to build on the Millennium Development Goals and aim to work towards what the latter goals have not achieved. Attendees of the second African Union-United Nations annual conference (July 2018) agreed on the need for the integration of the SDGs into the African Union's Agenda 2063 (Wahlen, 2018). The Sustainable Development Goals are linked and function together to balance economic, social and environmental dimensions (United Nations, 2015). One of the key difficulties in determining whether the African Union's goal of recycling at least 50% of waste by 2063 will be achieved is the lack of baseline data on current waste management and recycling practices (Wahlen, 2018). The study corroborates this challenge as such data were absent in the councils and city under study.

REFERENCES

- Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N & Bukenya, B. 2019. Status of waste management in the East African cities: understanding the drivers of waste generation, collection and disposal and their impacts on Kampala city's sustainability. *Sustainability*, 11 (19), 1–16.
- Department of Environmental Affairs (DEA). 2017. Maximising the circular waste economy in South Africa PCEA colloquium on waste management: industry waste plans presentation. South Africa: Department of Environmental Affairs.
- Eberhard, R. 2018. Waste management in South Africa's cities: Discussion paper. Pretoria, National Treasury, Government Printer.
- Godfrey, L., Ahmed, M.T., Gebremedhin, K.G., Katima, J.H.Y., Oelofse, S., Osinbajo, O., Richter, U.H., & Yonli, A.H. 2019. Solid waste management in Africa: governance failure or development opportunity? DOI: <http://dx.doi.org/10.5772/intechopen.86974> [Accessed 14/02/2020].
- Gundupalli, S.P., Hait, S., & Thakur, A. 2017. Multi-material classification of dry recyclables from municipal solid waste based on thermal imaging. *Waste Management*, 70, 13–21.
- Lemaire X., Kerr D. 2016. *Waste Management - Innovative Solutions for African Municipalities*, UCL Energy Institute / SAMSET.
- Mavropoulos, A., Marinheiro, L., Cohen, P., Law, J., Greedy, D., Loureiro, A., Plimakis, S., & Bouldry, T. 2015. A roadmap for closing waste dumpsites: the world's most polluted places. International Solid Waste Association report, Vienna, Austria.
- Republic of South Africa. 2011. *Environmental Management: Waste Management Strategy*. Pretoria: Government Printers.
- Salam, A. 2010. Environmental and health impact of solid waste disposal at Mangweneni dumpsite in Manzini: Swaziland. *Journal of Sustainable Development in Africa*, 12(7), 64–78.
- Stahel, W.R. 2016. The circular economy. *National News*, 531, 435 [Accessed 14/02/2020].

- Uganda's Plastic Bags Headache for Kenya. The East African (10 January 2018)
Available at: <http://www.theeastafrican.co.ke/business/Uganda-plastic-bags-imports-Kenya/2560-4258212-4fibkcz/index.html>. [Accessed 14/02/2020].
- United Nations (UN). 2016. General assembly – seventy first session (22 March 2016). *Report of the Secretary General*, United Nations Publications.
- United Nations (UN). 2015. Transforming our world: the 2013 agenda for sustainable development A/RE/70/1. United Nations Publications.
- United Nations (UN). 2017. World population prospects – data booklet. United Nations Publications.
- United Nations Environment Programme (UNEP). 2015. Global waste management outlook. Available at: <http://web.unep.org/ourplanet/september-2015/unep-publications/global-waste-management-outlook> [Accessed 14/02/2020].
- United Nations Environment Programme (UNEP). 2018a. Africa waste management outlook. United Nations Environment Programme, Nairobi, Kenya.
- United Nations Environment Programme (UNEP). 2018b. Banning Single-Use Plastics: Lessons and Experiences from Countries. Available online: https://wedocs.unep.org/bitstream/handle/20.500.11822/25496/singleUsePlastic_sustainability.pdf [Accessed 21/04/2020].
- Van Niekerk, S., & Wegmann, V. 2019. Municipal solid waste management services in Africa – Working Paper. *Public Services International*, 1–68.
- Wahlen, C.B. 2018. AU-UN Conference focuses on Development, Peace and Security. Available online: <http://sdg.iisd.org/news/au-un-conference-focuses-on-development-peace-and-security/>. [Accessed 21/04/2020].
- World Bank. 2016. Morocco lets nothing go to waste. Available at: <http://www.worldbank.org/en/news/feature/2016/02/16/morocco-lets-nothing-go-to-waste> [Accessed 21/04/2020].
- World Health Organization (WHO). 2016. WHO global urban ambient air pollution database. Available at: http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/. [Assessed 21/04/2018].

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This study was conducted in response to the need to identify and assess open waste dumping and burning practices and to determine waste management factors that cause such practices. The focus areas were one city council and four urban councils in the Lowlands in the Kingdom of Lesotho. The objectives of the study were to:

- Locate and record positions of dumping sites and sites where open burning occurred using a global positioning system (GPS);
- Determine social, environmental and economic factors leading to open dumping and burning of solid waste;
- Assess the environmental impacts of open solid waste dumping and burning practices;
- Review current legislation which prohibits open dumping and burning of solid waste;
- Evaluate public compliance with waste management legislation; and
- Utilize the data to recommend possible solutions towards the adoption of safe and effective solid waste management approaches.

6.2 Conclusion

This chapter highlights significant findings pertaining to current waste management practices in the study area that are related to the study objectives.

6.2.1 Identify and assess open waste dumping and burning practices

No sanitary landfill practices were observed at the one landfill site under study as the MSW disposal practices that were employed did not meet the minimum requirements for landfilling according to definitions and requirements stipulated in the literature. Moreover, the predominant prevalence of open dumpsites in the areas

selected by the town councils for waste disposal is a matter of concern. The disposal sites received waste from commercial, residential, health care, institutional and industrial facilities and these wastes were not segregated according to categories. Textile, tyre and other hazardous wastes, including medical waste and disposable soiled nappies, were observed at the dumpsites in some councils. At the majority of the disposal sites, waste was dumped without any treatment procedure and was frequently burned on site. Waste coverage with soil and compacting were observed at only one site. The general conditions at all the disposal sites were unsatisfactory. Most of these sites were unsuitably located as they were too close to human dwellings, agricultural land and water sources. Those sites that were properly sited needed to be upgraded and required proper management, fencing as well as leachate and access control. Recycling was done on site by waste pickers who generally resided in nearby villages. However, they used out-of-date and unsafe methods and were exposed to health hazards. The recycling businesses that are offset facilities for recyclable waste in the Maputsoe Urban Council and the Maseru City Council areas have the potential to grow because manufacturing industries that generate lots of recyclable waste operate successfully in these areas.

6.2.2 Factors leading to dumping and burning of solid waste

The findings revealed that limited/insufficient waste collection was a major contributor to poor waste management practices. It was found that most residents who did not receive waste collection services reverted to waste burning, burying and indiscriminate dumping as their most preferred waste management practices. Even in council areas where waste was collected, the services were interrupted or ceased entirely when there was a shortage of funds, and this disruption unfailingly occurred at the beginning of the fiscal year when funds had not yet been allocated. Most councils provided an inadequate number of waste bins and the capacity of the bins did not cater for the daily waste generation or their collection frequency, and this contributed significantly to waste littering and diminished aesthetics. Where waste

bins had not been emptied for a while, wastes were ultimately indiscriminately burned on site to reduce waste volumes.

Gas emissions at the disposal sites were not monitored or controlled and thus contributed to incidences of spontaneous combustion. The disposal sites were easily accessible and most had no security measures with either dilapidated or no fencing at all. The landfill site had a concrete fence but this site is located at some points within 50 m of human dwellings. Many community members burned their waste as they had no or little knowledge of the implications of this practice. This is because a limited number of residents had received any kind of information or education on waste dumping, burning, recycling or other proper management practices such as waste separation at source. It was thus found that the councils were negligent in this regard. Moreover, in some council waste workers burned waste at the disposal sites, which suggests a lack of training and law enforcement practices in the council areas, and this oversight aggravated the use of poor waste management practices.

6.2.3 Environmental impacts of solid waste dumping and burning

Whenever urban waste services and management systems are poor or have failed, inhabitants living in the vicinity of disposal sites endure deprived living conditions. This study discovered that the respondents' perceptions of risks associated with exposure to poor MSW management were low. They thus perceived that they were not significantly exposed to health risks associated with MWM practices. Those who did perceive a risk, generally understood that they were at risk of respiratory and gastrointestinal diseases.

Due to the hazardous nature of some of the waste dumped at the disposal sites, their unsuitable location and the fact that none of the disposal sites were well engineered, a high possibility existed that the soil and water sources, particularly

the drinking water sources, would have been contaminated. Mere observation of the quality of the leachate at one site suggested that this patch of open water was severely compromised. However, testing the soil and water for contaminants was beyond the scope of this study.

The informal waste pickers were contributing to the reduction of waste; however, their lack of personal protective equipment (PPE) and waste segregation procedures put their lives at risk as they were exposed to injuries and infectious diseases. Similarly, even the formal waste workers had inadequate PPE and training. Only the Maseru City Council had appointed environmental health practitioners (EHPs) and safety and health officials as waste managers. The fact that no such experts had been appointed by the other councils could account for the finding that they were not prioritising the safety and health of waste workers. Determining the reasons for the gaps in the latter regard in the Maseru City Council area was unfortunately beyond the scope of the study.

6.2.4 Review of current legislation and legal compliance

Many African countries, including Lesotho, signed international agreements that seek to protect human health and the environment from the adverse impacts of improperly disposed waste. However few, if any, have reached the targets of a sustainable environment, pollution control and the protection of human health. The study explored factors that inhibited proper enforcement of waste management and found that there was a lack of clear MSW related laws, particularly the prohibition of waste dumping and burning practices. Moreover, it was evident that the councils had failed to appoint suitable personnel to enforce existing legislation.

6.3 Recommendations

The recommendations are generally related to developmental projects that should be launched in the near future to address the shortcomings in MSWM in the councils in the Lesotho Lowlands. They also provide direction for future studies.

6.3.1 Sustainable MSWM

Waste minimization by reduction at source and efficient commercialized recycling enterprises should be encouraged and supported effectively to ensure sustainable solid waste management and development of the society. Separation of waste at source will help to increase recycling yields. The councils should consider establishing composting and anaerobic digester plants for municipal solid waste treatment. They should also explore opportunities for energy recovery from waste. Strategies to reach to households that are inaccessible due to a poor road system should be designed so that wastes can be collected from these households to limit indiscriminate waste dumping and burning practices. The councils should seriously consider the banning of hazardous waste streams reaching landfill and dumping sites. Moreover, preparations should be made to monitor disposal sites during their operation and after their closure to eradicate emissions of landfill gas and leachate.

6.3.2 Improvement of waste legislation, amendment of regulations and compliance enforcement

Local authorities should enforce the law that forbids the burying, dumping and burning of waste by households and all waste should then be collected at or near the dwellings of members of communities according to fixed schedules. This will reduce pollution levels caused by burning and leaching and diminish adverse waste disposal impacts on the health of communities living in the vicinity of waste dumps or landfills. Waste burning and dumping by households far from dumping sites

should also be prohibited as a matter of urgency. It is acknowledged that such legislation can only be enforced if these communities are serviced regularly by waste collection personnel who collect waste at regular intervals.

6.3.3 Improvement of resource allocation for MSWM

Councils should allocate adequate resources for waste service sustainability. Waste management services are the responsibility of local governments and councils are an integral part of the local government system. National government is strongly urged to budget appropriately for the fiscal year and to provide councils with the financial means to ensure that they can sustain effective waste management services to all communities throughout the year without interruptions.

6.3.4 Development of waste management strategy and the evaluation of MSWM systems

Comprehensive strategies need to be developed to overcome the many challenges associated with MSWM. Such strategies should also focus on the inclusion of unserved and underserved areas. Moreover, they should involve representative community members and waste management service providers in waste management planning. Concerted consideration should be given to the informal waste sector, financial allocations, and the implementation of effective policies that will drive effective waste management practices. Sustainable waste management practices should include efficient waste recycling and composting. Councils need to heed the call for good governance and, to achieve this goal, waste management strategies need to be functioning well in the interest of the health of society and the sustainability of a sound and aesthetically pleasing environment.

6.3.5 Appointment of waste management officers and occupational health and safety officers in the councils

There is a need for the functioning of efficient and task orientated waste management officers in the councils in the study area and, by implication, in Lesotho. In the latter context, the findings of the study may not be generalized due to the relatively limited scope of the study, but whereas the capital city of Lesotho has a landfill as well as appointed waste officials, surrounding council areas have only dumpsites and no officials. This is suggestive that the role of trained waste management officers should not be negated in councils in the Kingdom of Lesotho. It is acknowledged that an investigation into the many shortcomings at the Maseru landfill site were beyond the scope of the study, and the reasons why the appointed officials in the city council failed to implement proper landfill management practices thus remain understudied. Suffice it to say that appropriately educated waste management officials are trained in the law and are familiar with their responsibilities as specified by legislation. They know what actions to take in various circumstances and can provide their undivided attention to their waste management responsibilities. The appointment of such personnel and the proper execution of their duties should thus be urgently addressed.

6.3.6 Training and monitoring of waste management teams

To achieve better work performance, improved MSW practices and the conservation and maintenance of waste collection resources, councils should provide periodic waste management as well as legislative and safety and health training. Such training sessions should involve service providers and internal and/or external experts who share their knowledge and insights with workers. Vaccination programmes as well as pre-employment and periodic health surveillance should be conducted as a matter of course in order to monitor the health of workers and to detect early signs of possible disease outbreaks due to toxic waste. The necessity

of such practices is underscored by the measures that had to be implemented when the COVID-19 outbreak occurred globally early in 2020.

6.3.7 Establishment of a trade union for informal waste workers

All workers need unions in their workplace to help solve their problems and achieve common goals. The informal waste sector is marginalised due to the non-inclusiveness of waste pickers as a recognised labour force, the unequal status of their work, a lack of policies that guide their practices and safety and health issues, unsatisfactory income and wages, and various social issues. These problems will be pertinently addressed when informal waste workers have a representative body that is mandated to promote their rights.

6.3.8 Improvement and upgrading of waste disposal sites

The study found that all the waste disposal sites, even the landfill site, were operated as basic dumpsites where minimal recognised waste disposal practices were employed. This situation is unacceptable and councils should invest significantly in upgrading their official disposal sites so that they function as well-engineered sanitary landfills. All waste disposal sites should meet the minimum requirements of a landfill. For instance, they should be properly fenced, security services should be provided with controlled entry and signage boards and well-trained guards, landfill gas emissions should be monitored, and the separation of waste should be implemented and monitored along the waste disposal chain. Where disposal sites are inappropriately located, alternative disposal sites should be determined. Such sites should be established only after consultation with key stakeholders such as community leaders, council representatives, area chiefs, and representatives of relevant institutions and organizations operating in the proposed area where the sanitary landfill will be constructed.

6.3.9 Rehabilitation plans for disposal sites

In consideration of the future, councils should consider viable alternatives for what should be done with a current disposal site when it can no longer be operational. These plans should include the rehabilitation and sustained protection of the environment and should serve the interests of community members and informal waste workers alike. One sustainable project may be the conversion of the site to a recreational park and gardens. This can of course only occur after rehabilitation of the soil, but this may be accelerated through the collaborative efforts of all stakeholders, including the community and informal waste workers.

6.3.10 Health education and promotion

There is a need for public awareness that waste dumping and burning practices may have hazardous consequences. They should also be educated to understand that the promotion of environmentally friendly interventions like composting and recycling are constructive and will promote their health. Councils thus need to improve information dissemination to the public and such campaigns must involve all stakeholders.

6.3.11 Need for further research

It is difficult to estimate the extent of all the problems associated with waste dumpsites. What is even more difficult is to measure the potential costs for mitigation. This highlights the need to conduct research on the following topics:

- Cost-effective approaches for dumpsite rehabilitation;
- Dumpsite conversion into a well-engineered sanitary landfill; and
- Assessment of hazardous domestic waste (e.g. aerosols, detergents, sanitary pads and diapers) in the MSW streams that end up at disposal sites.

APPENDICES

Appendix 1: Residents' questionnaire

FACULTY OF HEALTH AND ENVIRONMENTAL SCIENCES



SOLID WASTE DUMPING AND BURNING IN THE LESOTHO LOWLANDS QUESTIONNAIRE

I Mamello Agnes Motaung, is currently studying for a Master of Health Sciences in Environment qualification at Central University of Technology, Free State. The purpose of the questionnaire is to identify, locate and assess factors leading to open dumping and burning of solid waste in Lesotho lowlands. This questionnaire is prepared for academic purpose only.

The participants are requested to please answer truthfully to obtain the correct results for the research. The **names** of the **participants** will be kept with confidential and please be aware that there is **neither a correct nor incorrect answer**.

Your participation in this study is valued and is highly appreciated because outcomes of this research may help the efforts made by the responsible bodies or individuals to resolve or mitigate the problems of solid waste management the area.

I, _____, give permission to Central University of Technology, Free State to use the information collected only or for the purposes of the study.

Email address

Cell no.

Signature:

Date

Instructions:

- **Mark the appropriate block with an 'X' or write your answer on the space provided.**
- **Please be honest when answering the questions below.**
- **The questionnaire is completed anonymously and cannot be traced back to you.**

BACKGROUND INFORMATION

1. Educational Background

Primary		1
Junior Secondary		2
High School		3
Tertiary		4

2. Occupation

	5
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3. I am this residence.

the owner		6
a family member		7
renting		8
other (specify):		9

4. Number of household members

1-3		10
4-6		11

7 and above		12
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5. Length of stay in the area

0-2 years		13
3-5 years		14
6-10 years		15
11-15 years		16
Over 15 years		17

SOLID WASTE MANAGEMENT PRACTICES

6. Do you have a temporary solid waste storage in your house?

Yes		18
No		19

7. What kind of storage do you use?

Bin		20
Sack		21
Plastic bags		22
Other: (specify):		23
		24

8. What means do you use to dispose of the solid wastes of your household?

Throw it on an open dump or on street		25
Digging a hole around the house and burn it		26
Disposing on the backyards of the house		27
Waste collectors take it		28
		29

Other specify:

9. How frequently do you usually dispose your wastes to your choice dumping place?

Every day		30
Every 3-5 days		31
Every week		32
Every two weeks		33
Once a month		34
Other (specify):		35

10. What time do you prefer to dispose your household wastes?

Early morning		36
Late morning		37
Noon		38
Afternoon		39
Early night		40
Other (specify):		41

11. Do the municipal or hired private collectors that collect solid wastes in your area?

Yes		42
No		43

If your answer to question 11 is "Yes", please answer question 11 and 12.

12. Do you pay for these services?

Yes		44
No		45
		46

If "Yes", indicate how much in Maloti:

13. Are the services offered satisfying?

Yes		47
No		48

14. If you are not getting the waste collection services, what could be the factors preventing you from getting such services?

.....		49
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15. Have you ever seen solid wastes from institutions and businesses dumped openly near your area or streets?

Yes		50
No		51

If your answer for question 15 is "Yes", how frequent do you come across these solid wastes dumped illegally in your area?

Always		52
Many times		53
Sometimes		54
Rarely		55

16. Have you ever seen informal waste pickers in open dumps?

Yes		56
No		57

If your answer for question 16 is “Yes”, how frequent do you see them?

Always		58
Many times		59
Sometimes		60
Rarely		62

17. Have you seen burning of solid waste practiced in open dumps?

Yes		63
No		64

If your answer for question 17 is “Yes”, how often does it occur?

Always		65
Many times		66
Sometimes		67
Rarely		68

RESIDENTS AWARENESS AND ATTITUDE TOWARDS SOLID WASTE MANAGEMENT

18. What do you think of solid wastes? Do you think solid wastes are?

Useless		69
Somewhat useful		70
Useful		71
Not useful		72
I do not know		73

19. Do you know that your solid waste generation is affected by or related to your consumption pattern?

Yes		74
No		75

20. Who do you think is responsible for solid waste management?

The municipality		76
The waste collectors		77
The municipality and the waste collectors		78
The residents		79
The municipality and household		80
All of the above bodies		81

21. Do you agree with the significance of recycling solid waste material?

Yes		82
No		83

22. Do you know where the nearest recycling centres are in your area?

Yes		84
No		85

23. How far would you be prepared to travel (one way) to recycling centres in your area?

Less than 2km		86
2-5 km		87
6-10 km		88
11 km and above		89

24. Do you know that there are rules and regulations of solid wastes in Lesotho?

Yes		90
No		91

25. How do you evaluate the follow – up by the responsible bodies to practice the rules and regulations of solid waste disposal in your area?

Regulation very strong		92
Regulation is strong		93
Regulation is fair		94
Regulation is weak		95
Regulation is very weak		96

26. Have you ever seen when violators of regulation in solid waste management penalized?

Yes		97
No		98

If your answer for question No. 26 is “Yes”, how do you evaluate the appropriateness of the penalty to prevent violators of solid waste management rules and regulations?

Very strong		99
Strong		100
Fair		101
Weak		102
Very weak		103

27. Have you ever come across any form of lesson associated with open dumping and burning of solid waste?

Yes		104
No		105

28. Have you ever taken any information/lesson/ regarding to open dumping and burning of solid wastes from the municipality?

Yes		106
No		107

ENVIRONMENTAL AND HEALTH HAZARDS ASSOCIATED WITH DUMPSITES

29.. Are you exposed to any type of risk for living close to the dump site?

Yes		108
No		109

If “Yes”, state type (s) of risk (s)

<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	110
---	-----

30. What steps do you have in place to minimize/manage risk(s)

<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	111
---	-----

Which hazards are you exposed to?

31. Odour

Yes		112
No		113
Not sure		114

32. Fire

Yes		115
No		116
Not sure		117

33. Smoke

Yes		118
No		119
Not sure		120

34. Pest (fly, rats and vermin)

Yes		121
No		122
Not sure		123

35. Birds

Yes		124
No		125
Not sure		126

36. Litter

Yes		127
No		128
Not sure		129

37. Leachate (black liquid from landfill)

Yes		130
No		131
Not sure		132

38. Surface water contamination

Yes		133
No		134
Not sure		135

39. Landfill Gas (Methane)

Yes		136
No		137
Not sure		138

40. Have you or your household members contracted illness or been injured from open dumps?

Yes		139
No		140

If the answer to question 40 is “YES”, specify illness or condition

.....

General Comments

THANK YOU FOR YOUR CO-OPERATION IN COMPLETING THE QUESTIONNAIRE

Appendix 2: Council management officials' questionnaire

FACULTY OF HEALTH AND ENVIRONMENTAL SCIENCES



SOLID WASTE DUMPING AND BURNING IN THE LESOTHO LOWLANDS QUESTIONNAIRE

I Mamello Agnes Motaung, is currently studying for a Master of Health Sciences in Environment qualification at Central University of Technology, Free State. The purpose of the questionnaire is to identify, locate and assess factors leading to open dumping and burning of solid waste in Lesotho lowlands. This questionnaire is prepared for academic purpose only.

The participants are requested to please answer truthfully to obtain the correct results for the research. The **names** of the **participants** will be kept confidential and please note that there is **neither a correct nor incorrect answer**.

Your participation in this study is valued and is highly appreciated because outcomes of this research may help the efforts made by the responsible bodies or individuals to resolve or mitigate the problems of solid waste management the area.

I, _____, give permission to Central University of Technology, Free State to use the information collected only or for the purposes of the study.

Email address

Cell no.

Signature:

Date

Instructions:

- **Mark the appropriate block with an 'X' or write your answer on the space provided.**
- **Please be honest when answering the questions below.**
- **The questionnaire is completed anonymously and cannot be traced back to you.**

SECTION A: BIOGRAPHICAL INFORMATION

1. Please indicate, in which council do you work?

Botha-Bothe Urban Council		1
Hlotse Urban Council		2
Maputsoe Urban Council		3
Berea Urban Council		4
Maseru City Council		5

2. Please indicate your work position in the council?

Councilor/ Municipal Manager		6
Environmental Health Practitioner		7
General Waste Worker		9
Other (please specify):		10

3. Please indicate how long have you worked for the council?

0-2 years		11
3-5 years		12
6-10 years		13
11-15 years		14
Over 15 years		15

4. What is your highest level of education?

Primary		16
Junior Secondary		17
High School		18
Tertiary		19

SECTION B: PROVISION OF WASTE MANAGEMENT SERVICES

5. Does your council collect waste?

Yes		20
No		21

If YES in question 5, please answer question 5.1 and 5.2 below:

**5.1. Please indicate from which of the following areas does your council collect waste?
(More than one option could be selected).**

Residential areas (e.g. households)		22
Businesses areas (e.g. retail stores, repair shops, food markets, hotels and taxi ranks)		23
Institutional area (e.g. schools, colleges, governmental and private organizations)		24
Industrial areas (e.g. manufacturing firms)		25
Health Care Facilities (e.g. clinics, hospitals and surgeries)		26

5.2. Please indicate since when has your council been collecting waste?

Before 1990		27
1991 - 2000		28
2001 – 2010		29
2011 – to date		30
Do not know		31
Other (please specify):		32

6. Please indicate other services, in addition to waste collection, that takes place in your council.

<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	33
--	----

7. Indicate what workers operate or work on the landfill or dump sites? (More than one option could be selected).

Municipal workers appointed to operate or work on landfill or dump sites		34
Community members		35
Contractors		36
Waste Pickers		37
Other (please specify):		38

.....

8. Which types of collection methods are used in your council? (More than one option could be selected).

Kerb side collection		39
Central collection point in area		40
Door- to- door collection		40
Other (please specify):		41

9. Does the council provide waste collection receptacles?

Yes		42
No		43

9.1. If the answer to question 9 is “YES”, what waste receptacles does the council provide to residents? (More than one option could be selected).

Plastic bags	Yes		No		44
Waste bins	Yes		No		45
Bulk containers (skips)	Yes		No		46
None					47
Other (please specify):					48

10. How often is waste collected in your area?

Once a week		49
Every two weeks		50
Once a month		51
Once every two months		52

Other (please specify):	53
----------------------------------	----

11. Was there any period of time when the council did not collect waste?

Yes		54
No		55
If you answered yes, please specify those periods:		
1.....		57
2.....		58
3.....		59
4.....		

12. Do the residents sort their waste before collection?

Yes		60
No		61
Do not know		62

13. Which method does the municipality use to communicate with the residents?

Radio		63
E-mail		64
Publish in newspaper		65
Pamphlet		66
Notifications at community centers		67
Other method (please specify):		

SECTION C: WASTE MANAGEMENT PERSONNEL AND EQUIPMENT

14. Are there contractors or service providers that render waste collection services in your council?

Contractors	Yes		No		69
Service providers	Yes		No		70

14.1.If the answer to question 14 is “YES”, please indicate how many contractors or service providers render waste collection services in your council?

Contractors		71
Service providers		72

15. Are there sufficient resources to render efficient solid waste management services in your council?

Yes		No		73
15.1.Please explain your answer:				74

16. Are the waste workers trained?

Yes		75
No		76

16.1 If the answer to question 16 is “YES”, please indicate the type of training received and the number of days per course. (More than one option could be selected).

	Yes	No	If yes, number of days	
Waste management training				77
Legislative training				78
Safety training				79
Health training				80

Other (specify): 1.				81
2.				82
3.				83

17. Are the workers provided with personal protective equipment (PPE)?

Yes		84
No		85

17.1.If the answer to question 17 is “YES”, please indicate what types of Personal Protective Equipment are provided to workers. (More than one option could be selected).

Overalls		87
Gloves		88
Safety boots/shoes		89
Face masks		90
Other (please specify): 1.		91
2.		92
3.		93
4.		94

18. Please indicate which type of vehicle is used by the council (including service providers) to collect waste? (More than one option could be selected).

Compactor truck		95
Skip-loader truck		96
Tractor-drawn trailer		97
Small bakkie		98
Other (please specify):		99

19. Please indicate the type of transport used to transport waste to the landfill site or dumpsite (More than one option could be selected).

Compactor truck		100
Skip-loader truck		101
Tractor-drawn trailer		102
Small Bakkie		103
Other (please specify):		104

SECTION D: SOLID WASTE MANAGEMENT PRACTICES AND COUNCILS' SERVICES

20. How is solid waste disposed in your area? (More than one answer can be selected).

Composting		105
Burnt		106
Collected and disposed at community landfill or dumpsite		107
Dump it in a secluded area or street		108
Recycled		109
Other (please specify):		110

21. What type of waste is disposed at the landfill or dump site? (More than one answer can be selected).

General household waste		111
Health care risk waste		112
Construction waste		113
Garden waste and soil		114
Electronic waste		115
Industrial waste		116

22. Please indicate the distance of the landfill or dumpsite site from residents?

50 m		117
More than 50m but less than 100m		118
More than 100m but less than 500 m		119
More than 500 m less than 1km		120
More than 1km but less than 10k		121

23. Are there any open dumpsites within the council?

Yes		121
No		122

23.1.If the answer to question 23 is “YES”, what happens with the dumped waste? (More than one answer can be selected).

Removed by municipality		123
Burnt		124
Left there		125
Burnt by waste management workers		126
Burnt by residents		127
Other procedures (please specify):		128

24. What are the factors that lead to open dumping of solid waste decisions?

.....		129
-------------------------	--	-----

25. What strategies can be recommended to reduce the problem of open dumping of waste?

.....		130
-------------------------	--	-----

26. Does the council run or promote recycling campaigns?

Yes		131
No		132

27. Do the Non-Governmental Organizations (NGO's) participate in waste reduction campaigns?

Never		133
Often		134
Sometimes		135

Very often		136
Always		137

28. Indicate what types of products are recycled? (More than one answer can be selected).

Plastic		138
Glass		139
Cardboard		140
Paper		141
Metals		142
Electronics		143
Other (please specify):		144

29. Do you know of any information provided to residents regarding composting?

Yes		145
No		146

29.1. If the answer to question 29 is “YES”, please indicate when information was shared with the residents?

.....		147
----------------	--	-----

30. Do you have a transfer station in your area?

Yes		148
No		149

31. Are there solid waste buy back centers in your council?

Yes		150
No		151

31.1 If the answer to question 31 is “YES”, please indicate if it is utilized by the residents.

Yes		152
No		153

32. Is the landfill or dumpsite a well-engineered disposal site?

Yes		154
No		155

33. Please rate the performance of the landfill or dumpsite in your area

Very bad		156
Bad		157
Good		158
Very good		159
Excellent		160

34. Do the residents participate in the decision-making processes for solid waste management?

Yes		161
No		162
Sometimes		163

35. Are the council leaders interested in environmental issues?

Yes		164
No		165
Sometimes		166

36. Are there environmental legislations to regulate solid waste management?

Yes		167
No		168

36.1 If the answer to question 36 is “YES”, please indicate the environmental legislations that are currently used.

1.		169
2.		170
3.		171
4.		172
5.		173

37. Do you think the solid waste management practices comply with the current environmental legislations?

Yes		174
No		175
Sometimes		176

38. Do you think that open dumping of solid waste a criminal offence?

Yes		177
No		178
Sometimes		179

39. Do you think that burning of solid waste a criminal offence?

Yes		180
-----	--	-----

No		181
Sometimes		182

40. Are there any challenges experienced in implementing Solid Waste Management systems?

<p>.....</p> <p>.....,</p> <p>.....</p> <p>.....</p>	183
--	-----

41. Are the current Solid Waste Management Systems evaluated?

Yes		184
No		
Don't know		

41.1. If the answer to question 41 is "YES", please specify how often:

<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	185
---	-----

42. General Comments

THANK YOU FOR YOUR CO-OPERATION IN COMPLETING THE QUESTIONNAIRE

Appendix 3 - CHECKLIST

GENERAL INFORMATION					
1.Date:					
2.Name of district:					
3.Name of Council:					
4.Name of the area;					
5.The place is a.....?	Residential area	Yes		No	
	Landfill site	Yes		No	
	Dumpsite	Yes		No	
LANDFILL/ DUMPSITE INFORMATION					
Landfill/ dumpsite site features		Yes	No	Not Required	Comments
6.Are the roads leading to site easy to access and well maintained?					
7.Are there notice boards and signs indicating that it is a landfill or dumpsite?					
8.Official site for municipality to dispose of waste?					
9.(a) Is the landfill site or dumpsite fenced?					
9.(b) If Yes, what type of fence is used?	Defender litter fence				
	Chain link wire fence				
	Barbed wire fence				
	Brick wall				
	Other:				
10.Is unauthorized access controlled?	Access allowed at specified times (e.g. 08:30- 16:000				
	Lockable gates				
	Security guard				
11.What is the distance from landfill/ dumpsite to the nearest residence/ shacks?					
OPERATIONS AND MAINTAINANCE					
Operational Processes		Yes	No	Not Required	Comments

12. Is waste segregated into clearly designated areas (e.g. scrap metals, glass, wood, tires)?					
13. Is the waste compacted?					
14. Is cover placed on the waste to prevent windblown litter?					
15. Is the waste covered with soil at the end of the day?					
16. Is there any hazardous wastes deposited into the landfill/ dumpsite (e.g. medical waste)					
17.(a) Is burning practiced on site?					
17.(b) Who burns the waste?	Community members				
	Council workers				
18. Is there visible air pollution or smoke on site?					
19.(a) Are there landfill/ dumpsite workers on site?					
19.(b) If Yes, how many workers are found on site?					
20. Is there safety equipment for workers?					
21. Are the landfill or dumpsite workers provided with working equipment?					
22. Is there a suitable shelter for workers at landfill site?					
23. Is the landfill/ dumpsite equipment suitable or well maintained?					
24. Are there waste pickers on site?					
25. Is the waste recycled on site?					
26. Are there people living on landfill or dumpsite?					

GPS SETTINGS

Appendix 4: Ethical approval letter



Health Sciences Research Ethics Committee

13-Aug-2018

Dear Miss Mamello Motaung

Ethics Clearance: **SOLID WASTE DUMPING AND BURNING IN THE LESOTHO LOWLANDS**

Principal Investigator: **Miss Mamello Motaung**

Department: **CUT - Central University of Technology**

MODIFICATIONS REQUIRED

With reference to your application for ethical clearance with the Faculty of Health Sciences, your research proposal has been considered by the Health Sciences Research Ethics Committee. However, the HSREC will only be able to approve this research once a revised application or supplementary documentation is received as per the following provisions:

Provisions:

Ensure that the particular legislation is referred to in the documents and that written permission from Council of Maseru is added. Please submit once received

The lay summary should not exceed 750 words, but is currently over 1200. Please shorten.

Ethics Clearance Application -

Please provide the locations of the study on the ethics application form.

Research with Minors - Form A :

This form is unnecessary if minors aren't included.

The HSREC 19 form is not signed by the PI. Please sign and submit

-Questionnaires and informed consent forms:

Please proof read the forms, as some grammatical errors exist.

Upon receipt of the above documentation/other requests from the HSREC, the project will be reconsidered.

Please note:

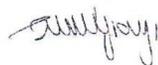
- Any and all changes made to documents in this application must be highlighted before resubmission. Please include a summary of changes. Failure to comply to this request might result in this project being withdrawn from further consideration.
- You have 30 calendar days from date of issuance to respond to this letter. If no response has been received by HSREC Administration within this time, this application will be withdrawn from further consideration and you will have to reapply.

Your ethical clearance number will be issued as soon as the HSREC has reviewed and approved your response to the above mentioned stipulations. For the time being, please use the following RIMS reference number in all correspondence: **UFS-HSD2018/0730**

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance. We look forward to receiving your response.

Yours Sincerely



Dr. SM Le Grange

Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee

Office of the Dean: Health Sciences

T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za

IRB 00006240, REC 230408-011; FORGD005187; FWA00012784

Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa

www.ufs.ac.za



APPENDIX 5 A: Lesotho Ministry of Health



LESOTHO

Ministry of Health
PO Box 514
Maseru 100

REF: ID102-2018

Date: June 07, 2018

To
Mamello Agnes Motuang
Central University of Technology
Free state

Category of Review:

- Initial Review
 Continuing Annual Review
 Amendment/Modification
 Reactivation
 Serious Adverse Event
 Other _____

Dear Ms. Mamello,

RE: Solid Waste Dumping and Burning Practices in the Lesotho Lowlands

This to inform you that the Ministry of Health Research and Ethics Committee reviewed and **APPROVED** the above named protocol and hereby authorizes you to conduct the study according to the activities and population specified in the protocol. Departure from the approved protocol will constitute a breach of this permission.

This approval includes review of the following attachments:

- Protocol: dated 09 May 2018
 Informed consent forms English and Sesotho:
 Questionnaires in English and Sesotho: Dated 09 May 2018
 Participant information sheets in English & Sesotho:
 Other materials: Letter of request to urban council and CV of the PI
This approval is **VALID** until June 06, 2019.

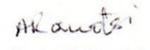
Please note that an annual report and request for renewal, if applicable, must be submitted at least 6 weeks before the expiry date.

All serious adverse events associated with this study must be reported promptly to the MOH Research and Ethics Committee. Any modifications to the approved protocol or consent forms must be submitted to the committee prior to implementation of any changes.

We look forward to receiving your progress reports and a final report at the end of the study. If you have any questions, please contact the Research and Ethics Committee at rcumoh@gmail.com (or) 22226317.

Sincerely,

Dr. Nyane Letsie
Director General Health Services


Dr. Amelia Ranotsi
Chairperson NH-IRB

APPENDIX 5 B: Maseru City Council

MASERU CITY COUNCIL

P.O. Box 911
Maseru 100
Lesotho



Telephone: (266) 22317386
Telex: 4223 MMC LO
Fax: (266) 22310418

Your Ref:

Contact Person:

Our Ref:

Date: 03 September 2018

Central University of Technology
20 President Brand Street
Private Bag X20539
Bloemfontein 9300

Dear Sir/Madam

RE: SOLID WASTE DUMPING AND BURNING PRACTICES IN THE LESOTHO LOWLANDS

This is to inform you that the Maseru City Council gives permission to Mamello Agnes Motaung, student no. 216007880 from Central University of Technology to conduct the study of the above named protocol according to the activities and population specified in the protocol. The council will assist the student with necessary information and assistance required for the completion of the study.

If you have any questions, please contact the Maseru City Council at mkhooe1@gmail.com (or) call +26656300868



Kind Regards

M. KHOOE

TOWARDS THE FUTURE TOGETHER
Town Clerk City Treasurer Director of Works Director of Health & Environment
Administrative Secretary Director of Planning & Development Director of Parks & Recreation

APPENDIX 5 C: Berea Urban Council



BEREA URBAN COUNCIL
P/BAG X028
BEREA
200

Date: 22nd November, 2018

Dr H Roberts
Central University of Technology Free State
Private Bag X20539
Bloemfontein

Dear Sir/Madam

RE: PERMISSION TO UNDERTAKE STUDY AT BEREA URBAN COUNCIL

This serves to confirm that Ms Mamello A. Motaung, your student has been granted permission to undertake her research study on 'solid waste dumping and burning practices in the Lesotho lowlands' in the Berea Urban Council in Teyateyaneng town.

Yours faithfully


Nkhato Thamae
TOWN CLERK



APPENDIX 5 D: Hlotse Urban Council



c/o P.O. BOX 1, Leribe, contacts: 22 400 709

Date: 06/11/2018

Ref: HUC/MAM/DMS/06/11/18/1

Ms Mamello Motaung

Ha Mathata

Leribe 300

Dear Madam,

Re: Permission to Study in Hlotse Dumping Site

This letter serves as confirmation that you have been given a permission to study the Hlotse Urban Council Dumping site. It is in line with your research at Central University of Technology, in South Africa. On this note you will be given all necessary assistance you may require for your studies as the council may provide.

We are looking forward to your work with regard to the waste management and would like to wish you the best in advance for your studies.

Yours in service,



L. Molalle (Mr)

Town Clerk

APPENDIX 5 E: Botha-Bothe Urban Council

Contact: +266 22461463
Facsimile: +266 22461463
Town Clerk: 62020741
Mayor: 62561231



BOTHA-BOTHE URBAN COUNCIL
P.O. BOX 871
BOTHA-BOTHE 400

06th / 11 / 2018

REF: BBUC/LM/11/18

DR. H ROBERTS
THE SUPERVISOR
DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES
CENTRAL UNIVERSITY OF TECHNOLOGY
FREE-STATE

DEAR SIR

RE: MS. MAMELO MOTAUNG: 216007880

This is to confirm that the aforesaid student has been granted permission to conduct her research on Solid Waste dumping and burning practices in Lesotho, particularly within Botha-Bothe Urban Council's boundaries as part of her research scope, and as per your request dated 22 August 2018.

We pledge our unwavering support to her to attain the desired results.

Yours Faithfully




T. NCHAKHA (MR)

TOWN CLERK

