AFRICA Waste Management OUTLOOK

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Abbreviations and acronyms

AfDB	African Development Bank
AIDS	acquired immunodeficiency syndrome
ASCE	American Society of Civil Engineers
AUC	African Union Commission
AWT	alternative waste treatment
CBA	cost benefit analysis
CBO	community-based organization
CCA	Canadian Construction Association
CFAF	CFA franc (currency used by countries in West Africa)
CO_2	carbon dioxide
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWG	Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries
DEA	Department of Environmental Affairs (South Africa)
DEAT	Department of Environmental Affairs and Tourism (South Africa)
EAC	East African Community
EACO	East African Communications Organisation
ECA	Economic Commission for Africa
ECOWAS	Economic Community of West African States
EEE	electrical and electronic equipment
EIA	environmental impact assessment
ELV	end-of-life vehicle
EPC	engineering, procurement and construction
EPR	extended producer responsibility
EWIT	E-waste Implementation Toolkit
FAO	Food and Agricultural Organization of the United Nations
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas(es)
GIZ	Deutsche Gesellschaft fuer Internationale Zusammenarbeit (German Agency for Technical Cooperation. Former GTZ for International Cooperation)
GRID	Global Resource Information Database
GWMO	Global Waste Management Outlook
HCRW	health care risk waste
HIV	human immunodeficiency virus
ICE	Institute of Civil Engineers
ICT	information and communications technology
IETC	International Environmental Technology Centre
ILO	International Labour Organization
ISRI	Institute of Scrap Recycling Industries
ISWA	International Solid Waste Association

Abbreviations and acronyms
(continued)

ISWM	integrated sustainable waste management
kW	kiloWatt
LCA	life-cycle analysis
LFG	landfill gas
MEA	multilateral environmental agreement
MSW	municipal solid waste
MW	megaWatts
NCPC	national cleaner production centre
NEMA	National Environment Management Authority
NGO	non-governmental organization
OECD	Organization for Economic Cooperation and Development
O&M	operation and maintenance
PCB	polychlorinated biphenyl
PET	polyethylene terephthalate
PJ	petaJoules
POP	persistent organic pollutant
PPP	public-private partnership
PRO	producer responsibility organization
RDI	research, development and innovation
SADC	Southern African Development Community
SAICE	South African Institution for Civil Engineering
SBC	Secretariat of the Basel Convention
SDG	Sustainable Development Goal
SIDA	Swedish International Development Cooperation Agency
SME	small and medium-sized enterprise
SWM	solid waste management
tWh	teraWatt-hour
UDDT	urine-diverting dry toilet
ULAB	used lead-acid batteries
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
UNHCR	United Nations High Commissioner for Refugees
UNIDO	United Nation Industrial Development Organization
USAID	United States Agency for International Development
WEEE	waste electrical and electronic equipment
WHO	World Health Organization
WMO	Waste management outlook
WtE	waste-to-energy
WWF	World Wide Fund for Nature

1 Waste management as a priority in Africa

1 Waste management as a priority in Africa

What the reader can expect

Chapter 1 provides an introduction to solid waste generation and management in Africa as compared to global trends and patterns. It provides an overview of the drivers, pressures and impacts of waste on the continent. The chapter also provides an overview of the different policy and strategy responses that African countries have adopted, demonstrating a certain level of commitment to solving the waste challenges at a continental, regional and national level. The chapter shows that waste management is an environmental challenge facing all African countries. If the Sustainable Development Goals are to be achieved, developing sustainable waste management approaches must be an environmental and public health imperative deserving political priority.

Key messages

The following are key messages regarding waste management in Africa:

- The urban population in Africa is increasing at a faster rate than any other continent (3.5 per cent per annum).
- Although waste generation is currently lower in Africa than in the developed world, sub-Saharan Africa is forecast to become the dominant region globally in terms of total waste generation if current generation trends persist.
- Waste generation in Africa, like in other developing regions in the world, is driven by population growth, rapid urbanization, a growing middle class, changing consumption habits and production patterns, and global waste trade and trafficking.
- The African Union has called on African cities to commit to recycling at least 50 per cent of the urban waste they generate by 2023 and to grow urban waste recycling industries.
- A number of international, continental and regional policies are in place to address pollution and waste in Africa. It remains unclear how these policies have been translated into action, however, and what progress has been made towards achieving their objectives and commitments.
- Improper waste management has serious health and environmental consequences. If it persists, it will undermine Africa's efforts to achieve the Sustainable Development Goals (SDGs).
- Solid waste management (SWM) is a sustainable development issue that cuts across socio-economic activities and needs to be a political priority for Africa.

1.1 Introduction

Africa is the world's second largest continent after Asia, with a total surface area of 30,365,000 km^2, including several islands. It stretches approximately from 37 degrees latitude north to 35 degrees latitude south and has 54 sovereign countries (48 mainland and 6 island States). It is bounded by the Mediterranean Sea to the north, the Atlantic Ocean to the west, the Red Sea to the northeast and the Indian Ocean to the east. Africa's population was estimated at 1.26 billion in 2017 (UNDESA 2017). Although Africa as a whole has a major development aspiration in the broader context of a global and continental economic development agenda, individual African countries are increasingly facing development challenges. Waste management is one of them. As the following chapters will show, while different countries face different issues, there are common waste management challenges that could be solved using the teachings and practices of other African countries. The Africa Waste Management Outlook (WMO) is therefore intended to highlight both the challenges and the possible solutions for sustainable waste management in Africa, and to provide opportunities for countries to learn from what others in Africa are doing.

1.2 Key policy documents, goals and statements

The management of waste in Africa is a major challenge that needs serious attention (Mwesigye *et al*. 2009, Okut-Okumu 2012, UN-Habitat 2014, Bello *et al*. 2016). To address the challenge, a number of regional waste policies and strategies have been developed, in addition to country-specific policy and legislation. Key policies that frame waste as a political priority for the continent are discussed below.

1.2.1 Continental policies

Agenda 2063: The Africa We Want (2013)

Agenda 2063 is a 50-year strategic socio-economic transformation framework for the African continent. It aspires to build a prosperous Africa based on inclusive growth and sustainable development, outlining ten aspirations to guide the continent's transformation (AUC 2015a). The Agenda 2063 Implementation Plan (2014–2023) outlines specific goals to be achieved during the first ten years, including reference to the expected transformation of waste management (AUC 2015b). In particular, under goal 1 of aspiration 1 (A high standard of living, quality of life and wellbeing for all citizens), priority area 4 (Modern, affordable and liveable habitats and basic quality services), cities will be recycling at least 50 per cent of the waste they generate by 2023. To achieve this target, indicative strategies that develop or implement policies for the growth of urban waste recycling industries will need to be considered. However, to monitor progress against this goal, Africa will need reliable waste and recycling baseline data, which as the following chapter shows, is missing for Africa.

> "African cities will be recycling at least 50 per cent of the waste they generate by 2023"

Libreville Declaration on Health and Environment in Africa (2008)

The Libreville Declaration was signed by African countries on 29 August 2008 in Libreville, Gabon, as a commitment to protect human health from environmental degradation (WHO 2008). It reaffirms African countries' commitment to the implementation of the Bamako Convention on the "*Ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa (1991)*" (AU 1991) and the Bali Declaration on "*Waste Management for Human Health and Livelihood*

(2008)" (UNEP 2008). The declaration recognizes the constraints on accelerated implementation of the integrated strategies needed to protect populations against risks resulting from environmental degradation, poor sanitation and poor waste management, among other things. Recognizing risk factors, including poor waste management, the declaration outlines 11 commitments aimed at alleviating environmental degradation and the associated impacts on human health.

1.2.2 Regional policies

East African Community Development Strategy (2011)

The fourth East African Community (EAC) Development Strategy outlines broad strategic goals for the region for the period 2011/12–2015/16, including specific targets to be achieved. The strategy recognizes a lack of effective legislation, inadequate funds and services for municipal waste management, and the low priority given to solid waste management, as major challenges facing member countries. Although the strategy does not have a recommended strategic intervention on waste management in general, development objective 6, priority area 4 (*Sustainable natural resource management, environmental conservation, and mitigation of effects of climate change across the East African region*), includes the harmonization of policy interventions on the management of plastics and plastic waste and the establishment of an electronic waste (e-waste) management framework. Specific waste targets outlined under the EAC development strategy include (i) having a regional policy on the management of plastic and plastic waste in place by 2014, and (ii) an EAC e-waste management framework developed by 2014 (EAC 2011). While there is no evidence that the regional policy to manage plastics was developed, Rwanda (2008) and Kenya (2017) have successfully imposed a total ban on the use of plastic bags (Kenya NEMA 2017) and others have introduced a partial ban (**see chapter 4**). In 2013, the East African Communications Organisation (EACO) developed a model framework for e-waste management (EACO 2013).

Southern African Development Community: Regional Indicative Strategic Development Plan (2001)

The Southern Africa Development Community (SADC) Regional Indicative Strategic Development Plan (RISDP) is a framework aimed at guiding the SADC's integration agenda over the period 2005–2020 (SADC 2001). The objective of the RISDP is to deepen integration in the SADC region so as to accelerate poverty eradication and the attainment of other economic and non-economic development goals. SADC recognizes major causes of poor waste management in SADC countries to be (i) the increasing rate of waste generation; (ii) limited capacity available to handle the high volumes of waste; (iii) high costs involved in the management of waste; (iv) lack of proper disposal technologies and methodologies; (v) inadequate manpower and equipment, and (vi) poor enforcement. As a result of these factors, open dumping of domestic and industrial waste is rampant in most SADC countries (SADC 2012). To address these challenges, SADC member States have committed to promoting sound environmental management through pollution control, waste management and environmental education, including (i) capacity-building and training on pollution and waste arising from urbanization and industrialization; and (ii) the development of projects on pollution control and industrial and domestic waste management (SADC 2001). It is unclear what progress SADC countries have made toward fulfilling these commitments.

Economic Community of West African States: E-waste regional strategy (2012), regional strategy on chemicals management and hazardous waste (2015) and plastic waste management strategy (2016).

In 2012, the Economic Community of West African States (ECOWAS) developed a draft e-waste regional strategy whose main objectives were (i) to strengthen existing institutional frameworks for collaboration in controlling the importation of used electrical and electronic equipment (EEE), and (ii) to encourage cooperation between different government agencies and the three tiers of government in ECOWAS States, African countries and regional organizations (Osibanjo 2012). ECOWAS also developed a draft regional strategy on chemicals management and hazardous waste in 2015 and a draft strategy on plastic waste management in 2016.

1.2.3 International conventions

Many African countries are party to multilateral environmental agreements (MEAs) that have a bearing on the protection of human health and the environment from waste-associated impacts. These include –

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1992) (UNEP 1989)

- Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (1991)
- Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1974) (UNEP 2009), whose objective is to prevent indiscriminate disposal at sea of wastes that could be liable for creating hazards to human health, harming living resources and marine life, damaging amenities, or interfering with other legitimate uses of the sea
- Minamata Convention on Mercury (2013) (UNEP 2013a)
- Stockholm Convention on Persistent Organic Pollutants (2001) (UNEP 2011)
- United Nations Framework Convention on Climate Change (1992) (UN 1992)

Among other things, all of these conventions require parties to manage waste in a way that does not cause harm to human health or the environment. They also require parties to report their efforts toward implementation. The status of ratification of these conventions by African countries is discussed further in **chapter 4**.

The above policies and strategies show that, at least on paper, there is political commitment to improving the management of solid waste at a continental, regional and sub-regional level in Africa. However, as shown in **chapters 3 and 5**, these commitments have not translated into improved waste management. The Africa WMO aims to support the implementation of these strategies and policies by providing an overview of waste management in Africa and examples on how integrated waste management can be achieved on the continent.

1.3 Drivers and pressures behind waste in Africa

While the following chapters provide details on the state of waste management in Africa and its impacts, this section very briefly introduces the reader to the drivers, pressures, state and impact of current waste management practices in Africa, using the DPSIR framework. The response aspect, in terms of policy and strategy, is covered in more detail in **chapter 4**.

1.3.1 Drivers of waste generation in Africa

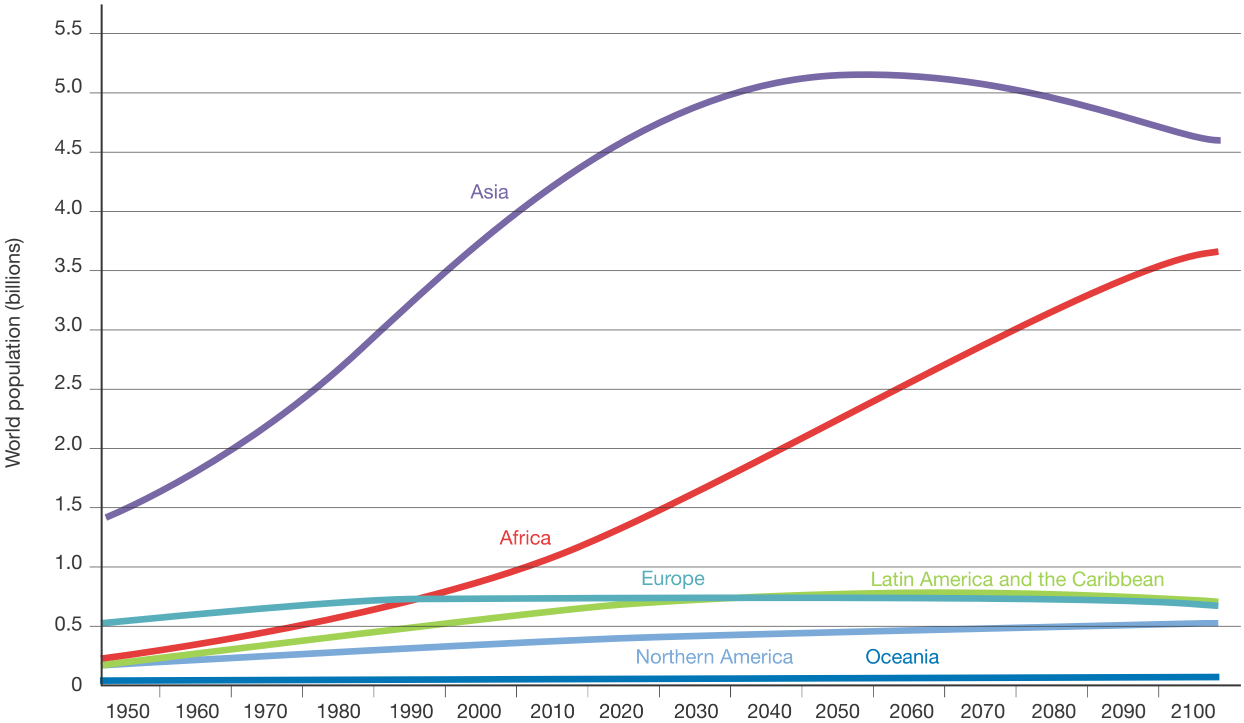
Population growth

The urban population in Africa has been rising steadily over time. It was estimated at 455 million in 2014 (UNDESA 2015a, 2015b) and around 472 million in 2015 (AfDB 2016a, Lall *et al.* 2017), and is increasing at a rate of 3.55 per cent per year (UNDESA 2015a). As shown in **Figure 1.1**, while Asia is forecast to reach its peak population around 2050, Africa's population is expected to continue to grow past 2100 (UNEP 2015). According to the United Nations 2017 revision, Africa's population is expected to increase from 17 per cent of the global population in 2017 (1.3 billion) to 40 per cent in 2100 (4.5 billion) (UNDESA 2017). This population increase will inevitably mean an increased waste burden on African cities and on already strained waste infrastructure (UNEP 2015).

Urbanization

While Africa remains mostly rural, with only 40.0 per cent of the population living in urban areas (as at 2014) (UNDESA 2015a), Africa and Asia are urbanizing faster than other regions. Over the last two decades, Africa has experienced urban growth of 3.55 per cent per year, which is expected to hold into 2050 (AfDB 2012, UNDESA 2015a). Africa's urban population is projected to reach 55.9 per cent of the population by 2050 (UNDESA 2015a). Projections also indicate that between 2010 and 2025, some African cities will account for up to 85% of the population (AfDB 2012). As cities grow, so does the amount of waste that they generate. However, development of waste management infrastructure in most African cities is not keeping pace with population growth, resulting in issues such as low waste collection rates and open dumping (**see chapter 3**) (UNEP 2015).

Figure 1.1 Estimated and projected world population by region for the 'medium variant'



Source: UNEP (2015)

Growing middle class and changing consumption habits

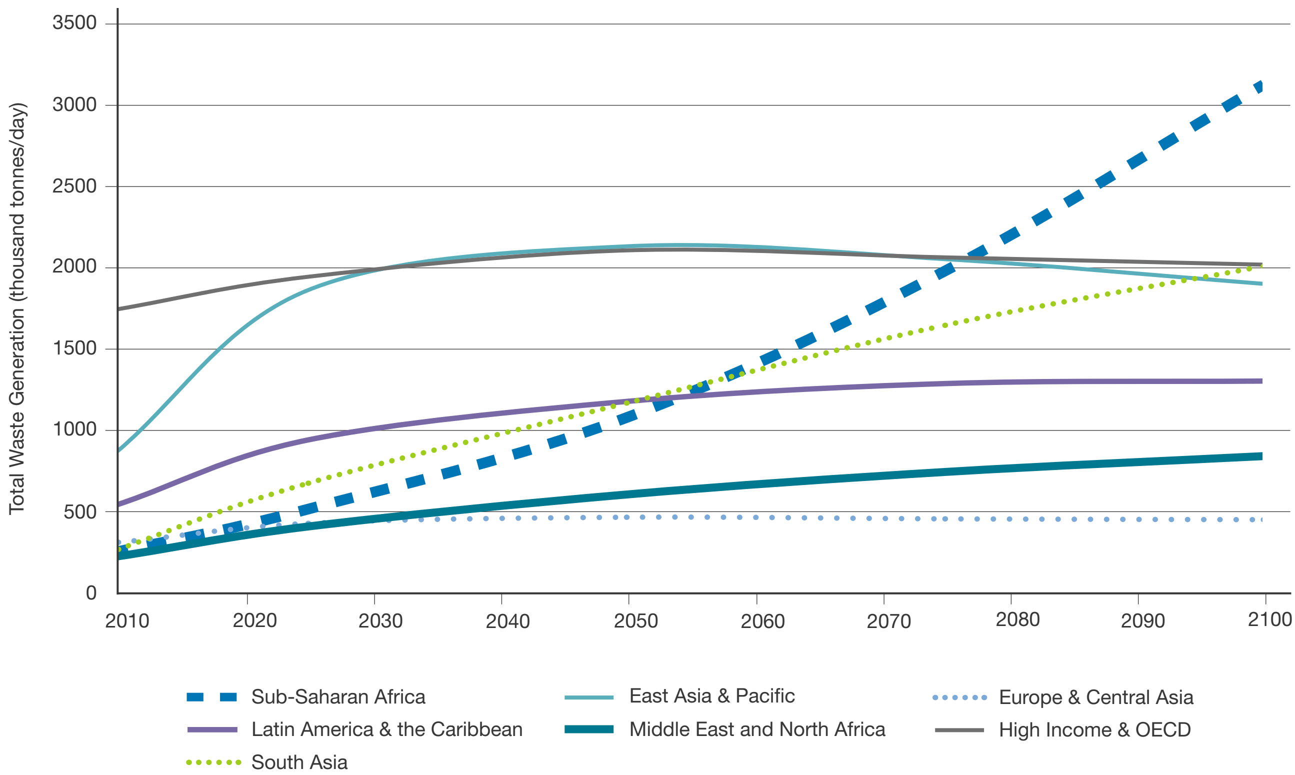
There is a correlation between the generation of municipal solid waste (MSW), wealth (gross domestic product (GDP) per capita), family income, changing lifestyle, changing consumption patterns of the growing urban middle class, and the changing structure of economic activities (WHO 2004, Lacoste and Chalmin 2006, Charles *et al*. 2009). Waste generation is expected to increase from 0.78 kg per capita per day in year 2002 to 1.0 kg per capita per day in 2025 (Achankeng 2003, WHO 2004). **Figure 1.2** shows a comparison of waste generation in Africa and other regions of the world for the period 2010 to 2100. The expected future increase in MSW generation, particularly in sub-Saharan Africa, is significant.

With changing consumption patterns come changes in the types and composition of MSW generated. Currently, in most African countries, organic waste constitutes more than 65 per cent of total waste, compared to only 30 per cent for developed countries (**see chapter 3**) (UNEP 2013b). **Figure 1.3** shows the expected changes in waste composition in African cities between 2010 and 2025, with decreasing organic waste content and increasing paper and packaging waste. The changing composition of waste in turn influences the choice of waste management technology and infrastructure, and underscores the importance of waste separation and integrated waste management (**see chapter 7**).

Economic development

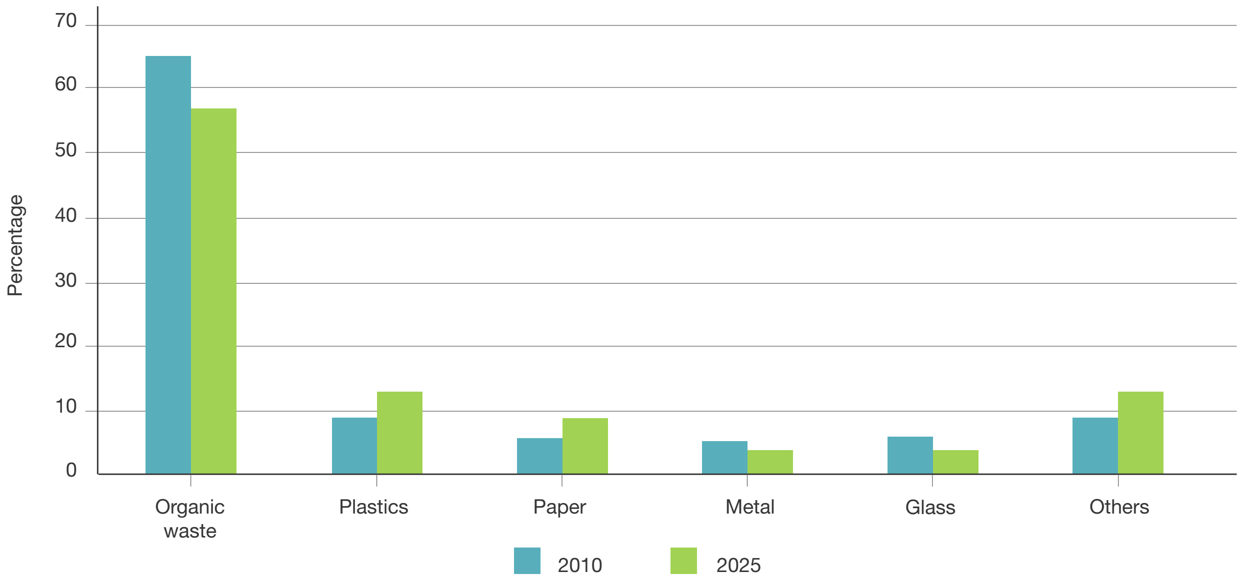
The majority of African countries aspire to achieve "middle-income" country status by 2025 (World Bank 2012, Steiner 2015, World Bank 2016). Considering that in Africa, children under the age of 25 account for 60 per cent of the population (in 2017) (UNDESA 2017), rapid economic growth is inevitable. The number of young Africans entering the workforce, estimated at 10-12 million per annum (AfDB 2016b) is, however, much higher than the estimated 3.1 million jobs created

Figure 1.2 Total MSW generation by region



Source: Hoornweg *et al.* (2015)

Figure 1.3 Changing composition of wastes in African cities



Source: Hoornweg and Bhada-Tata (2012)

every year. In order to address this problem of jobless growth, the African Development Bank has initiated a "*Jobs for Youth in Africa Strategy 2016–2025*" with the aim of creating 25–50 million jobs by driving inclusive growth across the continent and equipping youth to realize their full economic potential (AfDB 2016b). With a strong correlation between a country's GDP and waste generation (EPD 1998), this economic growth will inevitably lead to increased consumption of goods and services and increased waste generation (Oelofse and Godfrey 2008). This is compared to developed countries, which are beginning to realise decoupling of economic growth and waste generation, through the adoption of waste prevention, reuse, recycling and recovery strategies (UNEP 2015).

Global trade

Countries in Africa are being flooded with second-hand goods (especially electronic scrap), some of which are either already obsolete, or close to end of life on arrival (Switzerland Federal Office for the Environment 2011). In some cases, export of second-hand goods is used to circumvent regulations governing waste disposal and transboundary movements in order to get rid of waste products cheaply in developing countries. Traded goods include such things as used tyres, end-of-life vehicles (ELVs), and used and end-of-life electronic products (Osibanjo 2012). African countries often have no capacity or infrastructure for environmentally sound treatment or disposal of such waste, hence these traded goods end up as waste in dumpsites.

Current global waste movement follows a pattern of being produced in the global North and being exported to and disposed of in the global South (Willén 2008). Significant volumes of e-waste are being illegally exported to African countries and dumped in uncontrolled dumpsites, causing major threats to human health and the environment in Africa (UNEP 2005). This is typically the result of weaker legislation and lower disposal costs in Africa (Mackenzie 1992, Wong *et al*. 2007, Osibanjo and Nnorom 2007, Sthiannopkao and Wong 2013) (**see chapter 3**).

1.3.2 Pressures

Although almost all African countries have some policies that dictate how waste should be managed, there are many factors that constrain the waste management system. Such factors include weak legislation, lack of enforcement, low public awareness, negative attitudes, the poor state of services, corruption, political instability and conflicts. The following section briefly elaborates on these factors, while details can be found in **chapter 4**.

Lack of or weak legislation and enforcement

Although most African countries have ratified the MEAs on wastes and chemicals, they have typically not domesticated them into national laws (UNEP 2014). And while most African countries have some legislation to manage waste, competing needs or the failure to enforce this legislation gives rise to a culture of impunity and weakens the effectiveness of waste management in general (UNEP 2014). As a result, waste merchants take advantage of weak controls to engage in illegal transboundary movement of hazardous wastes.

Low public awareness and negative attitudes

Limited public awareness of proper waste handling and recycling, and poor household attitudes towards waste management as a service, are major constraints to integrated waste management in Africa. Typical issues include (i) a low level of public awareness; (ii) limited involvement of households as key stakeholders in service provision; (iii) a community attitude of waste disposal as a welfare service to be provided as a free social service by government; (iv) delays in the payment of collection fees by households; and (v) a collegial relationship between the households and the collectors that leads to non-payment of the services (Poswa 2001, Jatau 2013, Chengula *et al*. 2015). Additionally, social norms that focus on men for decision-making mean that community consultation processes often fail to take gender equality into consideration, thereby neglecting the needs of women. "*Unless explicit measures are taken to ensure women's participation, their priorities, responsibilities and needs as far as waste generation and management will not be heard.*" (Woroniuk and Schalkwyk 1998:1).

Political instability and conflicts

Waste management problems have been shown to be worse in African countries afflicted by conflict and political instability (Mwesigye *et al.* 2009). Conflicts create environments conducive to illegal transboundary movement of waste and a general lack of or weak governance and institutional capacity to support improved waste management in African countries and cities (Clayton 2005, Wilson 2007, Ognibene 2007, Lambrechts and Hector 2016).

Other pressures

Further pressures may include insufficient budgetary provision for waste collection and disposal, inadequate and malfunctioning operation equipment, lack of effective public participation, and inadequate waste management governance frameworks.

1.3.3 State of waste management in Africa

Waste management in Africa is often characterized by uncontrolled dumping and open burning, with limited cases of disposal to sanitary engineered landfills, or diversion of waste away from landfill towards reuse, recycling and recovery (Henry *et al*. 2006, Mwesigye *et al*. 2009, Mohammed *et al*. 2013). The state of waste management in Africa is discussed in some detail in **chapter 3**.

1.3.4 Impacts of waste management

Properly managed waste has been proven to have positive impacts on the environment, human health and the economy (Rybaczewska-Bàaẽjowska 2013). When solid waste is not managed, it results in serious environmental pollution, which in turn has serious harmful effects on human health and the environment. While the impact of solid waste management in Africa is unpacked in greater detail in **chapter 5**, the following sections very briefly introduce the reader to the health and environmental impacts associated with poor waste management.

Environmental impacts

Decomposition of solid waste in open spaces, uncontrolled dumpsites or storm water drainage and open burning of waste are likely to negatively impact the environment, including the pollution of soil, water (fresh and marine) and air (Abul 2010, UN-Habitat 2010; UNEP 2011, Kafando *et al*. 2013, Sankoh *et al*. 2013). Some waste also contains toxic chemicals (e.g. heavy metals) and persistent organic pollutants (POPs), which are persistent in the environment, can travel long distances, and are likely to accumulate in fauna and flora and in the food chain.

Human health impacts

The impacts of solid waste on human health are varied and depend on numerous factors, including the nature of the waste, method of disposal, duration of exposure, population exposed and availability of mitigation intervention. The impacts may range from mild psychological effects to severe morbidity, disability or death. The literature on health impacts of solid waste exposure in Africa remains weak and inconclusive in many cases. Uncollected waste left near houses, on streets, in markets or in drainage channels can become a breeding ground for disease carrying organisms such as malaria carrying mosquitos (AfDB 2002, Hoornweg and

Bhada-Tata 2012, Mangizvo and Wiseman 2012, Okot-Okumu 2012, Ziraba *et al.* 2016). Waste electrical and electronic equipment (WEEE) contains toxic substances such as lead, mercury and polybrominated diphenyl ethers. When dismantled inappropriately, WEEE exposes those in contact with it to chemicals with the potential to cause severe health consequences, particularly to the young men and women who trawl through the piles of waste in dumpsites hoping to find something worth selling (Osibanjo and Nnorom 2007). Other health impacts include respiratory disorders caused by inhalation of toxic substances from the burning of MSW.

Economic impacts

Traditionally, proper solid waste management has been advocated to protect human health and the environment (Soos 2017). However, experience from developed countries has shown that it has the potential to generate income from direct employment for both men and women, through reuse, recycling and recovery (Woroniuk and Schalkwyk 1998, Soos 2017). Waste prevention, reuse, recycling and recovery also has the potential to address national and global resource depletion (UNEP 2015). Waste needs to be viewed as a resource that should be incorporated into the human development agenda and urban development in African countries.

1.4 Solid waste management – A priority for African countries

Developed countries have succeeded in establishing higher treatment and recovery intensity and diverting a larger proportion of municipal waste away from landfill than developing countries. This has been driven by a combination of policies (regulatory, financial and economic) coupled with specific local market factors (Soos 2017). A number of waste management challenges for African countries have been highlighted here and will be discussed in detail in the following chapters. These challenges can be overcome by making solid waste management a political priority in the development agenda of African countries.

2 Background, Definitions, Concepts and Indicators

2 Background, Definitions, Concepts and Indicators

What the reader can expect

Chapter 2 provides insights into the Africa Waste Management Outlook, which provides the first comprehensive analysis of waste management on the African continent, including challenges and opportunities. It aims to make the cogent case that sound waste management is essential and politically expedient for ensuring public health and environmental protection, the benefits of which are likely to outweigh the costs of inaction for African countries. The definition of "waste" used in this regional outlook is aligned with that used in the Global Waste Management Outlook and the Basel Convention. While the focus of the Africa WMO is largely on municipal solid waste, other problematic general and hazardous waste streams emerging as wastes of concern for Africa are also addressed. These include electronic waste, used lead acid batteries and marine litter, especially plastics. The waste management hierarchy has been adopted as an analytical framework for waste management; hence many of the chapters of the Africa WMO are structured around the categories of the hierarchy, from prevention to final disposal.

Key messages

The following are the key messages regarding background, definitions, concepts and indicators:

- A multi-stakeholder participatory approach in the development of the Africa WMO, patterned against the Global Waste Management Outlook (GWMO), resulted in the identification of three additional chapters that were considered important for the African context.
- One of the limitations of the Africa WMO is the lack of reliable, comprehensive and up-to-date waste data for Africa, which is a constraint to effective waste management on the continent.
- Another limitation is the scarcity of empirical data on the impacts of unsound waste management (e.g. exposure to hazardous substances) on human health and receiving environments. Of particular concern are the risks to a large informal waste sector.
- It is difficult to develop performance indicators for waste management in Africa in a vacuum of waste-related data. The lack of data may be sequel to the fact that data on waste generation and disposal has not been recognized by the public and private sectors as valuable in waste planning and management.
- As definitions of "municipal solid waste" vary between countries, it is important to establish at the outset how MSW is considered by the authors. For the purposes of the Africa WMO, the authors have adopted the definition of MSW used by the United Nations Human Settlements Programme (UN-Habitat).
- The diversity of actors in the waste sector in Africa also requires that the Africa WMO include both the public and private sectors, and the formal and informal sectors.

2.1 An overview of the Africa Waste Management Outlook

2.1.1 Aims and objectives

The Africa WMO provides the first comprehensive analysis of waste management on the African continent. It forms part of a series of regional waste management outlooks prepared by the United Nations Environment Programme (UNEP). These regional outlooks stem from the GWMO, which provided a comprehensive global overview of the state of waste management around the world (UNEP 2015).

Acknowledging waste management as a political priority for Africa (**chapter 1**), the Africa WMO explores the current *drivers* of and *pressures* on waste generation in Africa. It attempts to quantify the *state* of waste generation, recycling and disposal on the continent and the associated *impacts* of poor waste management on human health and the environment (**chapters 3, 4 and 5**). In line with international trends, the Africa WMO unpacks the socio-economic opportunities of waste-to-wealth and employment creation and poverty alleviation in Africa, recognizing the critical role of the informal sector in the waste management value chain (**chapter 6**). Finally, delving into the appropriateness of social and technological innovation for Africa (**chapter 7**) and the financing of waste management infrastructure investment (**chapter 8**), the Africa WMO provides a *response* of proposed solutions and recommendations to address the waste management challenges facing Africa (**chapter 9**).

The Africa WMO aims to make the cogent case that sound waste management is much more than merely desirable, it is absolutely essential and politically expedient for ensuring public health and environmental protection. While limited findings exist for Africa, global insights show that the cost of inaction of poor waste management is significant. By recognizing waste management as a significant contributor to sustainable development and climate change mitigation, the benefits of correctly managing waste now are likely to outweigh the costs of inaction for African countries.

In light of this, the outlook recognizes the role of analytical frameworks such as integrated sustainable waste management (ISWM) and various assessment tools such as cost benefit analysis (CBA), environmental impact assessment (EIA) and life-cycle analysis (LCA) in the effective management of end-of-life products, to prevent and minimize waste and transit to a circular economy.

2.1.2 The development process

The Africa WMO has been developed through a multi-stakeholder process. An editorial team of seven lead authors with considerable experience across the continent was identified by the UNEP Regional Office for Africa. A preparatory workshop consisting of the co-ordinating lead author (editor) and lead authors, the UN Environment Regional Office for Africa (Nairobi), the UNEP International Environmental Technology Centre (UN Environment IETC) (Osaka, Japan), the United Nations Office for Project Services (Nairobi), the Climate and Clean Air Coalition, and international development partners from UN-Habitat took place in Nairobi from 22–24 February 2016.

Through a participatory process, the workshop participants identified a number of waste issues and challenges perceived as significant for the continent, including a number of emerging issues. These issues were clustered, discussed and mapped against the structure of the GWMO. The participants considered this important, both to ensure consistency of approach between the outlooks and to allow the Africa WMO to build on the global understanding of waste through a regional lens. **Table 2.1** provides a comparison of the themes addressed by the GWMO and Africa WMO.

Table 2.1 Comparison of themes addressed by the Global Waste Management Outlook and the Africa Waste Management Outlook

Global Waste Management Outlook	Africa Waste Management Outlook
1 Waste management as a political priority	1 Waste management as a political priority
2 Background, definitions, concepts and indicators	2 Background, definitions, concepts and indicators
3 Waste management: Global status	3 State of waste in Africa
4 Waste governance	4 Waste governance
–	5 Impacts of waste in Africa
–	6 Waste as resource, unlocking opportunities
–	7 Appropriate solutions for Africa
5 Waste management financing	8 Waste management financing
6 Global waste management – way forward	9 Africa waste management – way forward

Based on the waste priorities identified for Africa, three new chapters considered important for the African context were added. These include chapter 5, which summarizes the impacts of solid waste on human health and receiving environments; chapter 6, which recognizes waste as a secondary resource that provides socio-economic opportunities for the continent; and chapter 7, which explores the appropriateness of technologies for Africa, including social and technological innovation. In this way, the Africa WMO provides a storyline of the challenges and opportunities of solid waste management in Africa.

2.1.3 Limitations of the Africa Waste Management Outlook

Every author contributing to the Africa WMO has highlighted the lack of reliable, comprehensive and up-to-date waste data for Africa, at a local, national and regional scale. This lack of data significantly hampered the authors' ability to present the current state of waste management in Africa. The lack of waste data is not a new issue, however. Reports on waste management in Africa consistently cite the lack of data and information as a constraint for effective waste management (Achankeng 2003, Godfrey and Nahman 2007, Mwesigye *et al*. 2009). The lack of comprehensive data is further compounded by different approaches to data collection (DEA 2012). This raises the question: If this issue has been recognized for at least the past two decades, why have adequate measures not been put in place to ensure the generation and reporting of reliable, comprehensive waste data for Africa? Practical recommendations for addressing the waste data void in Africa are further discussed in **section 2.3.2**.

One of the main methods of capturing empirical waste data is by recording the tonnes of waste disposed of to landfill. As will be pointed out in chapter 3, much of Africa's waste is disposed of in uncontrolled dumpsites. Most of these sites do not have weighbridges, with the result that no accurate disposal tonnages are recorded. Recycling systems in Africa are often informal, as discussed in **chapters 3 and 6**, with little to no accurate information being captured on tonnages recycled. Where data is collected, it is not consolidated in central repositories. In the absence of weighing, practitioners are forced to model waste generation tonnages based on population, per capita waste generation, GDP growth, etc. This has been the case for the Africa WMO, which is based heavily on modelled data.

Scientifically proven relationships between waste and environmental and human health impacts are also difficult to source for Africa. The scarcity of data on human health risks related to exposure to hazardous substances in waste and on environmental pollution arising from unsound waste management, especially for the informal sector, is noted by Osibanjo *et al.* (2016).

2.2 Defining the scope and coverage of the Africa Waste Management Outlook

2.2.1 What does the Africa Waste Management Outlook mean by waste?

In the absence of a single definition or unified understanding of waste, the Africa WMO endorses the GWMO's standpoint that waste is a broad concept with multiple definitions and meanings, depending on the respondent answering the "*What is waste*?" question. In simplest terms, "*waste*" may be considered as "*stuff people throw away*", having little economic value (UNEP 2015). The definition of waste in the Basel Convention, the only global convention on waste, has been adopted in this document. The Basel Convention defines "waste" as "*substances or objects which are disposed of or are intended to be disposed of, or are required to be disposed of by the provisions of national law*" (UNEP 1989). This includes "*substances or objects which are subject to disposal operations which either lead to or do not lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses*" (UNEP 2015:22). Where it exists, national waste legislation in African countries is generally piece meal, not comprehensive and holistic, and does not cover waste of high risk to human health and the environment (Babayemi *et al*. 2016).

2.2.2 The progression of waste disposal

Terms such as "*open dumping*", "*uncontrolled dumping*", "*controlled dumping*", "*controlled disposal*" and "*sanitary engineered landfilling*" are used throughout this Africa WMO. For the purposes of clarity, the various terms as used in the context of this document are defined in **Table 2.2**. The International Solid Waste Association definition of "open dumping", as used in the key-issue paper on "Closing of open dumps", has been adopted (ISWA 2016).

Table 2.2 Definitions of terms used in the African Waste Management Outlook

Fly-tipping or "indiscriminate" dumping	Open or uncontrolled dumping	Controlled disposal	Sanitary engineered landfilling
Waste is deliberately, often illegally, dumped in open spaces in cities, towns, rural areas or, rivers	Waste is indiscriminately deposited at a designated site with either no, or at best very limited measures to control the operation and to protect the surrounding environment	Waste is deposited at a designated site, which has access control, cover and compaction, but no liners, leachate collection systems, etc.	Waste is deposited in an engineered, controlled facility, designed and operated to minimize impacts. Includes, e.g. liners, leachate collection systems, and landfill gas recovery

Progression in the management of waste →

2.2.3 Scope of Africa Waste Management Outlook

The scope of the Africa WMO, or the “system boundary” for what each chapter has considered, is summarized in **Table 2.3**. As in the case of the GWMO, the Africa WMO promotes the pragmatic view of waste as a “*resource*”, espousing a paradigm shift from a linear to a circular economy, by designing waste out of the system (prevention) and keeping resources in circulation (material flows) for as long as possible through reuse, repair, refurbishment, recycling and recovery of end-of-life products, and at the same time ensuring a solid foundation of good city cleansing and safe disposal of residual waste to sanitary engineered landfills.

The focus of the Africa WMO is largely on MSW, although chapters do address other problematic general and hazardous waste streams emerging as wastes of concern for Africa. These include e-waste, used lead acid batteries (ULAB) and marine litter, of particular relevance to coastal countries and small island developing States (SIDS) (see **chapters 3 and 5**). As definitions of MSW vary between countries, it is important to establish at the outset how MSW is considered by the authors. For the purposes of the Africa WMO, the authors have adopted the definition of MSW used by UN-Habitat (2010:6) which is “*wastes generated by households, and wastes of a similar nature generated by commercial and industrial premises, by institutions such as schools, hospitals, care homes and prisons, and from public spaces such as streets, markets, slaughter houses, public toilets, bus stops, parks, and gardens’. This working definition includes most commercial and business wastes as municipal solid waste, with the exception of industrial process and other hazardous wastes.*”

Given the challenges facing Africa, especially with regard to uncontrolled dumping, and the opportunities provided by bulky waste streams, it is necessary to include general commercial and industrial waste; construction and demolition waste; and organic waste streams, such as food waste, the organic fraction MSW, and agricultural and forestry wastes within the scope. The diversity of actors in the waste sector in Africa also requires that the Africa WMO include both the public and private, and the formal and informal, sectors (**Table 2.3**).

2.2.4 Geographical Scope of the Africa Waste Management Outlook

The Africa WMO focuses on solid waste management (SWM) on the Africa continent, including associated SIDS, although these are covered in more detail in the SIDS Waste Management Outlook. The Africa WMO presents data for both North Africa and sub-Saharan Africa; however, as noted by Hoornweg and Bhada-Tata (2012:8), “*data are particularly lacking for Sub-Saharan Africa.*” Where North Africa data is available, it is often part of the combined data for the Middle East and North Africa (MENA) region, making it difficult to extract only North Africa data.

The Africa WMO addresses waste management primarily at the local (city), regional and national levels. As most waste is generated in or near cities, and waste presents greater public health and environmental risks when in proximity to people, as in cities (UNEP 2015), urban areas are prioritized for focus in the Africa WMO.

Table 2.3 Scope of the Africa Waste Management Outlook: Setting the 'system boundary'

No.	Category	Main focus within the Africa WMO	Also considered	Outside the scope
1	**Receiving environmental media**	Air, water and soil, but with a focus on "solid waste" to land	Ecosystems and biodiversity	Gaseous emissions to air and wastewater discharges
2	**Waste as a resource**	Scope includes waste prevention, reduction, reuse, recycling and recovery	Related aspects of sustainable consumption and production	N/A
3	**'Source' of waste**	Some focus on MSW, including waste from households and smaller businesses and institutions Commercial and industrial (C&I) waste, and construction and demolition (C&D) waste, from larger waste generators	Agricultural and forestry (A&F) wastes	N/A
4	**Responsibility for waste**		Public and private waste sector	
5	**Types of waste**	Non-hazardous waste (general waste) and hazardous wastes (including hazardous health care and household hazardous wastes)	e-waste, ULAB, nano-waste, contaminated soil, post disaster waste, marine litter, obsolete stocks of POPs and containers	N/A
6	**Specific types of waste**	MSW (including mainline recyclables: paper, plastics, glass, metal), e-waste, ULAB, tyres, food waste, obsolete POPs and other agricultural wastes, disaster wastes, marine litter	Emerging waste streams, such as nano- and micro- wastes	Radioactive (nuclear) waste
7	**Public and private sectors**	Waste managed by both public and private sector operators. Private sector includes: waste generators, producers and distributors, waste industry, industrial value chain recyclers and agricultural value chain	N/A	N/A
8	**Formal and informal sectors**	Both formal and informal sectors, including both waste management and recycling	N/A	N/A
9	**Geographical scope**	Urban waste on the African continent Considers the local, regional and national levels, with a primary focus on national policy. Local and global markets for materials for recycling	Waste generated in rural areas	N/A

Key : N/A = Not Applicable

2.3 An analytical framework for the Africa Waste Management Outlook

The Africa WMO promotes the transition from waste management to resource management, which fits with the thinking of an integrated waste management system, taking into consideration the environmental, social and economic costs and benefits (McDougall *et al*. 2001). Many of the chapters of the Africa WMO are structured around the categories of the waste management hierarchy, from prevention to final disposal. While its limitations are recognized, the waste management hierarchy provides a useful framework for structuring the discussions on the state of waste management in Africa and the appropriate alternative waste treatment technologies to support the increased diversion of waste away from landfill towards prevention, reuse, recycling and recovery.

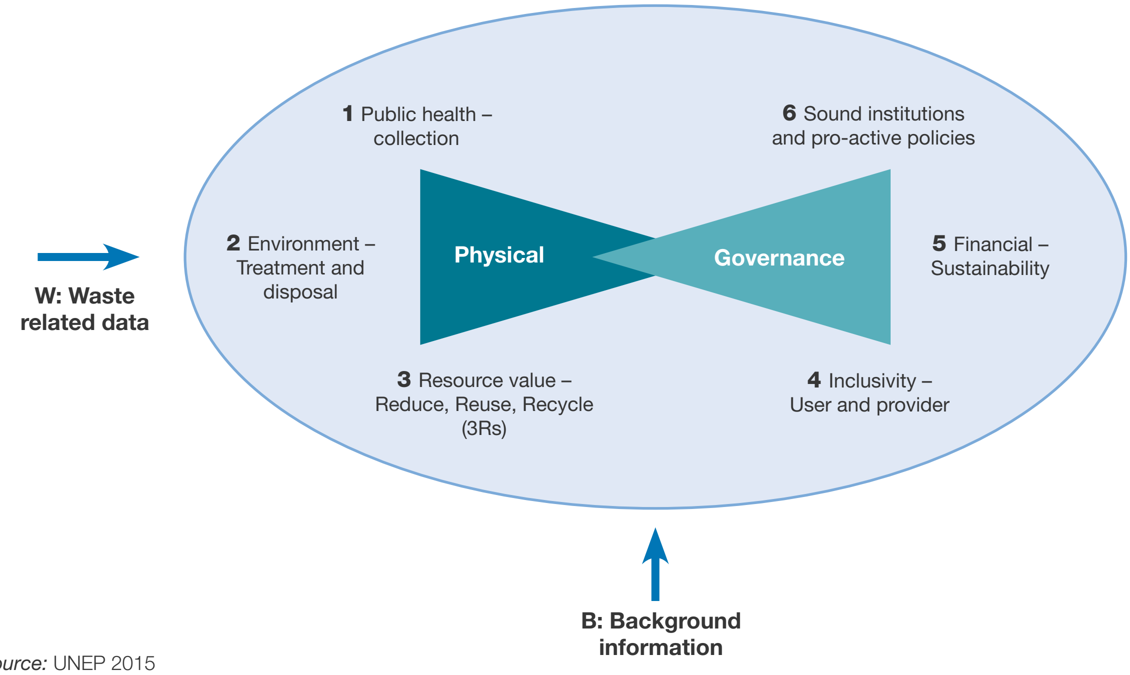
Tools such as LCA, EIA, CBA, and risk assessment are also applied in waste management, but still to a limited extent in Africa. These are all useful tools whose application needs to be strengthened in Africa; however, this will require further skills development and the generation of Africa-specific datasets as input to ensure that outcomes are relevant to Africa.

2.3.1 Integrated sustainable waste management

Recognizing that establishing an integrated sustainable waste management system is complex, the GWMO suggests that for such a system to be sustainable in the long-term, the following three elements must be considered individually and collectively, in an integrated manner: (i) infrastructure, (ii) all the stakeholders involved and (iii) all the strategic aspects, including the political, health, institutional, social, economic, financial, environmental and technical facets (UNEP 2015).

The term "*integrated waste management*" has been widely used, but often refers only to integration across the physical elements. ISWM systems that explicitly bring all three dimensions together are gradually becoming the norm in the discussion of solid waste management in developing countries (Davidson 2011). In the Africa WMO, the primary analytical framework used is a simplified form of ISWM, first developed for the UN-Habitat "*Solid Waste Management in the World's Cities*" (2010) publication, and adopted by the GWMO (UNEP 2015). This is shown schematically in **Figure 2.1** as two overlapping triangles that explicitly bring together all three dimensions.

Figure 2.1. The integrated sustainable waste management framework



Source: UNEP 2015

2.3.2 Waste-related data and indicators

Indicators are essential tools for tracking environmental progress and performance of environmental infrastructure, monitoring data flow, supporting policy evaluation or governmental decisions, driving investments and industry strategy, and informing the public (UNEP 2012). However, when it comes to waste generation, recycling or disposal, the underlying data sets that should populate indicators are difficult to obtain, and are virtually non-existent in Africa. Three globally agreed indicators are: (i) quantity and types of waste managed or finally disposed of; (ii) waste generation per capita; and (iii) amount of waste recycled (UNEP 2012). These indicators are meant to help Governments, municipalities and industry measure performance and progress in improving the waste situation.

It is difficult to develop performance indicators for waste in Africa in a vacuum of waste-related data. Data on waste generation and disposal has not been recognized by the public and private sectors as valuable in waste planning and management. Valuable materials such as scrap metals (e.g. aluminium, iron, copper) recovered from waste are roughly weighed for their economic and market value, largely by buy-back centres or recyclers. It is therefore urgent to mandate stakeholders to create the infrastructure needed to record waste flows (e.g. weighbridges at landfills, scales at recyclers), establish waste information systems to support national planning purposes and assess the performance of waste management systems. Since waste generation is forecast to double by 2025 (Mwesigye *et al.* 2009), it is crucial to deal with the waste data vacuum so that meaningful plans can be made to effectively manage the anticipated increase in volume of waste.

Furthermore, because waste is now seen as a potential resource, waste data and indicators should be more closely linked to economic and social information systems and material flow accounting. The measurability issue is critical to assessing waste generation (municipal, industrial, agricultural, mining, radioactive, etc.). Data on transboundary movements of hazardous waste are not readily available from the Secretariat of the Basel Convention (SBC) because many African countries do not submit annual returns on hazardous waste to the secretariat. UNEP has developed a training manual on waste data collection that provides a ready-made tool for capacity-building to bridge the waste-data gap on the Africa continent (UNEP 2009).

3 State of solid waste management in Africa

3 State of solid waste management in Africa

What the reader can expect

Chapter 3 presents the state of solid waste generation and management across the African continent. The focus of this chapter is on the quantity of waste generated and its characteristics, waste delivery services, and waste infrastructure, in formal, informal and rural settlements. Emerging issues associated with solid waste and its management are also discussed. Solid waste data for countries and cities are examined and narrated, and relevant case studies and topics sheets are presented. The spatial distribution of solid waste across the continent is mapped and important conclusions and recommendations drawn for future consideration. Although the initial intent behind the Africa WMO was to also produce city and country factsheets, this was not possible owing to a lack of data.

Key messages

The following are the key messages regarding the state of solid waste management in Africa:

- Data on the amount, source and type of solid waste is very important for sound planning and monitoring of waste services and infrastructure, and in the management of waste across the hierarchy.
- The total MSW generated in Africa (in 2012) was estimated to be 125 million tonnes per year, of which 81 million tonnes (65 per cent) was from sub-Saharan Africa. Waste generation in Africa is projected to grow to 244 million tonnes per year by 2025.
- The average MSW generation in Africa (in 2012) was estimated to be 0.78 kg per capita per day, which is much lower than the global average of 1.2 kg per capita per day. However, there is a sizable variation across the continent, ranging from 0.09 kg per capita per day to 3.01 kg per capita per day, owing to differences in such things as waste accounting, consumer attitude, income level and culture. MSW generation in Africa is projected to increase to 0.99 kg per capita per day by 2025, 1.27 times higher than in 2012.
- The average composition of MSW in Africa (sub-Saharan Africa) is about 57 per cent organic, 9 per cent paper/cardboard, 13 per cent plastic, 4 per cent glass, 4 per cent metal and 13 per cent other materials. The higher organic content relative to paper and packaging is typical of MSW in developing countries. However, the composition of MSW in Africa does vary from place to place, depending on consumer attitude, income level, culture, etc.
- While per capita waste generation in African cities is generally among the lowest in the world, the

Key messages (continued)

demand for waste services is still not matched by the supply. The largest part of the budget for solid waste management in developing countries goes to waste collection, yet total waste collected in Africa (in 2012) was only 55 per cent of total waste generated (68 million tonnes). The average MSW collection rate in sub-Saharan Africa was 44 per cent, although the coverage varies considerably between cities, from less than 20 per cent to well above 90 per cent. The situation is much worse in rural areas. The average MSW collection rate for the continent is expected to increase to 69 per cent by 2025.

- Good waste collection and transport services are often only found in the city centres, while services in suburbs are usually poor. In urban centres, door-to-door waste collection is the most common practice. Traditionally, waste collection services are provided by the public and private sectors, such as municipalities or private contractors. However, the role of the informal sector and community-based organizations (CBOs) in waste collection is equally important in many African countries.
- Uncontrolled and controlled dumping are the most common waste disposal practices in Africa. The waste in open dumps is left untreated, uncovered and unsegregated, with little to no groundwater protection or leachate recovery. However, the number of cities shifting from uncontrolled disposal to sanitary landfills is increasing.
- There is a lack of knowledge about waste re-cycling and associated opportunities. In general, waste recycling is not a priority for most munici-palities. The average MSW recycling rate in Africa is estimated at only 4 per cent. Recycling is commonly done by waste recycling businesses, supported by a large, and active, informal sector that includes itinerant buyers and waste pickers.
- Current waste management systems in Africa will be challenged as populations and economies grow, consumer patterns change and populations move from rural to urban areas (**see chapter 1**).
- Cheap and substandard products are increasingly being imported into African countries leading to new and emerging waste streams. The amount and types of hazardous waste are also increasing, with little awareness of its nature or management.
- There is a need for more comprehensive, better quality data on the amount, sources, types and composition of wastes generated in Africa, which should be shared among member countries.
- Waste management services and infrastructure in Africa should be carefully chosen in terms of their sustainability.
- Gender should be mainstreamed in waste man-agement strategies and policies.

3.1 Municipal solid waste

3.1.1 Generation and composition

Generation

The data presented in the following sections is based on the best available comprehensive data for Africa. The spatial distribution of MSW generation in African countries (**Figure 3.1**) was mapped based on data drawn from the World Bank (Hoornweg and Bhada-Tata 2012) and Scarlat *et al*. (2015)[1]. Most of the World Bank data was gathered prior to 2009. Where data was not available, a 0.5 kg per capita per day urban waste generation rate was assumed for the reference year 2005 (Hoornweg and Bhada-Tata 2012). Scarlat *et al*. (2015) used the World Bank data to estimate waste generation in Africa by using 2012 population data. For some countries, the solid waste data was generated by extrapolation from neighbouring countries, with some adjustment for national income differences.

The estimations focus on solid waste generation in urban areas in Africa, as data for rural waste generation and management in Africa is almost non-existent. It is generally assumed that per capita waste generation in rural areas is lower than in urban areas owing, for example, to lower purchasing power, higher rates of waste reuse, and lower household consumption patterns.

The total MSW generated in Africa (in 2012) was estimated to be 125.0 million tonnes a year, of which 81.0 million tonnes was from sub-Saharan Africa (Scarlat *et al*. 2015). North African countries have a relatively higher per capita waste generation than sub-Saharan countries (**Figure 3.1A**).

The average per capita waste generation in Africa in 2012 was 0.78 kg per day, which is much lower than the global average of 1.24 kg per day (Scarlat *et al*. 2015). However, there are considerable spatial differences in the amount of waste generated (**Figure 3.1A**), which range from as low as 0.09 kg per day (Ghana) to as high as 2.98 kg per day (Seychelles). High per capita waste generation rates are common among small-island States, often owing to high levels of tourism and better waste accounting (Hoornweg and Bhada-Tata 2012). Significant differences in MSW generation (tonnes per day) are also evident across Africa (**Figure 3.2A**). South Africa, Egypt and Nigeria, in particular, stand out as "*hot spots*" of MSW generation on the continent, with estimated MSW generation of 23.21, 18.35 and 17.45 million tonnes per annum, respectively (Scarlat *et al.* 2015).

Figure 3.1 Spatial distribution of daily per capita waste generation of African countries in 2012 (A) and 2025 (B)[2]

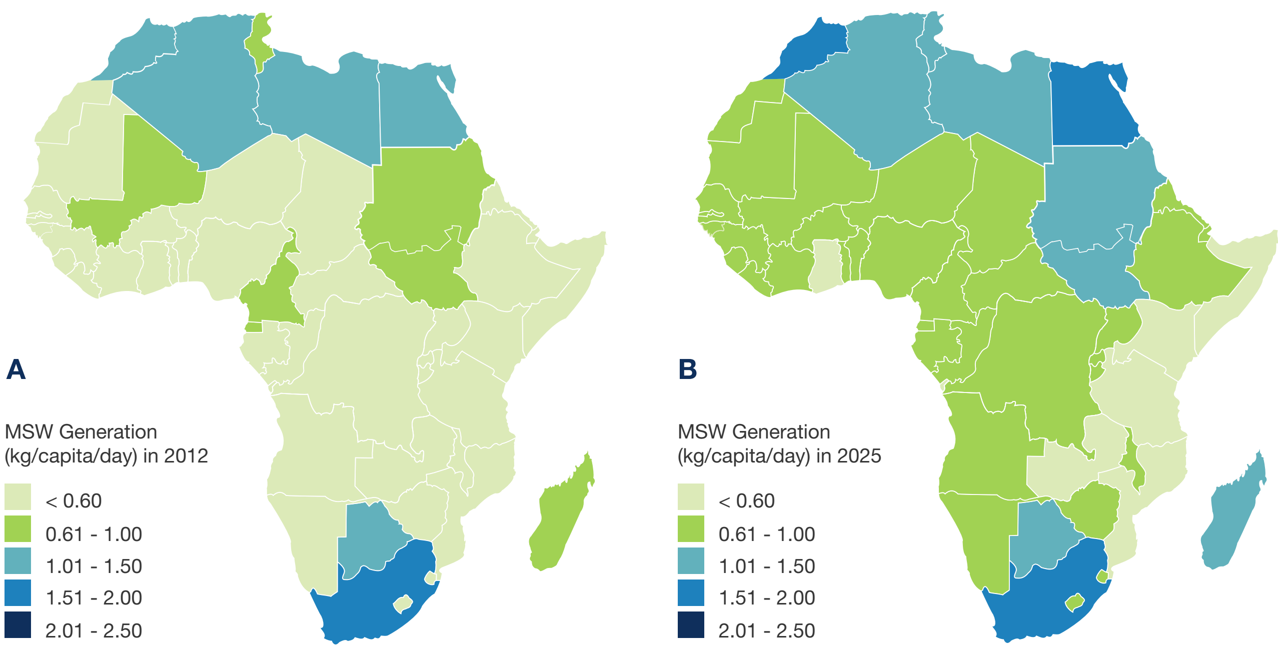
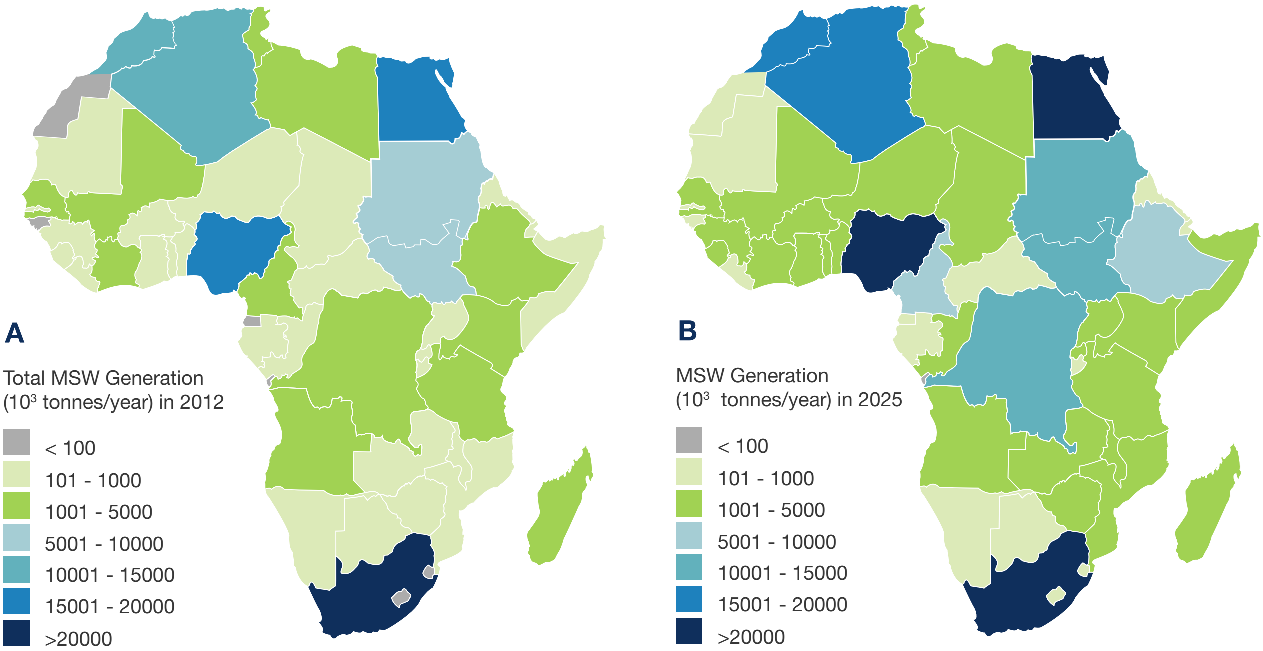
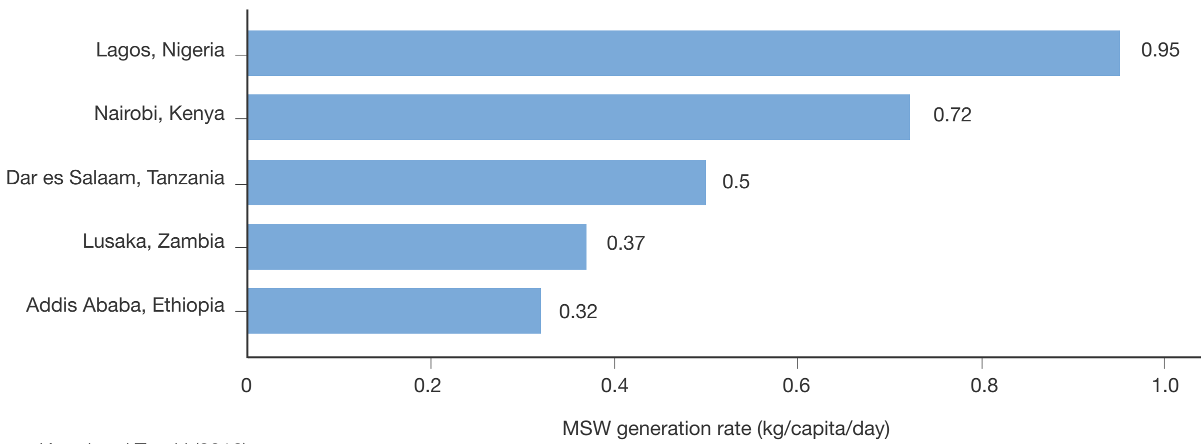


Figure 3.2 Total MSW generation (10^3 tonnes/year) of African countries in 2012 (A) and 2025 (B)[3]



As shown in **Figure 3.3** the MSW generation rate can also vary considerably among cities in Africa, from as low as 0.32 kg per capita per day for Addis Ababa, Ethiopia, to 0.95 kg per capita per day in Lagos, Nigeria (Kawai and Tasaki 2016). Differences in such things as waste accounting, consumer attitude, income level and culture, are some of the major factors for city and country variations in waste generation. There are also variations in the information gathered from different sources owing to differences in definitions and underlying assumptions.

Figure 3.3 Quantity of MSW generated in various African cities



Source: Kawai and Tasaki (2016)

1 Scarlat *et al*. (2015) have built on the MSW generation data of the World Bank (Hoornweg and Bhada-Tata 2012) by including data for more countries in Africa. The data has been used to re-calculate the MSW generation in 2012 and 2025. The projected values for 2025 are the same for both Scarlat *et al*. (2015) and the World Bank (Hoornweg and Bhada-Tata 2012).

2 Spatial distribution of per capita waste generation mapped in ArcGIS 10 based on country data obtained from Hoornweg and Bhada-Tata (2012) and Scarlat *et al*. (2015)

3 Total MSW generation (tonnes/day) of African countries in ArcGIS 10 based on country data obtained from Hoornweg and Bhada-Tata (2012) and Scarlat *et al*. (2015)

Table 3.1 Types and sources of waste

Type	Sources
Organic	Food scraps, yard (leaves, grass, brush) waste, wood, process residues
Paper	Paper scraps, cardboard, newspapers, magazines, bags, boxes, wrapping paper, telephone books, shredded paper, paper beverage cups
Plastic	Bottles, packaging, containers, bags, lids, cups
Glass	Bottles, broken glassware, light bulbs, coloured glass
Metal	Cans, foil, tins, non-hazardous aerosol cans, appliances (white goods), railings, bicycles
Others	Textiles, leather, rubber, multi-laminates, e-waste, appliances, ash, other inert materials

Source: Hoornweg and Bhada-Tata (2012)

Composition

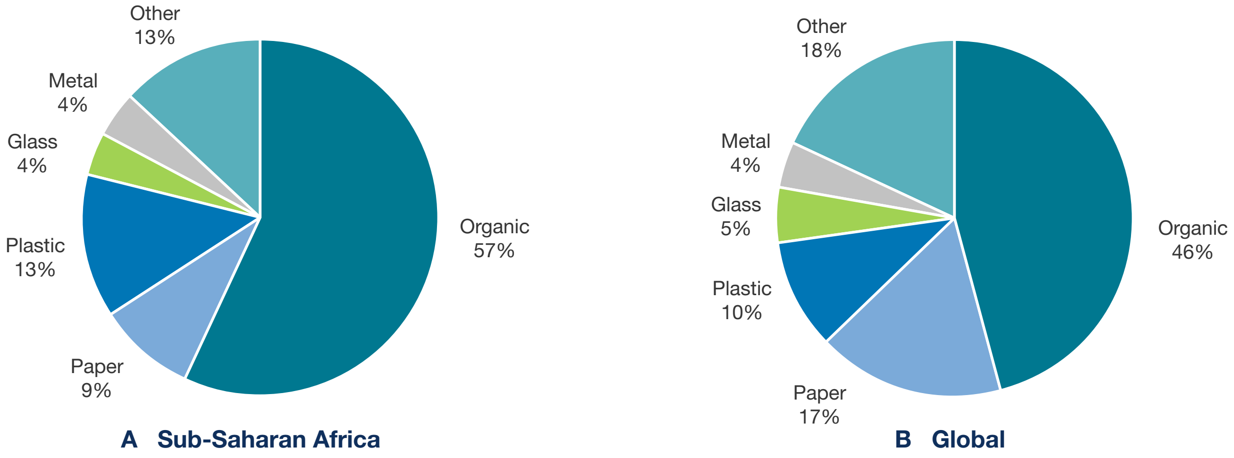
The composition of waste has direct implications for how it is collected and disposed of (Hoornweg and Bhada-Tata 2012). The composition of MSW is commonly expressed in terms of the proportion of organic, paper, plastic, glass, metal and other materials (**Table 3.1**) (Hoornweg and Bhada-Tata 2012).

According to the World Bank (Hoornweg and Bhada-Tata 2012), organic waste constitutes 57 per cent of the total MSW generated in sub-Saharan Africa (**Figure 3.4**), considerably higher than its proportion of the total global MSW (relative to the other waste streams). Plastic as a percentage of MSW for sub-Saharan Africa is also higher than the global average, at 13 per cent.

The composition of MSW varies among cities depending on consumer attitude, income level and culture, among other things. The data compiled for 11 African cities (**Table 3.2**) show an average of over 60 per cent organic waste in the total MSW, with considerable variation among cities. Waste generated in low- and middle-income cities has a large proportion of organic waste owing mainly to the preparation of fresh food, whereas waste in high-income cities is more diversified, with relatively larger shares of paper and packaging, including plastics (Hoornweg and Bhada-Tata 2012). Although plastic waste in cities constitutes less than 10 per cent of MSW on average (**Table 3.2**), it is a noticeable pollutant in Africa (**see chapter 5**).

The generally high percentage of organic waste means that MSW generated in Africa has a high moisture content, which has a direct bearing on the management of the waste, the potential environmental impacts of the waste when disposed of to landfill (**see chapter 5**), and the appropriateness of alternative waste treatment technologies adopted in Africa (**see chapter 7**).

Figure 3.4 MSW composition, sub-Saharan Africa and global



Source: Hoornweg and Bhada-Tata (2012)

Table 3.2 MSW composition for selected African cities

City	Composition (percentage)						
	Organic	Paper/ card-board	Plastic	Glass	Metal	Others	Reference
Kampala, Uganda	77.2	8.3	9.5	1.3	0.3	3.4	Bello *et al*. (2016)
Dar es Salaam, Tanzania	71.0	9.0	9.0	4.0	3.0	4.0	Bello *et al*. (2016)
Ibadan, Nigeria	69.6	7.67	4.47	2.00	1.65	14.6	Adeyi & Adeyemi (in press)
Accra, Ghana	65.0	6.0	3.5	3.0	2.5	20.0	Oteng-Ababio *et al*. (2013)
Moshi, Tanzania	65.0	9.0	9.0	3.0	2.0	12.0	Bello *et al*. (2016)
Sousse, Tunisia	65.0	9.0	9.0	3.0	2.0	11.0	UN-Habitat (2010)
Nairobi, Kenya	65.0	6.0	12.0	2.0	1.0	15.0	UN-Habitat (2010)
Lagos, Nigeria	62.6	10.7	4.2	2.5	2.2	19.7	Adeyi & Adeyemi (in press)
Abuja, Nigeria	56.3	11.4	10.2	3.9	5.2	N/A	Imam *et al*. (2008)
Cairo, Egypt	55.0	18.0	8.0	3.0	4.0	12.0	UN-Habitat (2010)
Tshwane, South Africa	53.8	11.5	9.5	6.7	1.8	16.7	Komen *et al*. (2016)
Windhoek, Namibia	48.0	15.0	11.0	14.0	4.0	8.0	Hartz & Smith (2008)
Average	**62.8**	**10.1**	**8.3**	**4.0**	**2.5**	**12.4**	

Abbreviation: N/A, not available

CASE STUDY 1

INTEGRATED ORGANIC WASTE MANAGEMENT: CASE OF LOKOSSA, BENIN

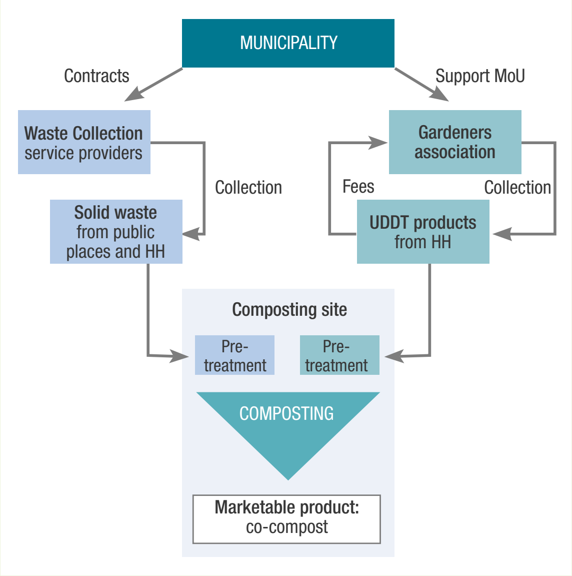
Lokossa is the capital city of Mono Department in southwest Benin, with a population of 77,065. Commissioned by the German Federal Ministry for Economic Cooperation and Development, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), organised a pilot project in Lokossa in 2011 to identify and explore new possibilities for jointly managing compostable organic waste from markets and households, and human waste from urine-diverting dry toilets (UDDT), through co-composting (GIZ 2015).

Door-to-door solid waste collection was contracted to local non-governmental organizations (NGOs) and tax-exempt small enterprises, while the municipality was responsible for collecting the market waste and managing the secondary collection. Part of the collected waste was delivered to a composting site where the compostable waste was separated. The non-compostable waste was then transported to the municipal dumpsite. The sanitation system was set up from scratch, as only 20 per cent of households had latrines. Because nearly 50 per cent of the population did not have access to sanitation facilities, the practice of open defecation in public and empty spaces was widespread. To that end, the pilot project financed and built 28 household UDDT and one public UDDT facility in the town hall courtyard.

UDDTs collect faeces and urine separately, with little water required for flushing. When the faeces chamber is full, it is opened to allow moisture to evaporate, after which the faeces is emptied into a drying chamber for sanitization and further drying. The urine containers are also exposed to sun for sanitization. The faeces and urine was collected, transported and pre-treated by a gardener's association (Figure 1) formed on the municipality's initiative. The association comprised of eight local market gardeners with experience in using manure. The pre-treated dried faeces and compostable solid waste fraction was then piled into windrows at the composting site. The moisture content of the windrow was controlled by the addition of the sanitized urine and rain water, and was aerated regularly to enhance aerobic digestion. The composting process took about six months. The matured compost was sieved and packaged for sale. Lab analysis showed that the quality of the compost produced by the association was good, and a survey showed high customer satisfaction. The association received initial support in the form of training and equipment from all project partners.

The association financed its operation through the sale of the compost and the human waste collection fees. Demand for compost is high in the Bono region, partly owing to the promotion efforts of GIZ on the benefits of using compost as a soil conditioner, through local radio broadcasts and site visits to the composting plant and demonstration site. The pilot project demonstrated that novel approaches are available for the concurrent management of human waste and the organic fraction municipal solid waste and, for achieving resource efficiency through the reuse of organic matter in farming.

Figure 1 Structure of the collection and treatment operation



Source: GIZ (2015)

3.1.2 Services and infrastructure

In most African countries, the state or municipality is responsible for providing waste services and infrastructure. Municipalities often do not have the technical or financial capacity to provide efficient services to all residents, with public waste management services frequently characterized as inefficient and expensive (McAllister 2015). The private sector is often better placed than municipalities to provide services and infrastructures at a lower cost (Imam *et al*. 2008), but typically only to those able to pay for the service. In many African cities, municipalities have partnered with the private sector or CBOs to render more inclusive, cost-effective and efficient waste services, resulting in improved solid waste collection (Bello *et al.* 2016). Hence, the role of municipalities is shifting gradually from service operation to service management (Le Courtois 2012).

Usually, a number of actors are involved in waste collection and transfer services, including the municipality, the informal sector, resident associations, and CBOs and NGOs, often with strong participation of women. **Table 3.3** shows the waste delivery models in three African cities. The undefined roles, mandates and boundaries among the actors can pose challenges, however, resulting in resource duplication and lack of leadership and ownership.

In low- and middle-income countries, solid waste management can be a city's single largest budgetary item, with most cities in developing countries spending 20 to 50 per cent of their annual municipal budget on MSW management (Dukhan *et al.* 2012, Kubanza and Simatele 2015), of which 50–90 per cent can go to waste collection alone (Hoornweg and Bhada-Tata 2012). Non-payment of waste services by residents and businesses therefore has a direct impact on a municipality's ability to render services. According to UN-Habitat (2010), less than half of residents in African cities pay for waste services. Examples of payment levels for waste services include – Cameroon (10 per cent) Moshi, Tanzania (35 per cent) and Nairobi, Kenya (45 per cent).

Women and men have different perceptions of waste use and disposal, and willingness to pay for waste services. According to Adebo and Ajewole (2012), in Ekiti-State, Nigeria, women are more willing than men to pay for waste disposal services. Thus, policies and strategies for improving waste services should consider gender differences.

Table 3.3 Basic waste service delivery models in selected cities in Africa

Country	Sweeping	Collection and transfer	Recycling	Treatment	Disposal
Maputo (Mozambique)	Municipality	Private sector and municipality	Private sector	N/A	Municipality
Ouagadougou, (Burkina Faso)	Private sector under municipal control	Private sector and municipality	Private sector and municipality	Municipality	Municipality
Qena (Egypt)	Municipality	Private sector and municipality	Private sector and municipality	N/A	Municipality

Source: GIZ (2014)

3.1.3 Collection

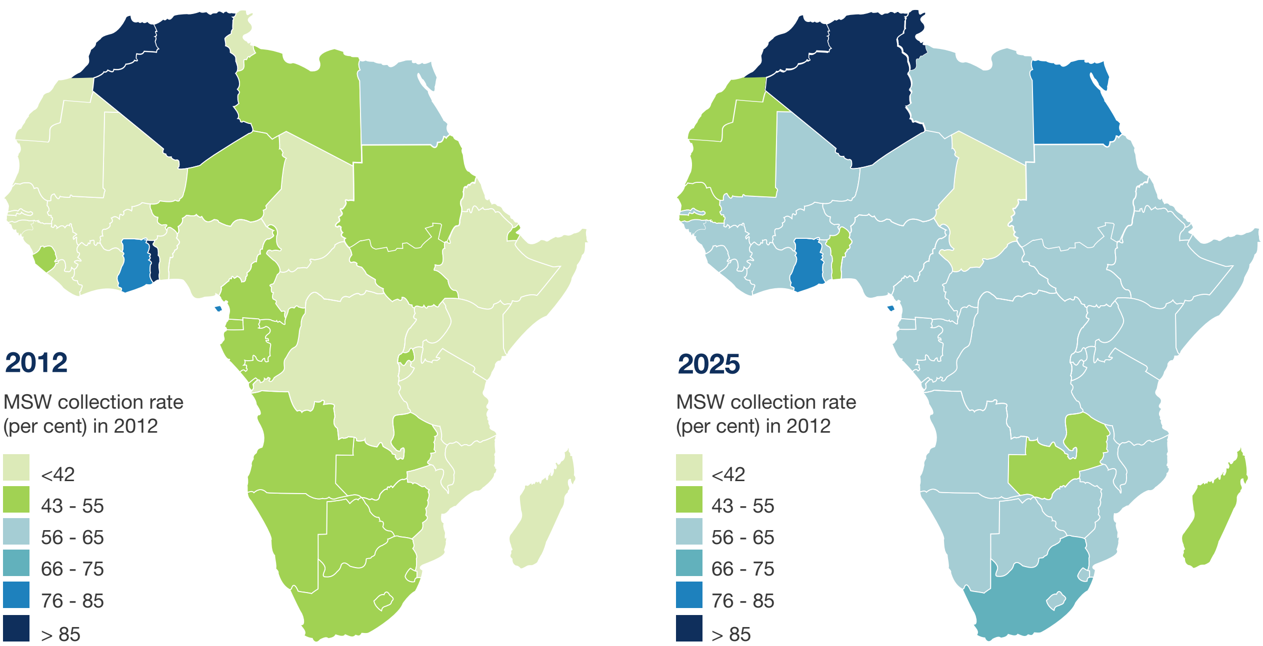
Collection rate[4]

Although the largest part of the budget available for solid waste management in developing countries goes to waste collection (Scarlat *et al.* 2015; Bello *et al*. 2016), the total MSW collected in Africa in 2012 was estimated to be only 55 per cent of that generated, an equivalent of 68 million tonnes (Scarlat *et al.* 2015). The average MSW collection rate in sub-Saharan Africa was only 44 per cent. The collection rate of African countries ranges from as low as 18 per cent to over 80 per cent (**Figure 3.5**). The average collection rate for the continent is projected to increase to 69 per cent by 2025 (Scarlat *et al.* 2015). Given the likely increase in MSW generation, however, the quantity of uncollected MSW is not expected to decrease, even with this improvement in collection rate. Thus, the challenge of MSW collection in Africa is likely to persist into the 2025 time horizon, continuing to pose a threat to human health (**see chapter 5**).

Collection coverage[6]

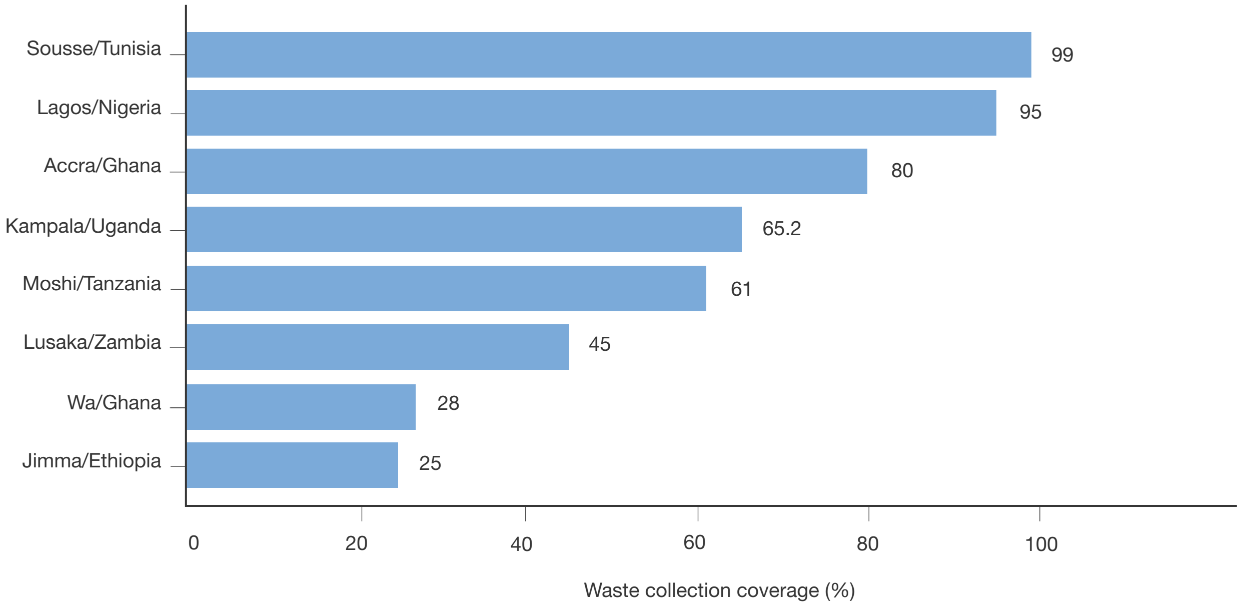
According to the GWMO, collection coverage in Africa ranges from 25–70 per cent (UNEP 2015). Collection coverage in African cities also ranges widely (**Figure 3.6**). In some cities, such as Sousse in Tunisia and Lagos in Nigeria, it can be above 90 per cent, while in others, such as Jimma in Ethiopia and Wa in Ghana, it can be well below the continental average of 55 per cent. Even within the same country, collection coverage can vary significantly from city to city. In Ghana, for example, Wa has a 28 per cent collection coverage whereas Accra has an 80 per cent coverage, due in part to variation in community structure.

Figure 3.5 MSW collection rate (per cent) in 2012 and in 2025[5]



4 Where “collection rate” refers to the ratio of total waste collected to total waste generated.
5 Spatial distribution of waste collection rates in Africa in ArcGIS based on the data obtained from Hoornweg and Bhada-Tata (2012) and Scarlat *et al*. (2015)
6 Where “*collection coverage*” refers to the percentage of households with access to a waste collection service.

Figure 3.6 MSW collection coverage for selected cities in Africa



Source: UN-Habitat (2010), Getahun ***et al***. (2012), Madinah ***et al***. (2014)

Moreover, there can be big disparities in collection services within the same city, with MSW collection typically being limited to city centres and affluent neighbourhoods (Medina 1999). In low- and middle-income countries, the waste collection coverage can be as high as 90 per cent in city centres, yet as low as 10 per cent in the marginal areas (UN-Habitat 2010). This results in uncollected waste accumulating in open areas near houses, on the streets and in markets, water courses and drainage channels. It is also not uncommon to see heaps of garbage at street corners in some cities (Simelane and Mohee 2012).

Indiscriminate dumping of waste in an urban area, Nairobi
Photo credit © Costas Velis, University of Leeds

Table 3.4 MSW collection methods in two cities in Africa

City	City area	Primary collection	Collection point	Secondary collection	Transfer station
Maputo, Mozambique	Inner city	1.1–2.5 cubic metre containers		Motorized communal collection	
	Residential inner city	Motorized door-to-door collection, one step			
	Suburban areas	Manual block collection	Large containers	Trucks	
	Rural areas	Self service	Unmanaged drop off point	Motorized communal collection	
Qena, Egypt	Urban areas	Manual block collection	Collection trucks	Trucks	
	Semi-urban areas	Motorized door-to-door collection, one step			

Source: Adapted from GIZ (2014)

Collection and transport infrastructure

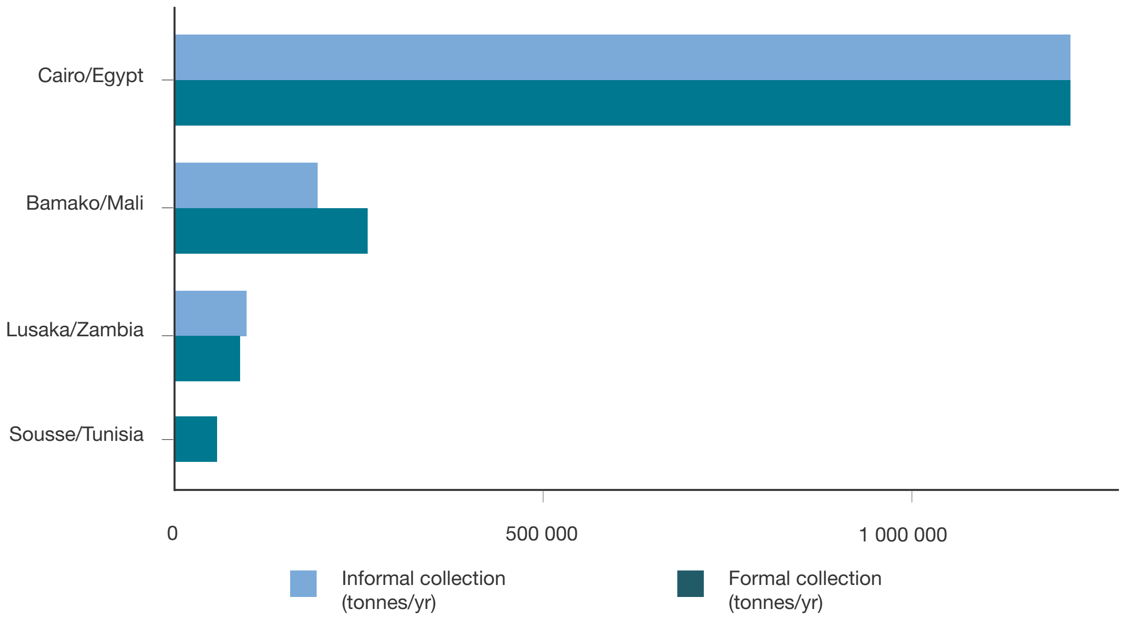
In African cities, good road infrastructure can often only be found in the city centres, with the roads in suburbs being of a poorer standard (GIZ 2014). As a result, the waste service delivery model or method may be different for different urban settings, and within and between cities and towns (**Table 3.4**).

In African towns and cities, primary MSW collection (from the point of generation to pick-up) is often non-capital-intensive, carried out by small- and micro-scale service providers (Le Courtois 2012, UN-Habitat 2010, GIZ 2014). In low-income areas and informal settlements where the roads are poor and often narrow, communal collection and block collection using manual equipment (e.g. push carts, tricycles or wheel barrows) are common (GIZ 2014). In urban centres, door-to-door waste collection is the most common practice (Bello *et al*. 2016). Transfer stations are not common in African cities. The types of motorized vehicles used in waste collection and transport in Africa include lorries, tippers, tractors, compactor trucks and side-loader trucks. Experiences in Abuja, Nigeria show that advanced compactor trucks provide little advantage for African conditions owing to the high proportion of organic matter in the MSW, as well as servicing requirements (Imam *et al*. 2008).

The frequency of waste collection varies considerably within and between cities. High-income neighbourhoods and urban centres are visited by collection crews more frequently than low-income or suburban areas (Mpofu 2013, Bello *et al*. 2016).

Traditionally, waste collection services have been provided by formal actors such as the municipality or private waste contractors. In many African cities, however, the role of the informal sector in waste collection is equally important (**Figure 3.7**). In Nairobi, for example, the main actors in waste collection are the city council (500 tonnes per day), private waste contractors (500 tonnes per day) and informal waste recyclers and pickers (350 tonnes per day). In addition, CBOs and self-help groups play an important role in primary waste collection in the very densely populated areas of Nairobi (Mwesigye *et al*. 2009).

Figure 3.7 Formal and informal collection in selected cities in Africa



Source: UN-Habitat (2010), Gunsilius *et al.* (2010)

Managing waste in informal settlements/slums

An estimated 56 per cent of urban populations in sub-Saharan Africa live in slums (UN 2017). Waste collection services are limited or non-existent in these poorer areas, partly due to lack of road access and waste infrastructure (UN-Habitat 2010). The roads in slum areas are usually narrow, unpaved and sloping, and also slippery during rainy seasons (Mwesigye *et al.* 2009). Modern waste collection systems cannot be easily implemented under such conditions. Social and technological innovation is required to ensure that all urban residents have access to waste collection services (**see chapter 7**).

Managing waste in rural areas

Although around 60 per cent of Africa's population live in rural areas (World Bank 2015), there are limited or no waste management services available in such areas (UNEP 2015). Effective waste collection services are generally difficult to provide in rural areas because houses are sparsely scattered over long distances. Rural wastes that are not reused or recycled are often illegally dumped or openly burned on site (Hangulu and Akintola 2017). This has become particularly problematic with increasing consumption of plastic, health care materials and disposable diapers (**See chapter 5**). There is scarcity of information on rural waste generation (Jakobsen 2012), including waste quantity, composition, sources and management. It is generally assumed that rural areas generate lower quantities of waste per capita, due, for example, to lower consumption patterns, use of less packaging material, lower purchasing power and higher rates of reuse of end-of-life products (Hoornweg and Bhada-Tata 2012). Given their generally high organic content, rural wastes such as food waste, animal manure and agricultural waste are often managed through reuse and recycling methods such as composting, and more recently, anaerobic digestion (Couth and Trois 2012, Jakobsen 2012). Proper composting and biogas technologies have huge potential for managing organic waste and meeting the energy and fertilizer demands of rural communities in Africa (Rupf *et al.* 2016).

Indiscriminate dumping and opening burning of waste in a rural area in Southern Africa
Photo credit: © Linda Godfrey, CSIR

Partly burned, illegally dumped diapers in a rural area in Southern Africa
Photo credit: © Linda Godfrey, CSIR

CASE STUDY 2

COMPARATIVE ANALYSIS OF SOLID WASTE MANAGEMENT IN RURAL AND URBAN GHANA

BACKGROUND

Historically, it has been believed that solid waste is not an issue in rural areas, and rural areas have consequently been less covered by solid waste services. This case study summarizes a comparative study of household solid waste management in rural and urban Ghana. The information presented here is based on a questionnaire survey by Boateng *et al.* (2016). The study did not establish the absolute quantity of the waste or its composition.

DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERIZATION

The differences in solid waste handling between rural and urban areas can be partly explained by the significant differences between rural and urban communities in terms of economic activities, resident education level, age distribution, household size and marital status. Rural Ghana is characterized by communities with more old, married, less educated residents and larger household size, which has implications for solid waste management. The large household size in rural areas means higher waste generation per household, which makes rural solid waste important.

SOLID WASTE SOURCES AND CHARACTERISTICS IN RURAL AND URBAN COMMUNITIES

In rural Ghana, almost all of the solid waste comes from domestic areas, whereas in urban Ghana, both domestic and commercial areas are common sources of solid waste. The solid waste from both rural and urban areas is characterized by high amounts of biodegradable organic matter (Table 1), mainly from

Table 1 Solid waste source and characteristics in rural and urban communities, Ghana

		Urban communities (%)	Rural Communities (%)	Total population (%)
Source	Institutional	8.8	0	4.4
	Industrial	7.4	0	4.0
	Commercial	37.0	14.0	23.5
	Domestic	46.7	92.4	67.8
Composition	Organic (putrescible)	50.5	63.6	56.5
	Paper	12	0	6.5
	Plastic	28.7	36.4	32.2
	Metal	5.1	0	2.8
	Inert waste	3.7	0	2.0
	Textile and leather	0	0	0
Means of solid waste storage	Open container	9.7	61.4	33.5
	Closed container	80.6	28.3	56.5
	Polythene bags and sacks	9.7	10.3	10.0
Means of waste collection	Open dumping	28.2	78.3	51.2
	Communal container	37.5	21.7	24.2
	Home collection	7.9	0	4.2
	Roadside collection	26.4	0	20.2

CASE STUDY 2 (continued)

COMPARATIVE ANALYSIS OF SOLID WASTE MANAGEMENT IN RURAL AND URBAN GHANA

food production, preparation and consumption. Fruits, tubers, roots and vegetables, which tend to have high potential for wastage, are daily food choices for many Ghanaians. The waste composition in urban Ghana is also more diverse than in rural Ghana. There has always been a perception that packaging waste is not generated in rural areas; however, the proportion of plastic waste generated in rural Ghana, close to 40 per cent, is alarming.

SOLID WASTE MANAGEMENT IN RURAL AND URBAN COMMUNITIES

Most urban communities (80.6 per cent) store their solid waste in closed containers, while rural communities tend to store their solid waste primarily in open containers (61.4 per cent), followed by closed containers (28.3 per cent). About 10 per cent of both rural and urban communities depend on polyethylene bags and sacks for solid waste storage. Solid waste is usually stored at roadside for collection, with the result that open waste containers often attract animals, which leads to the scattering of waste out of the container.

Urban communities largely depend on communal container collection systems for waste collection, whereas open dumping (78.3 per cent) is most common in rural areas. Rural areas are still not well covered by solid waste services. However, solid waste pollution is worse in urban communities than in their rural counterparts.

LESSONS LEARNED AND THE WAY FORWARD

Open dumping of solid waste in rural areas often consists of organic and plastic waste. Open disposal of plastic waste can have far-reaching consequences for the receiving environment. National waste management policies should recognize the right of rural communities to a clean and healthy environment. Thus, solid waste services need to be extended to rural areas, particularly for the non-organic waste that cannot be reused or recycled at source. Waste resource recovery from the organic waste fraction through composting or co-composting needs serious consideration.

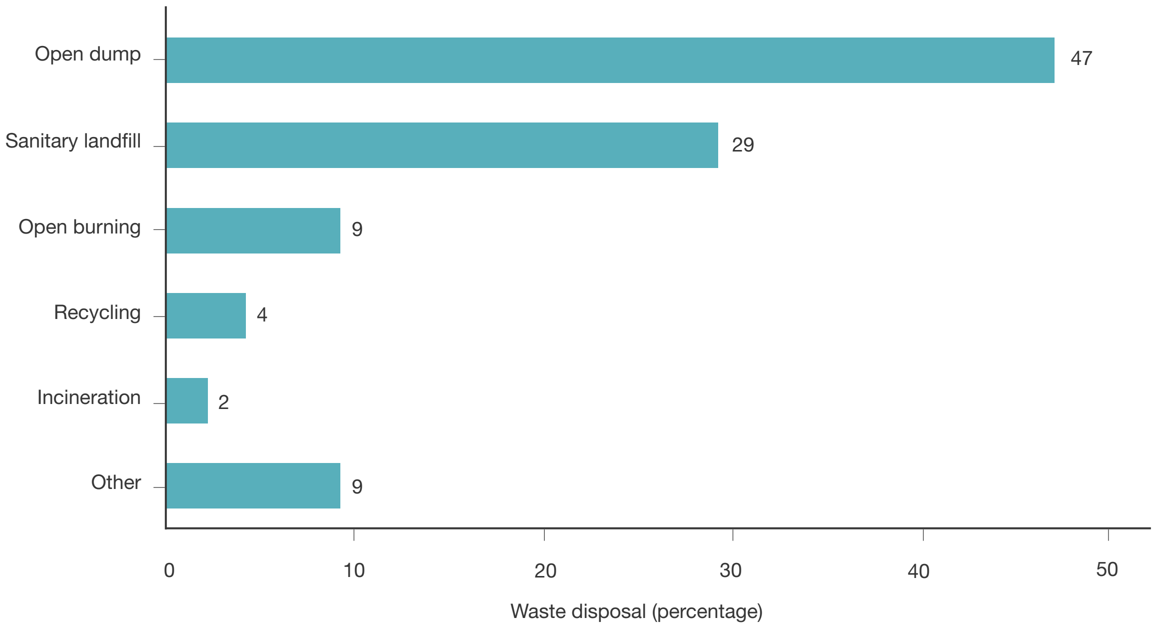
Data related to the quantity and composition of waste is still lacking, especially for rural areas. Thus, research is needed to accurately quantify solid waste generation and composition. This data needs to be made available in a national database for solid waste planning purposes.

3.1.4 Disposal

Controlled and uncontrolled dumping is the most common type of waste disposal in Africa because it is considered a cheap way of getting rid of solid waste (**Figure 3.8**). Controlled disposal in low-income and lower-middle income countries is typically below 35 per cent and 68 per cent, respectively (UNEP 2015).

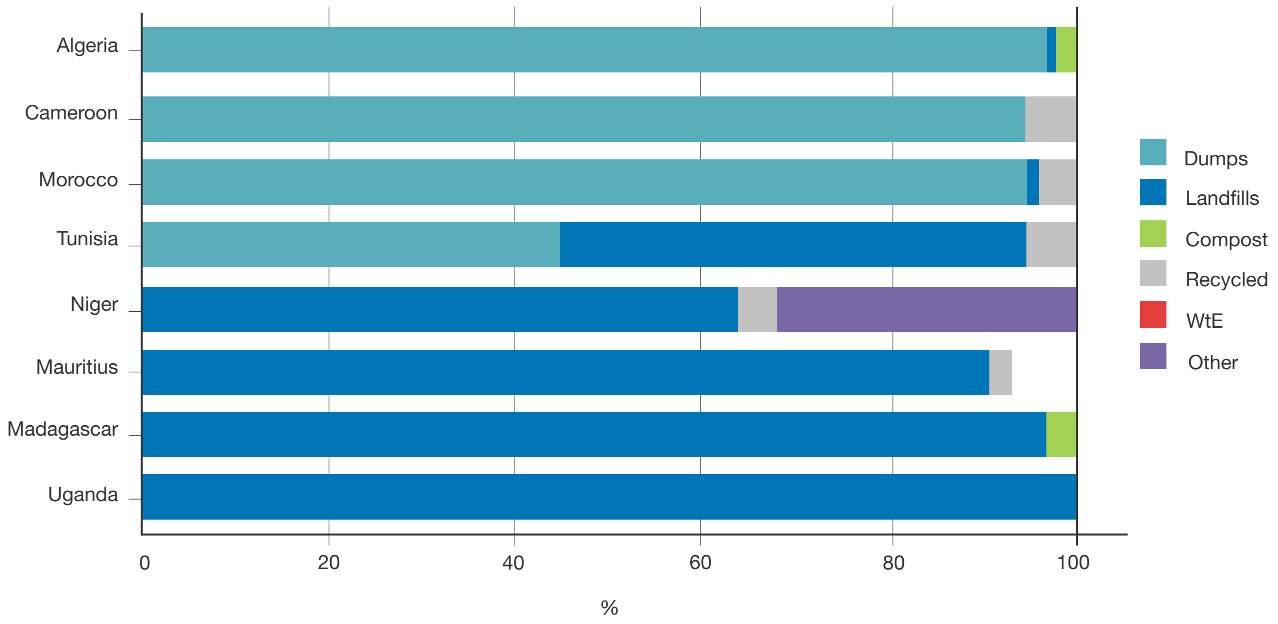
Open dumping involves indiscriminate disposal of waste with no plans for environmental protection (Johannessen and Boyer 1999). The waste in open dumps is left untreated, uncovered and unsegregated, with no groundwater protection or leachate recovery (Henry *et al*. 2006, Mwesigye *et al.* 2012, Mohammed *et al.* 2013). African countries are slowly upgrading their end-of-life disposal infrastructure, from open-dumping to controlled dumping, controlled landfilling and finally sanitary engineered landfilling. But experience shows that engineered landfills, once established, are often not operated in accordance with design specifications or legislation, owing to various operational challenges. The construction of a sanitary landfill for the city of Bishoftu, Ethiopia, was completed in 2013 but was not yet operational in 2016, owing to budget limitations and the lack of skilled manpower required to run the facility (Veses *et al.* 2016). One solution is to outsource landfill operation to the private sector, which can overcome municipal administrative challenges while still allowing the municipality to impose strict minimum operating requirements on the private operator. As expected, there are large variations among African countries in terms of disposal methods, as shown for eight African countries (**Figure 3.9**). **Figure 3.9** also highlights the transition that African countries are making away from dumping to uncontrolled and controlled dumping and landfilling.

Figure 3.8 Methods of end-of-life MSW disposal in Africa



Source: Hoornweg and Bhada-Tata (2012), Periou (2012)

Figure 3.9 MSW disposal methods for African countries



Source: Hoornweg and Bhada-Tata (2012)

Note: In this graph, "landfills: refer to all waste disposal to land, making it difficult to distinguish between disposal to controlled and uncontrolled dumpsites.

3.1.5 Recycling

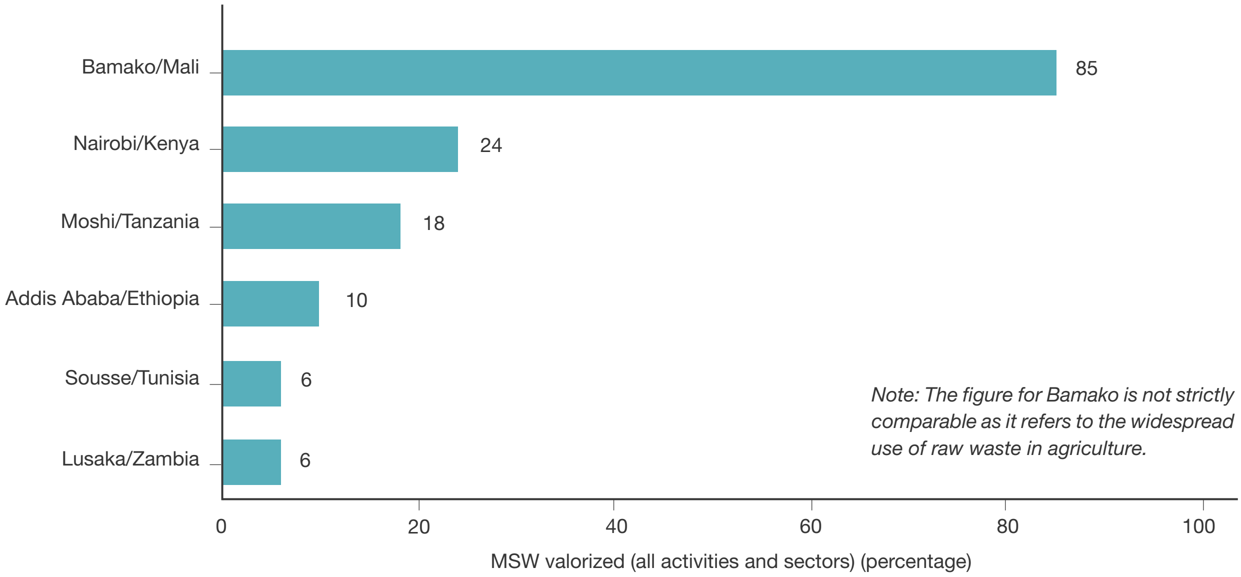
The average MSW recycling rate in Africa is only 4 per cent (**Figure 3.8**), lower than the average recycling rate of most countries of the Organization for Economic Cooperation and Development (OECD), which was 30 per cent in 2013 (OECD 2015a, 2015b). There are only a few formal recycling systems in sub-Saharan Africa. Some municipalities have established on-site material recovery facilities (MRFs) (e.g. South Africa) (CSIR 2011). However, most municipalities are not well equipped with the required logistics for waste segregation and separate collection of recyclables (CSIR 2011, Hoornweg and Bhada-Tata 2012).

There is little empirical data on recycling in Africa, because the collection of recyclables is usually carried out informally at the household level or by the informal sector (Wilson *et al.* 2009, CSIR 2011, Godfrey *et al.* 2016). The informal sector (e.g. itinerant buyers and waste pickers) recovers most of the post-consumer recyclables, such as ferrous metals, plastics, glass and paper, and supplies them to recycling businesses (Imam *et. al.* 2008, CSIR 2011, Hoornweg and Bhada-Tata 2012, GIZ 2014). For instance, 11,162 tonnes of waste (18 per cent of the total waste generated) is recovered in the Tanzanian city of Moshi every year by the informal sector (UN-Habitat 2010). Quite high recycling rates have been achieved in Cairo (Egypt), Moshi (Tanzania) and South Africa mainly by the informal sector (UN-Habitat 2010, CSIR 2011). In South Africa, for example, an estimated 80–90 per cent (by weight) of post-consumer paper and packaging is recovered by informal waste pickers, feeding into a growing local recycling economy that diverts 52.6 per cent of the 3.39 million tonnes of packaging consumed in South Africa (in 2014), from landfill (Godfrey *et al*. 2016).

The collection rate of recyclables varies from city to city (**Figure 3.10**). In some cities (e.g. Bamako), the collection rate is as high as 85 per cent (**Figure 3.10**), whereas in others (e.g. Addis Ababa, Lusaka and Sousse), the collection rate is lower than 10 per cent. The reason for the high recovery of recyclables in Bamako is that raw or partially decomposed organic waste has a lively market for swine feeding and soil conditioning (UN-Habitat 2010).

In some cases, the informal sector operates with strong support from the municipality and occasionally from the producers (e.g. in Tunisia and Morocco). However, the services provided by waste pickers are not usually appreciated by residents and authorities. In some

Figure 3.10 Recycling rates as a percentage of municipal solid waste in selected cities in Africa

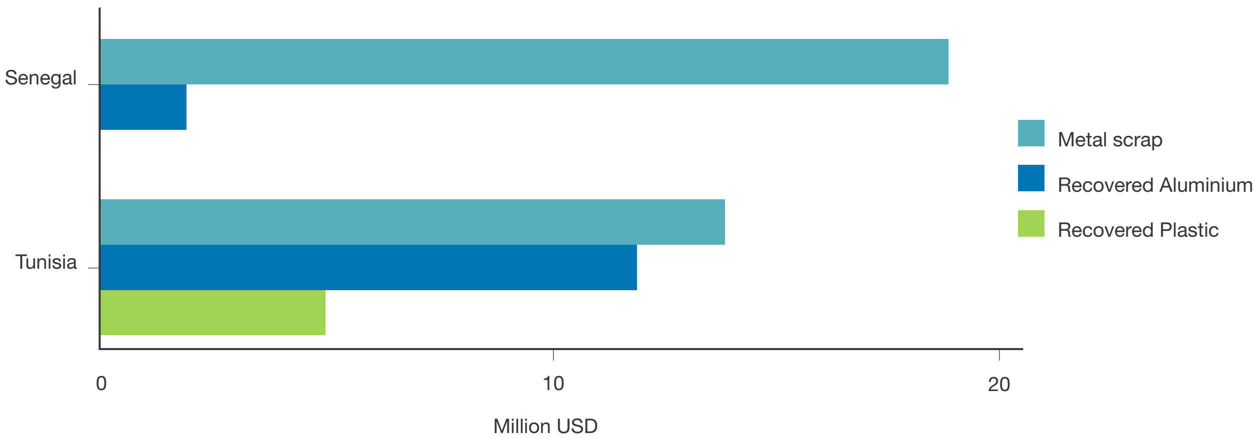


Source: UN-Habitat (2010), Regassa *et al*. (2011)

municipalities (e.g. Abuja), the informal sector has been accused of fly-tipping (Imam *et al.* 2008), vandalizing public infrastructure such as aluminium railings, electric cables and poles to recover metals for secondary markets. Godfrey *et al.* (2016) note that informal waste pickers in South Africa save municipalities US$20–50 million a year in landfill airspace (in 2014), at little to no cost to the municipality and with little support (financial or operational) from the municipality. Thus, the challenge for Africa is to optimize the benefits that the informal sector provides, through positive engagement, support and integration into the formal waste economy (Wilson *et al.* 2006).

There is little information available with regard to the secondary material value chain in Africa. Some of the recycled materials are exported and as such they bring hard currency to the exporting countries. In 2007, Senegal and Tunisia earned close to US$20 million and US$30 million respectively, from exports of metal scrap, recovered aluminium and plastics (Chalmin and Gaillochet 2009) (**Figure 3.11**). However, recent bans by countries such as China on the import of recyclable waste will negatively impact countries that have not established their own local end-use markets. South Africa has developed some resilience with regard to shocks in the global recycling markets, with only 4.6 per cent of the total paper and packaging collected for recycling exported to foreign markets (CSIR 2017).

Figure 3.11 Hard-currency earned from export of recycled materials



Source: Chalmin and Gaillochet (2009)

The diversion of waste away from landfill towards recycling programs has saved municipal waste handling costs in Lusaka, Zambia (US$1.7 million) and Cairo, Egypt (US$16.9 million) (Gunsilius *et al.* 2010).

3.1.6 Waste treatment and energy recovery

Alternative waste treatment such as waste-to-energy (WtE) is almost absent in Africa, with only a few successful projects (Johannessen and Boyer 1999), such as the eThekwini landfill gas (LFG) to electricity project in Durban, South Africa, which generates 7.5 MW of electricity from two landfill sites (Kayizzi-Mugerwa *et al*. 2014).

An estimated 1,125 PJ of energy could have potentially been produced from the waste generated in Africa in 2012, through landfill gas (LFG) recovery and incineration (Scarlat *et al.* 2015). This energy potential is significant considering that the primary energy supply in Africa in 2010 was about 29,308 PJ. Owing to low waste collection rates, however, the energy potential of the waste actually collected in 2012 was estimated to be only about 613 PJ (Scarlat *et al.* 2015). Potential electricity production from waste generated in Africa in 2012 was estimated at 62.5 TWh, or 9.5 per cent of the total electricity consumption of 661.5 TWh for Africa in 2010 (Scarlat *et al.* 2015).

In an effort to harness the energy potential of waste, Ethiopia is building a modern 50 MW WtE (incineration) facility in Addis Ababa as part of its strategy to build a green economy (**see chapter 7**). A 10 kW WtE (biogas) pilot project at Ikosi market in Lagos, Nigeria, appears not to have been sustainable, however, after initially being set up in 2013[7]. While the energy potential of organic waste, including industrial biomass, is significant for Africa (using technologies such as LFG recovery and anaerobic digestion), the high moisture content of the waste means that traditional thermal WtE technologies such as incineration, should be carefully considered and should be based on comprehensive waste characterization studies (**see chapter 7**).

3.2 Food waste

Food losses and waste are generated throughout the food supply chain in Africa, from initial agricultural production to final household consumption. In most African countries, however, data on food losses and waste is scarce, although extensive research has been conducted in South Africa (Oelofse and Nahman 2012, Nahman *et al*. 2012, Nahman and de Lange, 2013). More detailed information is provided in **topic sheet 1**.

A study conducted in three cities in South Africa (Cape Town, Johannesburg and Rustenburg) found average food waste generation to be 18.1 per cent, 11.0 per cent and 9.6 per cent of the total waste generated in low-, middle- and high-income areas, respectively (Nahman *et al*. 2012). The figures in most African countries could be higher, however, as most of the organic waste fraction is owing to poor food preservation and preparation.

7 https://www.theguardian.com/global-development/2017/sep/26/how-banana-skins-turned-on-the-lights-in-lagos-and-then-turned-them-off-again-nigeria

TOPIC SHEET 1

FOOD LOSSES AND FOOD WASTE:

Extent, cause and prevention[1]

Background and context

Globally, almost 800 million people go hungry every day owing to inefficiencies in the management of food systems (WWF 2017). According to available estimates, approximately one-third of all food produced globally (by weight) intended for human consumption (amounting to about 1.3 billion tonnes per annum) is lost or wasted. In sub-Saharan Africa, roughly 37 per cent of all the food produced is lost or wasted. However, compared to Europe and North America, where per capita food losses are 280–300 kg per year, per capita food losses in sub-Saharan Africa are much lower, at 120–170 kg per year (FAO 2011).

Significant regional differences are evident in the generation of food losses and waste. In developed countries, food losses and waste occur mainly downstream in the food supply chain, during the retail and consumption stages, whereas in developing countries, losses and waste occur primarily at the early stages of the food supply chain, at the post-harvest and processing stages (FAO 2011). In South Africa, an estimated 50 per cent of food losses and waste occur at the agricultural/post-harvest stage, 25 per cent during processing and packaging, 20 per cent during distribution and retail and only 5 per cent at the consumer level (WWF 2017).

Food waste at the consumer level in industrialized countries is 222 million tonnes, almost as high as the total net food production in sub-Saharan Africa (230 million tonnes) (FAO 2011). In sub-Saharan Africa, food waste at the consumer stage is relatively negligible but is growing rapidly as the economy grows.

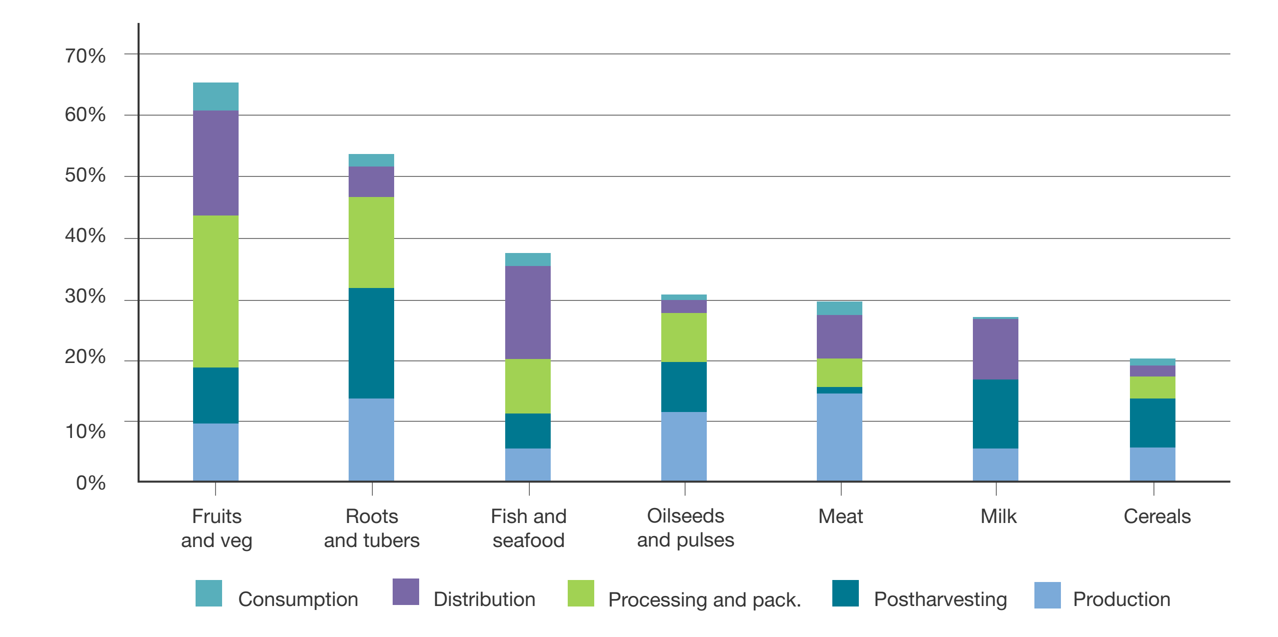
The proportion of food losses and waste generated at different stages in the value chain also varies depending on food type. In sub-Saharan Africa, the greatest food wastage occurs for fruits and vegetables (66 per cent), followed by roots and tubers, and fish and sea and marine products (Figure 1). Cereals are less vulnerable to losses but are still costing sub-Saharan Africa about US$4 billion per year (World Bank 2011).

1 Topic sheet prepared by Kidane Giday Gebremedhin, Suzan Oelofse and Linda Godfrey.

PRODUCTION	HANDLING AND STORAGE	PROCESSING AND PACKAGING	DISTRIBUTION AND MARKET	CONSUMPTION
During or immediately after harvesting on the farm	After produce leaves the farm for handling, storage, and transport	During industrial or domestic processing and/ or packaging	During distribution to markets, including losses at wholesale and retail markets	Losses in the home or business of the consumer, including restaurants and caterers

FOOD LOSSES AND FOOD WASTE:
Extent, cause and prevention[1]

Figure 1 Estimated/assumed waste percentages for sub-Saharan Africa



Source: FAO (2011)

While Nigeria is ranked as the second largest tomato producer in Africa (after Egypt) (Arah *et al.* 2015) and sixteenth in global tomato production, accounting for 10.8 per cent of Africa's tomato production and 1.2 per cent of global tomato production (Ayoola 2014), a staggering 45 per cent of tomatoes harvested in Nigeria are lost (Ugonna *et al.* 2015).

Food losses and waste in South Africa have been estimated at 10.2 million tonnes per annum, with a total cost of edible food waste throughout the value chain of R61.5 billion per annum (approximately US$7.7 billion). While this food waste cost, on a per capita basis, is relatively low when compared to developed countries (US$148 for South Africa compared to US$285–628 in the USA), it represents a significant proportion of the country's GDP (2.1 per cent compared to 0.6–1.3 per cent of GDP in the United States), highlighting the significant impact that unsustainable food systems can have in developing countries (Nahman and de Lange 2013).

Food waste and greenhouse gas (GHG) emissions

Food production involves the use of energy, water and land. FAO (2011) has estimated total greenhouse gas (GHG) emissions from the production of food that is not eaten to be 9 per cent of total global GHG emissions. Life-cycle GHG emissions from food waste are estimated to be 4.4 Gt CO_2 equivalent annually (FAO 2011), contributing 19–29 per cent of total global anthropogenic GHG emissions (DEA 2014). By 2050, annual GHG emissions from food waste could reach 5.7–7.9 Gt CO_2 equivalent (WWF 2017).

Causes and prevention of food losses and waste

The major causes of food losses and waste globally are (FAO 2011):

- Financial, managerial and technical limitations in harvesting techniques and storage and cooling facilities in low-income countries

- Lack of coordination among different actors in the supply chain
- Careless consumer attitudes

In Africa, these issues are exacerbated by the lack of reliable modern storage and processing technologies, inappropriate harvesting periods, inappropriate packaging material, poor field sanitation, poor road infrastructure, inappropriate modes of transport and the lack of reliable markets (Arah *et al*. 2015).

The proposed prevention measures include (FAO 2011):

- Research on improving the shelf-life of agricultural produce
- Investments in infrastructure, transportation, storage facilities, and the food-processing and packaging industries
- Increase coordination along the supply chain
- Public awareness creation

Lessons learned

There are major data gaps for food losses and waste in Africa. Research in this area is imperative if an impact is to be made in reducing wastage. Reduction in food losses could have an immediate, significant impact on the livelihoods of millions of small-holder farmers who live on the margins of food insecurity, as well as reducing GHG emissions. On the other hand, proper management of food waste (once generated), such as through composting and anaerobic digestion, could contribute to food and energy security.

If African countries are to achieve SDG target 12.3, "*By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses*", considerable effort is needed across the entire food supply chain in Africa.

CASE STUDY 3

THE SAHARAWI REFUGEE CAMPS IN ALGERIA

Following the outbreak of conflict in 1975, Saharawi people in the western Sahara began moving into the Tindouf region of Algeria. Since 1979, more than 250,000 people have been living in refugee camps in the area, in poor conditions. Each of the four refugee camps hosts 70,000–80,000 people (Garfí *et al*. 2009).

Waste is a major concern with respect to hygiene. The solid waste generation rate is estimated at 0.15 kg/capita/day, with a density of 170 kg/m3. About 90 per cent of the waste is packing plastics, paper, cardboard and wastes such as rubber, wood, textile and ferrous and non-ferrous material. Two tipper trucks are used to collect the waste and then dump it 3 km outside of the camp, where it is burned in an open area, exposing people to health hazards and adding to the already severe problems of air pollution and the risk of the spread of diseases. The situation led to a research project on how to solve this problem by introducing an appropriate waste management system.

RESEARCH CONDUCTED IN THE SAHARAWI CAMP

(Garfi *et al.* 2009)

The problems identified included the waste collection system and the method of disposal. The tipper trucks were not bought specifically for waste collection and were often used for other purposes. Two trucks were insufficient and people were often forced to remove their own waste to uncontrolled dumps near their settlements. With wind storms frequently striking the area, open dumping resulted in waste being spread around the area. Low-temperature burning of plastics in close proximity to homes resulted in the emission of gases, such as dioxin, which are hazardous to human health and the environment.

Saharawi politicians and the Saharawi Women's Union contacted European NGOs and informed them of their desire to implement appropriate waste collection systems. European cooperation agencies committed to implement the research and provide financial aid. Using a multi-criteria analysis which included a participatory approach focusing on the concerns of the local community, research was conducted to compare different waste management solutions in the Saharawi refugee camp. The proposed solutions were:

1. Waste collection using three tipper trucks, disposal and burning in an open area
2. Waste collection using seven dumpers and disposal in a landfill
3. Waste collection using seven dumpers and three tipper trucks and disposal in a landfill
4. Waste collection using three tipper trucks and disposal in a landfill

The alternatives were compared using technical, social, environmental and economic criteria. The study results indicated that local politicians were interested in implementing the first option, which was similar to the existing situation and only required the purchase of one additional tipper truck (low-cost solution). Other options were taken into account, however, with the aim of improving waste management and achieving environmental and social benefits. Finally, the results of detailed analysis showed that the best options for MSW management in the Saharawi refugee camps were option 2 or option 3, which precluded burning of waste. In addition, these solutions were found to be more sustainable, as dumpers, being small-scale technologies with less environmental impact, are more suitable than tipper trucks.

LESSONS LEARNED

As refugee camps are unplanned settlements resulting from natural and man-made instability, governments and NGOs supply food, typically packed in plastic, cardboard and cans. After consumption, this packaging and remaining food waste can become a major source of environmental pollution and diseases for the settlement area, if not removed and managed appropriately. Open burning of waste should be avoided because of the associated gaseous emissions that are generated and the fact that semi-burned waste becomes a source of environmental pollution.

The research study conducted in the Saharawi refugee camps, showed how participatory problem-solving involving all stakeholders can provide sustainable, appropriate waste management solutions for addressing current waste management problems.

3.3 Disaster waste

In Africa, conflicts and drought are the most dominant disasters, resulting in people migrating to neighbouring states and countries. The number of refugees in sub-Saharan Africa was 3.7 million in 2014 and continues to increase (UNHCR 2015). The refugees live in camps, often without appropriate waste management services and infrastructure. The solid waste is often burned or buried on the edge of camps or just outside, without any controls (Bjerregaard and Meekings 2008). Between 1990 and 2003, about 45,000 Liberian refugees reached Ghana and were detained in the Buduburam refugee settlement (Omata 2012). With the help of donors, the settlement is relatively well equipped with waste collectors; however, this is not the case for many refugee camps. At the Saharawi refugee camp in Algeria, for example, more than 250,000 people have been living under bad conditions since the camp was established in 1979 (see **case study 3**).

3.4 Hazardous waste

As noted in **chapters 1 and 4**, a number of African countries are party to international conventions on transboundary movements of hazardous waste. However, services and infrastructure for the management of household, commercial and industrial hazardous waste generated within African countries is often limited. Owing to very limited data, it is difficult to accurately estimate the magnitude and composition of hazardous waste generated in Africa (UNEP 2015). Systems for the management of household hazardous waste are almost non-existent in Africa. This results in the disposal of household products such as paint and paint thinners, batteries, household cleaners and household pesticides down sewers, onto land or with MSW, with the potential to cause significant environmental and human health impacts (Edokpayi *et al.* 2017, Mmereki *et al*. 2017).

Developed countries typically have very strict standards with regards to the collection, treatment and disposal of municipal and industrial hazardous wastes. The differences between developed and developing countries in the management of hazardous waste, including legislation, often lead to the "*export of waste to countries where environmental laws, occupational safety and health regulations, governance and monitoring are looser*" (ISWA 2011:3). This has also resulted in illegal trafficking of hazardous waste from developed countries to countries in Africa for cheap disposal, often without any treatment. For example, in the 1980s, 18,000 drums of hazardous waste were shipped from Italy and dumped in Koko, Nigeria, and 15,000 tonnes of waste was shipped from Norway and dumped in Guinea (Mott 2016). The Basel Convention and the Bamako Convention (**see chapters 1 and 4**) were established as a result of concerns raised by developing countries, including African countries, of continual dumping of hazardous wastes in their territories by developed countries (Schluep *et al.* 2012).

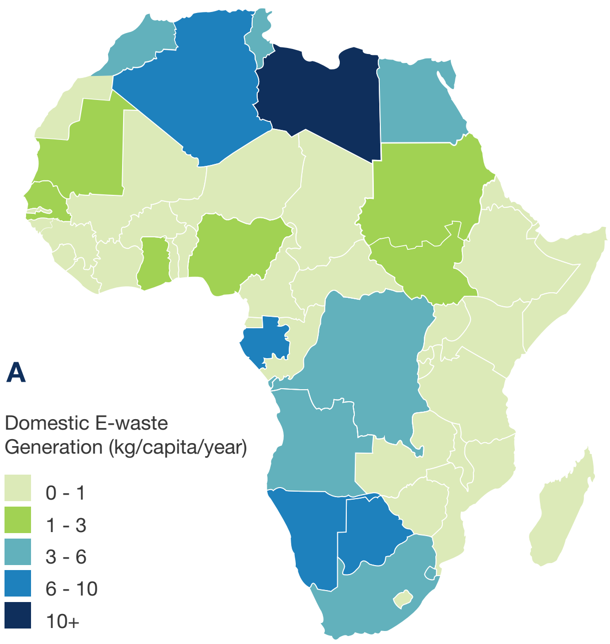
Hazardous waste generated in Africa is also increasing as a result of emerging waste streams such as e-waste, health care risk waste (HCRW) and obsolete agricultural chemicals. Freezing of transboundary movements of hazardous waste at borders in Africa has resulted in the stranding of toxic waste in smaller countries where there is little prospect for improving local infrastructure owing to the small size of local markets. This is illustrated by the failure of an e-waste recycling centre in Nairobi that could not obtain approvals to import the volumes of e-waste needed to make it profitable (Mott 2016). Thus, there is a need for African countries to limit transboundary movements of hazardous waste for the simple purposes of dumping, while at the same time developing regional markets to achieve sufficient economies of scale for investment in specialty waste facilities and infrastructure to ensure safe recycling, treatment or disposal (Mott 2016). This requires creating enabling environments such as favourable regulations and policies, strong institutions and waste governance, strict enforcement of legislation, and mechanisms to improve private sector investment.

3.4.1 E-Waste

About 2.2 million tonnes of e-waste was generated in Africa in 2016. The three countries in Africa that generate the largest quantities of e-waste are Egypt (0.5 Mt), South

Africa and Algeria (0.3 Mt) (Baldé *et al.* 2017). Average annual per capita e-waste generation (excluding imports) is just 1.9 kg in Africa, compared to 16.6 kg in Europe and 11.6 kg in the Americas. And as noted by Baldé *et al.* (2015:6), "*very little information is available* [on Africa's] *collection rate*". However, per capita e-waste generation varies significantly among African countries (**Figure 3.12**), with the per capita e-waste generation figures for Seychelles (11.5 kg), Libya (11.0 kg) and Mauritius (8.6 kg) on par with those of developed countries (Baldé *et al.* 2017).

Figure 3.12 Domestic e-waste generated in Africa[8]



The quantity of e-waste is increasing rapidly in Africa owing to increases in EEE demand and supply. For example, the number of personal computers and cell phones in Africa has increased in the last decade by factors of 10 and 100, respectively (Schluep *et al*. 2012). Moreover, the lifespan of this EEE is short owing to rapid changes in technology (UNEP 2015) and/or lower-priced substandard or used product imports (Schluep *et al*. 2012). The e-waste in Senegal, Uganda and South Africa is also projected to increase by a factor of two to eight in the next 10 years (Bello *et al.* 2016).

Locally generated e-waste is estimated to be between 50–85 per cent of total e-waste generation in Africa, the rest coming from illegal transboundary imports from developed countries in the Americas and Europe and from China (SBC 2011). West African countries such as Nigeria and Ghana have high direct imports of used EEE (**Table 3.5**) largely owing to the absence of laws and regulations that prohibit/discourage import of used materials. Nigeria generated 1.1 million tonnes of e-waste in 2010 and is the leading importer of used EEE on the continent. According to Baldé *et al.* (2017), European Union (EU) member States were the origin of approximately 77 per cent of the used EEE imported into Nigeria in 2015/2016.

Table 3.5 Electrical and electronic equipment import, use and e-waste generation data for selected African countries

Country	Year	EEE imports tonnes per year	EEE in use tonnes per annum	E-waste generated Tonnes per year
Benin	2009	16 000	55 000	9 700
Côte d'Ivoire	2009	25 000	100 000	15 000
Ghana	2009	215 000	984 000	179 000
Liberia	2009	3 500	17 000	N/A
Nigeria	2010	1 200 000	6 800 000	1 100 000

Source: Schluep et al. (2012)

8 Domestic e-waste generated in Africa mapped in ArcGIS 10 based on data obtained from Baldé *et al*. (2017).

TOPIC SHEET 2

THE E-WASTE CHALLENGE IN AFRICA: A sweet and sour story[1]

Introduction

Early obsolescence of electronic products is causing the production of uncontrollably large volumes of e-waste, estimated globally at 44.7 million tonnes (Mt) of e-waste annually in 2016, or 6.1 kg per capita (Baldé *et al*. 2017). This is fuelling high levels of export of e-waste from developed countries to developing countries, globalizing the e-waste problem. Used electrical and electronic equipment (EEE) is valuable for the socio-economic development of Africa, as most information and communications technology (ICT) activities, including cybercafés, educational institutions and small businesses, depend on imported second-hand computers and mobile phones (Osibanjo and Nnorom 2007, Nnorom and Osibanjo 2008). If not managed properly, however, e-waste has the potential to cause significant environmental and human health impacts in Africa.

The Secretariat of the Basel Convention e-waste Africa project

The dumping of e-waste in African countries, such as Nigeria, Ghana, Kenya, United Republic of Tanzania, Senegal and Egypt, has been in the international news (Osibanjo and Nnorom 2007), alerting African governments to the dangers of e-waste as a threat to sustainable development on the continent. In response, the e-waste Africa project was launched in 2008. The project was funded by the European Commission, the Governments of Norway and the United Kingdom of Great Britain and Northern Ireland and NVMP, a Dutch association for the disposal of metal and electrical products, and managed by the Secretariat of the Basel Convention (SBC). The project is a comprehensive programme of activities aimed at enhancing environmental governance of e-wastes and creating favourable social and economic conditions for partnerships and small businesses in the recycling sector in Africa (Schluep *et al*. 2012). The project provided the first ever inventory of e-waste in Africa.

The use of EEE in Africa is low but growing at a staggering pace. In 2009, up to 70 per cent of EEE imported into Ghana was used and 30 per cent of that was non-functional. In 2010, 15–50 per cent of the e-waste on the continent was owing to the import or trafficking of end-of-life electronic devices (SBC 2011). West Africa is identified as the major trading route of used EEE and end-of-life electronic devices to Africa. An enforcement programme was customized for some African countries, including Benin, Egypt, Ghana, Nigeria and Tunisia, to monitor and control transboundary movements of used EEE. A scheme for exchanging information on used EEE between exporting and importing states was also developed (Schluep *et al*. 2012).

1 Topic sheet prepared by Oladele Osibanjo and Kidane Giday Gebremedhin.

TOPIC SHEET 2

THE E-WASTE CHALLENGE IN AFRICA:
A sweet and sour story[1]

Some of the major challenges to sound e-waste management in Africa are the absence of infrastructure for environmentally sound management of e-waste, legislation dealing specifically with e-waste or a framework for end-of-life product take-back, and inadequate public education and awareness on the problems associated with the uncontrolled importation of near-end-of-life and end-of-life EEE. According to Baldé *et al*. (2017), only Madagascar (2015), Kenya (2016) and Ghana (2016) have passed draft e-waste legislation. South Africa, Zambia, Cameroon and Nigeria are still working on legislation.

The e-waste project sensitized African leaders and the international community and resulted in, among other things, the *"Nairobi Declaration on the Environmentally Sound Management of Electrical and Electronic Waste"*, the *"Durban Declaration on e-Waste Management in Africa"*, the *"Abuja Platform on E-waste"*, and the *"Call for Action on E-waste in Africa"*. The first Pan-African Forum on e-waste was also organized in March 2012 at UN Environment headquarters in Nairobi to review the project findings (SBC 2011) and identify priority areas for intervention.

All of these activities and documents have been instrumental in moving the e-waste topic forward in national political agendas, in Ghana, Kenya, Nigeria, South Africa and the United Republic of Tanzania, for instance (Mogilska *et al*. 2012). There is currently a strong drive to enforce some guidelines to control illegal trafficking of e-waste. A number of African countries, including Nigeria and Egypt, are contemplating a new set of regulations for e-waste; for instance, new legislation in Egypt has banned the importation of working EEE that is more than five years old (Chaplin and Westervelt 2015, cited in Heacock *et al*. 2016). However, a complete ban could limit the legal movement of e-waste to places where there is infrastructure for its recycling or proper disposal.

Urban Mining, Challenges and Opportunities for Africa

"Urban mining" is a term for recycling of waste in order to reduce extraction of raw material through "primary mining". E-waste has precious metals that can be readily extracted through recycling, often in higher concentrations that that found in ore (Mogilska *et al*. 2012). Urban mining is being practised by the informal sector in many African countries and will continue to increase into the foreseeable future. This will create new job opportunities and new markets. However, current practices have high social and environmental costs and are inefficient, with low material recovery. Thus, there is a need to create efficient, effective and clean urban mining systems in Africa.

Environmental and social impacts of poor e-waste handling in Africa

E-waste contains a wide variety of potentially hazardous chemical compounds such as heavy metals, fire retardants, lubricants and plasticizers. The e-waste illegally hauled to Africa is often open-burned. Burning e-waste releases toxic gases that can cause health risks, especially to vulnerable groups such as children. Those involved in dismantling and recycling are highly exposed to chemicals, with a high possibility of accumulating considerable levels of toxic materials in their bodies (Igharo *et al*. 2014). Exposure to e-waste can take place through various routes, including air, water and ingestion through contaminated food. Recipient age, length of exposure time, reactions with other chemicals and possible synergistic or other reactions, are decisively important (Grant *et al*. 2013).

E-waste also threatens the environment and ecosystems in a variety of ways. In some cases, e-waste is buried if not burned, causing serious impacts on soil-inhabiting

Table 1 Percentage of population covered by e-waste legislation by sub-region, in 2014 and 2017

Sub-region	Percentage of population	
	2014	2017
East Africa	10%	31%
Middle Africa	14%	15%
Northern Africa	0%	0%
Southern Africa	0%	0%
Western Africa	49%	53%

Source: Baldé *et al.* (2017)

organisms and may move to humans through the translocation of toxic compounds in edible crops. Many of the studies on the environmental impacts of e-waste are from Asia, however, especially India and China, where e-waste recycling is widely practised, with little reliable, quantitative information on the impacts of e-waste recycling in Africa (Heacock *et al*. 2016, Sepúlveda *et al*. 2010, Adeyi and Oyeleke 2017).

The way forward

More African countries need to put appropriate legislation and guidelines in place to deal with the increasing transboundary movements of e-waste and used EEE and in support of product take-back or extended producer responsibility (EPR). Moreover, adequate infrastructure necessary for material recovery should be put in place, even if only to support safer e-waste dismantling and pre-processing for now; recognizing that limited quantities of e-waste constrain the development of local e-waste processing end-markets. Public education and awareness creation is very important for enforcing e-waste legislation and sustaining e-waste infrastructure.

While the movement of many waste streams, including e-waste, between countries in Africa can be crucial to creating regional secondary resources economies, thereby allowing for economies of scale and investment in appropriate recycling and recovery infrastructure (e.g. the East Africa e-waste recycling hub), this must be done in a way that does not result in the dumping of end-of-life products in dumpsites in Africa. Furthermore, transboundary movements of waste to regional recycling hubs should promote full product recycling, not just the selective recovery of, for instance, metals from e-waste, with associated plastic and glass being disposed of in local dumpsites or landfills.

3.4.2 Health care risk waste

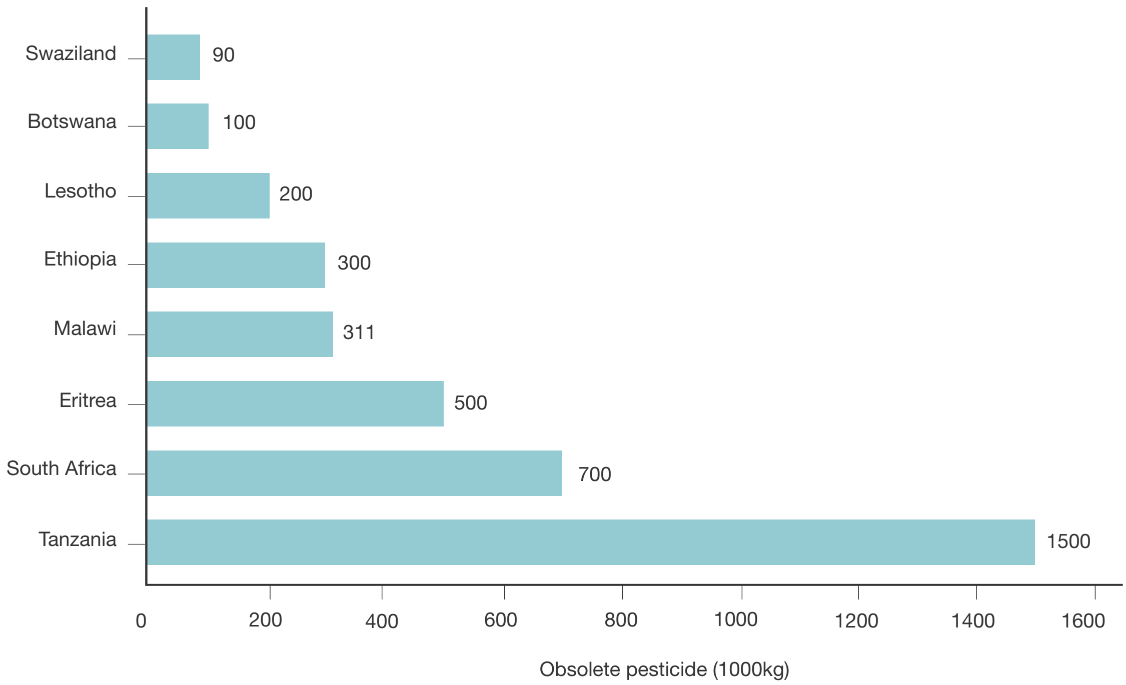
Little is known about the management of HCRW, or medical waste, in Africa. Udofia and Nriagu (2013) estimated that 282,447 tonnes of HCRW per year was generated from an estimated 67,740 health care facilities operating across Africa. Owing to the improved living standards of people in many African countries, the amount of HCRW generated is increasing. Algeria and South Africa, both upper-middle income economies, generate as much as 30,000 tonnes and 46,291 tonnes of HCRW a year, respectively (Sefouhi *et al*. 2011).

The hazardous fraction of health care waste is typically 10–25 per cent, but HCRW in Africa is thought to be higher owing to poor waste handling practices, resulting in contamination of the non-hazardous health care fraction (Udofia *et al*. 2015). In Africa, HCRW management is characterized by open dumping, uncontrolled emissions from incineration and poor operation of treatment facilities. Uptake of alternative waste treatment technologies, and even sound landfilling in many countries, requires significantly more private capital investment in technology and infrastructure than is currently occurring (**see chapter 8**).

3.4.3 Obsolete pesticides and other agricultural chemicals

Agriculture is the main economic activity in many African countries, and many African governments have been trying to intensify food production by increasing agricultural inputs such as fertilizers and pesticides. Large stocks of pesticides and other agricultural chemicals are becoming obsolete owing to the purchase of unsuitable products, excessive donations and purchases, poor stock management, inadequate coordination, commercial interests, and pesticide bans (FAO 2017). It is estimated that 50,000 tonnes of obsolete pesticides have been accumulated in sub-Saharan Africa (WHO 2014). **Figure 3.13** shows the amount of obsolete pesticide accumulation in open spaces in African countries for 2008; the largest quantity of obsolete pesticide accumulation was in the United Republic of Tanzania, followed by South Africa and Eritrea.

Figure 3.13 Obsolete pesticide stocks in African countries



Source: WHO (2014)

3.5 Conclusions and recommendations

There is limited reliable, geographically comprehensive data and information on the quantity, composition, sources and management of solid waste in Africa. This makes it extremely difficult to plan, evaluate and monitor local, national and regional waste management systems.

Although per-capita waste generation in African cities is among the lowest in the world, demand for waste services is not matched by supply. This is especially true in low-income settlements. Some of the reasons for poor waste services and infrastructure in Africa are:

- Lack of political willingness, and resultant financial capability, to invest in waste services and infrastructure
- Weak governance and policy environment necessary for an enabling environment
- Weak enforcement and monitoring of legislation
- Lack of technically skilled waste practitioners in both the public and private sectors
- Lack of public awareness of the threats and opportunities of waste
- Adoption of, often, inappropriate technologies
- Lack of local end-use markets for waste reuse, recycling and recovery

As noted in **chapter 1**, solid waste generation is expected to increase significantly over the next century, which will place considerable strain on already strained municipal waste infrastructure. If waste generation is to be curbed and waste reuse, recycling and recovery is to be promoted in Africa, appropriate infrastructure must be put in place now. Uncontrolled dumping and open burning must be eliminated in Africa as the continent moves towards the use of sanitary engineered landfills for residual waste.

Recommendations for improving the management of solid waste in Africa are as follows:

- Attention should be paid to the regular collection and documentation of reliable data on the amount, sources, types and composition of solid waste (general and hazardous) generated. This information should be freely available and used for, among others things, benchmarking, planning, monitoring and evaluation, and research purposes.
- The public should be educated on the health and environmental impacts of poor waste management (**see chapter 5**) via all available means, including school campaigns, radio campaigns, posters and flyers, informal meetings with community leaders, and social media. Environmental clubs in schools should train students to be agents of change in environmentally sound waste management. There should be strong public and stakeholder participation in all steps of waste management projects.
- North-south cooperation is essential to accelerate appropriate technology and knowledge transfer. African countries should create an enabling environment to attract private investors into the waste sector (**see chapters 7 and 8**).
- Waste services and infrastructure should be carefully chosen in terms of their sustainability and should be implemented progressively. Municipalities should generally start with low-technology, low-capital, labour-intensive and culturally acceptable technologies. There are diverse waste delivery services in Africa designed to meet local needs. Those that work well from an economic and environmental perspective should be documented and promoted for replication elsewhere (**see chapter 7**).
- Waste generators should be charged a reasonable fee in accordance with the waste services they receive and the level of revenue of the clients should be taken into account. This would generate funds to expand waste services.
- The use and import of high-waste-generation, low-recyclability products should be discouraged through the introduction of financial disincentives (e.g. higher tax) or extended producer responsibility (EPR) (**see chapters 4 and 8**)
- Waste management policies with strict law enforcement should be introduced (**see chapter 4**). Moreover, gender should be mainstreamed into waste governance.
- The financial sustainability of waste management projects should be assessed before implementation (**see chapter 8**)

- Owing to their potential health and environmental impacts, hazardous wastes such as e-waste and medical waste should be collected, treated and disposed of separately, thereby ensuring that non-hazardous wastes are not contaminated.

- Private sector investment in waste facilities and infrastructure should be encouraged by creating an enabling environment through such means as favourable regulations and policies, strong institutions and waste governance. Moreover, mechanisms should be created to improve regional markets to achieve sufficient economies of scale for investment.

- Culturally, there is a high tendency for waste reuse in Africa. This behaviour should be encouraged and maintained, and single-use products should be discouraged where appropriate and where end-use markets do not exist.

- Local governments should put favourable policies and incentives in place for the promotion of waste minimization through the 3Rs (reduce, reuse, recycle). Waste separation-at-source should be promoted to make waste recycling and recovery easier and more affordable, and to ensure collection of clean recyclable waste streams with higher value (**see chapter 6**).

- The informal sector, as major actors in MSW collection and recycling, should be recognized, supported and integrated into the waste management system (**see chapter 6**). Governments should help the informal sector establish links to markets for secondary materials through the creation of regional networks. The informal sector should get appropriate training and safety procedures.

- Privatizing waste service delivery can be a good alternative for municipalities struggling to deliver satisfactory results, allowing them to enforce compliance through performance contracts and improve the overall standard of solid waste management.

4 Waste governance

4 Waste governance

What the reader can expect

The focus of this chapter is on the enabling governance environment to support sustainable waste management systems in Africa. The introduction section provides background on what is meant by governance and good governance and the status of governance in Africa. The next section focuses on regulation, and the status of the regulatory frameworks in different African countries. Shortcomings in the regulatory framework are highlighted through examples in various countries. Specific policy instruments aimed at waste prevention and reduction are also discussed. The chapter also includes insights into the use of economic instruments in the waste sector in Africa, with examples of specific instruments and the successes and failures of their implementation. Lastly, the chapter provides an overview of the role players in the waste sector, the arrangement of the different actors and examples of sound partnerships.

Key messages

The following are the key messages regarding waste governance in Africa:

- Good governance is crucial for creating an enabling environment for sustainable materials management (including resource and waste management) (Wingqvist and Slunge 2013)
- The main challenge in Africa is the inability of governments and private industry to keep pace with growing waste streams and the timely development of policies and strategies to effectively deal with it (Onibokun and Kumuyi 1999).
- There is a need to create sufficient capacity (financial, institutional, technological and infrastructural) to drive environmentally sound waste management (Bello *et al*. 2016)
- The limited use, and poor design, of economic instruments in solid waste in Africa represents a "*lost opportunity"* (UNEP 2005).
- Non-domestication of international agreements is making Africa an easy target for illegal dumping of hazardous waste from outside of the continent (Osibanjo 2002, Ahmend-Hameed 2016).

4.1 Introduction

"*Urban governance presents the most daunting and challenging task for sub-Saharan African countries in this century*" (Rakodi in Lwasa and Kadilo 2010:27). Governance refers to how power and authority are exercised and distributed, how decisions are made and implemented and the extent to which citizens are able to participate in decision-making processes and hold decision-makers accountable (Wingqvist and Slunge 2013). Onibokun and Kumuyi (1999:4) define good governance as "*the presence of a government with good and legitimate leadership, a lawful claim to power and authority (based on a mandate derived from the people's will), vision and a progressive socio-political agenda acceptable to, and accepted by, the people and implemented with honesty, transparency, and accountability*". They go further to state that "*good governance will lead to the institutionalization of appropriate policies, programmes and strategies for urban management that help to eliminate or ameliorate the problems posed by rapid urbanisation*". Therefore, good governance aims to ensure inclusive participation, making governing institutions more responsive and accountable, and respectful of international norms and principles (Wingqvist and Slunge 2013).

The success of municipal solid waste management relies heavily on an enabling governance environment determined by social, economic and psychological factors, including public participation, policy, and public attitudes and behaviour (Ma and Hipel 2016). The effectiveness and sustainability of waste management services, being one of the most visible urban services, therefore serves as an indicator for sound municipal management, successful urban reforms and good local governance (Okot-Okumu 2012).

"*The last three decades have seen the steady rise of a discourse of 'good governance' in African cities, ideologically deployed in both the rhetoric and practices of democratization, privatization, decentralization and liberalization*" (Myers 2011:104). Unfavourable operating environments for solid waste management nevertheless remain a reality in Africa (Mbuligwe 2012).

4.2 Direct regulation

Environmental problems associated with solid waste management (**see chapter 5**) have traditionally been addressed through command-and-control regulations. A review of solid waste management in Africa, found that a number of countries have regulations and policies on how waste should be managed (Bello *et al.* 2016). The Guidelines for Framework Legislation for Integrated Waste Management (UNEP 2016) highlights the need to include mechanisms to manage the implementation of the legislation. It appears that despite strong legislation in some countries, however, the implementation and enforcement of this legislation remains weak. In some countries, state officials "*are not even aware about the strategies of service delivery that exist*" (Makara 2009).

The subsections below provide some examples of identified problem areas associated with waste regulation in Africa.

4.2.1 Weak regulatory framework

The legal framework for waste management is often fragmented and the provisions dealing with municipal solid waste, weak. This was found in the case of Egypt, for example, where there is no clear distinction between roles and responsibilities of the governorates, municipalities, service providers and waste generators (NSWMP 2011). Similarly, Nigeria has a plethora of legislation relating to the environment that touches on waste management, but with a lack of implementation and enforcement of the laws (Nwufo 2010). Although South Africa has strong legislation, it has not been translated into practical action plans, which resulted in government not meeting the National Waste Management Strategy targets set for 2016 (DEA 2012).

4.2.2 Unsupportive policy, legal and regulatory environment

The private sector should play an important role in the management of waste throughout Africa, but in some instances municipal by-laws assign full responsibility for waste management to government bodies, creating a barrier to private sector involvement (Bello *et al*. 2012). Kenya is a case in point, where responsibility for waste collection and disposal, regulation and monitoring of activities of waste companies and generators of solid waste, enforcement of all laws and by-laws relating to solid waste, and coordination of actors involved in solid waste management are all assigned to the local municipality (Van Dijk and Oduro-Kwarteng 2007). However, in Nairobi, private sector participation in solid waste collection is spontaneous, unplanned and open to competition without regulation. In addition, it is reported that "*companies violate many of the solid waste laws and by-laws, especially those on disposal*" (Van Dijk and Oduro-Kwarteng 2007). The command-and-control waste strategies of Kenya proved to be inefficient, as evidenced by the mountains of uncollected and illegally dumped waste (UNEP 2005, Kazungu 2010). The failure of the waste management laws and regulations is largely owing to ineffective provisions and sanctions to deal with transgressors and the inability or unwillingness of officials to enforce laws (Kazungu 2010).

According to Mbuligwe (2012), East African countries have policy, laws and regulatory provisions that restrict improvements in solid waste management by restricting cost recovery, which is necessary for service sustainability in the long run and to cover short-term shortfalls from traditional budget sources. In Ghana, the Local Government Act, 1993 (Act 462) confers power to local authorities to promulgate and enforce by-laws to regulate solid waste management, among other things, but private companies cannot operate without the approval of, or a licence from, the local authority (Van Dijk and Oduro-Kwarteng 2007). A similar situation has emerged in South Africa, where the new regulatory framework (post 2009) has resulted in significant changes in the requirements for business to operate legally in the waste sector. Businesses entering the waste economy in South Africa have identified time delays in environmental authorization approvals, subjectivity in the interpretation of legislation, and site specific waste management licences, among other things, as barriers. Ensuring legal compliance is hampering the growth and sustainability of businesses in the waste sector, especially small businesses (Oelofse and Mouton 2014).

The legally binding framework for solid waste management in Uganda is spread over several different acts and ordinances (Göransson 2012). The policy framework is seen as lacking coherence. The conditions a company must fulfil to win a bid discourage small enterprises and co-operatives in the lower income brackets from earning an income through community contracting (Lwasa and Kadilo 2010). A legal framework that does not allow for community contracting and too high a barrier for registering a company are complicating factors (Göransson, 2012). The decentralized and privatized system of urban service delivery is said to be in a transition phase where guidelines are yet to be developed and implemented, which is why the system is not yet spelled out in the ordinances (Göransson 2012). There is also still the lack of a clear strategy on how networking, partnerships and community awareness will be achieved. The lack of operating institutional functions (including the absence of environmental committees in the area) could be a possible explanation for the knowledge gap in policy-making (Göransson 2012). Experiences in Kampala, Uganda, highlight the knowledge gap for making urban service delivery pro-poor (Lwasa and Kadilo 2010). A small policy change to allow the use of wheel barrows and other small-scale equipment that can access unplanned settlements, instead of the current prescribed use of trucks, would remove one of the most significant barriers for CBO and NGO involvement (Tukahirwa *et al*. 2010).

While making waste management a municipal function is seen as being crucial to ensuring that all citizens (rich and poor) receive a service, it can result in municipalities becoming gatekeepers to the waste, especially waste that can be reused, recycled and recovered. Public-private partnerships are key to unlocking this opportunity, however, if municipalities are stuck in traditional collect-transport-dump mode, opportunities to move waste up the hierarchy can be lost. Currently, this problem is being somewhat bypassed in Africa as a result of a large, active informal waste sector that is able to access recyclable waste at kerbside and on landfill in spite of local government policies regarding the private sector.

4.2.3 Weak enforcement of legislation

Waste policies and legislation will at best be an exercise in futility if they are not effectively enforced and complied with (Nwufo 2010). Oelofse and Godfrey (2008) argue that despite some deficiencies, the mere enforcement of available legislation, including municipal by-laws, will improve the waste situation at community level in municipalities. Indiscriminate dumping and littering are by default illegal activities that should be treated as such by law enforcement officers. It is therefore important that enforcement officers know what their responsibilities are under the law, and what actions can be taken under various circumstances.

Nigeria has a well-structured National Policy on Environment (1989) and the Rivers State blueprint on sustainable environmental practices (2004), but enforcement remains poor owing to a number of factors, including poor staffing, weak penalties, conflicting roles and attitudinal problems (Nwufo 2010, Elenwo and Urho 2017). A study in Uganda (Göransson 2012) found that the solid waste ordinance had not been implemented owing to a lack of enforcement mechanisms. Gray (2003) argues that the gap between legislation and enforcement may be symptomatic of centralized government decision-making processes that do not account for the weakness of lower-level institutions. Alternatively, a decentralized government system can potentially create problems such as inefficient coordination and poor distribution of information and monitoring systems, and can further be complicated by distrust between central and local officials and administrators. South Africa has seen a steady increase in environmental enforcement actions (including pollution and waste) over the past number of years, mostly attributed to the increase in enforcement officers appointed (DEA 2016b).

Ultimately, poor management of waste found across many African countries (**see chapter 3**) and the resultant environmental and human health impacts (**see chapter 5**), are the direct result of poor or no enforcement of environmental and waste legislation.

Cohan (2013) holds that courts of law can play an effective role in enforcing legislation if they have the means to make binding decisions. There is, however, no clear guidance on the viability of the establishment of specialist environmental courts in Africa. In South Africa, there is no simple answer as to whether or not to pursue environmental courts. The Hermanus environmental court was closed down by the Government despite its apparent successes, with no reasons for the decision made public. Cohan (2013:63) therefore concludes that "*Only once South Africa has reached a stage where there are presiding officers, prosecutors and lawyers well versed in environmental law, can the issue of the viability of specialised environmental courts be discussed*".

4.2.4 Harmonization of policy (across regions, link to regional approaches)

"*The choice of instruments for environmental management is increasingly influenced by the specific state of African environmental and technological capacity and by a call for the recognition of the role of traditional customs in nature conservation. This African perspective on environmental management is further intensified by an unmet need for regional, transboundary cooperation in the West African subcontinent*" (Hens and Boon 1999:337).

Cities in the SADC region, for example, are grappling with high volumes of waste, low waste management capacity and high costs of proper waste management. This is exacerbated by the lack of appropriate technologies and equipment coupled with poor enforcement. The SADC Secretariat is therefore developing a regional programme on waste management that will require a harmonized approach across the SADC (SADC 2017).

4.2.5 Policies to prevent waste

In August 2017, Kenya joined a number of other African countries that regulate the use of plastic bags through legislation aimed at waste prevention (Njugunah 2017). The list of countries with regulations on plastics and the year of the regulations are shown in **Table 4.1**. These regulations vary considerably, from a ban on only single-use (thin) plastic bags and associated requirements for bag thickness to complete bans on all plastic bags. This movement to ban plastic bags across Africa is sparking discussions between governments and industry on possible further bans on other single-use plastic products, such as polyethylene terephthalate (PET) beverage bottles and food services industry products such as plastic cups, containers, utensils and straws. Zimbabwe, for instance, instituted a ban on expanded polystyrene containers in the food industry in 2017 (Mhofu 2017). However, while many opportunities for "greener" product replacement exist, such bans must be carefully considered in terms of broader health and safety issues, like access to clean drinking water and safe food in Africa, and opportunities for local recycling of such products.

Table 4.1. Summary of introduced and imminent regulatory action on single-use plastic products

Country	Year	Level	Policy	Features
Benin	2018	National	Ban – entry into force	Ban on import, production, sale and use of non-biodegradable plastic bags
Botswana	2007	National	Levy – entry into force	Levy on retailer. No enforcement of retailers to charge for plastic bags. Retailers decided if and how much to charge
Burkina Faso	2015	National	Ban – entry into force	Ban on production, import, marketing and distribution of non-biodegradable plastic bags
Cameroon	2014	National	Ban – entry into force	Ban on non-biodegradable plastic bags
Cape Verde	2017	National	Ban – entry into force	Ban on the sale and use of plastic bags
Chad	2010	Local	Ban – entry into force	Ban on the importation, sale and use of plastic bags in the capital city, N'Djamena
Côte d'Ivoire	2014	National	Ban – entry into force	Ban on the importation, production, use and sale of non-biodegradable plastic bags <50μ
East Africa	2017	Regional	Ban – entry into force	The East African Legislative Assembly introduced a ban on the manufacturing, sale, importation and use of polythene bags
Egypt	2009	Local	Ban – entry into force	Ban on the use of plastic bags in Hurghada
Eritrea	2005	National	Ban – entry into force	Ban on importation, production, sale and distribution of plastic bags
Ethiopia	2007	National	Ban – entry into force	Ban on production and importation of non-biodegradable plastic bags <30μ
Gambia	2015	National	Ban – entry into force	Ban on the sale, importation and use of plastic bags
Guinea-Bissau	2016	National	Ban – entry into force	Ban on the use of plastic bags
Kenya	2017	National	Ban – entry into force	Ban on the importation, production, sell and use of plastic bags
Malawi	2015	National	Ban – entry into force	Ban on the use, sale, production, exportation and importation of plastic bags <60μ
Mali	2012	National	Ban – approved	Ban on the production, importation, possession, sale and use of non-biodegradable plastic bags
Mauritania	2013	National	Ban – entry into force	Ban on the manufacture, use and importation of plastic bags

Country	Year	Level	Policy	Features
Mauritius	2016	National	Ban – entry into force	Ban on the importation, manufacture, sale or supply of plastic bags. 11 types of plastic bags for essential uses and hygienic and sanitary purposes are exempt (for example roll-on bag for meat products, waste disposal bags, bags as integral part of packaging, bags manufactured for export)
Morocco	2009	National	Ban – entry into force	Ban on the production, importation, sale and distribution of black plastic bags
	2016	National	Ban – entry into force	Ban on the production, importation, sale and distribution of plastic bags
Mozambique	2016	National	Ban – entry into force	Ban on the production, importation, possession and use of plastic bags <30µ
Niger	2015	National	Ban – entry into force	Ban on production, importation, usage and stocking of plastic bags
Rwanda	2008	National	Ban – entry into force	Ban on the production, use, importation and sale of all polyethylene bags
Senegal	2016	National	Ban – entry into force	Ban on the production, importation, possession and use of plastic bags <30µ
Somalia	2015	Local	Ban – entry into force	Ban on disposable plastic bags in Somaliland
South Africa	2003	National	Ban and levy – entry into force	Ban on plastic bags <30µ and levy on retailer for thicker ones
Tanzania	2006	National	Ban – approved	Ban on plastic bags and bottles
Tunisia	2017	National	Ban and levy – entry into force	Ban on the production, importation and distribution of single-use plastic bags in major supermarkets and levy on consumer on thicker ones (>50µ)
Uganda	2009	National	Ban – entry into force	Ban on lightweight plastic bags <30µ
Zanzibar	2006	National	Ban – entry into force	Ban on the importation, distribution and sale of plastic bags <30µ
Zimbabwe	2010	National	Ban and levy – entry into force	Ban on plastic bags <30µ and levy on consumer for thicker ones
	2017	National	Ban – entry into force	Ban on Styrofoam products

Data source: adapted from UNEP (2018)

Bans on products also extend to hazardous materials. South Africa introduced regulations in 2008 placing a ban on the import and export of any asbestos or asbestos-containing product. This regulation also placed a ban on the import of any asbestos or asbestos containing waste material other than from a member of the Southern African Development Community (RSA 2008). The East Africa Legislative Assembly passed a bill on polythene materials control in 2011[9]. The Heads of State of the EAC needs to assent to this bill in order for it to come into effect.

4.2.6 Non-domestication of conventions

Osibanjo (2002) identified gaps in policy, "*piece-meal*" regulations and non-domestication of international agreements as weak links that make Africa an easy target for illegal dumping of hazardous waste from outside the continent. E-waste is a case in point, where the flow of e-waste into Africa is happening faster than the development of policies, safeguards and enforcement (**see chapter 3**). This institutional vacuum leads to serious human and environmental impacts in the importing countries (**see chapter 5**) (Osibanjo 2009 in Wingqvist and Slunge 2013). Common features of countries receiving e-waste are the lack of environmental regulation, capacity and infrastructure to manage this type of waste (Wingqvist and Slunge 2013).

African countries are significant players in the negotiations of environmental treaties (Osibanjo 2002, Gray 2003). However, these negotiations are often done by the Foreign Affairs offices rather than the ministries and departments that are responsible for implementation (Gray 2003). Shared and similar ecological and economic problems underscore a sense of solidarity among African countries, but there are numerous barriers to the implementation of these multilateral environmental agreements (MEAs) in Africa (Osibanjo 2002, Gray 2003). The African countries that are party to conventions relating to waste are listed in **Table 4.2**. The need for mainstreaming environmental considerations, including the domestication of conventions into government policy is only beginning to be acknowledged (Gray 2003).

Nigeria is a case in point, where the Government actively participates in international conferences and negotiations on treaties relating to the environment and is party to several international treaties, including the Minamata, Basel, Bamako, Stockholm and Rotterdam conventions (Ahmed-Hameed 2016). As a party to these treaties and conventions, Nigeria is under the obligation to apply international standards and measures in regulating and monitoring the environment. The country also has the duty to put in place policies and structures for the implementation of those standards within Nigeria. But evidence suggests that most Nigerian states and local institutions involved in environmental resource management lack funding, trained staff, technical expertise, and other prerequisites for implementing meaningful environmental protection policies and programmes. Furthermore, existing policies and practices are not aligned with international standards. Therefore, Nigeria appears to either lack the capacity or be unwilling to implement and enforce the provisions, obligations and standards enshrined in the international treaties, despite being a signatory (Ahmed-Hameed 2016).

4.2.7 Transboundary waste management

The Basel, Rotterdam and Stockholm conventions are the forefront of global efforts to track and manage the cross-border movement of waste (Rucevska *et al*. 2015). The Basel Convention is the only global treaty controlling transboundary movements and requiring the environmentally sound management of hazardous and other wastes (SBC 2011). According to the convention's provisions, transboundary movements of hazardous waste can only take place after the prior informed consent procedure has been followed and all states involved have given their consent to the transboundary movement. In the case of transboundary movements of materials such as e-waste and EEE, there are several challenges related to the enforcement of the Basel provisions. Specific challenges include "*the challenges of clear distinction between used EEE and e-waste and between hazardous and non-hazardous waste, as well as the overall challenge of monitoring and enforcing the Basel Convention and the Waste Shipment Regulation*" (SBC 2011:12). This is of specific relevance to Africa in the context of the global waste management system, especially as it relates to global trade in recyclables and the evolution of crime (**see chapter 6**).

The Bamako Convention was adopted by the 12 nations of the Organisation of African Unity, who were of the view that the Basel Convention was not strict enough

9 http://www.eala.org/media/view/eala-passes-bill-on-polythene-materials-control

Table 4.2 Ratification status[10] of waste related conventions (October 2017)

Country	Minamata	Basel	Bamako	Stockholm	Rotterdam	Country	Minamata	Basel	Bamako	Stockholm	Rotterdam
Algeria	–	a	–	R	–	**Liberia**	S	a	–	a	a
Angola	S	a	–	a	S	**Libya**	S	a	R	a	a
Benin	R	a	R	R	R	**Malawi**	S	a	–	R	a
Botswana	a	a	–	a	a	**Mali**	R	a	R	R	R
Burkina Faso	a	a	–	R	R	**Mauritania**	R	a	–	R	A
Burundi	S	a	–	R	a	**Morocco**	S	a	–	R	a
Cameroon	S	a	R	R	R	**Mozambique**	S	a	a	R	a
Central African Republic	S	a	–	R	–	**Namibia**	a	a	–	a	R
Chad	R	a	–	R	R	**Niger**	R	a	R	R	a
DRC	–	a	a	a	R	**Nigeria**	S	R	–	R	a
Republic of the Congo	S	a	a	R	R	**Rwanda**	a	a	–	a	a
Cote d'Ivoire	S	a	R	R	R	**Senegal**	R	a	R	R	R
Djibouti	R	a	–	R	a	**Sierra Leone**	R	a	–	a	R
Egypt	–	a	–	R	–	**Somalia**	–	a	–	a	a
Equatorial Guinea	–	a	–	–	a	**South Africa**	S	a	–	R	a
Eritrea	–	a	–	a	a	**South Sudan**	–	a	a	R	a
Ethiopia	S	a	–	R	a	**Swaziland**	a	a	–	a	A
Gabon	A	a	–	R	a	**Tanzania**	S	a	R	R	R
Gambia	R	a	–	R	a	**Togo**	R	a	R	R	R
Ghana	R	a	–	R	R	**Tunisia**	S	a	R	R	R
Guinea	R	a	–	R	a	**Uganda**	S	a	a	a	A
Guinea–Bissau	S	a	–	R	R	**Zambia**	R	a	–	R	A
Kenya	S	a	–	R	R	**Zimbabwe**	S	a	a	R	A
Lesotho	a	a	–	R	a						

Abbreviations: A (acceptance), a (accession), R (ratification), S (signature)

10 Minamata: www.mercuryconvention.org/countries
Basel: www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx
Bamako: https://treaties.un.org/pages/showDetails.aspx?objid=080000028009385c
Rotterdam: www.pic.int/Countries/Statusofratifications/tabid/1072/language/en-US/Default.aspx
Stockholm: http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatories/tabid/4500/Default.aspx

to protect Africa against "dumping" from the developed world (DEAT 2000). Unlike the Basel Convention, Bamako does not exclude certain hazardous wastes (e.g. radio-active wastes). It is, however, limited in its application to countries that are parties (SBC 2011).

Another global treaty that addresses some aspects of e-waste management is the Stockholm Convention. Several POPs regulated under this convention have been widely used in the manufacture of EEE plastic components. Under the Stockholm Convention, articles containing such chemicals have to be identified and disposed of in an environmentally sound manner at the end of their useful life. Other chemicals regulated under the convention, in particular dioxins and furans, are generated through the open-burning of e-waste. The convention requires that measures be adopted to reduce the total release of such chemicals (SBC 2011). Management of the components regulated under the Stockholm Convention is a challenge in African countries that do not have facilities for safe disposal.

The control of transboundary movements of waste within Africa is also important and necessary because some countries do not have sufficient and appropriate waste management facilities to manage certain hazardous waste streams, while there is available capacity elsewhere on the continent. It will also become even more important in the future if a regional approach to secondary materials management is pursued (**see chapter 3 and 6**).

4.3 Economic instruments

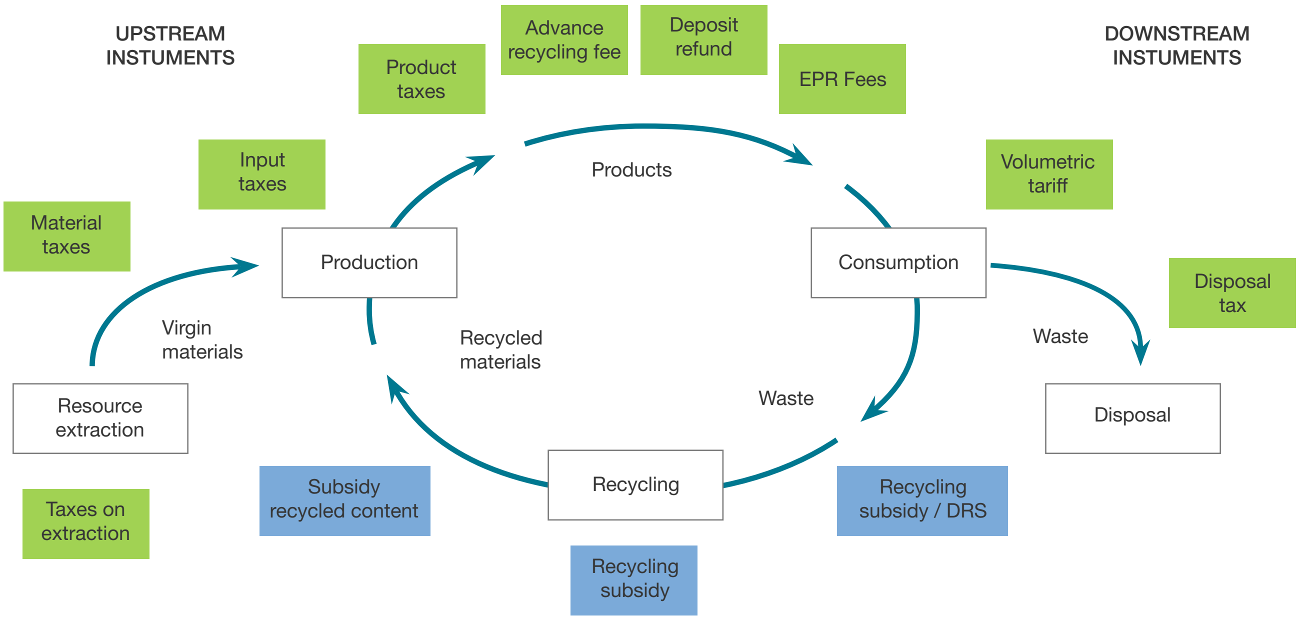
In contrast to command-and-control regulations, economic policy instruments such as taxes and subsidies, aim to change behaviour indirectly by changing prices. The main aim of using economic instruments in the waste sector is typically to reduce waste generation or divert waste away from landfill towards recycling and recovery (Nahman and Godfrey 2010). In the African context, economic instruments could also be used to promote cost effectiveness and service efficiency and to generate revenue. **Figure 4.1** provides an overview of various types of economic instruments that can be implemented at various stages along the product/waste value chain (Nahman and Godfrey 2014, DEA 2016a).

A variety of user charges are being (or have been) used in African cities. These charges include monthly solid waste charges, pay-as-you-dump fees, a collection charge as part of a monthly service fee (e.g. for low income groups in Gaborone) and annual municipal rates (e.g. for home owners in Gaborone and Harare). In Kenya, user charges, subsidies and licences, import duty waivers and deposit-refund systems are used, but to a limited extent. The user charges are often not based on weight or volume, however, and are not cost reflective (UNEP 2005).

South Africa currently has both mandatory and voluntary waste management charges in place. Mandatory charges are levied on plastic bags, waste tyres and incandescent light bulbs, through various product taxes. The levies are currently set by the Government at R0.08 per plastic bag (US$0.01), R2.30 per kg for tyres (US$0.16) and R6.00 per electrical filament lamp (US$0.42) (SARS 2017). Voluntary EPR fees are levied on products such as paper, packaging, oil and batteries, and have encouraged the development of local secondary commodity markets. The voluntary charges are currently collected by product responsibility organisations (PROs) (DEA 2016a). The situation in South Africa is, however, changing fast with the gazetting of the National Pricing Strategy for Waste Management (DEA 2016a). While the pricing strategy allows for a range of economic instruments (punitive and rewarding), the Government is leaning towards the implementation of product taxes (to fund EPR) and landfill taxes. The pricing strategy also outlines the approach to the implementation of industry waste management plans (EPR schemes), which, as with tyres, will most likely be financed through product taxes collected by the South African Revenue Service. This is different from what is found in many developed countries, particularly across the European Union, where EPR is funded through an EPR fee collected directly by PROs (DEA 2016a).

A deposit-refund system has been successfully applied on beverage containers in Kenya. This system is reported to be popular owing to its ease of administration, which involves collaboration with wholesalers, retailers and consumers (UNEP 2005). A deposit-refund system on plastic bottles was at one point considered by the South African Department of Environmental Affairs, but appears to have been superseded by the move to EPR.

Figure 4.1. Examples of economic instruments in the product/waste value chain



Source: Nahman and Godfrey (2014)

In Ghana, a system of taxes and charges was set up to discourage the import of old cars. Technically, the penalty was a tax paid by importers of cars that at the moment of import exceed a defined age from the date of manufacture. This system failed to achieve the environmental target because it was still cheaper to import an old car than to buy one less than five years old; imports of scrap engines were not affected by the tax and old vehicles already in the country were not taxed (Hens and Boon 1999).

The limited use, and often poor design, of economic instruments in solid waste in Africa represents a "*lost opportunity considering the huge potential of these instruments*" (UNEP 2005:20). International experience has shown that moving waste up the hierarchy towards minimization, reuse and recycling can be achieved through the use of economic instruments, provided they are appropriately designed and implemented (Nahman and Godfrey 2010).

4.4 Role players

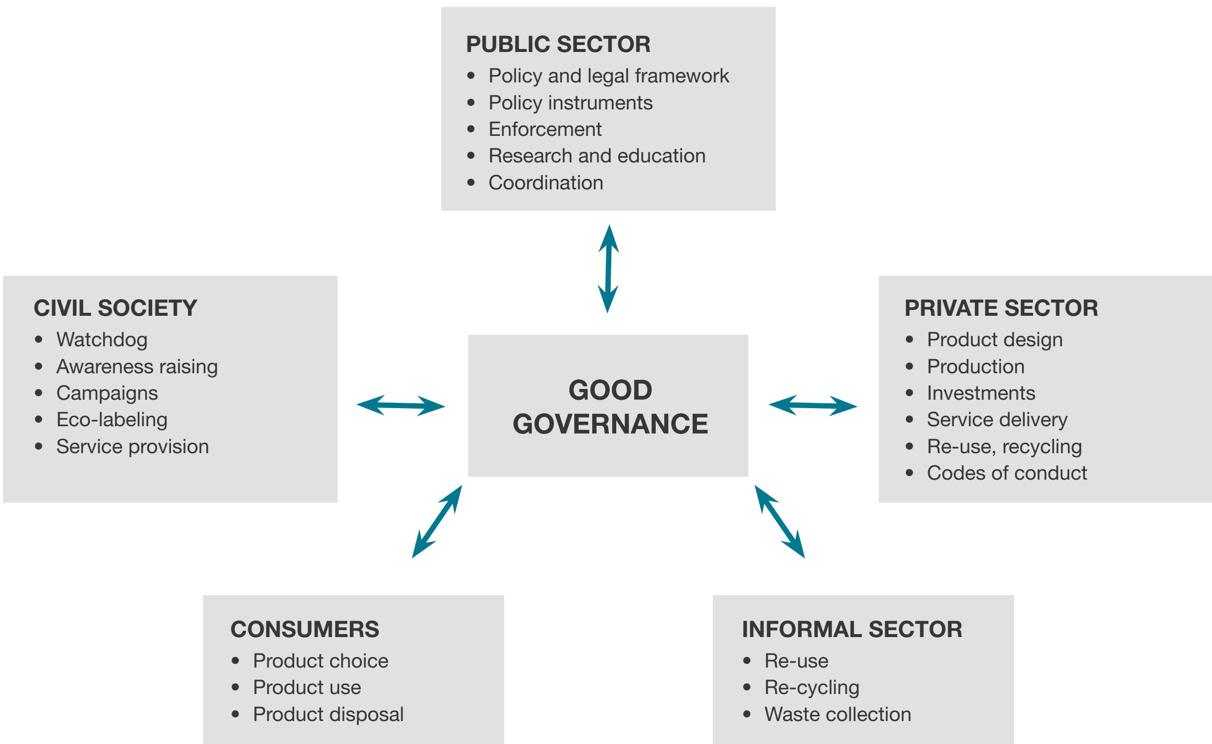
In most urban areas in Africa, solid waste management is the responsibility of the municipality (UN-Habitat 2010). Government has a key role in the formulation and implementation of policies, strategies and regulations. Other important actors in waste governance include the private sector (industry and business), civil society, consumers and the informal sector (**Figure 4.2**) (Wingqvist and Slunge 2013). NGOs and CBOs are becoming increasingly involved in urban service provision; however, there is generally a lack of knowledge on the kind of activities NGOs take up and the results achieved (Tukahirwa *et al*. 2010). These actors, however, help to strengthen governance capacity (Wingqvist and Slunge 2013).

The absence of effective coordination among the various stakeholders can, however, be a problem. This is the case in Dar es Salaam, where lack of coordination has affected collection of user fees and enforcement of law against defaulters. The municipal authorities have the legal mandate to enforce the regulations, but the private service providers are the ones affected by uncollected revenue. In addition, the municipal authorities have limited trust in the performance of the private sector, resulting in short-term contracts (not exceeding two years) being awarded. This affects the private sector's ability to employ skilled staff, expand services through financial support and loans, formulate strategies and develop innovative technologies for effective service delivery (Kirama and Mayo 2016).

In East Africa, there are no examples where the state is acting in isolation in its management of waste, but there are also no examples where non-state actors have taken the lead in solid waste management. The typical waste management arrangement in East Africa is illustrated in **Figure 4.3**.

In Maputo City, Mozambique, there are three government institutions with responsibilities concerning waste management, namely the Ministry of the Environment (policy and regulation at national level), the Fund for the

Figure 4.2 Actors involved in sustainable materials management



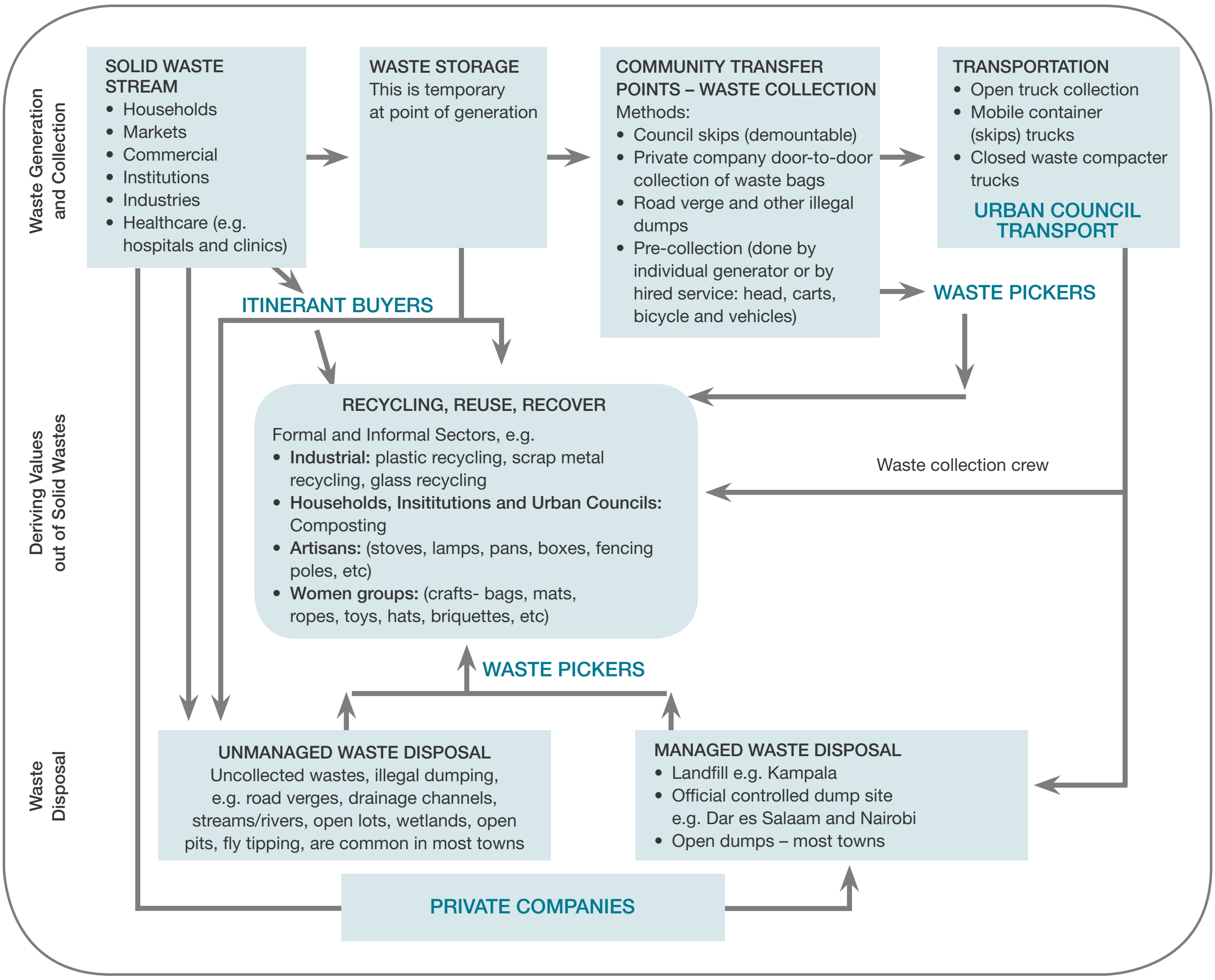
Source: Wingqvist and Slunge (2013)

Environment (training of environmental teachers) and the Municipal Department of Solid Waste Management and Health (MSW service delivery, strategies relating to MSW issues and public education and awareness) (Dos Muchangos *et al*. 2017). The civil society stakeholders are non-governmental and non-profit organizations, volunteer associations and the media. The role of civil society is mostly concerned with environmental education, projects and campaigns, but also includes support and management of waste processing and treatment initiatives and lobbying for the introduction and improvement of pertinent laws and policies. Academia is responsible for research and providing support to civil society and, lastly, the MSW generators are responsible for payment for waste management services and compliance with MSW-related rules and directives (Dos Muchangos *et al*. 2017). An important conclusion of Dos Muchangos *et al*. (2017:133) is that "*for a solid waste management system to be sustainable and integrated, all the stakeholders are required to be present and collaborate throughout the processes of planning, implementation and monitoring of how the system is structured and functions*".

4.4.1 Stakeholder mapping

Arrangements for waste service provision range from self-provision by the municipality through collective action independent of external agencies to indirect state provision through sub-contracting to other agencies, including NGOs, private companies and user groups (Majale-Liyala 2013) (**see Case Study 4**).

Figure 4.3 Typical waste management arrangement in East African urban centres



Source: Okot-Okumu (2012)

CASE STUDY 4

MODELS OF WASTE SERVICE DELIVERY IN KENYA, UGANDA AND THE UNITED REPUBLIC OF TANZANIA

An analysis of the involvement of non-state actors in solid waste management in Kenya, Uganda and the United Republic of Tanzania (Majale *et al*. 2010) revealed three models of waste service delivery:

- Market dominance and networking (Jinja, Uganda)
- Community-dominated (Mwanza, United Republic of Tanzania)
- Hierarchical arrangement (Kisumu, Kenya)

MARKET DOMINANCE AND NETWORKING

Efforts to privatize waste management resulted in waste management services (specifically collection and transfer to disposal sites) being contracted out by council through open bidding. Contracts were awarded to two service providers (private companies with several employees/casuals) operating in different areas in the city. The duration of each contract was one year. Payments from the council to the service providers were based on the number of skips emptied at the disposal site. In the case of Jinja, households did not pay directly for the service, as previous attempts to introduce a fee had not been successful, but they paid indirectly through property tax (Majale *et al.* 2010).

In addition to the "market scenario", there are also women and youth groups involved in road sweeping and clean-ups on an ad hoc and voluntary basis. The National Environmental Management Authority (NEMA) (a State organ) has established pedagogic centres to showcase exemplary activities and is assisting in sourcing additional skips to be used in the council. These additional skips augment the service provided by the contractors. International organizations are also involved, including the "Lake Victoria Region Local Authorities and Counties Cooperation", which has been active in promoting the sharing of practices among council members, and the International Labour Organization and Lake Victoria Basin Commission, which has been involved in capacity-building (Majale *et al.* 2010).

In this model, there is a suitable environment for competition, but time is of essence to ensure timely signing of contracts and payment and good return on investment. The by-laws recognize the role of private contractors, and contracts are only reviewed based on performance. However, decision-making, including policy development, remains with the council and service providers do not attend council meetings (Majale *et al*. 2010).

COMMUNITIES AND NETWORKS

In this model, the communities are the major implementers of solid waste management services, with minimal state involvement. In the case of Mwanza, the privatization of solid waste management services resulted in the council awarding contracts to CBOs and two private companies that serve the central business district. Similar to the scenario in Jinja, the contracts are annual, which does not encourage continuous improvement in service delivery. The contracts are awarded following a democratic process (but not without complaints of political interference). The CBOs are required to register as waste service providers and pay registration fees (Majale *et al*. 2010).

The contractors are people from the community that they serve. This model therefore provides employment opportunities to local community members, who in turn take pride in their work keeping their community clean. All households receiving the service pay a standard fee to the contractors. In instances of non-payment, the contractors can approach the council's legal office for assistance (Majale *et al*. 2010).

The CBOs and public decide on the location of transfer stations or a skip. The CBOs collect the waste from the households, but the council is responsible for transporting the skips from the transfer stations to the disposal site. In this model, the CBOs have legal contracts and social recognition, but they have limited influence on decision-making. Responsibility and financial burden are shared between the contractors and the municipality (Majale *et al*. 2010).

HIERARCHICAL ARRANGEMENTS

Governance as hierarchies refers to governance conducted by and through vertically integrated State structures, with imposition of laws and other regulation. In Kisumu, the council is still solely responsible for solid waste management, with a typical command-and-control management regime and no official arrangements that involve other non-State actors in solid waste management. The collection services are concentrated in the central business district. Only a few residential areas receive a service from the council, with non-State actors unofficially providing a service to most residential areas. The problem with the non-State actors is that they are not legally recognized in the solid waste arena (Majale *et al*., 2010).

Payment for waste services in Kisumu is included in the water bill. The private companies in Kisumu are operating in open competition purely based on a willing-buyer-willing-seller basis. Payments are made at the end of the month as per a verbal agreement with the household. CBOs operate mostly in middle- to low-income areas and charge fees agreed upon with the household (Majale *et al*. 2010).

4.4.2 Relationship between formal and informal

The failure of the formal solid waste sector to provide adequate waste collection and transportation systems creates an environment in which the informal waste sector can thrive (Noel 2010). The informal sector are generally not controlled and do not follow any health and safety regulations (Okot-Okumu 2012). Morocco is the only country in Africa with a national policy that recognizes the informal sector as part of the private sector and authorizes it to collect recyclables (Scheinberg and Savain 2015).

Informal waste pickers operating in urban councils in East Africa deal directly with households, markets and other establishments. The positive contribution of the informal sector is also reflected in its financial contribution to the formal waste management sector. The activities of the informal waste sector often translate into direct cost reductions for the formal waste management system, such as in Lusaka, Zambia, where the net cost of informal waste collection is only US$1.60 per tonne which is US$10.40 per tonne less than in the formal sector (Aparcana 2017).

Although these pickers have a positive impact on urban solid waste management, they also contribute to social problems, including littering, nuisance, and social disruption. The informal pickers also compete for zones allocated to formal collectors, causing financial losses for contracted collectors (Okot-Okumu 2012). Achankeng (2003) has reported such conflicts in Cameroon.

The formal waste management sector in South Africa recognizes the value of pickers by providing lockable facilities at landfills where recyclables can be stored until quantities viable for transport have been collected. The formal sector also makes provision for picking at transfer stations, providing opportunities and space for pickers to do their work (Oelofse and Strydom 2010). In Bamako, Mali, the informal sector carries out 100 per cent of total recycling activities (Aparcana 2017). Several authors cited in Okot-Okumu (2012) conclude that communities (through CBOs) and the public, private and informal sectors can all work together to improve waste management in urban areas. Okot-Okumu (2012) argues that formalization of waste picker groups can "*make them more effective, make them follow health and safety regulations and protect them against exploitation*".

Lock-up facilities at a landfill in South Africa
Photo credit: © Linda Godfrey, CSIR

According to Wilson *et al.* (2006), there is a direct link between the level of structure of the informal recycling sector and the capability of the people involved to add value to the secondary materials.

Incorporating existing informal recycling systems into the operations of formal municipal solid waste management can bring significant benefits (Oelofse and Strydom 2010). Strategic planning of municipal waste management systems must document, understand and build on existing informal collection and recycling systems. Careful consideration must also be given to preventing marginalization of women working in the informal sector when the informal sector is integrated.

4.4.3 Role of industry (exchange)

Privatization of municipal services is often prompted by poor service delivery by public sector entities (Fobil *et al.* 2008). In many sub-Saharan cities, the waste management services provided by local authorities are not responsive to the needs of the communities, resulting in "*widespread dissatisfaction by residents and lack of confidence in the service delivery by local government authorities*" (Fobil *et al.* 2008:263). Pressure from international sponsors of urban waste management initiatives in Africa often force local authorities to privatize or at least scale down government involvement (Fobil *et al*. 2008, Makara, 2009). The decentralization of services is often also the result of dependence on donor funds for projects (Devas 1999, Göranson 2012).

4.4.4 Sound partnerships

Private sector involvement in urban service delivery has proliferated throughout the African continent. In Uganda, the recognition by the Government of the weakness of public authorities in solid waste management (especially in Kampala) led to the development of the strategic framework for reform in 1997. One of the main elements of the strategic framework was to shift service delivery activities to the private sector while the municipal council focused its efforts on planning, specification, supervision and monitoring to ensure adequate coverage and quality in service delivery. The importance of NGOs and CBOs in service delivery is acknowledged in the legislation, including the constitution and the Local Governments Act of 1997 (Tukahirwa *et al*. 2010).

Solid waste management in Africa should not be seen as a monopoly of government or of private companies. Partnerships are said to promote the "*expansion in the quantity and quality of public goods and services that can be produced, beyond the levels possible under pure private or pure public arrangements* (Ayee and Crook 2003:3). Partnerships in solid waste management in Africa have mainly emerged between government and large private companies through formal contracts. NGOs and CBOs participate in different forms of partnerships (often in more than one partnership) with government, private companies and other NGOs and CBOs (Tukahirwa *et al*. 2010). The success achieved by local and international NGOs and CBOs in Kampala, Uganda, in the "*Waste to Wealth*" programme in Cameroon, Nigeria and Uganda, and by the "*Women Initiative the Gambia*" are documented in the GWMO (UNEP 2015).

Partnerships between CBOs and private companies are predominantly for collection and recycling activities. Some foreign private companies sponsor the purchasing of equipment for waste collection and for the construction of demonstration sites for recycling. Private plastic recycling companies support the community mobilization and awareness activities of local NGOs and CBOs. Government authorities have brought NGOs and CBOs in to assist private companies with community awareness of waste collection issues and fees. It is important to note that such partnerships were only successful when the CBOs and NGOs were involved from the start of the waste collection contract (Tukahirwa *et al*. 2010).

Successful implementation of partnerships is not easy and comes with major challenges, including the division of tasks, responsibilities and power. NGO and CBO involvement has been hampered by shortage of resources, donor dependencies, central policies that favour formal large-scale private companies and lack of government recognition. While policies advocate NGO and CBO involvement, the official conditions included are not supportive of CBOs and NGOs (Tukahirwa *et al*. 2010).

4.5 Conclusions and recommendations

The success of solid waste management in Africa relies heavily on an enabling governance environment determined by social, economic and psychological factors, including public participation, policy, and public attitudes and behaviour. The current governance environment in most African countries is not supportive of sustainable and effective waste management. The regulatory framework in most countries assumes that what works well in one municipality will work well in others, but this is not always the case. Organizational structures, by-laws and waste collection systems vary between countries and between different municipalities within the same country (CSIR 2011). Given the challenges experienced by local authorities across Africa, the importance of partnerships between government, the private sector, civil society, consumers and the informal sector should be recognized and strengthened.

Fragmentation in legislation needs to be addressed and mechanisms should be created to manage implementation and effective enforcement. Transboundary movements of waste into Africa need to be controlled through the domestication of conventions and treaties to avoid Africa being an easy target for illegal dumping of hazardous waste from outside the continent. However, responsible and controlled movements of waste and secondary materials between countries in Africa need to be supported to ensure safe management, treatment and disposal of waste and secondary resources at appropriate facilities.

5 Impacts of waste in Africa

5 Impacts of waste in Africa

What the reader can expect

This chapter focuses on the impacts of poorly managed waste on human health and the environment in African countries. It brings major flaws in waste management practices to the fore, including uncontrolled dumping and open burning, the most commonly used waste management practices in Africa. The impact of these practices on human health and the environment is discussed, with supporting case studies. The chapter also sheds light on illegal cross-border trafficking of waste and its impacts on human health, especially on vulnerable groups, including waste collectors, children and women. In addition, the chapter considers the hazards posed by the poor management of health care and nano wastes and the need for more stringent measures and regulatory frameworks for hazardous waste in general. The chapter draws attention to the impact of poor waste management practices on climate change and ecosystems, including the impact of littering on the marine environment. The chapter ends with recommendations to reduce the negative impacts of waste in Africa.

Key messages

The following are the key messages regarding the impacts of waste on human health and the environment in Africa:

- Waste management is a major challenge facing many African countries. Factors such as lack of awareness; weak environmental legislation and enforcement; and limited resources, including financial resources, result in inefficient waste management in many African countries, with the potential to directly impact human health and the environment.
- Open dumping (uncontrolled and controlled), often associated with burning, are the predominant disposal methods used in Africa (**see chapter 3**), with the potential to have serious implications for human health and the environment.
- The impacts are not always local, but can be far reaching (e.g. methane and black carbon released through open burning of waste are short-lived climate pollutants with strong effects on regional and global climate change).
- Africa is a global destination for end-of-life EEE and vehicles exported from developed countries in North America, Europe and Asia, where it accumulates as waste (See **Topic Sheet 2** in **chapter 3**). Current e-waste recycling practices, often informal, pose potential risks to people and the environment. Children and women are heavily involved in e-waste recycling in Africa, constituting the most vulnerable group for this waste.
- Recycling of used lead-acid batteries in informal workshops in Africa is a major source of lead pollution, exposing considerable numbers of people and the environment to adverse effects.

Key messages (continued)

- In many African countries facilities for the final treatment or disposal of health care waste are inadequate or sub-standard. It is therefore imperative to enforce special legislative and regulatory measures to help manage the often virulent nature of health care waste.
- Emerging waste streams such as nano-waste, pose a potential future risk for Africa, as these wastes usually end up in the MSW, exposing communities and ecosystems to potential risk.
- Plastic waste is growing in Africa. With weak waste collection systems and disposal of waste to uncontrolled and controlled dumpsites, the leakage of plastic into the environment poses a significant threat to the environment and economies. This is compounded by the lack of recycling in Africa.

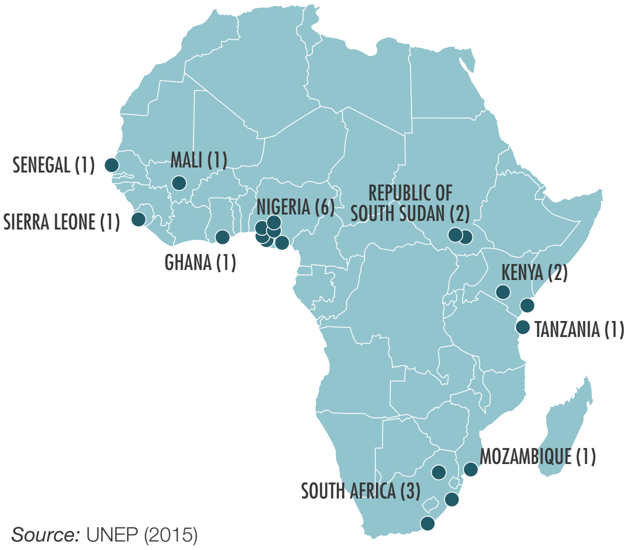
5.1 The waste-environment-public health nexus

Chapter 3 presented the state of waste and waste management in Africa and highlighted the key waste management challenges facing the African continent. These include:

- Uncontrolled dumping of waste
- Open burning of waste
- Poor waste collection coverage, resulting in the accumulation of waste in urban areas
- Trafficking and dumping of waste, particularly hazardous waste, in Africa
- Informal collection and recycling
- Informal land reclamation
- The emergence of new, often complex waste streams

The impact of these activities on human health and the receiving environment (water, air, soil) in Africa are discussed in the following sections.

Figure 5.1 Dumpsites in Africa included within the world's 50 biggest dumpsites



Source: UNEP (2015)

5.1.1 Uncontrolled dumping

Open dumping (uncontrolled and controlled), with associated burning of waste, is the most common waste disposal method in Africa (Hoornweg and Bhada-Tata 2012, Johannessen and Boyer 1999) (**see chapter 3**). According to UNEP (2015), 19 of the world's 50 biggest dumpsites are located in Africa, all in sub-Saharan Africa (**Figure 5.1**). Uncontrolled dumping of waste in African cities has the potential to cause significant direct and indirect impacts[11] on communities and receiving environments (Mpofu 2013, Jerie 2016). Residents, particularly those living adjacent to dumpsites, are at risk from the improper disposal of waste, owing to the potential of the waste to contaminate water and food sources, land, air and vegetation (Kimani 2012). Furthermore, the impacts of open dumping and burning on human health and environment can be diverse.

Dandora dumpsite, Nairobi, Kenya

Photo credit: © Janis Brizga, Green liberty / EEB

11 According to the GWMO (UNEP 2015) direct health impacts affect those coming into contact with uncollected wastes or breathing the fumes if those wastes are burned. Indirect health impacts occur for example via blocked drains and watercourses, which provide breeding grounds for vectors causing infectious diseases such a cholera, dengue fever and plague, and also cause flooding.

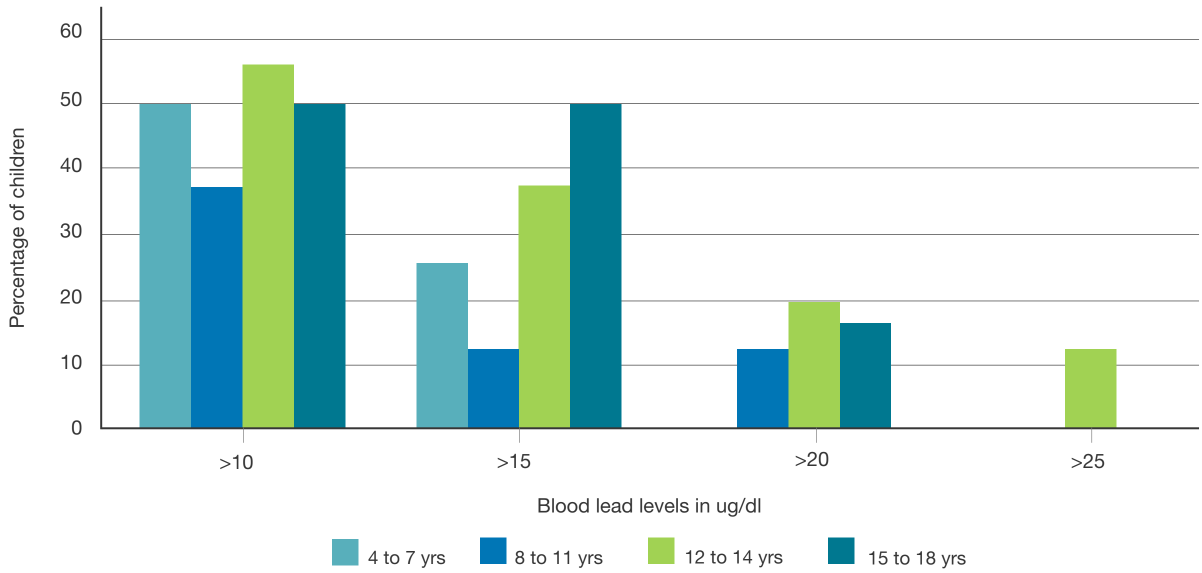
Table 5.1 Analysis of soil samples from Dandora dumpsite, Nairobi, Kenya

Elements	Mean elemental conc. of soil samples (ppm)			Reference values in soil standards	
	Within the dumpsite	Adjacent to the dumpsite	Waithaka soil samples (pre-urban area on the outskirts of Nairobi)	The Netherlands	Taiwan
Potassium	19 100	20 758	7 835	–	–
Calcium	77 000	14 558	4 300	–	–
Titanium	6 100	5 433	5 650	–	–
Chrome	689	157	118	100*/250**	100[a]/400[b]
Magnesium	3 500	4 366	2 400	–	–
Iron	84 800	45 800	57 100	–	–
Copper	507	105	BDL	50*/100**	120[a]/200[b]
Zinc	2 100	462	133	200*/500**	35[a]/500[b]
Mercury	46.7	18.6	BDL	0.5*/2**	0.29[a]/2[b]
Lead	13 500	264	34.5	50*/150**	50[a]/500[b]
Cadmium	1 058	40	–	1*/5**	2[a]/5[b]

Source: Kimani (2012)
Abbreviations: BDL, below detection limit
* Tentative soil quality standards for the Kingdom of the Netherlands
** Reference value for good soil quality
[a] Taiwan's standard values to assess soil quality,
[b] The upper limit of the background concentration

A study of the Dandora municipal waste dumping site in Nairobi, Kenya, for example, showed high levels of heavy metals not only within the dumpsite, but also in adjacent soils, well above the control sample taken from a residential area on the outskirts of Nairobi (Waithaka) and reference values in soil standards (**Table 5.1**) (Kimani 2007, 2012). Dandora is the main disposal site for most of the solid waste generated in the Nairobi area, and is surrounded by both informal and formal residential areas. The risks from the disposal of waste at Dandora are further complicated in that the Nairobi River flows in close proximity to the dumpsite, and waste from the dump ends up in the river. This creates additional potential risks to downstream communities who use this water for domestic and agricultural purposes (Kimani 2012).

Figure 5.2 Blood lead levels in children living in proximity to the Dandora dumpsite, Kenya



Source: Kimani (2012)

Through various routes of exposure, pollutants from uncontrolled dumping can have a direct impact on human health. A medical evaluation of children and adolescents living and schooling in close proximity to the Dandora dumpsite reported respiratory, gastrointestinal and dermatological illnesses such as upper respiratory tract infections, chronic bronchitis, asthma, fungal infections, allergic and unspecified dermatitis (Kimani 2012). Blood samples collected from children in the vicinity of the Dandora dumpsite showed that half of the children examined had blood lead levels equal to or exceeding internationally accepted toxic levels of 10 µg/dl (**Figure 5.2**).

In addition to risks caused by heavy metals, uncontrolled dumping of waste also presents a potential threat of pathogenic infections, chronic diseases and the infestation of vermin. Proximity to open dumps has been significantly connected with the upsurge and spread of pathogenic infections, including cholera and other diseases, in various African cities (Abul 2010, Jerie 2016, Suleman *et al*. 2015). A study focusing on the spatial dependency of cholera prevalence in Kumasi, Ghana, showed a direct spatial relationship between cholera prevalence and the density of refuse dumps, and an inverse spatial relationship between cholera prevalence and distance to refuse dumps. A GIS-based buffer analysis showed that the minimum distance for the siting of refuse dumps from community centres is 500 m. The study concluded that proximity and density of open dumps play a contributory role in cholera infection in Kumasi (Osei and Duker 2008). Several case studies have highlighted the connection between uncontrolled dumping and human health impacts across the African continent (Kebedde 2004, Mpofu 2013, Osei and Duker 2008).

Table 5.2 Related diseases contracted and distance from disposal sites, Kumasi, Ghana

			Distance of final disposal sites			Total
			Less than 5 minutes	5-10 minutes	11-15 minutes	
Related diseases contracted	Cholera	Count	4	2	0	6
		Percentage	67	33	0	100
	Malaria	Count	75	26	2	103
		Percentage	73	25	2	100
	Typhoid fever	Count	9	3	0	12
		Percentage	75	25	0	100
	Skin infections	Count	13	5	0	18
		Percentage	72	28	0	100
Total		Count	101	36	2	139
		Percentage	73	25	2	100

Source: Suleman *et al*. (2015)

A study conducted in the Sawaba community in Kumasi, Ghana, showed startling relationships between proximity to open dumpsites and incidence of disease (**Table 5.2**). The study showed cholera cases for 67 per cent of participants who lived less than 5 minutes from the open dumpsite but none for residents living 11 to 15 minutes away. In the case of malaria, 73 per cent of participants who lived less than 5 minutes from the open dumpsite had suffered from the disease compared to only 2 per cent of participants living 11 to 15 minutes away. Similar relationships between proximity and incidence of disease were found for typhoid fever and skin infections (**Table 5.2**). Open dumpsites typically included building sites, areas along water channels and other unauthorized places (Suleman *et al*. 2015).

Box 5.1. Dumping of waste and the spread of *Aedes aegypti* and the Zika Virus

Aedes aegypti is one of several species of mosquitos that breed in stagnant water and can transmit human diseases. *A. aegypti* has been implicated in the spread of dengue fever and recently, the Zika virus. Following the outbreak in 2007 in West Africa, the Zika virus has spread rapidly throughout the tropics and sub-tropics, and recently into the Americas. *A. aegypti* appears to thrive in artificial habitats created by discarded waste such as tyres, cans and plastic containers. The rapid spread of Zika in South America and the Caribbean in 2015 and 2016 may have been exacerbated by the lack of effective waste collection and disposal (UNEP 2016).

Rescue workers search for those buried by a landslide at Koshe landfill, Addis Ababa, Ethiopia
Photo credit: © Minasse Wondimu Hailu / Anadolu Agency - Getty Images

Finally, uncontrolled dumping of waste can cause direct physical risks to neighbouring communities, often poor communities that spring up around dumpsites. The past year has seen more than 130 people killed in waste landslides in Africa, the most devastating of which was at the Koshe landfill in Addis Ababa, Ethiopia, in March 2017, where 115 people were killed, including children[12]. The second waste landslide was at the Hulene landfill in Maputo, Mozambique, where 16 people were killed. More than two thirds of those killed in these landfill collapses were women, many of whom informally picked for food and recyclables on the landfill sites (Moshenberg 2018).

Other dumping incidents relevant to Africa include the 2006 illegal dumping of petrochemical slops from the ship "Probo Koala" at the port in Abidjan, Côte d'Ivoire. Eighteen casualties were reported, over 30,000 people injured and over 100,000 people sought medical attention. The owners of the ship, Trafugura, eventually paid heavy financial penalties and compensation in relation to the incident (BBC 2010). For a discussion on the impacts of uncontrolled dumping of illegally trafficked e-waste from developed countries into Africa, see the **Topic Sheet 2 in chapter 3**.

12 https://www.reuters.com/article/us-ethiopia-accident/ethiopia-trash-dump-landslide-death-toll-rises-to-115-idUSKBN16N0NR

Box 5.2. The impact of poor waste management on bird migration in East Africa

The Rift Valley-Red Sea Flyway is the second most important flyway in the world for migrating soaring birds. Twice each year over 1.5 million birds from 37 species migrate between their breeding grounds in Europe and West Asia and wintering areas in Africa. For some species, 50-100 per cent of the global or regional bird populations pass along this route over just a few weeks, through narrow “bottlenecks”. These migratory birds are vulnerable to a number of threats along the route, one of which is the poor management of waste disposal facilities (Clark 1987 in UNDP/GEF n.d.).

Waste disposal sites, when properly designed and managed, offer a number of ecological services, including resting and feeding sites for migrating and resident birds. However, improper waste management such as uncontrolled dumping, common across Africa poses a number of threats.

Negative impacts of poor waste management on migratory soaring birds include intoxication from contaminated water or ingestion of hazardous substances such as plastics, heavy metals, polychlorinated biphenyls (PCBs), endocrine disrupting chemicals (EDCs) and veterinary drugs; injuries from such things as exposed broken glass or wire; accidents such as drownings in sludge; accidental poisoning from poison baits set to control animals like scavenging foxes, jackals or feral dogs; and infections and spread of disease such as botulism, salmonellosis or avian cholera. Furthermore, smoke from the open burning of waste, common at many of Africa’s dumpsites, may contain toxic gases that can affect the health of birds. Inhalation of, or plumage impregnation by, toxic compounds can affect bird fitness and navigation capabilities and cause breeding problems for both local and migrant populations.

Waste sites pose particular threats in desert environments (predominant in the Rift Valley-Red Sea Flyway corridor) where they represent attractive sources of food and water to migrating soaring birds.

Source: Porter (2006) in UNDP/GEF (n.d.)

Developing integrated waste management and conservation strategies in the Rift Valley-Red Sea Flyway corridor countries could therefore be an important step in both addressing the waste challenges experienced in those countries and protecting migrating birds by extending the flyway corridors beyond the existing protected areas.

[a] Information drawn from UNDP/GEF (n.d.)

5.1.2 Open burning

Open burning of waste is widely practised across Africa. It provides a means of reducing the volume of accumulated waste where waste collection services do not exist, or managing waste in dumpsites (UNEP 2015). Typical emissions associated with open burning of waste include dioxins, polycyclic aromatic hydrocarbons and black carbon, which are highly toxic, carcinogenic and powerful short-lived climate pollutants respectively (UNEP 2015). Open burning is often the result of a lack of awareness of alternative disposal options, high levels of poverty, and lack of environmental regulation or enforcement (Cointreau 2006, Oelofse and Musee 2008, Al-Khatib *et al.* 2009, Narayana 2009, Hilburn 2015, Jerie 2016).

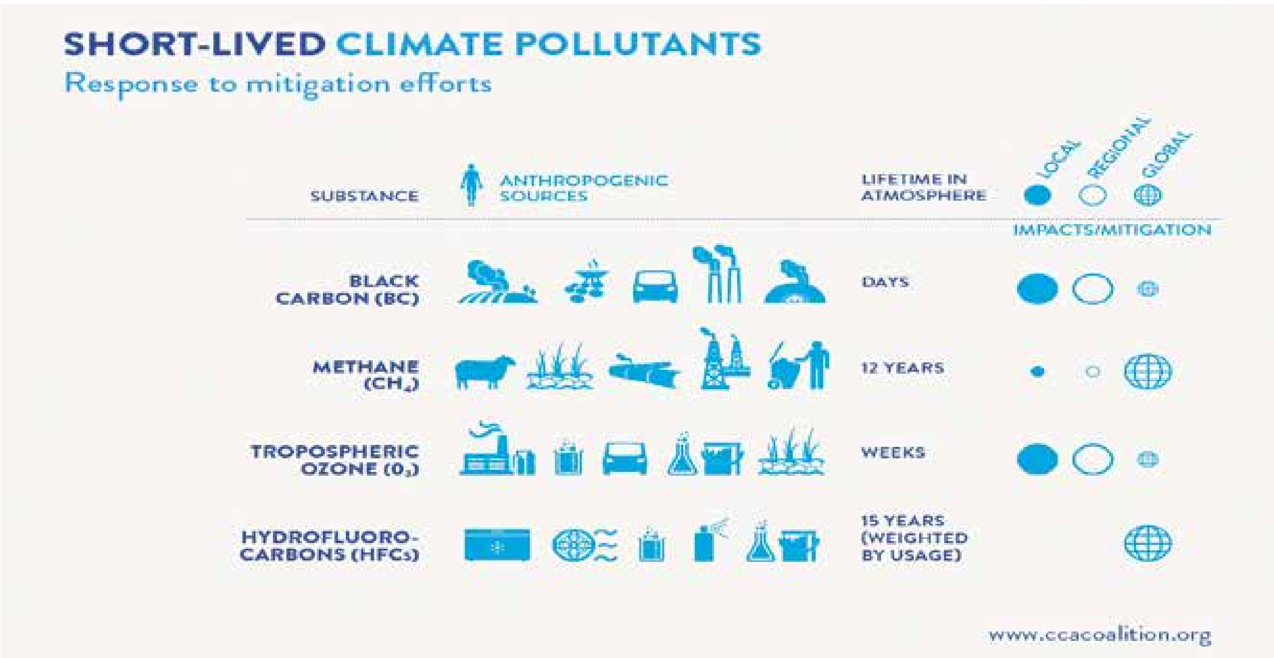
Families with inconsistent waste collection services in Accra, Ghana, who were forced to burn their waste as a management solution, for example, were found to be vulnerable to respiratory diseases. The burning of waste was the suspected cause of their symptoms. Children and women, the main people involved in the burning process, were found to be the most vulnerable in the community to respiratory diseases (Surjadi 1993). Open burning of agricultural waste, particularly rice straw, is a common practice in Egypt that causes a host of allergic reactions and lung infections in many residents (Safar and Labib 2010). Furthermore, the black clouds of smoke caused by the burning process are heavily laden with greenhouse gases (GHGs).

Open burning of waste on a kerbside in Nairobi, Kenya

Photo credit: © C Velis, University of Leeds

Open burning of waste at dumpsite
Photo credit: © Manoocher Deghati, IRIN

Figure 5.3 Short-lived climate pollutants



Source: CCAC (2017)

Waste and climate change, open burning and short-lived air pollutants

The poor management of waste can have significant repercussions on the global climate, aggravating climate change. Open burning of waste and the decomposition of high volumes of organic waste in uncontrolled dumpsites generates many atmospheric pollutants. According to Hoornweg and Bhada-Tata (2012) methane from landfills represents 12 per cent of total global methane emissions. A study by the European Environment Agency noted that the amount of municipal waste was expected to grow by 25 per cent from 2005 to 2020. It also indicated that limiting or avoiding growth in waste volumes would reduce GHG emissions from the waste sector and deliver other benefits to society and the environment. Africa has one of the highest rates of population growth and as a result the contribution of the waste sector in Africa to climate change is expected to increase (Nakićenović *et al.* 2000). While global annual methane emissions from landfilling of solid waste were estimated at 29 Mt in 2010, methane emissions from landfills in Africa were estimated at 1.3 Mt, equivalent to 32 Mt of CO_{2e} emissions (Scarlat *et al*. 2015).

The most recent Greenhouse Gas Inventory for South Africa (DEA 2014) shows that the waste sector was the second largest contributor to total national methane emissions in 2010, accounting for 37.2 per cent. Furthermore, while other economic sectors have shown declining contributions of methane (and total GHGs), the methane contribution from the waste sector has increased by 11.3 per cent, reflecting the increase in waste generation and disposal in South Africa. GHG emissions from the South African waste sector increased by 59.3 per cent from 2000 to 2010 (from 12,434 Gg CO_2 eq to 19,806 Gg CO_2 eq) (DEA 2014). This is in stark contrast to the European Union, where GHG emissions from waste have more than halved over the period 1990 to 2007 (Hoornweg and Bhada-Tata 2012), as a result of efforts aimed at decoupling economic development from waste generation.

Open burning is a major source of black carbon, one of the short-lived climate pollutants, a group of pollutants that have a particularly high impact on climate change (**Figure 5.3**) (Hansen *et al*. 2010).

Eliminating uncontrolled dumping and open burning of waste in Africa and diverting organic waste away from landfill towards alternative waste treatment technologies such as composting and anaerobic digestion (**see chapter 7**), have the potential to create significant positive benefits for Africa, including reduced GHG emissions.

Box 5.2. Endocrine disrupting chemicals and e-waste burning

There is growing concern about e-waste as a source of endocrine disrupting chemicals when burned (UNEP/WHO 2013). Burning e-waste is a common practice in a number of African countries, but research on the impacts on human health and the environment in Africa is meagre. The possible impacts of endocrine disrupting chemicals on humans and the environment in Africa is a priority that needs to be fully investigated. In many African countries, women and children are on the front lines of extracting recyclable resources from e-waste, besides being highly involved in burning waste (Moukaddem 2011). The International Labour Organization (ILO) has highlighted the difficulties of assessing the extent to which children are involved in e-waste recycling, though many studies indicate that children are a significant proportion of all workers. The difficulties are largely attributable to a lack of data on the segregation of e-waste, as there is a considerable knowledge base for child labourers working as "waste pickers" (Lundgren 2012).

5.1.3 Poor collection coverage

In Africa, a lack of waste collection and disposal facilities has compelled many communities to use watercourses such as rivers and canals for waste disposal. The problem is compounded by the attitude of communities that do not responsibly participate in waste management, and further aggravated by the inability of local councils to enforce existing waste management laws (Majale-Liyala 2011). A body of literature has documented the impacts of waste disposal on receiving water resources in many African countries. In addition to chemical and microbiological pollution of the water, disposal of solid waste to watercourses results in blocked canals, stagnant water and flooding (Uchegbu 2002, Adeyemo 2003, FAO 2005, Etuonovbe 2009, Akinbile 2012, Okot-Okumu 2012, Fortune *et al.* 2015).

The impacts of uncollected waste are also likely to reach farther than just the immediate area of disposal. For example, over 80 per cent of ocean plastic is thought to originate on land, entering the oceans via rivers and storm-water runoff or directly discharged into coastal waters. Of that, 75 per cent comes from uncollected waste (poor city cleansing) and 25 per cent from collected waste, where the waste re-enters the environment from poorly operated formal or informal dumpsites (Ocean Conservancy 2015). Rivers act as conduits for pollution, moving mismanaged and uncollected waste from inland to coastal areas and finally into the oceans. The impact of uncollected waste in Africa on marine litter is likely to be significant, particularly as populations on the continent grow and corresponding waste volumes increase (**See Topic Sheet 3**).

Accumulation of municipal solid waste, in particular plastic waste, in urban river in Kenya.
Photo credit: © James Wakibia

13 https://www.aljazeera.com/news/2018/01/dr-congo-floods-leave-45-dead-thousands-homeless-180111090152024.html

Box 5.3 Poor waste management and urban flooding

The lack of proper waste management services in many African countries compels people to dispose of their waste in streets, open spaces and watercourses, leading to water stagnation, pollution and flooding. Heaps of waste left uncollected in streets is often washed into drainage systems, damaging pumping stations and causing flooding. In Kampala, Uganda, indiscriminate dumping of waste in stormwater canals blocks water drains, causing floods and health hazards, as well as aesthetic impacts (Okot–Okumu 2012). Ziraba *et al.* (2016), discussing flooding in urban cities in Africa, identified poor urban planning as a major culprit, but added that the problem could also be attributed to rampant blockage of drainage systems by solid waste, especially non-degradable plastic bags. They added that floods claim lives and damage sewerage systems, causing even wider environmental contamination. Lamond *et al.* (2012) pointed out that in Africa, waste can quickly block drain systems, causing flooding in neighbourhoods with inadequate solid waste management or drain maintenance. In Dar es Salaam, United Republic of Tanzania, residents of Tandale district, Kinoni municipality, expressed their discontent about the poor management of waste, which when dumped in streams resulted in blockages and heightened the impact of flooding (Dodman *et al.* 2011).

A study of poor settlements in Accra, Kampala, Lagos, Maputo and Nairobi revealed that housing development in floodplains and inadequate waste management are potential causes of flooding. The study indicated that people in these settlements dump solid waste haphazardly into valleys and natural drains (Douglas *et al*. 2008). Waste dumped in watercourses also contaminate surface and groundwater with serious health implications. A serious outbreak of diarrhea in Kenya was attributed to solid waste dumped upstream from an irrigation canal, causing water stagnation. Downstream water used to irrigate vegetable farms was badly affected by stagnation and was considered the main source of the outbreak (Henry *et al.* 2006).

According to Ojolowo and Wahab (2017) 27.2 per cent of the waste generated in Lagos, Nigeria was dumped in canals and lagoons. This indiscriminate dumping of waste was identified as a major cause of flooding within the city, resulting in the spread of water-borne diseases. An estimated 11.2 per cent of the MSW was collected by the Lagos Waste Management Authority (LAWMA), 9.9 per cent by private service providers, and 29.2 per cent by cart pushers, while 16.7 per cent was disposed of to communal dump-grounds, 1.3 per cent burnt and 4.6 per cent buried.

In January 2018, at least 45 people died from flooding in Kinshasa, Democratic Republic of Congo, and more than 5000 people were left homeless[13]. Many residents accused blocked drainage channels in the city for the flooding, which further exacerbated an ongoing cholera outbreak (ISWA 2018).

Waste dumped by upstream community and market accumulate in river, Cameroon
Photo credit © Nche Tala Aghanwi

TOPIC SHEET

3

MARINE LITTER IN AFRICA: Identifying sources and seeking solutions[1]

Introduction

The following text is an extract from a discussion document prepared for the first African Marine Waste Conference held in South Africa in July 2017. The discussion document was further extended and published as Jambeck *et al.* (2017a).

Plastic has been found on the remotest of beaches, afloat in the middle of the ocean, frozen within polar ice, building up on the sea floor, and inside marine animals and sea birds. In fact, this manufactured material is now recognized as being one of the most noticeable pollutants affecting the ocean worldwide (UNEP 2016). Recent studies have suggested that the ocean receives an estimated 8 million tonnes of plastic waste per year. As plastic remains in the environment for hundreds of years, the trillions of plastic pieces accumulating in the ocean form part of a global pollution issue that affects all coastal countries (van Sebille *et al*. 2015). If nothing changes, by 2025 the ocean could contain 1kg of plastic for every 3kg of fish. Despite this stark reality, awareness of this issue has grown slowly, alongside a global consensus that action must be taken to stem the flow of plastic entering the ocean.

Current estimates of the volume and weight of plastic entering the ocean from land are generally based on the following indicators: (i) waste generation per capita, (ii) proportion of waste that is plastic and (iii) percentage of waste that is mismanaged. Calculations using globally available data have shown that the majority of countries contributing most significantly to marine litter are in Southeast Asia. However, with significantly less data available from the majority of countries in Africa, the regional governmental complexities and the scale of African waters (an exclusive economic zone three times the size of its landmass), the amount of mismanaged waste in this region is more difficult to estimate with accuracy.

Why Africa? A continental overview

Africa, the world's second largest continent, is experiencing unprecedented population growth, with predictions that it will add 1.3 billion people to the planet by 2050. This is the equivalent of 3.5 million more people per month, or 80 additional people per minute, thus making Africa the biggest contributor to future global population growth (UNEP 2015). Furthermore, the highest rates of population growth and urbanization are expected in the coastal zone, with an estimated 49 million more people in flood plains by 2060 (Neumann *et al.* 2015). Alongside this rapid rate of urbanization, Africa's growing middle class is creating large consumer markets for plastic goods and goods packaged in plastic, and supermarkets are replacing informal shops and markets. Eighty per cent of the continent's GDP is concentrated in just 11 African countries (Nigeria, South Africa,

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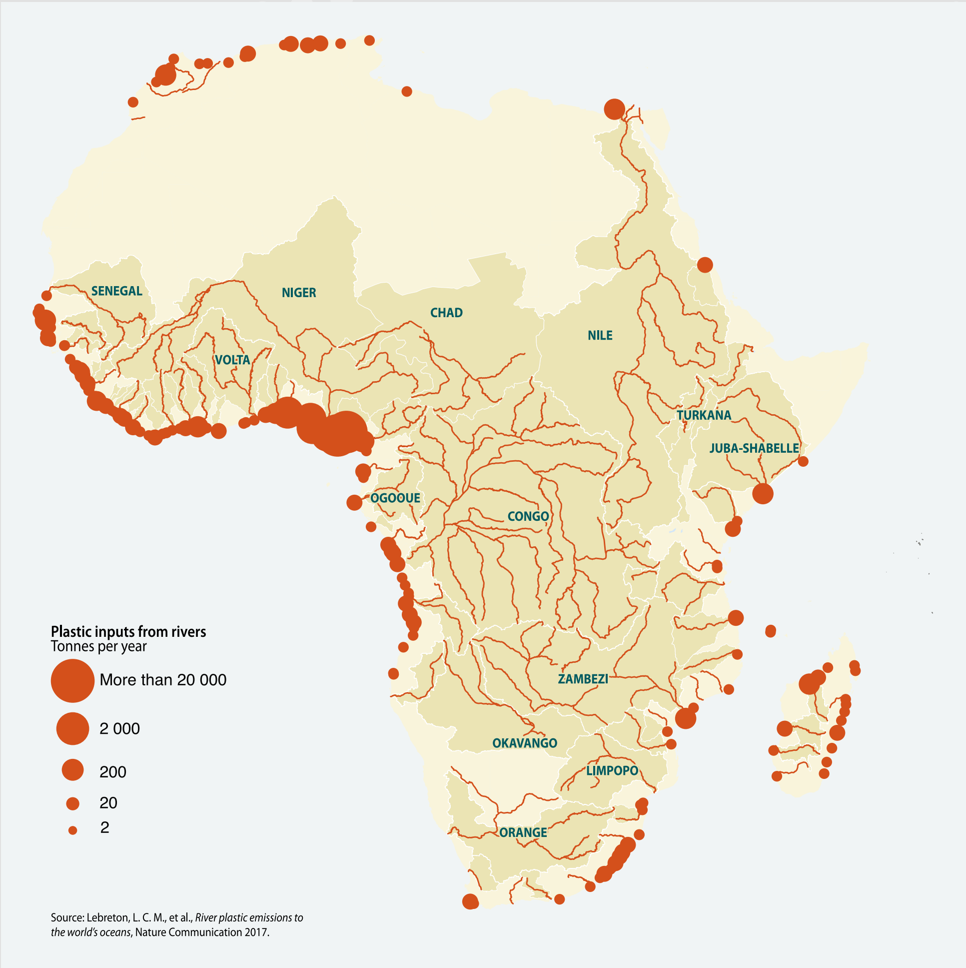
Egypt, Algeria, Angola, Morocco, Sudan, Tunisia, Kenya, Ghana and Libya), all of which have prominent coastlines (Deloitte 2014).

Similar to the expanding coastal populations in Africa, there are an increasing number of people living in high densities a short distance from river systems. For example, the population density of the Nile delta is 1,000 people per square kilometre, which is much higher than the global average for coastal areas (80 people per square kilometre). The extensive river basins of the Niger, Congo, Zambezi and Nile contain some of the largest cities in the world and empty a significant volume of fresh water into the Atlantic Ocean, the Indian Ocean and the Mediterranean Sea. A lack of waste management infrastructure in these areas also means that these rivers are likely to transport a large volume of pollution, including plastic waste, as they make their way to the ocean (**Figure 1**).

While land-based sources of plastic pollution in the ocean are significant, it is also important to consider the plastic pollution resulting from Africa's shipping and maritime activities, such as fishing. Abandoned, lost or otherwise discarded fishing gear contributes an estimated additional 640,000 tonnes of marine litter globally (Macfadyen *et al.* 2009). With over 12 million people engaged in Africa's fisheries sector, this is therefore likely to be a factor in African waters. Furthermore, given that subsistence fishing is significant in African countries and the proportion of protein intake from fish is high (i.e. 50 per cent in Mozambique, 60 per cent in Sierra Leone and Ghana, and 70 per cent in the United Republic of Tanzania), marine litter represents a significant threat to food security, economic development, the viability of marine ecosystems and the establishment of a vibrant and productive blue economy (Climate Smart Oceans 2017).

The increasing trend in per capita consumption, urbanization and population growth is especially worrying when combined with a lack of sufficient infra-structure to deal with the increased waste generation.

Figure 1
Mass of river plastics flowing into oceans



Source: Jambeck *et al.* (2017b)

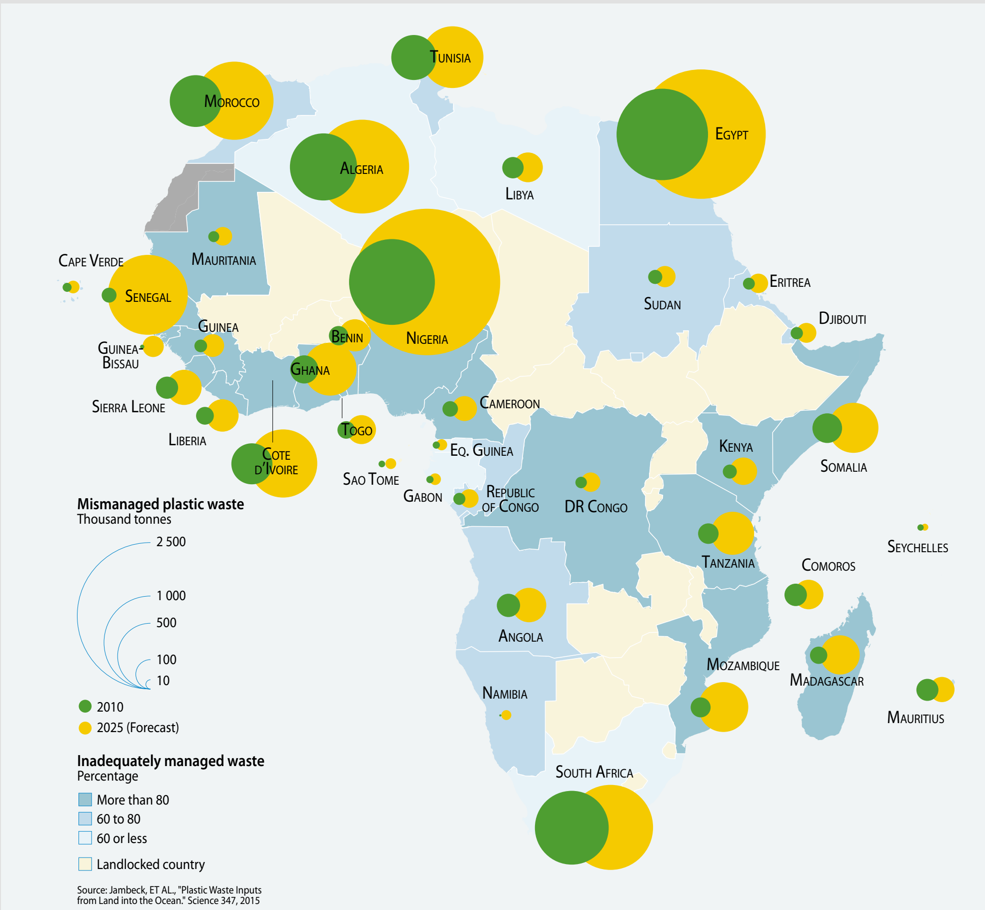
TOPIC SHEET 3

MARINE LITTER IN AFRICA:
Identifying sources and seeking solutions[1]

In fact, the resulting potential for waste accumulation is so severe that many fear Africa could become the most polluted continent on Earth, if it is not already. This presents a significant risk to human health, the environment and the economy. As seen in the Ghanaian capital of Accra, where plastic bags and other plastic consumer goods accumulated in waterways and clogged drains, causing significant flooding that killed at least 150 people and caused millions of dollars of damage (Hinshaw 2017). Furthermore, it is worth noting that improperly disposed of plastic waste on land may also contribute to the spread of disease by providing standing water for mosquitoes to use as breeding grounds, enabling the spread of diseases such as Zika virus, dengue fever, malaria and chikungunya (Moss *et al.* 2017). In response to the environmental and health threat posed by plastic bags, more than 20 countries on the African continent have now put bag bans and taxes in place (Global Press Journal 2015).

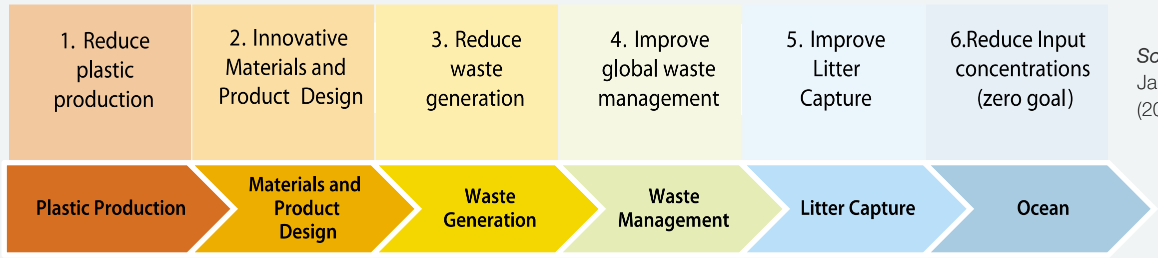
Although the data is patchy, a recent study estimates the quantity of mismanaged plastic waste available to enter the ocean from each of Africa's coastal and island countries. Of particular relevance are Egypt, Nigeria, South Africa, Algeria and Morocco, which are estimated to be among the top 20 countries around the world contributing to marine litter each year. Based on country-level data, the total mismanaged plastic waste for the continent was estimated at 4.4 million tonnes in 2010 (out of 32 million tonnes globally) and could be as much as 10.5 million tonnes in 2025 if the trend continues ("business-as-usual") (**Figure 2**).

Figure 2
Mismanaged plastic waste, 2010 actual and 2025 forecast



Mismanaged plastic in Africa (2010 and 2025).

Source: Jambeck *et al.* (2017b)



Source: Jambeck (2017b)

Figure 3 Intervention points to mitigate the flow of plastic to the ocean

Solutions and innovation across Africa

The three African regional seas conventions and action plans (RSCAPs) including the Barcelona Convention (Mediterranean), the Abidjan Convention (West Africa) and the Nairobi Convention (East Africa), are instrumental in encouraging regional cooperation and coordination among countries sharing common resources along their coastlines. Globally, the three conventions have pioneered the development of regional seas action plans on marine litter. For example, Mediterranean coastal states have recently adopted one of the most advanced regional instruments on marine litter, with a strategic plan that includes legally binding measures. Initial scoping work is being done under the Abidjan and Nairobi conventions for the development of their respective action plans.

Initiatives aimed at mitigating the flow of plastic into the ocean can occur at various intervention points along the plastic value chain. These possible interventions include activities that reduce plastic production, provide innovative materials and product design, reduce waste generation, improve waste management, improve litter capture and reduce input concentrations to the ocean (Jambeck 2017b).

While the examples in this section relate to interventions on solid waste management, other actions can be taken both upstream and downstream. Most importantly, these actions can be integrated with each other along an entire continuum of possible solutions (**Figure 3**).

Summary and way forward

The marine environment is an important source of livelihoods, food security and economic development in the 38 African coastal and island countries. Interest in the blue economy is growing rapidly. Given the potential for economic opportunities to be undermined by pollution, it is critical that the issue and scale of marine litter be explored, understood, managed and mitigated on a pan-African scale. This is essential if the continent is to avoid the scale of marine litter and waste-related challenges that are plaguing other regions. The situation in Africa undoubtedly requires African-led solutions.

Establishment of the African Marine Waste Network is a critical step in facilitating collaboration on this issue and the development of regional and national action plans. Such plans will need to take the local context into consideration, current realities in Africa, and the barriers and opportunities that exist within Africa to address marine litter and other waste-related issues across the continent.

In short, the African continent can no longer be ignored on the issue of marine litter and plastic waste leakage into the ocean. There is a significant opportunity for Africa to play an important role on the world stage with regard to reducing global marine litter.

Plastic waste on the shoreline of Accra, Ghana

Photo credit: © Christoffer Back Vestli

5.1.4 Informal collection and recycling

Africa has a very active informal waste sector, reclaiming food and valuable recyclable material from waste at kerbside (households and businesses) and from open dump sites and landfills (**see chapter 6**). Informal waste pickers in Africa are vulnerable to a wide range of chemical, biological and physical health risks posed by waste. These include such things as wound infections from sharp objects, inhalation of dangerous gases, swallowing of dangerous and contaminated materials including condemned food, diseases like cholera, typhoid, diarrhoea, viral hepatitis and human immunodeficiency virus (HIV) infection, and musculoskeletal injuries from manual lifting or sorting tasks (Phuka *et al*. 2003, Riungu 2003, Jerie 2016). Informal waste workers that work at kerbside are also at risk from traffic hazards while transporting their material in the streets (ILO 2013). The safety and security of informal waste pickers is also an issue, as many resort to sleeping on the streets at night to be close to the recyclable material, making them vulnerable to crime (Schenck *et al.* 2013).

Informal waste pickers sort and store their recyclable material recovered from a dumpsite in Southern Africa
Photo credit: © Linda Godfrey, CSIR

Box 5.4 Used lead-acid batteries: Impacts on health and environment

Lead-acid batteries are widely used in many African countries as a source of power for things like passenger and commercial cars, tractors, and telecommunication gadgets. Around 85 per cent of the total lead produced worldwide is consumed by lead-acid batteries (ILA 2012). Batteries reaching their end-of-life are in most cases recycled to take advantage of their lead content. Lead is a very toxic heavy metal, however, causing direct effects on red blood cells and interfering with the absorption of calcium. Children and women are particularly vulnerable to lead toxicity, and during pregnancy lead can cross the placenta and affect the unborn child. Lead is a major concern in Africa, as used lead-acid batteries are often recycled in small unlicensed, informal workshops, mostly operating in the open air, with very limited infrastructure.

In March 2008, Senegal was unfortunate to experience the deaths of 18 children under 5 years of age in the Dakar neighbourhood of Thiaroye-Sur-Mer from acute exposure to deadly lead dust, owing to informal recycling of used lead-acid batteries from cars (Blacksmith Institute 2009). With the lack of proper facilities for recycling, these illegal workshops are potential sources of lead pollution causing irreversible damage to human health.

Informal recycling of core lead from used lead acid batteries
Photo credit: © UNEP 2017

Well-equipped recycling plants with environmentally safe technologies are expensive to establish, and require large volumes of end-of-life batteries to be economically viable. One option to tackle this hurdle is for African countries to come together to establish regional facilities that can handle batteries coming from different countries, under safe conditions (UNEP 2017). However, this regionalization of secondary resource economies can be hindered by international conventions, aimed at protecting countries from illegal dumping of waste, particularly hazardous waste (**see chapter 4**).

5.1.5 Informal land reclamation

In some coastal regions in Africa, vehicle tyres and other debris have been used to reclaim land where land for housing is in short supply or too expensive. In Sierra Leone, mangrove land in the coastal area is subjected to major encroachment by poor communities who deposit huge volumes of waste, including vehicle tyres and other debris, to build their informal houses. The Kroo Bay slum in Freetown, on the coast of Sierra Leone, is one such site (Frazer-Williams, 2014). The slum is adjacent to two rivers, and highly exposed to frequent floods. Inhabitants dispose of their waste along the coastline, causing serious impacts on the quality of life in the adjacent ocean.

In some parts of Africa, waste is used for flood control during heavy rains and storm surges. This practice, usually called waste-filling, is not only a cheaper alternative to sand-filling when constructing the foundation of a house it also generates an income for waste collectors. In many parts of Africa, especially in poor settlements, MSW is used to control frequent floods in the heavy rain seasons. In the informal settlement of Badia, near Lagos, Nigeria, waste-filling is a source of pollution for the local environment and exposes residents to flood risks, as Lagos is a coastal city with a history of flooding owing to low-lying terrain (Njoku *et al.* 2015).

5.1.6 Health care waste

The state of health care waste management in Africa, particularly health care risk waste (HCRW), has been highlighted in **chapter 3**. Currently, poor HCRW management practices, including inappropriate or insufficient treatment technology, mean that untreated HCRW is often dumped in uncontrolled dumpsites, active with informal waste pickers. HCRW is also illegally dumped in open areas owing to the lack of treatment infrastructure or lack of willingness to pay for safe treatment and disposal (Stinger 2011, Nwachukwu *et al*. 2013, Hangulu and Akintola 2017). HCRW management is of particular importance because of the dire and wide-spread impacts it can have if not managed properly.

A common practice in many urban areas in Africa is the disposal of untreated HCRW along with MSW (Okot-Okumu 2012). A study in Nigeria showed that waste handlers at some hospitals treat HCRW the same as domestic waste (Nwachukwu *et al*. 2013). Furthermore,

Kroo Bay slum, Sierra Leone, where debris is used to reclaim land for building informal homes

Photo credit: © UNEP 2017

in the absence of take-back programmes, unwanted pharmaceuticals may be dumped into the local sanitation outlet, whether a sewage system, septic tank or latrine, causing pollution of the receiving water environment (USAID 2009).

Impact of HCRW on human health

HCRW is the second most hazardous waste after radioactive waste (Manyele 2004). The major threat of HCRW is the transmission of diseases. Pathogenic microorganisms can enter the body through punctures, cuts in the skin, mucous membranes in the mouth, or inhalation (WHO 1992). The WHO has estimated that in 2000, injections with contaminated syringes caused 21 million hepatitis B virus infections (32 per cent of all new infections), two million hepatitis C virus infections (40 per cent of all new infections) and 260,000 HIV infections (5 per cent of all new infections) worldwide (WHO 2007). In this respect, it is worth mentioning that syringe reuse is practiced in some African countries (Nwachukwu *et al.* 2013).

The WHO also reports that in Africa, infectious waste from health care activities is not adequately segregated, which increases the volume of infectious waste requiring special treatment and increases treatment costs. In the absence of proper treatment and safe disposal, this poses high risks to operators, the public (in particular children and other vulnerable groups) and the environment in general (WHO 2010). In Africa, waste handlers, health care workers and also drug addicts who handle sharps are most vulnerable and highly exposed to infection with HIV/AIDS and the hepatitis B and C viruses (USAID 2009).

Impacts of HCRW on the environment

Besides the health impacts of HCRW, this waste stream also poses a potential threat to the environment. Contamination of water bodies from untreated HCRW can have serious effects. Infectious stool and bodily fluids can cause serious epidemics if not treated properly before disposal, as sewage treatment in Africa is often non-existent (USAID 2009).

The lack of sanitary landfills had led to the increased use of incinerators for HCRW. While it is estimated that there are more than 1,000 incinerators in Africa, many are reported to be inoperative or operating below standards. Some hospitals have re-built their incinerators a number of times owing to frequent break downs (Harhay *et al.* 2009, UNDP 2009). The environmental and health impacts of improper incineration may cause irreparable damage. SBC and WHO (2005) report that incineration, or the incineration of unsuitable materials, results in the release of persistent pollutants into the air, including dioxins and furans, which are human carcinogens with a wide range of adverse health effects. In addition, incineration of heavy metals can release and spread toxic metals into the environment.

5.1.7 Emerging waste streams

Chapter 3 alludes to new emerging waste streams, such as nano-wastes (nanomaterials and nanoparticles) and micro-wastes. Nanotechnology is widely used in large and diverse industries that include computers, cellular phones, cosmetics, textiles and medicines. In many African countries, however, these wastes are being disposed of together with conventional MSW without any special segregation, precautions or treatment, despite inherent risks. While this may be owing to lack of awareness by communities and authorities, it raises the question of whether current waste treatment and disposal technology is appropriate for dealing with these waste streams, and what impacts these nano- and micro-wastes may have on human health and receiving environments during and/or after treatment (OECD 2016). Failing to address nano-waste as a special constituent of the waste stream may have significantly adverse repercussions on human health and environment. There is a pressing need to raise awareness on these emerging waste streams, particularly in African countries that are often ill-equipped to deal with such wastes, as well as to introduce the infrastructure needed to identify and segregate nano- and micro-waste and provide the necessary training to mitigate and manage related risks.

5.2 The cost of inaction

The cost of providing sound waste management services is considered a burden and a challenge by African governments with limited resources and many priorities. However, failing to provide sustainable waste management services has long-term impacts that come at a cost to society and to the economy, as shown in this chapter.

The cost of inaction can be defined as the damage incurred to human and environmental health as a result of environmental degradation, in this case from poor waste management services (UNEP 2015). The OECD (2008:3) goes further, suggesting that "*some of the costs of inaction will be incurred locally (and immediately), while others will fall on citizens in other countries (and perhaps in the distant future).*" The GWMO points out that the major impacts of inaction include public health impacts of uncontrolled waste and environmental impacts of open dumping and burning (UNEP 2015).

Assessing the cost of inaction is crucially important to placing the human health and environmental impacts of poor waste management in context and, in particular, in an economic context that business and government understand. Assessing the cost of inaction is not always a straight forward process, however. In addition to the complication of establishing the baseline conditions and the limits of the estimates, it entails several uncertainties, especially at the economic level. This is particularly true for psychological damage (non-tradable goods), as the impact of inaction is not usually reflected in market values. Examples of this would include the feeling of unease and suffering that can be evoked in some people by the eyesore of heaps of accumulated mismanaged waste in their vicinity. Information about the monetary value of inaction of poor waste management in Africa is further limited by the dearth of comprehensive, reliable waste data and information. Very few studies have been done on the monetary value of inaction in Africa, although sporadic assessments of the cost of waste management inaction are reported in some North African countries as part of general studies on the cost of environmental degradation (Hussain 2008, Sarraf *et al.* 2004).

Hussain (2008) showed that the average annual damage costs of environmental degradation for waste management in North African countries ranges between 0.1–0.5 per cent of GDP. Here, environmental degradation is seen to include loss of healthy life and well-being, economic losses and the loss of environmental opportunities. Owing to the lack of data, however, no cost estimates could be calculated for environmental degradation associated with industrial, hazardous and hospital waste, which would significantly increase the estimated costs. In Morocco, the cost of groundwater pollution from contamination by unsanitary landfills was estimated at US$25 million per year (Hussain 2008), while in Tunisia, the annual damage costs associated with solid waste management were calculated at 0.15 per cent of GDP (Sarraf *et al.* 2004).

Nahman and de Lange (2013) calculated the total cost of edible food waste throughout the value chain in South Africa to be approximately US$4.8 billion[14] or 2.1 per cent of GDP, a significant percentage of the country's GDP. The results highlight the significant impact that unsustainable food systems can have in developing countries like South Africa (**See Topic Sheet 1 in chapter 3**).

Table 5.3 Average annual damage costs of environmental degradation from waste in countries in the Middle East and North Africa

	Average annual damage costs (percentage of GDP)			
	Algeria	Egypt	Morocco	Tunisia
Waste management cost	0.1	0.2	0.5	0.1

Source: Hussain (2008)

14 Assuming an exchange rate (at the time of writing) of R12.93 per United States dollar

5.3 Waste and gender

Women are actively involved in waste collection and sorting activities in many African countries, on dumpsites, at kerbside, and in waste facilities. In many cases, owing to limited alternatives for child care, their children accompany them and are exposed to the same conditions and risks. The Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, also known as the Maputo Protocol, guarantees the right of women to live in a healthy and sustainable environment (AU 2003). This includes ensuring that parties take all appropriate measures to "*regulate the management, processing, storage and disposal of domestic waste; and ensure that proper standards are followed for the storage, transportation and disposal of toxic waste*" (AU, 2003:17).

According to Amugsi *et al.* (2016), women tend to have a subordinate status when it comes to waste management activities, which exposes them to greater health and environmental risks than men. Studies in Ghana and Nigeria have found that men typically have access to higher value materials, leaving women to access the lower value, dirtier materials, usually from dumpsites, placing them at great risk (Amugsi *et al.* 2016). Gender division of labour strongly influences men's and women's differential exposure to specific health risks. In a study on the informal sector in Bulawayo, Zimbabwe, women and children who collect waste at dumpsites for recycling and re-sale were found to be more at risk (Jerie 2011). Brender *et al.* (2011) outlined significant relationships between maternal residential proximity to hazardous waste sites and adverse health effects, such as adverse pregnancy outcomes, childhood cancers, asthma hospitalizations and chronic respiratory symptoms, stroke mortality, PCB toxicity, end-stage renal disease and diabetes. Moshenberg (2018) points out that *"when it comes to urban disasters – both natural and otherwise – death has a gender".*

More than two thirds of the people killed in the Ethiopia and Mozambique landfill collapses in 2017 and 2018 were women. Waste management in Africa has largely ignored gender disparities. Women must be brought into the decision-making and policy process in Africa, to ensure that waste strategies, policies and services are gender-sensitive.

Woman and her children collecting recyclables from households, South Africa
Photo credit: © Linda Godfrey, CSIR

Women working informally on waste dumpsite

Photo credit: © Linda Godfrey, CSIR

5.4 Conclusions and recommendations for future action

This chapter has shown how the current waste management challenges facing Africa have resulted in significant environmental and human health impacts, and will continue to do so unless services and infrastructure improve. Lack of resources, awareness and rigorous regulations are among the major causes of the problem. There is an urgent need to enforce a set of special measures to help improve the management of waste on the continent, in order to mitigate current impacts. These measures would include:

Awareness raising

One of the chief problems facing waste management in Africa is the low level of citizen awareness of the impacts of waste. It is of crucial importance to raise awareness and to change people's perception of and attitudes towards waste and its associated impacts, especially emerging wastes. There is also an urgent need to change people's attitude towards uncontrolled dumping and open burning of waste, the chief precursors of air pollution and chronic respiratory diseases. On the other hand, it is the role of authorities to provide suitable, cost-effective alternatives that meet sound hygienic and environmental codes and requirements. Within the same discourse, civil society and NGOs have a major role to play in empowering communities when it comes to sound waste management practices. The media is one of the most influential instruments affecting awareness and can play a prominent role through its various programmes.

Training and education

Provision of sound training is an elemental step in waste management. Ideally, training would comprise a blend of bottom-up approaches that involve customized training programs for different tiers of waste management staff, raising their awareness, and providing them with the knowledge for sound waste segregation and handling. On a similar level, a top-down approach would be designed to enable and raise government capabilities in addition to upgrading administrative know-how. UNEP has already launched an initiative to introduce a graduate course in waste management in a number of African universities. Graduates would be equipped with advanced know-how to tackle waste issues in an integrated manner. It is hoped that this initiative would encourage other African universities to follow suit to help promote sound waste management throughout the continent. South Africa has taken the initiative of developing dedicated honours and master's degrees with specialization in solid waste management in an effort to strengthen its national capacity. In the same context, special curricula should be developed and incorporated into high- and medium-level educational programmes. Medical schools ought to consider providing training on health care waste as an integral part of their curricula as a vital component of good health and a safe environment.

Provision of proper infrastructure for health care waste

Health care waste management is of particular importance because of the dire and wider impacts it can have if not managed properly. Most African countries have ratified the Stockholm, Basel and Rotterdam conventions and committed to ensuring proper treatment and disposal of health care waste and other hazardous waste. However, health care waste management facilities in many African countries are inadequate, with sub-standard treatment and disposal. African countries should provide and improve health care waste management bodies by introducing legal and institutional frameworks specifically designed for health care waste.

Public-private partnerships

Sustainable waste management is one of the most expensive services provided by government. The low priority often assigned to waste by key stakeholders, combined with communities unwillingness to pay for waste services, means that there is often no funding available to improve waste service delivery and invest in waste infrastructure. To make ends meet, partnering with private sector organizations could be a positive strategy towards building robust infrastructure for tackling many waste problems. Experience from a number of African countries has shown that the private sector is many steps ahead of government in dealing with waste. The involvement of the private sector in waste management should be a priority for African countries. Governments need to explore how such partnerships can be encouraged through such things as economic incentives and land allocations (**see chapters 4 and 8**).

Regulation of imported end-of-life electrical and electronic equipment

Africa is a major destination for used electrical and electronic equipment. The huge hauls of e-waste are becoming a flourishing business and the main source of income for a considerable number of Africans, despite the potential risks involved. Trade in end-of-life equipment is also turning waste into more sustainable resources, conserving valuable materials while creating a new class of African entrepreneur. However, the lack of a legislative body for the trade is creating many gaps and logistic flaws, with potential for significant human and environmental impacts. Countries involved in this trade should revisit their regulatory frameworks and assess whether mechanisms need to be put in place to address illegal imports. Frameworks should also embrace special measures and instruments, such as end-of-life measures and take back policies like EPR.

6 Waste as resource: Unlocking opportunities for Africa

6

Waste as resource: Unlocking opportunities for Africa

What the reader can expect

The global waste sector is undergoing a paradigm shift from "waste" to that of "secondary resource" within the vision of a circular global economy. The circular economy emphasizes keeping resources in use for as long as possible through re-use, recycling and recovery of materials. This chapter focuses on understanding the economic and social opportunities in waste that could potentially be unlocked in Africa, and how these opportunities can be used as lever to overcome the challenges in solid waste management on the continent. It covers (i) economic opportunities in waste as a resource (i.e. the economic value of waste as an input to downstream economic activities); (ii) social opportunities, including social benefits (job creation), poverty alleviation, enterprise development and integration of the informal sector; (iii) regional approaches to secondary resource management; (iv) waste trading; and (v) resource crime. It aims to estimate the intrinsic value of waste as a resource in Africa and the associated economic and social benefits that could potentially be unlocked for Africa through increased waste recovery and recycling. It also touches on Africa's role within the global waste management system.

Key messages

The following are the key messages regarding unlocking the opportunities presented by waste in Africa:

- A conservative estimate of the value of MSW generated in African urban areas is US$8.0 billion per annum, of which US$7.6 billion worth of valuable resources (96 per cent) is currently lost through the disposal of waste each year, typically to open dumpsites with associated burning. This takes into account only a limited set of waste streams and should therefore be seen as a conservative, lower-bound estimate.
- Opportunities in Africa to develop a "waste as secondary resource" approach are still largely unexplored.
- Labour-intensive collection and sorting of secondary resources could create many direct jobs and even more indirect and induced employment opportunities at higher levels of pay, with a specific focus on empowerment of women.
- Local beneficiation of these secondary resources will ensure that fewer jobs are likely to migrate to other countries.
- The best functioning systems are those that embrace and include the large, very active informal waste sector.
- Crime organizations are known to collude with local institutions to control waste markets, and organized crime and corruption are major obstacles to achieving better waste performance.

6.1 Introduction

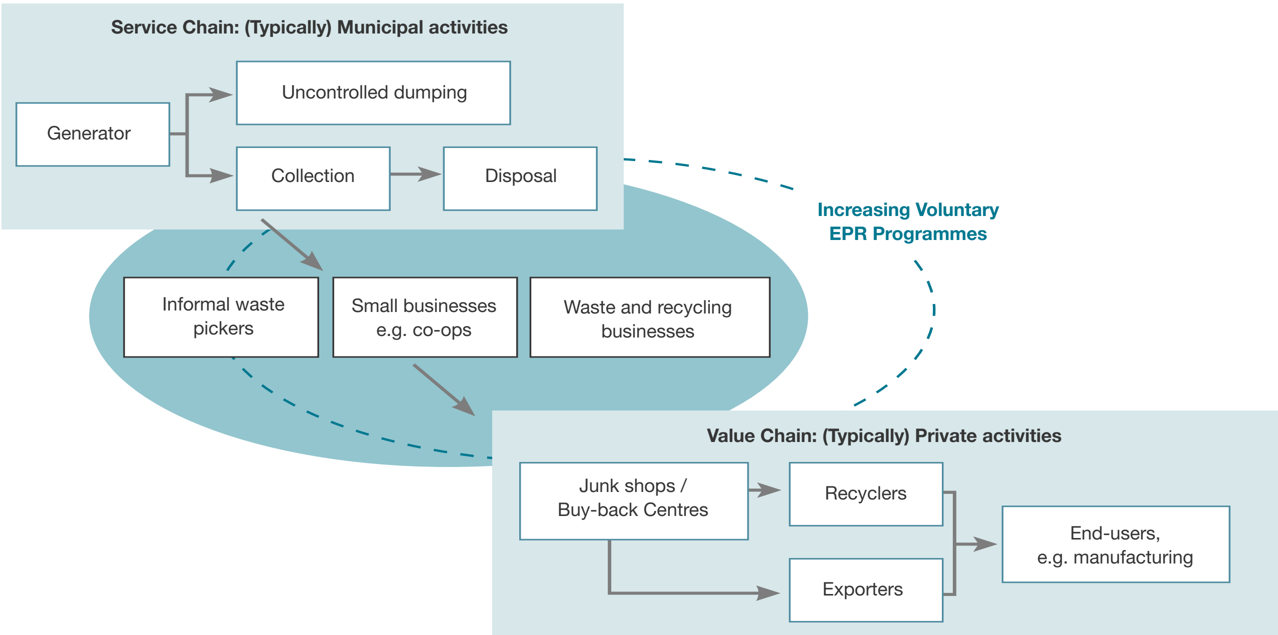
Open dumping and unsanitary landfilling tend to be the cheapest and therefore the predominant form of waste disposal in many African countries (**see chapter 3**) (Simelane and Mohee 2015). In many cases, alternative waste treatment (AWT) technologies are either not required by law or have not yet achieved the economies of scale that would enable them to compete with the business-as-usual approach. As such, there is little incentive from a purely financial perspective for moving up the waste management hierarchy (i.e. away from dumping/landfilling, towards waste prevention, reuse, recycling and energy recovery). Achieving economies of scale in alternative technologies requires an initial investment in such technologies (**see chapter 8**). However, to make the case for increased investment in AWT technologies, it is essential to highlight the benefits of these alternatives relative to the status quo.

Although AWT technologies cannot currently compete with open dumping and unsanitary landfilling from a purely financial perspective, from a broader "green economy" or sustainable development perspective (i.e. from a broader economic, social and environmental perspective), there are a number of benefits to moving up the waste management hierarchy (EEA 2011; UNEP 2013; DST 2014). These include:

- Waste prevention, reuse and recycling all reduce the social and environmental costs ("externalities") associated with landfill disposal (health hazards, odours, visual impacts, contamination of soil and water resources, emissions of greenhouse gases, reduced land availability and value, etc.).
- Waste prevention and re-use can reduce the financial, social and environmental costs associated with waste collection and disposal, and hence their place at the top of the waste management hierarchy.
- Recycling and energy recovery contribute to economic growth and job creation, and can also foster innovation and create new business opportunities.
- Recycling and energy recovery allow for valuable materials and energy to be recovered and recirculated into the economy. These materials can in turn be used as inputs in the manufacturing of new products.
- Recycling and energy recovery displace the use of virgin materials and therefore reduce the financial, social and environmental costs associated with virgin material extraction.

Unlocking the above social and economic opportunities from waste requires a combination of an enabling governance environment (**see chapter 4**) and the development of local and regional value chains to create demand for end-of-life products. It also requires bridging the service- and value-chains, thereby diverting waste away from dumping and landfilling towards value-add opportunities (**Figure 6.1**). Advanced policy instruments such as EPR can play a role in developing local recycling businesses in Africa.

Figure 6.1 Bridging the service- and value- chains in unlocking opportunities in Africa



Source: Adapted from OECD (2015)

6.2 Economic opportunities

The total MSW generated on the African continent in 2012 was 125 million tonnes per annum (**see chapter 3**). However, the average waste collection rate in Africa is only 55 per cent, and more than half of the collected waste is disposed of through uncontrolled dumping and open burning (**see chapter 3**). The average MSW recycling rate in Africa is 4 per cent (**see chapter 3**). In Africa, waste reuse, recycling and recovery is mostly associated with informal pickers and salvagers and is often processed through unsafe and informal activities (**see chapter 5**).

According to Simelane and Mohee (2015), alternative uses for waste in Africa, such as energy-generation, composting and recycling, are all capable of converting waste into valuable assets. Adoption of these technologies is desirable to allow African countries to address the waste management challenges they face, and in so doing unlock the economic and social potential of waste for economic growth and job creation (**see chapter 7**). Therefore, the choice of technology should aim to maximize the benefits of waste for the economy and society.

For the continent to attain this, however, a number of hurdles still need to be overcome. These include improving the methods currently used to collect and dispose of waste. Discussion around moving waste away from landfilling towards AWT technologies are usually stalled by the perceived higher cost of alternatives relative to landfilling (DST 2014). The lack of advanced waste management methods, supported by appropriate technologies, means that there are very few alternative practical uses for solid waste in Africa.

Furthermore, where alternative technologies do exist, they tend to be expensive relative to dumping or landfilling and are therefore a less attractive option. Tipping fees at "landfills", if charged at all[15], tend to be artificially low, since many municipal landfill sites are not designed and operated according to sanitary engineered landfill standards. Higher capital and operating costs associated with sanitary landfilling would drive up costs and make alternative waste treatment options more attractive (DST 2014). At the same time, investment in solid waste management and related technologies needs to be attracted to increase economies of scale and reduce the costs of alternatives relative to dumping and landfilling (Simelane and Mohee 2015) (**see chapter 8**).

6.2.1 Economic value of waste as a resource

This section focuses mainly on the first of the benefits referred to above, namely the recovery of valuable resources and energy and their insertion back into the economy. We quantify this in terms of a "resource value". In other words, we estimate the monetary value of the resources that can potentially be recovered through recycling and WtE applications.

Importantly, this implies that the values reported in this section are a crude (but indicative) estimate that will, inevitably under-estimate the full benefits of moving up the waste hierarchy. The other benefits mentioned above (e.g. benefits associated with job creation and economic growth, as well as the avoided costs and externalities associated with virgin material extraction and landfilling), are not taken into account here, owing to a lack of data for Africa.

The value of waste resources in Africa was quantified using the same methodology applied in South Africa (DST 2014), where the resource value associated with potential increased recovery of 13 waste streams currently being landfilled in South Africa was estimated. This methodology draws on the following insight, namely that:

> "*Data on… waste generation signal the maximum amount that could be recycled. Assuming that all waste is recycled provides an indication of the maximum potential for recyclables to meet… material consumption needs. Of course, this upper limit is theoretical because in reality not all waste can be recycled.*" (EEA, 2011:18).

Essentially, this methodology involves quantifying the amount (in tonnes) of each of the key materials that could potentially be recycled, and multiplying this by a representative unit value per tonne of the recovered material to arrive at an indication of the value of additional recoveries:

$$\text{Resource value}_{i\text{-}n} = (Q_1 \times UV_1) + (Q_2 \times UV_2) + \cdots (Q_n \times UV_n)$$

Where: Q_i = quantity of waste stream '*i*' available to the economy (tonnes)

UV_i = unit value per tonne of waste stream '*i*' (US$/tonne)

Here, we apply this methodology to the data available for waste generation in Africa. Owing to data limitations, we focus specifically on those waste streams for which status quo data was available, as presented in **chapter 3** of this report. As such, we focus specifically on MSW generated in African urban areas (cities), with specific reference to the following streams:

- organic waste
- paper
- glass
- plastic
- metals
- other (**see chapter 3**)

15 Inability to collect cost-reflective charges is a consequence of poor governance and may even relate to political interference and corruption

Data on quantities (in tonnes) of each of these waste streams were derived from **chapter 3**. It is noted in **chapter 3** that total urban MSW generation for the continent amounts to 125 million tonnes per year. The composition of this waste (percentage of the total) across the above-mentioned waste streams is also provided. Based on that information, the quantity generated each year for each waste stream was calculated (**Table 6.1**).

Data on unit values (prices per tonne) were not available for a representative sample of countries across Africa. It should be noted that values can vary significantly across the continent, depending on, among other factors, the maturity of the end-use market. South Africa has a relatively mature recycling market with a relatively high demand for recyclate. As such, prices may be higher than would be paid in countries with a less mature end-use market. Relevant unit values for specific countries should therefore ideally be used to estimate the resource value at a country level. For the purposes of this report, however, owing to a lack of price data from other countries, the unit values used in the South Africa study (DST 2014) were used. These unit values were based on average industry prices paid by recyclers to collectors for the recovered waste materials (note, therefore, that the resulting values do not reflect the further value adding that occurs along the value chain). These prices (in 2013 South African rand) were adjusted to 2016 values using South African Producer Price Index (PPI) inflation rates[16] and then converted to United States dollars[17] (see **Table 6.1**).

Note that the methodology described above requires assumptions regarding the proportions of waste currently being disposed of that could potentially be reclaimed (i.e. regarding the extent to which reclamation rates could potentially be increased). Generally speaking, it is not realistic to assume that 100 per cent reclamation rates can be achieved, particularly not in the short- to medium-term. Materials differ in terms of the physical and economic feasibility of recycling. The secondary resource value for Africa was therefore modelled for a number of scenarios:

- **Scenario 1:** Status quo, based on current recovery rates, in order to provide an indication of the value currently derived from resources that are already being recycled in Africa. According to **chapter 3**, the average recycling rate for urban MSW in Africa is 4 per cent (with much variation between cities)
- **Scenario 2:** Based on 25 per cent recycled or recovered

Table 6.1 Municipal solid waste generation and average composition in selected African cities, and relevant unit values

Waste stream	Composition (percentage of total)	MSW generated, urban areas (tonnes per year)	Average unit value (US$ per tonne)
Organics	57	71 246 580	16.28
Paper	9	11 249 460	64.26
Glass	4	4 999 760	42.30
Plastic	13	16 249 220	269.28
Metals	4	4 999 760	195.95
Other	13	16 249 220	31.71
TOTAL	**100**	**124 994 000**	**–**

Source: MSW composition from Hoornweg and Bhada-Tata (2012); unit value from (DST 2014)

16 http://www.statssa.gov.za/publications/P01421/P01421September2016.pdf

17 Based on currency exchange rates as at 28 October 2016 (R13.88 per United States dollar)

- **Scenario 3:** Based on 50 per cent recycled or recovered
- **Scenario 4:** Based on 100 per cent recycled or recovered. Although a rate of 100 per cent is not realistic, the intention of this scenario is to provide an indication of the maximum value of all waste resources that are currently being generated, and which could (hypothetically) be reclaimed

The results for each scenario are presented in **Table 6.2**. The results imply the following:

- Currently (scenario 1), of the 125 million tonnes of MSW generated annually in African urban areas, only 5.0 million tonnes per annum (4 per cent) is reclaimed for recycling or other uses. The estimated value of these recovered resources is US$318.6 million per year.
- If the recovery rate were to increase to 25 per cent (Scenario 2), 31.3 million tonnes per annum could be reclaimed (an additional 26.2 million tonnes per annum relative to the status quo), and the estimated value of the resources reclaimed would increase to US$2.0 billion per annum (an additional US$1.7 billion per annum).
- If the recovery rate were to increase to 50 per cent (Scenario 3), 62.5 million tonnes per annum could be reclaimed (an additional 57.5 million tonnes per annum relative to the status quo), and the estimated value of the resources reclaimed would increase to US$4.0 billion per annum (an additional US$3.7 billion per annum relative to the status quo).
- Finally, although a 100 per cent recovery rate (Scenario 4) is not realistic to achieve, it is worth noting the total estimated value of waste resources that are currently being disposed of to landfill (or open dumping), i.e. the value of potentially recoverable resources that are not being reclaimed and that are essentially lost the economy. The 125 million tonnes of MSW generated annually in African urban areas has a total value of US$8.0 billion per annum. However, with only 4 per cent (5.0 million tonnes per annum, valued at US$318.6 million) currently being reclaimed, this means that 120.0 million tonnes per annum of potentially recoverable materials are currently being disposed to dumpsite or landfill. As such, purely in terms of MSW from urban areas that is not being recovered; US$7.6 billion worth of valuable resources are currently lost to African economies each year.

These results are an underestimate of the total value of waste resources in Africa, as they are based on only MSW generated in urban areas (**chapter 3**), for a limited number of waste types.

In order to put the results for Africa into context, it may be useful to compare them with the results from the South Africa study (DST 2014). That study was based on 13 waste types (including MSW), amounting to 101.1 million tonnes per year (2011 data), of which approximately 10.9 million tonnes per year (11 per cent) was being reclaimed, with the rest (90.2 million tonnes per year, or 89 per cent) being landfilled. The total value of waste resources (based on 2013 Rands) in that study was estimated at R25.2 billion (US$2.2 billion in current US$), of which only R8.2 billion (US$700 million) was being reclaimed. The study concluded that, just for South Africa, R17.0 billion (US$1.5 billion) of potentially recoverable valuable resources were therefore lost to the economy each year as a result of waste being landfilled rather than reclaimed. Unfortunately, it is difficult to extrapolate these values to the African continent as a whole owing to a lack of data on overall waste generation (as described in **chapter 3**), but suffice it to say that the values provided in **Table 6.2** are only a small part of the overall picture.

Furthermore, as discussed above, in addition to the value of recovered resources, there are a number of other benefits associated with moving up the waste management hierarchy that are not taken into account in the analysis provided in this section. As such, the values presented in this section should be seen as lower-bound estimates of the overall benefits of moving up the waste management hierarchy. Some of the social benefits (e.g. in terms of job creation) are discussed in more detail overleaf.

Table 6.2 Resource values per waste stream (based on MSW generated in Africa)

	Tonnages recovered per annum				Unit values, US$ per tonne	Total resource value, US$ per year			
	Status Quo 4% Recovery	Scenario 2: 25% Recovery	Scenario 3: 50% Recovery	Scenario 4: 100% Recovery		Status Quo 4% Recovery	Scenario 2: 25% Recovery	Scenario 3: 50% Recovery	Scenario 4: 100% Recovery
Organics	2 849 863	17 811 645	35 623 290	71 246 580	16.28	46 395 773	289 973 581	579 947 161	1 159 894 322
Paper	449 978	2 812 365	5 624 730	11 249 460	64.26	28 915 612	180 722 575	361 445 150	722 890 300
Glass	199 990	1 249 940	2 499 880	4 999 760	42.30	8 459 594	52 872 462	105 744 924	211 489 848
Plastic	649 969	4 062 305	8 124 610	16 249 220	269.28	175 023 598	1 093 897 490	2 187 794 981	4 375 589 962
Metals	199 990	1 249 940	2 499 880	4 999 760	195.95	39 188 119	244 925 743	489 851 486	979 702 972
Other	649 969	4 062 305	8 124 610	16 249 220	31.71	20 610 511	128 815 692	257 631 383	515 262 766
Total	**4 999 760**	**31 248 500**	**62 497 000**	**124 994 000**	–	**318 593 207**	**1 991 207 542**	**3 982 415 085**	**7 964 830 170**
Increase relative to status quo		**26 248 740**	**57 497 240**	**119 994 240**	–	–	**1 672 614 336**	**3 663 821 878**	**7 646 236 963**

6.3 Social opportunities

In addition to the economic opportunities associated with a secondary resources economy, there are a number of social opportunities that could be realized by diverting waste away from landfill towards prevention, reuse, recycling and recovery. These social opportunities include job creation, poverty alleviation, enterprise development, entrepreneurship and women's empowerment. Given the large, active informal waste sector in Africa, opportunities also exist to improve the livelihoods and working conditions of waste pickers through the integration of the informal sector into the waste and secondary resources economy, being mindful not to marginalize women working in the sector. If implemented sustainably, this will also create environmental benefits, such as improved resource efficiency, environmental quality and the maintenance of ecosystem services (UNEP 2013). It is important to ensure that the social opportunities created by treating waste as a secondary resource, are realized locally and regionally on the African continent. This creates an opportunity for the waste sector to contribute to achieving the SDGs particularly the targets for SDGs 1, 5 and 8 (**see Topic Sheet 6 in chapter 9**). To achieve this, local and regional approaches to improved waste management must be developed and implemented and export of secondary resources managed. More importantly, markets for recycled materials and processing capacity must be developed on the African continent, supported by all African states.

6.3.1 Job creation

According to the European Environment Agency, recycling and recovery "*create more jobs at higher income levels than landfilling or incinerating waste*" (EEA 2011:7). This statement is confirmed by a study in the United States, where waste collection and landfill disposal creates less than one job per 1,000 tonnes managed, while the collection, processing and manufacturing of products with recycled materials as feedstock creates 6–13 or more jobs per 1,000 tonnes, depending on the material (NRDC 2014). For the European Union and the United Kingdom, Friends of the Earth (2010) used a multiplier of 1.5 and 1.75 to calculate the indirect and induced new jobs in the recycling sector. Moving waste up the hierarchy not only results in a net increase in employment,[18] these new jobs are typically higher paid and the working conditions greatly improved relative to landfilling and incineration (DST 2014). Experiences from the United States and the European Union suggest that exporting recyclate could create overseas jobs at the expense of local employment opportunities (Friends of the Earth 2010). It can therefore be concluded that the more opportunities for recycling that are created within Africa (rather than exporting recyclate off the continent), the more jobs can be created on the continent rather than in other countries.

In Ouagadougou, Burkina Faso, a project for collecting and recycling plastic waste has helped improve the environmental situation and created jobs and generated income for the local community. The project gave rise to the first recycling centre in the country, which is managed by 30 women and supported by around 2000 informal collectors. The recycling centre is also assisted by two technicians. All are locals, working eight hours a day, five days a week, earning the equivalent of US$67 per month, a reportedly good salary compared to other occupations in the local economy. The 2,000 or so waste collectors earn up to US$1 per day. Since implementation, the city and its suburbs are cleaner. The recycling centre has allowed many people to secure an income, either by collecting the plastic waste or by working as full-time employees at the recycling centre. Many of them used to be among the poorest of Ouagadougou's suburban population (ILO 2007).

18 Where job losses in landfilling are outweighed by the creation of "green" jobs in recycling and recovery.

Workers at a material recovery facility in South Africa
Photo credit: © Suzan Oelofse, CSIR

Workers at an e-waste dismantling and pre-processing facility in South Africa
Photo credit: © Linda Godfrey, CSIR

6.3.2 Poverty alleviation

A study of informal waste pickers in Victoria Falls, Zimbabwe, revealed that involvement in resource recovery improved the socio-economic status of the respondents (Masocha 2006). The study showed that most respondents (84.6 per cent) could afford to pay school fees for their children. As many as 61.5 per cent of respondents had improved their living conditions by moving from informal settlements to Chinotimba, where they stayed in decent accommodation with electricity, piped water and flush toilets. At the time of the survey, most waste pickers were paying monthly rent for their accommodation using the income generated from the sale of recovered materials. A local scrap metal dealer in Victoria Falls bought the scrap metal from waste pickers, sold some of the metal to recycling companies in Bulawayo and manufactured various metal products, such as window frames, gates and door frames. The sale of five standard gates and 10 four-pane window frames earned the dealer a monthly income of about US$1,881 (Z$190,000). At the time, this income compared favourably with the monthly salary of most middle-level managers in the town. From this example, it can be concluded that if informal waste pickers are up-skilled to add value to the material they collect, they can increase their earning potential significantly (Masocha 2006). It is, however, important to ensure gender equality in realizing opportunities and earning potential.

6.3.3 Enterprise development

The collection, reuse, recycling, recovery and disposal of various waste streams provides economic opportunities for the private sector to partner in service provision, given an enabling environment for private sector investment in waste management. Micro-, small- and medium-sized enterprises (SMEs) have an important role to play in waste management in Africa. However, a major challenge that public authorities face is in creating an environment that enables such enterprises to enter the waste management industry, and in so doing, increase employment potential and productivity (UN-Habitat 2014). When appropriately supported, SMEs can play an important role in solid waste management on the African continent.

Small-scale entrepreneurs can, for example, play a role in the recycling of non-harmful wastes, such as composting of organic materials (UN-Habitat 2014). Currently, such activities are mostly being done by informal pickers, but with appropriate assistance, they could be scaled-up and better managed at the neighbourhood level. Such efforts can improve urban environments while simultaneously generating income opportunities and improved livelihoods for the men and women of Africa.

6.3.4 Entrepreneurship

There are multiple opportunities for entrepreneurship in the waste economy in Africa. They are spread throughout the value chain, including the uptake of technological innovation to reduce waste generation. Some examples are discussed below and also in **chapter 7**.

Construction and demolition waste (e.g. bricks, concrete and scrap metal) reclaimed from dumpsites in Zimbabwe are reportedly sold to small-scale entrepreneurs for construction of tuck shops. Some materials, such as bricks and concrete stones, require no processing before they are sold, while others, such as stone, are reclaimed from concrete slabs, converting the waste materials into reusable items with resale value (Masocha 2006). Similar observations were made for South Africa, where reclaimed bricks are sold at varying prices, based on the type of brick (Oelofse and Strydom 2010).

Reclaiming bricks from a landfill in the City of Tshwane, South Africa
Photo credit: © Suzan Oelofse, CSIR

Manufacturing of dog kennels from waste wood on a landfill in the City of Tshwane, South Africa
Photo credit: © Suzan Oelofse, CSIR

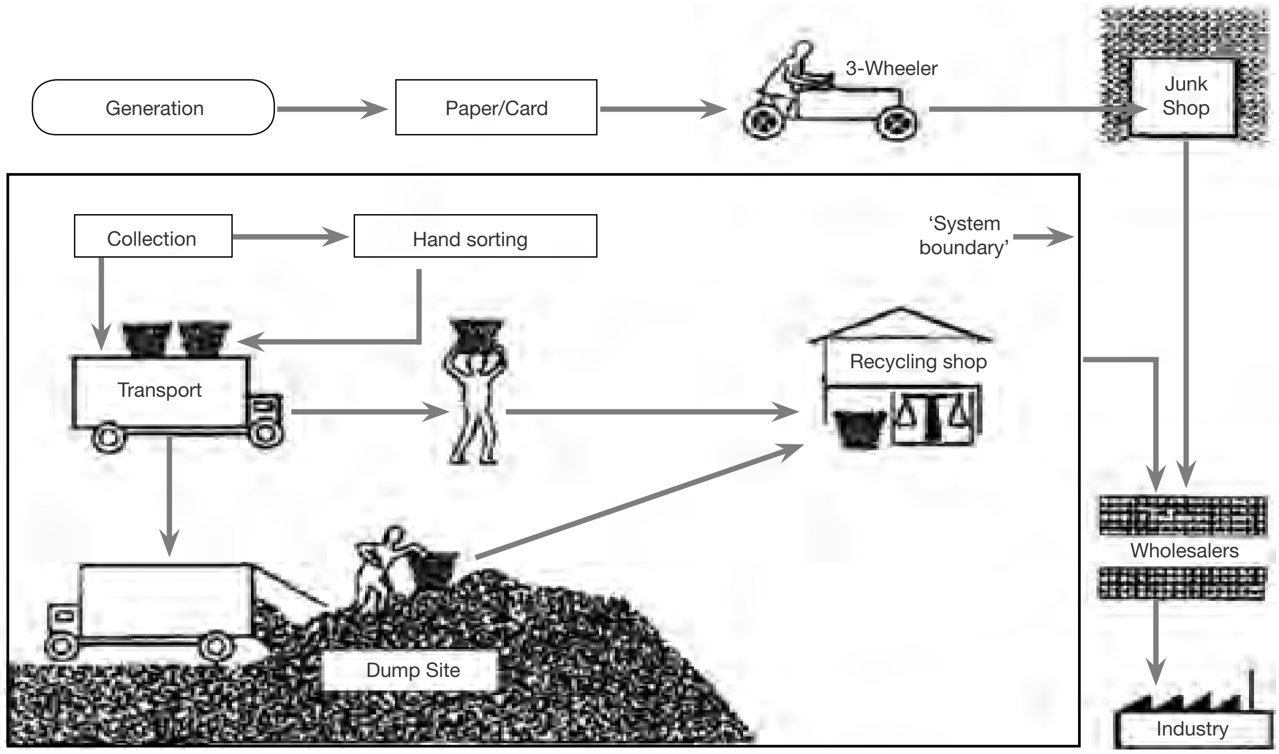
Reclaiming garden (organic) waste also presents opportunities for entrepreneurs, as was observed in the City of Tshwane, South Africa, where plants recovered from waste sites are planted in pots and sold. At one drop-off site in KwaZulu-Natal, South Africa, a make-shift nursery was constructed from shade netting. This type of entrepreneurial activity can be expanded to a profitable, full-scale operation and combined with the benefits of a composting facility (Oelofse and Strydom 2010).

Manufacturing of products is another innovative entrepreneurial activity observed at landfills in South Africa and Zimbabwe. One entrepreneur, assisted by at least two co-workers, manufactures dog kennels from reclaimed wood at a landfill in the City of Tshwane, South Africa. Each manufactured kennel is painted to add further value and is sold either directly from the dump or next to a nearby road. The co-workers are proud of being involved in this venture and managed to improve their social status from waste pickers to craftsmen (Oelofse and Strydom 2010).

6.3.5 Integration of the informal sector

Informal waste management is prevalent in many African cities (**see chapter 5**). While waste management by the informal sector can often be innovative, the non-integration of the informal sector is a major limitation to the social acceptance of their activities. According to Nzeadibe (2015), social acceptance of informal waste management as a legitimate economic activity is important to achieve the objective of an "inclusive city", meaning a place where everyone, regardless of wealth, gender, age, race or religion, is able to participate productively and positively in the opportunities the city has to offer. There remains much debate, still, on whether this means formalization, integration or professionalization. Unfortunately, there is no one-size-fits-all solution, with the model of integration depending on things like local circumstances, cultures and needs. Integration is not without its challenges, as developing countries across the world are experiencing.

Figure 6.2 Schematic representation of the informal recycling system



Source: adapted from Wilson *et al*. (2001)

The integration of informal waste pickers has been further complicated by the recent emergence of EPR schemes, or at least discussion thereof, in some African countries. If not implemented correctly, EPR can threaten the livelihood of informal waste pickers, who see this policy instrument as a potential threat. Discussions among key stakeholders in South Africa, including informal waste pickers, identified possible scenarios for their integration, including (Godfrey *et al.* 2016):

- *Status quo (no interference):* Informal waste pickers continue in their current role, as a largely marginalized, unregulated community, recovering value at little to no cost to the value chain (and hence producers)
- *Independent entrepreneurs:* Informal waste pickers are recognised as independent entrepreneurs, but are left largely to operate in their current form, with some level of increased control and monitoring (e.g. registration, provided with personal protective equipment) and increased support (e.g. access to recyclables through source separation programmes and in industry-provided buy-back centres (static or mobile) to increase the tonnages collected) (*Producer Responsibility Organisation (PRO) supports end-use recyclers thereby creating demand (pull) for recyclables*).
- *Formalization:* Government and business push to formalise the informal sector through the establishment of co-operatives and SMEs, taking on the responsibility for business development support (incubation, mentoring and training). These emerging businesses are assigned geographic areas to "service" (*PRO provides financial and operational support for business development, potentially increasing supply (push) of recyclables*)
- *Employment:* The formal waste and recycling sector drive a labour-intensive collection, sorting and recycling process based on an employment model of absorbing informal waste pickers into new businesses as employees. In so doing, the sector also takes on the responsibility for training and capacity building (*PRO sets clear contracting conditions to participate in formal EPR collection, sorting and recycling programmes that require labour intensive approaches*).

The OECD (2015:33) notes that "*the best-functioning systems are those which embrace an open strategy that includes both informal collectors and the existing value chain enterprises in the system*". In reality, it is likely that a combination of the above scenarios will have to be implemented, based on the specific conditions of the city or town (Godfrey *et al.* 2016). The slums in Lagos, Nigeria, provide an example of integration of the informal sector (Nzeadibe and Anyadike 2010).

6.4 The global waste management system

The secondary resources economy has emerged as a global business (Hoornweg and Bhada-Tata 2012). In the light of the earlier discussion on the establishment of local end-use markets for secondary resources, a discussion on transboundary waste management, regional approaches, global trade in recyclables and the evolution of crime, including transnational organized crime in the waste sector, is particularly relevant. It is noted, however, that these issues are often in contravention of global and regional policies on the transboundary movement of waste (**see chapter 1**) and can result in local environmental impacts (**see chapter 5**).

6.4.1 Regional approaches to secondary resource management

Developing countries often generate too little waste to warrant investment in reprocessing technologies, and little progress has been made towards regional approaches for managing secondary resources in Africa.

A recent study on the e-waste dismantling, pre-processing and processing technology landscape in South Africa showed that one of the biggest challenges affecting sourcing, operation and implementation of e-waste recycling technologies was the low volumes of e-waste in South Africa, resulting in the inability of companies to achieve economies of scale, remain profitable and invest in upgrading and expanding operations (Lydall *et al*. 2017). At current collection volumes, e-waste recycling was found not to be profitable as a standalone business for small firms, with 58 per cent of small businesses regarding e-waste recycling as a secondary activity, the more profitable aspect being e-waste refurbishment (making up to 60 per cent of revenues) (Lydall *et al*. 2017). Creating regional economies (within or across countries), amasses more recyclable waste and creates economies of scale necessary for investment in local end-use markets. Some key features of existing regional management systems for specific waste streams are outlined below.

Waste oil

The management system for waste oils is not highly organized in Africa and tends to be informal. There is little reliable information on the existing waste oil management systems. It is reported, however, that in all countries, waste oil is collected from most of the larger sources by some very active waste oil collectors, some of which apply relatively high standards. Waste oil finds ready markets, mostly as fuel for burning in a variety of combustion systems, and the informal sector plays a key role in the collection systems. Waste oil collected in several African countries is sent to South Africa for recycling, because the export countries do not have treatment facilities or because prices paid by the South African recyclers are higher. Some cooperation is reportedly developing between major waste oil generators seeking common solutions for common problems, resulting in economies of scale and higher standards. There are also reports of investment or planned investment in facilities that process waste oil into high quality fuel in several African countries (Africa Institute 2013a).

Used lead-acid batteries

According to the Africa Institute (2013b), the management system for ULAB in Africa is not highly organized and tends to be informal, much like the system for waste oil. The main sources of ULAB are automobile batteries generated by many small generators and collected by the informal sector. Industrial and other uses of ULAB in

Africa, such as for storage of solar power in rural areas, are growing. Economically viable, environmentally sound collection of used batteries is a challenge. However, it is reported that the majority of ULAB (70–90 per cent, depending on the country) are captured by the existing systems owing to their high value. All ULAB collected finds ready markets, but only three Africa Institute member countries (South Africa, United Republic of Tanzania and Zambia) have proper lead smelters. A large portion of ULAB is reported to be exported to Asia, where the prices paid are higher. There is a high demand for lead from secondary lead smelters in the African region, giving ULAB a high value and ensuring that most ULAB are captured in the existing collection system. There is thus potential to extend the current collection system in the future, however, there is also a need to strengthen the policy framework around ULAB and potential for exchange of knowledge and expertise among Africa Institute member countries.

E-waste

EACO has developed a model policy for e-waste management in the East African region to guide the development of e-waste management policies in their member countries (EACO 2013). It is not clear, however, whether this model policy framework has had any uptake in the region (**See Topic Sheet 2 in Chapter 3**).

6.4.2 Global trade in recyclables

Cross-border trade of recyclables such as metal, paper and plastics is driven by demand. Trade in recycled materials is growing rapidly, with the recycling market becoming increasingly globalized. This has been fuelled largely by growing demand for both raw and secondary materials in emerging economies, particularly China and India (Fakir 2009). The volume of traded recyclables has become significant in the resource trade market, which includes trade in virgin resources and recyclables (Michida 2011). Growth in demand from these highly populated, rapidly growing economies is driving a sustained trend in rising commodity prices, while increasing demand for recycled materials. China's recent notice to the World Trade Organization that it intends to ban imports of certain waste streams by end of 2017 (WTO 2017) will have huge implications, including job losses in the recycling industry, especially for countries that do not have their own local processing facilities. This ban by China may, however, also create an opportunity for Africa to develop local markets and processing facilities for recyclables, thereby creating some resilience to global shocks in the secondary resources market.

World markets

Secondary commodities (recovered and recycled materials) are increasingly behaving like primary resources (BIR 2010). In an environment where primary commodity supply has lagged behind demand, secondary materials shadow primary materials both in demand and pricing. Secondary materials can function as a backup that ensures steady supply (Fakir 2009). This statement holds true for non-ferrous and ferrous scrap and at a certain level also for recycled paper and plastics (BIR 2010). The development of derivative markets could therefore also affect the recycling industry in the near future. In the secondary materials market, the materials move to where the demand directs them, irrespective of their origin. Unlike the trade in primary commodities, which can be affected by large inventory swings, the secondary resources trade is a volume business. Recyclers do not buy secondary resources inherently expecting to hold them until prices increase; they buy them to meet their customers' monthly requirement (ISRI 2016).

Prices are based on a marketplace made up of consumers who use these recycled materials to manufacture steel, aluminium, copper, paper, electronics, glass and rubber products, among others. The processors buy materials from thousands of sources to keep up with expected consumer demand, process the material into specification-grade material and deliver their product based on current market conditions dictated by the customer. Secondary materials processors are viewed as the price taker, not the price setter, hence the phrase, "*Scrap is bought, not sold.*" (ISRI 2016).

Geographical location also plays an important role in price setting owing to differences in machinery and materials prices, and production and labour costs (Ferreira *et al.* 2012). Africa should therefore consider developing local markets for recyclables rather than selling them into existing world markets and effectively exporting job opportunities (and opportunities for the development of downstream manufacturing industries) together with the waste material.

Paper

The global trade in recovered paper amounts to approximately 50 million tonnes per annum (ISWA 2012). Africa collected 2.46 million tonnes of paper in 2011 and consumed 2.39 million tonnes of recovered paper in 2011 (BIR 2011), and is therefore a net exporter of recovered paper (**Table 6.3**). This suggests opportunities for growing local end-use markets for waste paper recycling.

Plastic

The annual volume of globally traded plastics waste is around 15 million tonnes, which is less than 15 per cent by weight of new plastic production (2012 figures). The international recycling markets for plastic waste depend on a complex interplay of five key market factors (Velis 2014):

- National (domestic) solid waste collection capabilities (formal and informal), reprocessing capabilities and needs, and export/transport laws and controls.
- Market demand and import controls at the major destination countries and investment in raw material production elsewhere (e.g. Chinese investment in Africa).
- Global supply chain networks: transport, logistics and costs.
- Cost of primary resins, which is dependent on oil and natural gas prices (prime determinant of the price of recycled plastics).
- Technological innovation (e.g. new resins, composites, compostable plastics, sensor-based sorting and chemical recycling).

E-waste

Lundgren (2012) provides an indication of the main flows (import and export) of e-waste globally (**Figure 6.3**). The trade in e-waste shows similarities with that of other commodities (Lepawsky and McNabb, 2010). Trade in e-waste in Africa was mostly externally oriented in 2001, with e-waste mostly exported to Korea and Spain, but by 2006 had shifted by more than ten percent towards internal trade of e-waste in Africa (Lepawsky and McNabb, 2010), likely reflecting the growing use of digital technologies by consumers and businesses within Africa. E-waste is imported into Africa through the ports of Lagos, Mombasa, Dar es Salaam and Cairo (Schmidt 2006). In 2001, imports of e-waste into Africa were exclusively from Europe and America, but the number of regions from which e-waste was imported had increased by 2006 (Lepawsky and McNabb 2010).

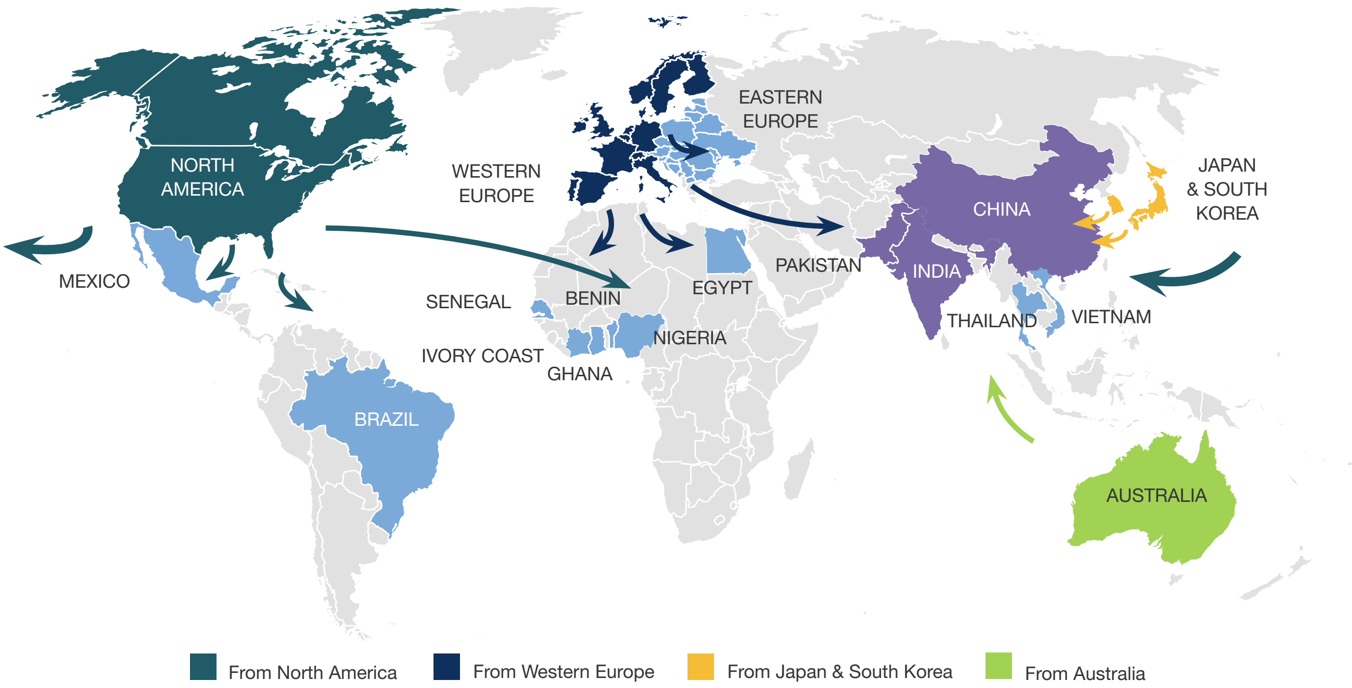
In the case of e-waste, there is not necessarily a one-way transformation of value-to-waste along a linear chain of production-consumption-disposal (Lepawsky and McNabb, 2010). More e-waste is predicted to end up in West Africa in future owing to the increased tightening of import regulations in Asian economies. While this could create significant environmental and human health risks (**see chapter 5**), it also provides opportunities for Africa to develop the required capacity and acceptable standards to handle this waste stream responsibly (minimizing associated environmental impacts), while creating jobs and benefiting local and regional economies (**See Topic Sheet 2 in chapter 3**).

Table 6.3 Collection, net imports and apparent consumption rates for recovered paper in 2011 (tonnes)

Country	Collection	Imports	Exports	Apparent consumption
Asia	96 505 000	39 802 000	8 090 000	125 430 000
Europe	61 760 000	15 800 000	24 800 000	52 750 000
North America	52 390 000	1 740 000	23 000 000	30 380 000
Latin America	11 465 000	2 130 000	920 000	12 670 000
Australasia	3 610 000	3 000	1 580 000	3 033 000
Africa	2 450 000	30 000	140 000	2 338 000
Total	**228 180 000**	**59 505 000**	**58 530 000**	**226 601 000**

Source: Bureau of International Recycling (2011)

Figure 6.3 Flow of e-waste



Source: Lundgren (2012)

6.4.3 Resource crime

The evolution of crime in the waste sector, including transnational organized crime, is a significant threat. According to Rucevska *et al.* (2015), criminal activity can occur at various stages of the waste chain. It can range from illegal dumping or unsafe waste management to organized crime, including tax fraud and money laundering. The extent of illegal trade in waste in Africa is unknown. Common criminal actions include falsification of customs forms and tax fraud through over- or under-invoicing costs and income. Waste is deliberately classified as "other items" to deceive law enforcement authorities. For example, non-hazardous waste codes or product codes are used for hazardous waste, and many shipments of e-waste are disguised as second-hand goods.

Key destinations for large scale shipments of hazardous waste in Africa, including e-waste, include Ghana and Nigeria, but high volumes also go to Côte d'Ivoire and the Congo (**see chapter 3**). Capacity for repairs and reuse of WEEE accounted for high imports into the West-Africa sub-region. The key driver for illegal waste shipments to destination countries is reported to be the profit generated from payments for safe disposal of waste that is then either dumped illegally or unsafely recycled. It may further include additional profits from recycling of certain components, while the majority of the waste is simply dumped (Rucevska *et al.* 2015).

Criminal activities in the waste sector are usually structured along a legal chain of operations, albeit where the players take advantage of loopholes in control regimes and actual control capacities. According to Rucevska *et al.* (2015), "*There is likely no other area of organized crime that provides such a significant opportunity for money laundering and tax fraud as waste disposal, with its near complete lack of monitoring, statistics or reporting*". Without effective enforcement efforts aimed at mapping, investigation and possible prosecution of criminals involved in illegal waste management activities, illegal dumping and transport activities are likely to grow, as will the associated threats to human health and environmental integrity. Crime organizations are known to collude with local institutions to control waste markets, and the role of organized crime within local municipalities is a strong obstacle to achieving better waste performance (D'Amato *et al.* 2015).

6.5 Conclusion and recommendations

Current waste management practices on the African continent are characterized by significant backlogs in waste collection coverage; and disposal to open dumps or unsanitary landfills (**see chapter 3**). These practices are not conducive to realizing the potential economic and social opportunities in waste as a secondary resource. It is estimated that the 125 million tonnes of MSW generated annually in African urban areas has a total resource value of US$8.0 billion, of which only a small percentage (4 per cent) is currently being recovered. This value estimate is based on only a limited set of waste streams, and only on the direct value of the resources at a specific point in the value chain, and therefore understates the true value of all waste streams across the continent. The value of the potentially recoverable resources that are not currently being collected and are essentially lost to the economy is estimated at US$7.6 billion per year. Moving waste up the waste management hierarchy is essential if this potential for Africa is to be realized.

Unlocking the opportunities associated with waste as a secondary resource will unlock social and economic opportunities, including economic growth, poverty alleviation, job creation, women's empowerment, improved livelihoods for people and improved environmental health and ecosystem services. However, the benefits for Africa will depend on the extent to which the opportunities associated with secondary resources are realized within Africa or exported to other countries.

Secondary materials are part of the global economy, and will therefore be subject to global market fluctuations and volatility. However, it is important to ensure that the benefits are realized on the African continent, and not abroad through the export of materials. Economies of scale will be required to develop sustainable local processing capacity, markets for recyclables and facilities for processing materials and manufacturing high quality goods using recycled input materials. A regional approach to secondary materials management will have to be followed to maximize the benefits for Africa.

It is therefore recommended that an "*African regional strategy for secondary materials management*" be developed and implemented. An enabling governance environment, combined with supporting data, infrastructure, institutional capacity, financial provisions, monitoring and control mechanisms, will also have to be put in place to enforce such a strategy.

7 Appropriate solutions for Africa

7 Appropriate solutions for Africa

What the reader can expect

Many proven alternative waste treatment technologies (to landfilling) are available worldwide. However, not all of these are appropriate or economically viable (at least in the short-term) for implementation in Africa. This chapter explores the social and technological innovations that have emerged in Africa to deal with the increasing volumes of waste generated on the continent. Social innovations in waste prevention, reuse or collection and alternative waste treatment technologies for waste recycling and recovery are explored, and planned new waste technologies are highlighted. These innovations are also reflected on through relevant case studies.

Key messages

The following are the key messages regarding appropriate solutions for Africa:

- Many alternative waste treatment technologies are available worldwide, but only some of them are appropriate, or economically viable, for Africa, at least in the short- to medium-term.
- Some excellent social and technological innovations have emerged in the waste sector in Africa;
- As source separation of waste is not currently effected in most African cities, conventional waste treatment technologies are difficult to implement.
- Uncontrolled dumping and open burning remain the dominant "technology" choice for the management of waste on the African continent.
- Low-technology (and low-cost) solutions such as cargo bicycles, motor tricycles or donkey-carts are good alternatives for waste collection in African cities.
- Including informal actors in the waste management system is an opportunity for improved livelihoods and income generation for often disadvantaged groups.
- Reuse of end-of-life goods is already widespread across Africa, but often driven informally, with opportunity to scale up.
- Recycling technologies are already being implemented for wastes such as plastic, paper, glass, metal, oil, e-waste and organic waste, but could be significantly scaled up through the development and strengthening of local and regional end-use markets.
- Energy recovery technologies, such as landfill gas recovery, biodigestors for the organic fraction of MSW and industrial biomass are currently very limited in their implementation in Africa.

7.1 Introduction

The previous chapters have shown that while some degree of reuse, recycling and recovery is taking place in Africa, uncontrolled dumping and open burning remain the dominant "technology" choice for the management of waste on the continent. If we are to improve the management of waste and unlock the environmental, social and economic opportunities of moving waste up the hierarchy away from landfilling towards prevention, reuse, recycling and recovery, large-scale adoption of appropriate, alternative waste treatment technologies (AWT) is required.

However, a large spectrum of possible AWT technologies are available worldwide for immediate implementation. Decision makers therefore have to make the right choice of treatment and disposal solution based on the specific requirements and constraints of each town or city.

Box 7.1 Measuring the appropriateness of waste technologies in Africa

In Africa, where most countries are classified as low- and lower-middle income, there are many parameters to consider when selecting AWT technologies, including:

- sensitivity to the quantity and quality of waste;
- capital investment costs
- operation and maintenance (O&M) costs
- cost recovery potential
- efficiency of the technology
- end-product utility
- environmental impacts of operation
- land, energy and water requirements
- availability of local competences to properly manage the system
- inclusion of both formal and informal actors in the system

Guidance note: Lessons learned

- An appropriate technology should not be considered in isolation; it must be placed within an integrated waste management strategy.
- Both formal and informal actors must be considered to insure the efficiency of the waste management strategy (high level of waste collection, improvement of recycling and/or reuse, high material and energy recovery, social inclusion and income generation for the poorest people).
- The choice of the appropriate technology should consider the following:
  - The technology should be proven based on effective operating experience in African/low-income country contexts.
  - The technology should be economically viable in the context of low-income countries.
  - Technical issues related to the implementation of the technology should be easy to fix: the presence of qualified human resources for management and maintenance must be considered.
  - Low cost technologies are preferred as waste treatment solutions.
  - The technology should be an opportunity for social innovation (job creation, social inclusion, income generation).

As outlined in **chapters 3, 4 and 5**, Africa faces many challenges regarding the management of waste, especially MSW. Of the 125 million tonnes per year of MSW generated in Africa in 2012, only 4 per cent was recycled, with the bulk of the waste disposed of to dumps, often associated with open burning. With an average collection rate of only 55 per cent for the continent (**see chapter 3**), uncontrolled dumping of uncollected waste contaminates urban centres. Considering that 70–80 per cent of MSW generated in African cities is recyclable, it does not make sense that viable secondary resources are so poorly managed on the continent (**see chapter 3**).

The following sections explore real examples of the social and technological innovations that have emerged on the African continent to address the challenges of waste collection, separation at source and the diversion of waste away from landfills.

7.2 Waste prevention

According to the United Nations Industrial Development Organization (UNIDO), waste prevention "*makes more sense than trying to recycle, recover and treat wastes and pollutants once created or already discharged into the environment.*" (UNIDO 2015:3). Following the 1992 United Nations Conference on Environment and Development (Rio Conference), efforts by UNIDO, UNEP and other development partners aimed at decoupling resource use and environmental impacts from manufacturing growth through improved energy, water and materials efficiency led to the development of national cleaner production centres (NCPCs). According to UNIDO[19], "*NCPCs contribute to improved environmental performance and resource efficiency of enterprises*". However, waste prevention, as a concept, is still in its infancy in Africa. In 2015, 14 African countries were represented by NCPCs (UNIDO 2015).

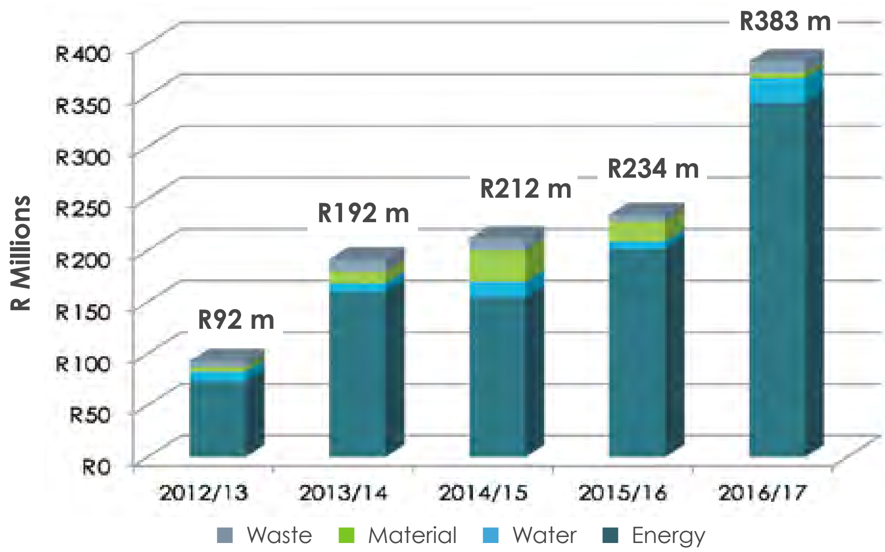
In 2016, the NCPC South Africa identified potential energy, water and materials savings of R382 million per year (around US$30 million) for local companies through resource efficient and cleaner production mechanisms (**Figure 7.2**). Furthermore, its national industrial symbiosis programme realised 6,160 tonnes of waste diverted from landfill and 8,800 tonnes of virgin input material saved in 2016 through waste exchanges between businesses (NCPC 2017).

Figure 7.1 Countries with national cleaner production centres in 2015

Source: Resource Efficient and Cleaner Production Network (RECPnet) http://www.recpnet.org

19 http://www.unido.org/ncpc/o5138.html

Figure 7.2 Potential savings identified through cleaner production assessments



Source: NCPC (2017)

7.3 Waste collection and social innovation

In high-income countries, waste collection is under the responsibility of municipalities and formal contractors. Waste is collected from households and businesses by vehicles and transported to transfer points and treatment facilities, with final residual waste going to sanitary engineered landfills. This type of collection model is currently not used in most African countries. Source separation of waste is not common in African cities and towns, nor is it mandatory, whereas it is a basic requirement in most high-income countries. It is well known that the waste collection strategy has a direct impact on the efficiency of technologies for resource recovery and reduction of final disposal volumes (Gomez 1998; Zhuang *et al.* 2008; Giugliano *et al.* 2011). Waste collection and source segregation plans therefore need to be adapted to the African context, and the opportunities for social innovations identified.

In Africa, where municipalities are struggling to implement collection services, informal collectors, small-scale entrepreneurs and private businesses have stepped in to provide service. The informal waste sector has been shown to be very effective and efficient in collecting waste, in particular valuable recyclable material that can be sold (**see chapter 6**). There is growing consensus that the informal sector must be taken into account when improving waste management systems in developing countries (Ali 2006, Dias and Alves 2008, Agamuthu 2010, Gutberlet 2010, Chaturvedi 2011, Luken 2011, Sang-Arun 2011, Besiou *et al.* 2012, Scheinberg *et al*. 2011, Scheinberg 2012). Indeed, these informal actors cover areas where it is difficult for official contractors to operate, such as suburban zones, informal settlements and areas with little to no purchasing power.

There are significant opportunities for improved waste management in Africa, by integrating informal actors, including:

- Better coverage of the city for waste collection and recycling
- Generation of income for disadvantaged people
- Lower fuel consumption and extension of lifetime for vehicles when replacing conventional waste collection vehicles with motor tricycles and donkey-carts in suburbs and areas with difficult access
- Structuring of informal actors and perception of additional taxes by the municipality

CASE STUDY 5

WECYCLERS, LAGOS, NIGERIA

In Nigeria, a small company Wecyclers (http://wecyclers.com), was started in 2012 by a young female entrepreneur as a for-profit social enterprise to address the waste management challenge facing the city. At the time, only 40 per cent of Lagos' waste was collected and only 13 per cent was recycled. Furthermore, recycling firms in Lagos faced supply constraints, unable to access adequate supplies of quality recyclable material, often operating at 50–60 per cent below capacity. Wecyclers uses low-cost, environmentally friendly cargo bicycles called "wecycles" to provide households and businesses in Lagos with convenient collection services for recyclable waste, thereby helping communities reclaim their neighbourhoods from unmanaged waste (Iwuoha 2015). According to the company, "*Wecyclers gives households a chance to capture value from their waste while providing a reliable supply of materials to the local recycling industry*". Waste volumes in programme areas in Lagos, Nigeria, have been reduced by over 35 per cent owing to this social entrepreneurial innovation. The principle is simple and adaptable to other communities in Africa.

In Ouagadougou, Burkina Faso, donkey-carts are used to collect waste from suburban households and transport it to transfer centres. Informal women's groups are generally in charge of this activity. In business and residential areas, waste is collected by vehicles and formal contractors. This integrated system of informal and formal ensures a better waste collection rate and provide incomes for both formal and informal actors.

Wecyclers tricycle collection service for recyclables
Photo credit: © Wecyclers

Women collecting waste in Ouagadougou with donkey-cart
Photo credit: © fedevaco

7.4 Alternative waste treatment technologies

As noted in **chapter 3**, the average composition of MSW in sub-Saharan African cities is about 57 per cent organic, 9 per cent paper/card board, 13 per cent plastic, 4 per cent glass, 4 per cent metal and 13 per cent other materials. An estimated 70–80 per cent of MSW in African cities could therefore be diverted away from landfills towards AWT. This would leave only 20–30 per cent residual waste requiring treatment and final safe disposal to sanitary engineered landfills. The high organic content of MSW is typical of developing countries and requires special consideration when implementing AWT technologies. Many AWT technologies, especially high-temperature thermal treatment, have failed in developing countries because they fail to take the high organic content, and therefore high moisture content, into consideration.

There are many waste treatment technologies (mechanical, biological and thermal) that can be adopted in Africa. **Table 7.1** lists categories of waste treatment technologies that can be used to manage organic waste, recyclables such as paper and packaging, and residual waste.

Table 7.1 Technology options for the management of MSW (including the organic fraction)

Technology	Purpose of the technology
Biological treatment	• Used to reduce the biodegradability of the waste and its volume under controlled conditions. • Treats organic waste such as agricultural waste, food and food processing waste, garden waste. • Includes technologies such as composting (open windrow or in-vessel composting) and anaerobic digestion. • Typically produces a soil improver/conditioner material that may generate income/agricultural benefit. • Some technologies (anaerobic digestion) are also designed to recover energy from the waste.
Materials recovery facilities (MRF) – clean	• Used to extract recyclable material from source-separated waste in order to recover value as marketable products. • Combination of various mechanical processes used to separate materials.
Materials recovery facilities (MRF) – dirty / residual waste	• Used to extract recyclable material from mixed waste streams in order to recover value as low-grade recyclate. • Produces a fraction with good combustion properties that may be appropriate for use as a fuel (refuse derived fuel). • Combination of various mechanical processes used to separate materials.
Mechanical biological treatment (MBT)	• Used to extract recyclable material from mixed waste streams in order to recover value as low grade recyclate. • Recover a fuel fraction from the waste (refuse derived fuel). • Derive biogas (for anaerobic digestion systems) for energy recovery. • Generate a compost-like output. • Stabilize (or partially stabilize) the waste and reduce its volume.
Thermal treatment – incineration	• Used to reduce both volume and biodegradability of the waste, usually also deriving energy in the form of electricity and/or heat. • Temperatures are maintained at high levels and the waste is burned to an ash. • Bottom ash from the process may be recycled in some circumstances but the fly ash and air pollution control residues require specialist disposal.
Advanced thermal treatment – pyrolysis, gasification and plasma gasification	• Used to derive energy from the waste and to reduce both the volume of the waste and its biodegradability. • Higher temperature processes may produce a usable aggregate or slag.

Source: Adapted from DEA (2015)

Table 7.2 Appropriateness of technologies for municipalities in South Africa in the short-, medium- and long-term

Promising technologies – short-term	Technology options that are in practice and/or under development in South Africa and those which have a strong potential for contributing to advanced integrated solid waste management in South Africa	• Open windrow composting • Clean materials recycling facility • Dirty materials recycling facility
Potential technologies – medium-term	Technology options that have scope for successful applications in South Africa where appropriate conditions are in place. These conditions would require a technology that is well suited to the waste streams, affordable and competitive, and that represents a considered component of an advanced integrated solid waste management system	• Anaerobic digestion • Mechanical biological treatment • In-vessel composting • Energy from waste (incineration)
Potential technologies – long-term	Technologies that are unlikely to have applications in South Africa in the short- to medium-term, except under specific circumstances (e.g. for processing a "difficult" waste stream) or where exceptional factors are in place (e.g. grant funding for a demonstration unit)	• Gasification • Pyrolysis • Plasma gasification • Mechanical heat treatment

Source: Adapted from DEA (2015)

Given the challenges facing developing countries with respect to the implementation of AWT technologies and evidence of the failings of inappropriate technologies, the South African Department of Environmental Affairs chose to prioritize the following as short-, medium- and long-term technologies for consideration in South Africa (DEA 2015) (**Table 7.2**).

The following section provides examples of different waste treatment technologies in operation in various African countries, from low-tech (and low cost) to high-tech waste management solutions.

7.4.1 Waste reuse

Africa has many examples of waste reuse initiatives. Reuse (accompanied by repair and refurbishment), is often driven by larger socio-economic issues such as poverty and unemployment, rather than integrated waste management solutions. Examples of waste reuse are evident across numerous waste streams, including paper and packaging, waste tyres and e-waste. Examples are provided in the case studies below.

CASE STUDY 6

REUSE OF WASTE TYRES IN OUAGADOUGOU, BURKINA FASO

Ouagadougou, Burkina Faso, has experienced a significant growth in the volume of waste tyres from approximately 500 tonnes in 2013 to over 8,000 tonnes in 2015 (Touré 2015). These used tyres are imported from Europe or the USA, as the local people have limited budgets for the maintenance of cars. Instead of paying about US$290[20] for four new tyres, customers pay only US$73 for used ones. As the life of these used tyres are very limited, large volumes of waste tyres are generated. In the absence of commercial recycling and recovery technology, local initiatives have been launched for the reuse of these used tyres. Many of these initiatives are subsistence activities (formal and informal in nature), conducted by individuals (and families) who earn a very basic wage from these activities. In a few cases, these initiatives have grown into unofficial business activities and still further into official business activities generating incomes above the living wage for those involved.[21]

Atelier Reclycl'Art launched by Mawourata Koné, a graduate student from the University of Ouagadougou, is one such initiative. This small business manufactures furniture from used tyres, employing about ten people.

Besides furniture and other handicrafts, citizens in Ouagadougou have also reused waste tyres as informal roundabouts for traffic regulation.

20 At an exchange rate of 549 CFA per United States dollar

21 The definitions for subsistence activity, unofficial business activity and official business activity have been adopted from ISO (2017)

Other small businesses manufacturing furniture from waste tyres have also emerged.

Waste tyres used as furniture
Photo credit: © jolijolidesign

Sale of used goods on kerbside, Kenya
Photo credit: © Janis Brizga, Green Liberty / EEB

CASE STUDY 7

REUSE OF PLASTIC WASTE AS SCHOOLBAGS IN SOUTH AFRICA

An example of social innovation in waste reuse can be found in the Rethaka Foundation's Repurpose Schoolbag initiative in South Africa, a social startup founded by two young female entrepreneurs in 2013 as a green initiative to help school children in their local community (Iwuoha 2015). Their young business collects and repurposes plastic waste such as PVC billboards into low-cost schoolbags for local disadvantaged students.

These "upcycled" plastic bags have a solar panel in the flap, which charges as the children walk to and from school. They also have strips of reflective material, an added safety design to make the children more visible to traffic. The charged solar panels are used to provide light at home in the evening, which the children can use instead of candles to do their homework and study. This helps students to do more school work and saves money that would have been spent on candles. The company has partnered with local individuals and organizations that are willing to cover the cost of the bags on behalf of the students. According to the foundation's website, "*over 10,000 Repurpose Schoolbags have been given to children in six countries on the African continent*" (http://www.rethakafoundation.org/).

This simple but highly effective idea has attracted a lot of attention. In 2014, these young entrepreneurs were first runners-up for the Anzisha Prize, a pan-African award celebrating entrepreneurs aged 15–22 who have come up with innovative ways to solve problems in their communities.

Repurpose schoolbags

Photo credit: © Repurpose schoolbags Facebook page

CASE STUDY 8

REUSE OF E-WASTE IN ABIDJAN, CÔTE D'IVOIRE

The EWIT Consortium (2016) estimated that 15,000 tonnes a year of e-waste were generated in Abidjan, Côte d'Ivoire, based on measurements at two recycling associations. E-waste collection and the reuse/repair activities are informally managed through individual actors and have a strong presence in the local economy. E-waste collectors have organized themselves into an association. They sell their wares to various repair shops situated in large refurbishment markets. These markets are also organized as an association, with a president who represents the interests of the repair shops in stakeholder engagements. Each repair technician rents space from the association, is individually registered with the municipality as a tradesman with a registration number, and pays taxes.

Repair shop in Marcory, Abidjan

Photo credit: © EWIT Consortium

7.4.2 Waste recycling

Waste recycling is still in its infancy in Africa, with only 4 percent of MSW recycled (**see chapter 3**). It is entirely market driven and has grown organically, largely due to an active informal sector that collect recyclable material from kerbsides and landfills *(supply-side)* (DEAT 2005, Samson 2010) (**see chapter 6**). This has facilitated the growth of local and international end-use markets, which use this recyclate in the manufacture of new products *(demand-side)*.

The informal sector and recycling micro-enterprises can achieve considerable recycling rates, up to 20–30 per cent by weight in low-income countries (Wilson *et al.* 2009, Wilson *et al.* 2012). According to Wilson *et al.* (2012) and Scheinberg *et al.* (2010), local authorities can save around 20 per cent or more of their budget through diversion of recyclables by the informal sector and micro-enterprises.

The majority of commercial waste recycling initiatives have been initiated by the private sector, with some public and private sector financing (**see chapter 8**). Waste sorting in African cities is essentially done manually, most of the time by informal actors or in small material recovery facilities. Such manual sorting strategies appear appropriate for countries with high levels of unemployment and a real need to create jobs for unqualified people. Source separation and recycling are sometimes encouraged by municipal authorities in establishing waste buy-back centres and garden waste drop-off centres, where waste is separated into different streams such as glass, paper/cardboard, cans, scrap metal, plastics and garden waste (CSIR 2011). Authorities can also arrange dedicated spaces on landfills for waste sorting, where reclaimers can work in controlled, relatively safe conditions (Saranel 2007, PSRDO-CER 2010). In many cities like Cairo, Egypt, despite formal contracts with delimited zones attributed to contractors, informal actors are involved in waste sorting and recycling. The official contracts signed by the municipality prohibit such actors from participating in waste collection or recycling, but authorities and formal contractors turn a blind eye to their activities. This ensures income for urban poor and favours better waste collection coverage. The inclusion of informal actors in the collection of recyclables appears to be an innovative way to improve waste recovery and reduce the volume of waste disposal to landfills in Africa.

The following section highlights recycling activities taking place in various African countries, ranging from low-technology (and low-cost) composting to high-technology (and high cost) plastic recycling and thermal treatment.

CASE STUDY 9

RECYCLING OF PLASTIC WASTE IN KENYA

The experience of EcoPost in Kenya shows how job opportunities can be created through the recycling of waste. EcoPost is a social enterprise created in response to the need to find alternative waste management solutions to Kenya's plastic waste problem. Founded in 2009 by a young female entrepreneur, the company collects plastic waste and manufactures commercially viable, highly durable and, most importantly, environmentally friendly fencing posts. EcoPost has not only provided Kenya with a commercial alternative to timber, but has in the process created over 300 jobs, generated much needed revenues, saved over 250 acres of forests and taken more than one million kilogrammes of plastic waste out of the environment (Hawken 2014).

EcoPost plastic lumber products
Photo credit: © Money Spent Well

CASE STUDY 10

MANUFACTURING UTENSILS FROM ALUMINIUM WASTE IN ABIDJAN, CÔTE D'IVOIRE

In PK 18, a district of the municipality of Abobo, in Abidjan, Côte d'Ivoire, several workers have specialized in the making of kitchen utensils from aluminium waste (Kouamé 2014). With skills passed down from generation to generation, Kanté Sakamissa, head of a workshop space of around 1,200 square metres since 1992, now employs others in the recycling of aluminium. "*I did not go to school, since my childhood my father taught me to do this work. Today, I have many workers*", he says. The technology used to produce the utensils from recycled aluminium comprises three stages housed in three different workshops: melting of aluminium, mould preparation and finally, correction of slight defects by polishing.

The melting step: Any recovered aluminium, including packaging of alcoholic or non-alcoholic beverage cans, used sheet metal, other miscellaneous packaging, piping and accessories from motor vehicles or other machinery is melted at high temperatures (around 1,000°C). In practice, beverage cans make up the bulk of the scrap material, as other materials are scarce.

The moulding step: The mould is an impression of the utensil that the craftsmen want to reproduce. The technique consists of mixing sand and wet clay. When the mould is finished, it is ready to receive the molten metal from the blast furnace. Once the metal has solidified and cooled, the mould is destroyed and the utensil is extracted. This step generally takes less than 30 minutes after casting. The workshop produces products such as furnaces, pots, skimmers, spoons, pans, and ladles. About 30 pots can be manufactured per day.

Finishing step: Once cooled, the manufactured object is transported to the finishing section where files and metal saws are used for polishing and filing as necessary.

The prices of the items vary according to the size. A small stove for making tea sells for 2,000 CFAF (US$4), while larger sizes sell for 30,000 CFAF (US$55). There is a high demand for such utensils in lower- and middle-income communities, where these products are used mainly for cooking purposes.

Melting the aluminium waste

Photo credit: © Afrique in visu

Polishing a pot at the end of the process

Photo credit: © Afrique in visu

CASE STUDY 11

COMPOSTING ORGANIC WASTE IN CAPE TOWN, SOUTH AFRICA

Cape Town is one of the three largest cities in South Africa. In 2004, 2.3 million tonnes of solid waste was collected and treated in the City of Cape Town Municipality. Some 120,000 tonnes was pure green waste, of which 30 per cent was composted. A further 31,200 tonnes of mixed household waste was treated in the municipality's facilities. Altogether, 2 per cent of all waste was treated biologically as an alternative to landfill. The warm climate in the region is favourable for the production of compost all year round, but the hot and windy summer weather puts high demands on water supply for the composting process (Ekelund and Nyström 2007).

Organization and financing of the compost project: The municipality has treated mixed wastes in municipal compost plants since 1969. When starting up the separate handling and treatment of green waste, the municipality chose a solution involving a public-private partnership. The municipality owns the drop-off sites where the green waste is received, and puts out tenders for the management of the sites. The contractor undertakes to not only manage the receipt and chipping of green waste, but also to manage the site and the sub-contractors appointed by the municipality to take away and treat other fractions of waste that are received at the site. The contractors are compensated for the site management and for the amount of chipped green waste they deal with. The City of Cape Town Municipality chose this arrangement with private contractors because commercial composting was not identified as part of their core activities. This case study focusses on one contractor: Reliance.

Reliance compost site in Cape Town

Photo credit: © Reliance

Type and collection of waste: When Reliance converted to organic farming in 1998, it started composting to fill its own needs for an organically approved fertilizer. In 2003, Reliance became a contractor to the municipality and started composting municipal green waste. Each month, Reliance collects approximately 50,000 m^3 of chipped green garden refuse from nine dropoff facilities and landfills around the City of Cape Town. Over the last decade, the company has kept over 20 million m^3 of green garden refuse out of landfills, thus preventing over one million tonnes of CO_2 from escaping into the atmosphere and mitigating the impact on climate change (http://reliance.co.za/aboutus.html).

Process: The chipped waste is treated with inoculum and placed into 1.8 metre high windrows. The intention is to measure temperature and CO_2 emissions daily and use that information to determine turning intervals, but with growing quantities the operators tend to use standard times. Turning and watering is done by a tractor-pulled straddle turner. The compost is considered ready when the temperature falls to ambient and the company's own laboratory tests show that the compost has the right pH value and is low in the phytotoxics, NO_2 and H_2S. The whole composting process takes 6–8 weeks. The ready compost is then sifted and bagged, or sold in bulk.

End product and market issues: Reliance produces different types of compost, such as plant feed, soil conditioner, lawn dressing, potting soil and mulch. Besides the company itself, the main customers are landscapers. The bulk price per cubic metre is R187 for compost and R50 for mulch. The price for wood chips that have not been composted is R45 per cubic metre. The company has a reputation for producing a high quality product and the compost has previously been organically certified.

Since Cape Town is in an expansion phase, there is a lot of construction work underway, and the company has no difficulty finding customers. Relations with many of its customers are long-term, with monthly delivery of compost.

CASE STUDY 12

PET (BOTTLE-TO-BOTTLE) RECYCLING IN SOUTH AFRICA

Extrupet (www.extrupet.com) is the largest, most advanced recycler of waste polyethylene terephthalate (PET) plastic bottles on the African continent. It specializes in reclaiming and converting waste PET bottles into various grades of PET chips and flakes. In 2015 it established the first Coca-Cola approved bottle-to-bottle recycling plant.

Waste PET bottles are converted into fibre, thermoforming, food-grade and strapping-grade material to produce high-quality, reliable end-products for use in packaging and other applications.

Currently, Extrupet has the capacity to recycle over 2.5 million PET bottles per day. Extrupet not only contributes significantly to solving the problem of post-consumer PET waste in the environment, it also helps to alleviate poverty by creating opportunities for thousands of mini-entrepreneurs and informal waste collectors in South Africa.

The company is an important part of the PET plastic recycling industry in South Africa, assisting in the country achieving a 55 per cent post-consumer bottle PET recycling rate in 2016 (PETCO 2017).

Africa's first bottle-to-bottle recycling plant, Wadeville, Johannesburg
Photo credit: © GlobalPSC

CASE STUDY 13

PROTEIN FROM WASTE IN SOUTH AFRICA

There are incredible opportunities for innovation in the waste sector. In addition to traditional organic waste treatment technologies such as composting or biogas recovery, opportunities for high-value product recovery from organic waste are emerging globally, including in Africa. Research on high value product recovery from organic waste, such as the valorisation of chicken feather waste or the recovery of xylose from sawdust waste, is currently being funded by the Department of Science and Technology in South Africa (www.wasteroadmap.co.za).

One company AgriProtein (https://agriprotein.com), based in Cape Town, South Africa, has taken eight years of research and development into commercial-scale recovery of protein from organic waste.

One of the products produced from the recycling of organic waste, AgriProtein, Cape Town
Photo credit: © Philippi Economic Development Initiative

The need: Industrial livestock farming of chickens, pigs and fish relies on protein for feed. This protein is currently sourced from either land-based grains or marine-captured fishmeal. Producing traditional agricultural protein requires vast amounts of land and water to grow crops, while marine-sourced protein has significant impacts on marine stocks. As Africa's population grows and the demand for food increases, so will the demand for protein.

The solution: Waste-to-nutrient company AgriProtein has come up with a novel solution to this problem – produce large quantities of sustainable natural protein using fly larvae fed on organic waste. The company produces three commercial products from processed organic waste, an insect-based protein, an extracted fat and a residual soil conditioner. In 2016, AgriProtein opened the world's first industrial-scale insect recycling facility in Cape Town, South Africa, with the capacity to divert 100 tonnes per day of organic waste away from landfill and produce over 2,000 tonnes per year of insect-based protein. The organic waste is currently sourced from food factories, supermarkets, farms and restaurants.

The way forward: According to Engineering News (2017), Austrian-based Christof Industries, has partnered with AgriProtein to build up to 25 fly farms a year. The new standard 250 tonne per day AgriProtein waste bio-conversion plants will each divert over 90,000 tonnes a year of organic waste away from landfill to recycling and nutrient recovery. Similar insect feed for poultry and fish production initiatives are underway in Kenya and Uganda (IDRC n.d.)

Box 7.1 The importance of source separation

In high-income countries, separation-at-source plays a key role in waste management strategies. Before thinking about re-use, recycling, recovery and safe disposal, waste has to be segregated at source. In most African cities and towns, waste management consists of uncontrolled dumping of mixed waste in open dumpsites. Municipalities and private waste contractors dump waste without thinking about prior reduction of volume.

Separation-at-source should be clearly encouraged in Africa if the full potential of "waste as resource" is to be achieved, and the efficiency of waste management systems improved. In some cities and towns, source separation is being implemented at the pilot scale (Mbiba 2014).

There are both challenges and benefits associated with separation-at-source (CSIR 2011). The challenges include:

- Source separation of recyclables without any significant financial benefit can be challenging as it is considered time consuming by households and other waste generators.
- The lack of appropriate infrastructure can hinder source separation.
- Incorporating separate collection of recyclables into existing collection systems can be challenging as typically there is no legal requirement for separation-at-source in Africa, and collection vehicles are not adapted for separate collection systems.
- The easier it is for communities to dispose of recyclables, the more likely they are to take part in the initiative.

The benefits of separation of waste at source are:

- Higher quality and quantity of recyclables entering the recycling stream, with a higher resale value.
- A cleaner working environment for workers in the recycling industry.

7.4.3 Waste recovery

Waste recovery has yet to take off at scale in Africa. This includes technologies such as anaerobic digestion, landfill gas recovery and high temperature thermal treatment such as incineration. Except when used for special waste streams like HCRW, WtE technologies for the treatment of MSW are often cost prohibitive. With the current approach to MSW management in Africa being largely uncontrolled dumping, these WtE technologies are usually unaffordable to cities and towns. While many municipalities have undertaken feasibility studies to explore WtE, the energy produced by such technologies is often more expensive than energy generated through traditional means such as coal, and now through renewables such as wind and solar. WtE technologies are therefore typically both a more expensive way of managing waste and a more expensive way of producing energy (**see chapter 6**).

CASE STUDY 14

ENERGY RECOVERY FROM MSW LANDFILL GAS IN TUNISIA

Context and background: Landfills are known to be a source of greenhouse gas emissions. Recovering the biogas produced by landfills can help minimize the adverse environmental effects of landfills. Furthermore, it can produce clean energy that offset polluting fossil fuels. Waste-to-energy (WtE) technologies are still rare in Africa. This case study presents the potential for landfill gas-to-energy at the Jebel Chakir landfill, the first and largest landfill in Tunisia (Aydi 2012).

The 2012 study addressed the followings points:

- The amount of landfill gas (LFG) produced
- The energy potential of the LFG recovered
- Greenhouse gas emission reductions
- The opportunity for revenue generation through the sale of the certified emission reductions regulated by the Clean Development Mechanism.

Background: LFG is produced from the decomposition of the organic fraction of municipal solid waste. It includes mainly methane and carbon dioxide, but also ammonia, carbon monoxide, hydrogen and oxygen. Non-methane organic compounds are also present in the stream, at less than 1 per cent of the landfill gas. Worldwide, many landfill sites have installed LFG recovery and utilization systems, or landfill gas-to-energy systems, to recover the energy value of LFG and minimize the induced pollutant effects. The rate and volume of LFG produced depends on the age and composition of the landfilled waste, moisture content; site geology; leachate level, temperature distribution within the landfill, the presence of oxygen and the effectiveness of capping of the site. Methane is considered one of the most important GHGs, with a global warming potential more than 25 times higher than carbon dioxide. It is also explosive at concentrations of 5–15 per cent in air. The LFG recovery system installed at the Jebel Chakir landfill is aimed at reducing GHG emissions and recovering energy from LFG.

Enabling environment: The Jebel Chakir landfill is located 10 km southwest of Tunis City. It has a capacity of about 7 million tonnes of MSW and an area of 31.32 ha. Landfilling started in 1999 and stopped in 2010. The composition of waste in the landfill includes an organic fraction (composed mainly of food waste) (65 per cent); paper/cardboard (12 per cent); fines (8 per cent); plastics, leather and rubber (7 per cent); metals (4 per cent); textiles (3 per cent); and glass and ceramic (1 per cent). A biogas extraction plant has been in operation on the site since 2008. **Table 1** presents the biogas flow rate measured at the plant from 2008 to 2011. It shows that biogas flow rates were almost constant from 2008 to 2010, then decreased in 2011 after landfilling stopped.

Table 1 Biogas flow rates, 2008-2011

Year	LFG (m^3/h)
2008	1012
2009	1050
2010	1024
2011	867

The annual production of LFG at the landfill was modelled using the LandGEM model developed by the United States Environmental Protection Agency. The model determines the amount of methane generated by the landfill based on the methane generation capacity and the mass of waste in the landfill.

Key findings: Annual LFG production as predicted by the LandGEM model is depicted in **Figure 1**, along with the LFG actually collected over the 38 month period from the end 2008 to 2011. The model predicted that LFG production would peak at an estimated rate of 2.61×10^7 m^3/year, one year after landfill closure (2011).

Figure 1 Annual LFG production provided by LandGEM and collected (2008-2011) in Jebel Chakir landfill

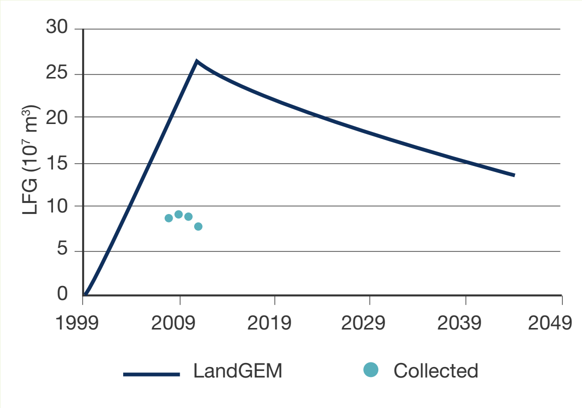
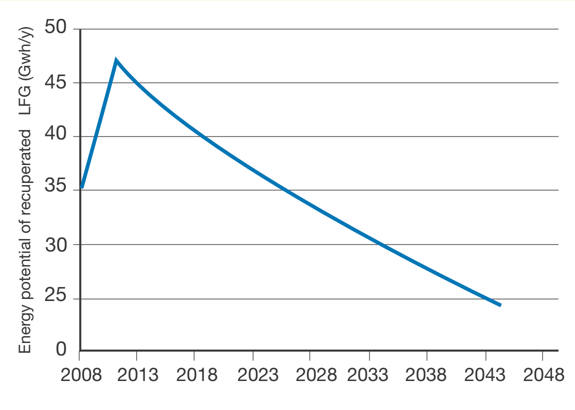


Figure 2 LFG energy potential (GWh) in the landfill of Jebel Chakir



Based on the LFG production, the electric energy potentially of the Jebel Chakir landfill was calculated (**Figure 2**).

The model showed that the estimated LFG produced and recovered in 2011 would have been sufficient to generate about 47 GWh of energy. By 2025, the plant would be 15 years old and the recovered landfill biogas would be sufficient to generate 35.5 GWh of energy, providing a significant power generation opportunity from the Jebel Chakir landfill. Furthermore, as landfill biogas recovery projects decrease greenhouse gas emissions, a landfill biogas recovery system and power plant should be in a position to draw income from carbon credit mechanisms.

CASE STUDY 15

INDUSTRIAL-SCALE BIOGAS FROM ORGANIC WASTE IN BRONKHORSTPRUIT, SOUTH AFRICA

The Bio2Watt plant is a commercial anaerobic digester that treats organic waste (www.bio2watt.com). In the process it produces biogas that is converted to electricity on site. The power produced by the plant is purchased by BMW for its Rosslyn production facility in Pretoria, South Africa. The BMW South Africa – Bio2Watt renewable energy partnership is the first commercially viable biogas project in South Africa. The information presented below was drawn from Bio2Watt's website and Core Earth Resources (2009).

Site selection: The site is located on a feedlot near the town of Bronkhorspruit, thereby providing the plant with access to an important waste source (manure), as well as grid connectivity and sufficient water supply from pollution control dams.

Technology: Organic waste is fed from a receiving tank towards primary and secondary digesters after being mixed with water, aiding its transport towards the digesters. The water used in the plant is obtained from pollution control dams on the feedlot. Two types of conditions are present in the airtight (oxygen-free) primary and secondary anaerobic digesters, which resemble large tanks. Thermophilic conditions in the primary digesters, where bacteria operate at temperatures of between 50–52 °C and mesophilic conditions in the secondary digesters, where bacteria operate at temperatures around 39 °C. The gas produced is eventually directed into an internal combustion engine, or gas engine, that produces electricity. A by-product of the plant is the nutrient-rich digestate, which is used as fertiliser.

Feedstock: Bio2Watt estimates that as much as 120,000 tonnes of organic waste (cattle manure and mixed organic waste) per year is fed into the plant, to

Bio2Watt biogas plant, Bronkhorstpruit

Photo credit: © Energy and Environment Partnership

[a] Based on currency exchange rates as at 28 October 2016 (R13.88 per United States dollar)

produce the biogas feedstock for a combined heat and power application. Tshwane Municipality and Kimberly Clarke are key suppliers of waste for the project. The plant is fed with 160 tonnes of manure per day, plus another 340 tonnes of waste from other sources.

Capacity: The plant has an installed electrical capacity of 4.6 MW and 3 MW of heat available for beneficiation. Its modular design means that it could be scaled up to around 8 MW, which would be in line with BMW's 12 MW demand at their Rosslyn plant.

Project cost: The project cost of R150 million (US$10.8 million[a]), or R34,090/kW (US$2,456/kW) was financed through a R98 million (US$7.0 million) loan from the Industrial Development Corporation (IDC), a R16 million (US$1.2 million) grant from the Department of Trade and Industry and about R36 million (US$2.6 million) in equity.

Partnerships: The project involves partnerships among Bio2Watt, BMW, the City of Tshwane and Eskom. Bio2Watt, a small independent power producer sells its electricity directly to BMW, a private industrial consumer, using the national grid (Eskom) to transport the power into the municipal area (the City of Tshwane). Although the electricity generated at Bronkhorstspruit is purchased by BMW, the biogas-generated electricity is not physically taken up at the Rosslyn plant. A power wheeling arrangement between the Bronkhorstspruit biogas plant and the City of Tshwane, as well as Eskom, allows the plant to connect to the grid and facilitate the sale of electricity between Bio2Watt and BMW. BMW pays a slightly higher premium for the "greener" power and Bio2Watt pays a monthly fee to Eskom for use of the grid and a wheeling fee to the city. Through this agreement, 25-30 per cent of BMW Rosslyn plant's electricity requirements are generated from renewables.

CASE STUDY 16

ELECTRICITY FROM OIL PALM RESIDUES IN ABOISSO, CÔTE D'IVOIRE

This project involves the construction and operation of the Biovea power plant in Aboisso, some 100 kilometres east of Abidjan, Côte d'Ivoire. The project is a joint venture among Biokala SA (a subsidiary of SIFCA, an Ivorian agro-industrial company) and two French partners, electrical company EDF and industrial group Bouygues. Biokala entered into a joint venture with its French partners in 2014, and in late 2017, the two companies and the Government of Côte d'Ivoire signed a rate agreement for the electricity to be generated at the plant. The project is expected to cost 120 billion CFAF (US$225 million) and create some 1,300 direct and indirect jobs.[a]

Côte d'Ivoire has one of the largest biomass deposits in Africa owing to its large agro-industrial sector. Its biomass potential is estimated at 12 million tonnes per year. The Ivorian government intends to take advantage of this potential by switching to a 15 per cent share of renewable energy from biomass in the energy mix by 2020. Biovea will be the first biomass plant on the African continent and the largest in the world exclusively fuelled by oil palm residues (branches and trunks). The biomass will be used as fuel in a boiler to produce steam and power an electric turbine. Two units of 23 MW are planned, for a total installed capacity of 46 MW.

Biokala will actively participate in improving the living conditions of rural populations through the collection of 400,000 tonnes per year of trunks and palms, both in the industrial and village plantations of Côte d'Ivoire. This collection chain, for which Biokala will be responsible, will be the subject of an additional investment of about US$11.45 million.

[a] http://www.commodafrica.com/01-12-2017-la-centrale-biomasse-biovea-entre-sifca-edf-et-la-cote-divoire-va-de-lavant
Accessed 31 March 2018

CASE STUDY 17

A 50 MW WASTE-TO-ENERGY PLANT IN ADDIS ABABA, ETHIOPIA

The Reppie waste-to-energy facility will be located within a vacant brown-field site currently used to dump, burn and dispose of waste in Addis Ababa, Ethiopia. As part of a proposed transfer station that will see roughly 1,200 tonnes of waste a day, the facility will be located within a 7-hectare area, within the 37 hectare dump site. The WtE facility will be constructed within the dump site to avoid the additional cost of transporting waste from the transfer station and also to mitigate the environmental impacts by averting waste sent to landfills or open dumpsites (Messenger 2017).

The energy needs of Ethiopia are expanding rapidly, and the Government has indicated a need for a diverse range of energy sources, including new technologies like WtE, in order to alleviate dependence on factors outside of its control (the weather).

Technology: Waste combustion with energy recovery

Total estimated project: US$120 million, including transmission line

Capacity: Waste throughput of 350,000 tonnes per annum; energy output 50 MW

Feedstock: Residual municipal and commercial solid waste, and other similar waste types

Executing agency: Ethiopian Electric Power Corporation

The Koshe site has been used as an open dump and has served as the only landfill site for Addis Ababa for over 45 years. It is an area of vacant brownfield land with little ecological or visual value in its present state. Once completed, the Reppie facility will process over 1,400 tonnes of waste a day (roughly 80 per cent of the city's waste), and supply the city of Addis Ababa with 30 per cent of its household electricity needs[a].

Reppie 50MW waste-to-energy plant at the Koshe dump in Addis Ababa, Ethiopia
Photo credit: © Embassy of Ethiopia

[a] http://www.africawte.com/about.html and https://www.unenvironment.org/news-and-stories/story/ethiopias-waste-energy-plant-first-africa

TOPIC
SHEET
4

APPROPRIATENESS OF ALTERNATIVE WASTE TREATMENT TECHNOLOGIES FOR AFRICA:

A focus on waste-to-energy[1]

Introduction

Waste-to-energy (WtE) is a well-proven, advanced waste management technology. It has been in use for more than 100 years in Europe and has undergone significant technological evolution over this period. Today there are more than 500 European and 90 North American WtE facilities in operation (ISWA 2012). Furthermore, there are now more than 350 WtE facilities in operation in South-East Asia, primarily China. China is now the region experiencing the highest growth in WtE capacity, and it is estimated that more than 400 WtE facilities will be built in China in the coming 20 years. There are also significant numbers of WtE facilities in India, Taiwan, Singapore, South Korea and Japan, and WtE plants are currently being built in Ethiopia and the Middle East.

Globally, the most used, well-proven WtE technology is the movable-grate mass burn type. There are also fluidized bed WtE facilities and some relatively small pyrolysis and gasification facilities. To date pyrolysis and gasification are generally regarded as less robust and less proven for large-scale waste-to-energy conversion.

This topic sheet focuses on high-temperature thermal treatment by movable-grate fired WtE facilities, which is globally the most widely applied type of WtE facility in operation. Plant capacities of such facilities vary from as little as 2 tph to 35 tph (per line). Typically, a facility consists of several identical lines. Currently, only a few suppliers can supply plants with capacities in excess of 35 tonnes per hour of solid waste. Typically, economies of scale are acceptable for plants capable of treating in excess of 250,000 – 350,000 tonnes per year. However, there may be an acceptable business case for even 50,000-150,000 tonne per year plants located on remote islands or in isolated mountain communities, for instance, especially if alternative waste disposal options are problematic or energy sale is attractive.

Critically important issues for successful WtE projects

This topic sheet does not introduce details of the WtE facility design, energy production or environmental performance, as a wealth of information on those aspects is available from reputable global sources of knowledge such as the World Bank, UNDP and WHO. This topic sheet focuses on the key decision criteria and the critically important considerations in terms of WtE technology appropriateness for Africa.

[1] Topic sheet prepared by Torben Kristiansen

TOPIC SHEET 4

APPROPRIATENESS OF ALTERNATIVE WASTE TREATMENT TECHNOLOGIES FOR AFRICA:
A focus on waste-to-energy[1]

Critically important issues include:

- Waste incineration plants based on 1970, 1980 and even early 1990 design and standards of the European Union did cause unacceptable emissions to the air. There have, however, been significant improvements in combustion and flue gas cleaning technology, which means that all other past and potential environmental impacts have been engineered away, so that WtE facilities built according to current European Union standards have no local environmental impacts, other than traffic and visual impacts.

- Whereas WtE provides a 95 per cent volume reduction of waste, the flue gas cleaning system produces a small hazardous waste residue that requires safe disposal in an engineered hazardous waste landfill. The bottom ash, which is the largest part of the solid residue, can in many instances be recycled or used for road construction or as fill material, depending on processing, input waste quality and local regulations.

- WtE is capital intensive, typically requiring an initial investment in the range of US$800–1,100 per tonne of annual plant capacity (i.e. a 500,000 tonne per year plant would cost in the range of US$400–550 million, all-inclusive, depending on the actual cost of project development, planning, permitting, procurement policy and route, land development, utilities, access roads, architectural design standards, design policy, soil conditions, etc.). Annual operation and maintenance (O&M) costs are also significant and highly dependent on the revenue from sale of energy, etc. Hence, there will always be the need for a significant gate fee for the waste, even when the energy produced can be sold at a premium.

- The critically important WtE business risks include: i) waste quality and quantity risk, ii) gate fee payment risk, iii) permitting and planning risks, iv) change of legislation and policy risks, v) cost of residue disposal risk, v) revenue from energy sale risk, vi) plant availability risk, vii) currency exchange risk, viii) technology risk including obsolete technology risk and viii) political risk.

- Successful planning and procurement of WtE facilities requires international and local experience to ensure that the business case is sound and robust, all business case risks are managed well and that excellent design choices are made.

- Successful O&M requires access to skilled and qualified staff, as well as access to supplies and spare and wear parts of suitable quality.

- Well-defined and predictable waste quality, in particular in terms of calorific value, is critically important for the functioning of the plant, the available plant capacity, energy yield and the total business case. It is critically important that the waste flow and waste quality are well understood and can be controlled. The calorific value should never be less than 6 MJ/kg throughout all seasons and should preferably be higher than 7 MJ/kg. In Central and Northern Europe, the calorific value of the residual municipal solid waste is typically in the range of 9–12 MJ/kg, with residual refuse-derived fuel typically having a calorific value on the range of 11–15 MJ/kg.

- Especially in emerging economies, it is critically important to understand the informal waste management sector, including informal and formal waste picking, which can significantly affect the quality of residual waste arriving at the WtE facility.

African experience with WtE

There is only very limited and largely negative experience with WtE in Africa today. This is largely because most facilities in operation in Africa are very small waste incinerators based on 1970 type technology, mostly used for health care risk waste or certain types of hazardous waste and operated with limited or no flue gas cleaning systems (i.e. flue gas cleaning based on 1980 or early 1990 European flue gas cleaning standards).

Several WtE projects that comply with current European Union environmental standards are being considered or implemented in Africa. Environmental NGOs have been opposed to many of these, fuelled in part by the negative experience of the past.

At the moment, a modern 50 MW WtE facility is being built in Addis Ababa, Ethiopia (see **case study 17**). This project should be in operation by 2018, with construction having started in September 2014. This is a good example of how to implement WtE in Africa, where the Ethiopian power company has established the required momentum and addressed one of the critical risks, namely ensuring a reliable high revenue stream from sale of electricity. A strong international consortium of engineering, procurement and construction (EPC) contractors, advisors and project developers and strong local support also made this possible.

Several large cities in South Africa (e.g. Johannesburg, Cape Town, Pretoria, Pietermaritzburg and Rustenburg) have sought to establish advanced waste treatment facilities, including WtE plants. No investment decisions have yet been made, however.

WtE is considered a viable, relevant waste treatment technology, especially for Africa's mega-cities and high-growth urban areas, where simple collect-and-dump waste solutions are no longer sustainable or possible owing to a lack of landfill capacity, increasing transport distances and the increasing cost of land. In such areas, rapid economic growth has resulted in an explosion in waste quantities, and waste quality approximates that of many European cities. Unfortunately, the experience from many past attempts to establish WtE facilities shows that projects fail or halt because:

- The planned public-private-partnerships (PPPs) have been unattractive for potential PPP concessionaires owing to one-sided allocation of most or all business-critical risks to the private party.
- Unrealistic expectations of the revenue from the sale of electricity and recyclables and allocation of revenue risk to the PPP concessionaire and, hence, unrealistic expectations of low or no gate fees for waste.
- Inability of the public party to guarantee the put-or-pay payment and waste quality and quantity commitments, required to make the PPP concession bankable through commercial banks.
- Limited confidence in the public side's ability to honour payment commitments in a timely fashion.
- Lack of market appetite among PPP concessionaires to accept, for instance, permitting risks, political risks, regulatory risks and site procurement and development risks without caps or compensation mechanisms.
- Public opposition driven by vocal NGOs and political unwillingness to firmly support the choice of technology and required changes to waste management bylaws and residents' and businesses' waste collection fees.
- Legal or financial obstacles limiting municipalities' ability to either i) enter into PPP concession agreements or ii) finance, build and operate capital-intensive waste treatment infrastructure within the municipalities own structures or utilities.
- Resistance or regulatory barriers to securing long-term attractive power purchase agreements that secure long-term revenue and bankability of the WtE plant.

The institutional, regulatory, political and commercial barriers presented above have in many cases proved unsurmountable, even though the waste quality has often proved suitable for WtE in terms of the calorific value of the waste and the options for securing suitable waste quality through, for instance, diverting waste from markets and low-income settlements for alternative disposal to avoid waste with high food waste and moisture content.

For advanced waste treatment infrastructure such as WtE facilities to be an economically viable option, it is necessary not only to compare the cost of the WtE option with the cost of operating a non-compliant dump (where all costs have been sunk), but to also calculate the actual costs of the complete current waste management system, including the avoided costs of long-distance waste transfer and well-engineered distant landfills, complete with leachate collection and treatment and landfill gas collection and treatment systems. Typically, in most developing cities, the municipal budgets for waste

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management are currently far from reflective of the full and true costs, in part because major investments in such things as vehicles and new landfills are often financed via discretionary grants, with no reckoning of capital costs, amortisation etc. of the current assets.

Global drivers in solid waste management and their impact on WtE appropriateness globally and in Africa

Globally, we see the same key drivers for advanced waste treatment infrastructure, namely the urgency of:

- Sustainable urban living: improved public health and delivery of good, efficient public services.
- Improved resource efficiency supporting a shift towards a circular economy.
- Reduced greenhouse gas emissions and avoidance of further climate change, including avoidance of methane emissions from landfill gas, and securing of materials and energy recovery from residual waste.
- Increasing cost of land and need for urban development into peri-urban areas and conversion of former industrial and waste sites into liveable urban areas.
- Increasing cost of waste transportation and increasing cost of, and distance to, engineered landfills.
- A sense of ownership by municipal authorities, an enabling environment that provides a regulatory system supportive of thermal treatment of waste, and a low level of political resistance to development.

These urban development drivers result in, among other things, the need to change from collect-and-dump to a multi-stringed waste collection and recovery/treatment/disposal infrastructure that requires more organization, capital, skills and regulatory support systems.

Hence, there is a need for careful planning of plant capacity and ensuring that waste avoidance, resource recovery and energy recovery complement and support each other rather than competing. This puts a strain on ability of cities' to plan, finance, procure and implement, as well as enforce.

A multi-stringed waste management system that prioritizes waste avoidance, resource recovery and energy recovery is complex and requires complex regulation in terms of permitting, planning and fiscal measures, as well as capacity planning and mechanisms that support a circular economy/demand for high quality recovered materials.

Conclusion on WtE appropriateness for Africa

WtE is one of a few suitable advanced waste management technologies that, in a multi-stringed collection and treatment system, support the overall objective of sustainable urban liveable cities, such as landfill diversion, resource efficiency, energy recovery, greenhouse gas avoidance and a high level of public service.

Waste quantities are increasing in most growing African mega-cities, and there is significant availability of waste suitable for WtE treatment and energy recovery. Owing to the often large difference between less-affluent and highly affluent suburbs in African mega-cities, it is possible to source and mix the waste from the most suitable suburbs, urban centres and business districts to secure a calorific value in the range of 8–11 MJ/kg, which is suitable for energy conversion by WtE. Typically, a suitable calorific value can be maintained, particularly if there is source separation and recovery of such things as paper, cardboard, plastic bottles and perhaps garden waste/kitchen waste in affluent suburbs.

Based on technical and objective criteria, it is therefore possible in most fast-growing African mega-cities to establish WtE facilities that can contribute to much needed landfill diversion and electricity generation for the city, and support near-urban waste treatment. If the WtE facility can be located in or near (e.g. within 2 km of) industrial estates with energy-intensive industries that have large heating or cooling needs, it would further be possible to use more of the energy produced as industrial process energy. The critical factor for making WtE technology a success is not the technology itself but the mega-city's ability to evolve institutionally. This includes developing the ability to make and deliver on long-term financial and contractual commitments and the financial, institutional, enforcement and operational capacity to support a multi-stringed, capital-intensive waste management system, and securing the necessary specialised operational skills (e.g. via operational contracts or concession agreements).

In short, WtE should be considered a relevant and robust treatment technology for residual waste in fast-growing African mega-cities.

Reppie waste-to-energy plant, Addis Ababa, Ethiopia
Photo credit: © The Kenyan Wall Street

7.5 Planned new waste technology in Africa

At the time of writing, a number of large waste infrastructure development projects were planned or in construction in Africa, highlighting the growing waste management opportunity on the continent (Ecoprog GmbH 2017). These include:

Ethiopia / Addis Ababa 50 MW waste-to-energy plant	The Reppie waste-to-energy facility in Addis Ababa is expected to be commissioned in 2018. The facility at Ethiopia's largest landfill, Koshe, will produce 50 MW of electricity from the processing of 350,000 tonnes of solid waste annually. The US$118.5 million facility was fully financed by the Government of Ethiopia and jointly built by British firm Cambridge Industries Limited and China National Electrical Engineering Company. Ethiopia plans to increase energy production capacity from 4,200 MW currently to about 17,300 MW by 2020 from hydro, wind, geothermal, solar and biomass sources. http://news.xinhuanet.com/english/2017-08/31/c_136571944.htm
Zimbabwe / Harare project	The Harare City Council is awaiting government approval for a waste-to-energy power plant at the Pomona landfill and a biogas digester in Mbare. The Mbare facility is said to be 85 per cent complete, while the WtE plant is at an advanced stage of contract award. https://www.dailynews.co.zw/articles/2017/08/31/harare-moves-to-turn-organic-waste-into-energy
Nigeria / Wine bottle recycling plant opened in Jos	Nigerian recycling company Jos Masterminds Ltd. has opened a wine bottle recycling plant in the Plateau capital. At the plant, wine bottles collected from the region are cut into different shapes and sizes. The glass will then be further used for production. The source does not disclose information about the plant's capacity. https://www.pmnewsnigeria.com/2017/08/16/wine-bottle-recycling-plant-established-jos/
Nigeria / Lafarge Africa to focus on using more RE sources	In mid-2017, Lafarge Africa, one of the leading cement manufacturers in Nigeria, said that is was adding capability to use industrial waste, refuse-derived fuel from municipal solid waste and shredded tyres as a replacement for fossil fuels. This is part of the company's commitment to use renewable energy to enhance sustainable development of the construction industry. The company already uses palm kernel shells to produce biomass that fuels its plant. http://www.thetidenewsonline.com/2017/08/14/cement-firm-recommits-renewable-energy-sourcing/
Nigeria / Lagos looks for investors for waste projects	In mide-2017, the Nigerian city of Lagos issued a call for investors to invest in a new waste management programme called the "Cleaner Lagos Initiative". Under this programme, the local government aims to set up a 10-year concession plan based on a PPP, including improved waste collection services and waste treatment, recycling and the generation of energy from waste. Around US$136.38 million (NGN 50 billion) would be needed for this initiative. https://guardian.ng/business-services/money/lagos-woos-investors-for-n50b-waste-bond/

South Africa / Update on Drakenstein WtE project	According to local news, a memorandum of understanding has been signed for a WtE project in the Drakenstein municipality, South Africa. The state government has allegedly signed a memorandum of understanding with its preferred bidder for the project, South African firm Interwaste. The municipality was attempting to launch the project on a PPP basis, but had not yet received state government approval. The exact capacity of the site remains uncertain. https://www.iol.co.za/news/south-africa/western-cape/wellington-waste-project-flawed-illegal-10537494
Namibia / Windhoek city plans to invest in waste-to-energy power plant	The chief executive officer of Windhoek city, said in a recently launched strategic plan that part of an additional area of focus in the next five years includes investments in renewable energy generating 50 MW and WtE power plants creating 5 MW of power. This initiative is part of the key focus area under the spatial development framework to be completed within the 2017/18 financial year. https://www.newera.com.na/2017/07/26/windhoek-needs-to-spend-n4-billion-to-survive/
South Africa/ Johannesburg	Johannesburg landfill gas to energy plants producing up to 13W of energy. https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/
Nigeria/ Lagos	MSW Composting project developed by Earthcare Nigeria Ltd processing 1,500 tonnes of solid waste per day to produce composted material. https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/
Ghana/Kumasi	The biogas plant at Kumasi Abattoir, Ghana, involving production of biogas from the treatment of animal, crop and sewage waste. https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/
Nigeria/ Lagos	The Ketu Ikosi biogas project in Lagos being developed by Midori Environmental Solutions in conjunction with Waste Management Authority, treating food waste as the livestock. https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/
Senegal/ Ferlo	The pilot biogas initiative, Ferlo, Senegal involving a development of 40 bio-digesters in Ferlo using animal waste as feed stock. https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/
Kenya/Naivasha	Gorge Farm AD power plant, Naivasha commissioned by Tropical Power with biogas plant manufacturer, Snow Leopard Projects GmbH, processing 500,000 tonnes of organic waste per year https://www.ashurst.com/en/news-and-insights/insights/waste-to-energy-african-opportunities/

7.6 Conclusion and recommendations

A large range of alternative waste treatment technologies are available on the market and could be immediately inserted into cities and towns in Africa. The appropriateness of these technologies for Africa must be questioned, however. Constraints to technology uptake include lack of political will, lack of enabling regulatory environment, large investment requirements, lack of local technical skills to properly manage the system and the need to include both formal and informal actors in the system. A further restriction is the lack of widespread separation-at-source of potentially recyclable waste. Low-cost technologies for recycling and recovery of secondary resources, combined with social innovation, appear to be the most effective technologies at this stage.

While producing real environmental and social benefits, however, many of the required social innovations may not achieve the scale of reuse, recycling or recovery necessary to address the expected growth in waste generation in Africa (**see chapter 1**). Africa will therefore need to consider a combination of technologies, ranging from small-scale, low-cost to appropriate larger-scale, traditional waste prevention, recycling and recovery technologies in the medium- to long-term. Modern recycling and recovery solutions are emerging on the continent, including various WtE technologies for organic and residual waste, which is promising for future investment and uptake.

With 19 of the world's 50 largest dumpsites in Africa (UNEP 2015), the shift from uncontrolled dumping to sanitary engineered landfilling of "residual waste" must be a priority for the continent. The resultant increase in disposal costs at sanitary engineered landfills will create opportunities for the adoption, adaptation and localization of local and inbound AWT technologies in Africa. In so doing, it creates numerous opportunities for job creation and income generation, including integration of informal actors involved in waste collection and sorting.

8 Financing waste management in Africa

8 Financing waste management in Africa

What the reader can expect

This chapter focuses on understanding the costs and benefits of waste management in Africa; investment needs; waste management as a public service and as a business in the African context; currently applied and potential waste management financing models; and constraints and challenges concerning waste management in Africa. It includes case studies on (i) Africa's first waste-to-energy plant, in Addis Ababa, Ethiopia, (ii) Chinese development finance, (iii) examples of private sector involvement financing mechanisms, and (iv) development finance for the waste management sector in Africa, including waste management carbon financing.

Key messages

The following are the key messages regarding the financing of waste management in Africa:

- Understanding both the financial and economic costs of waste management remains a tremendous challenge in Africa.
- The economic, ecological and social costs of not addressing waste management problems in Africa (cost of inaction) are difficult to quantify, in particular in terms of the effects of waste on public health and the environment.
- Estimated investment needs for the sector range from a cumulated US$6 billion to US$42 billion in 2015, which will triple to US$17 billion to US$125 billion by 2040, given current population growth and urbanization patterns and assuming investment in large-scale waste technologies.
- Poor financing management is a key constraint for efficient waste management in Africa. There are a number of problems with the current scenario of waste financing in Africa.
- Existing waste management financing models currently used in Africa are limited, aggravated by weak institutional frameworks and poor governance of public resources.
- The waste management sector is perceived as a high-risk investment in Africa. Strengthening institutions and regulatory frameworks is paramount in reducing perceived sector risk.
- Sustainable waste management solutions require reliable, quantitative economic and scientific data for project finance. Much more work needs to be done in African countries to gather such data.
- There is a huge need for investment finance in the waste sector. However, raising investor confidence is a challenge, particularly in low-income countries.
- There are tremendous challenges and constrains to waste management finance and to setting up sustainable revenue models. Project costing and cost recovery is often poorly understood by the government agencies in charge of waste logistics and management.
- More tailored, gender-specific schemes need to be applied to diverse geographical and socio-economic conditions, in particular to avoid the marginalization of women.

Key messages (continued)

- Integrating the informal sector into waste financing project models is key to achieving long-term economic sustainability.
- Salient issues include conflicts between private versus public financing, and the accountability of public sector actors.
- Implementing economic instruments, such as EPR, can provide important revenue for addressing Africa's waste management challenges and developing local and regional waste and secondary resource economies. But this must be done in a responsible way that ensures maximum reinvestment of EPR funding back into the waste and secondary resources sector, at the least cost to society.

8.1 Introduction

A key challenge in providing adequate waste management services lies in sector financing and investment. The complexity of the waste sector requires an integrated waste management approach that covers all elements from waste generation to final disposal, including the policy frameworks in place, to facilitate investment in the sector.

Financial constraints are central to waste management challenges in African countries (UN-Habitat 2010a). The World Bank reports that MSW is the most underfunded sector in developing countries, with a global annual deficit of at least US$40 billion (World Bank 2014). Waste services are still largely considered a non-priority in Africa, and as a result, are often underfunded. For instance, in East African countries such as Kenya, United Republic of Tanzania and Uganda, prioritization of waste services by urban councils is low (Okot-Okumu 2012). In South Africa, a third of municipalities are considered "financially unsound" (Madubula and Makinta 2014; UN-Habitat 2010a) directly affecting their ability to invest in waste services and infrastructure.

Although African cities are spending significant parts of their financial budgets on solid waste management, in particular waste collection (Hoornweg and Bhada-Tata 2012), only 55 per cent of the waste was collected in 2012 (**See Chapter 3**), serving less than 50 per cent of the population (Achankeng 2003; Delmon 2015, Lohri *et al*. 2014). The rest is uncollected or illegally dumped (Achankeng 2003). Local authorities typically do not offer an integrated waste management service, choosing to focus on collection and disposal (with varying levels of success). For instance, in Dar es Salam, United Republic of Tanzania, one of the fastest growing cities in Africa, less than 40 per cent of the estimated 4,200 tonnes of waste generated per day in 2011 was collected and dumped at the Pugu dumpsite (World Bank 2014). In developed as well as developing cities, less than 0.5 per cent of the GDP is spent on urban municipal services, a percentage that only covers a third of the overall cost (World Bank 1999, UNEP 2005).

Inefficient revenue collection systems are one of the main challenges faced by African municipalities. In Ethiopia, for example, the fees received from households and commercial enterprises covered only around half the costs (Lohri *et al*. 2014). African urban residents are reluctant to pay for a service that is viewed as sub-standard and sometimes perceived as more of a welfare service (Okot-Okumu 2012, UNEP 2005). Moreover, poor regulatory control and institutional deficiencies contribute to poor cost recovery. The practice of non-payment by clients has been attributed to citizens' overall low-incomes, poverty, illiteracy and a poor economy. This has led to the development of decentralized, individual waste management methods such as uncontrolled dumping and open burning, which is highly polluting and ineffective (Okot-Okumu 2012) (**see chapters 3 and 5**).

Other major issues include high and often underestimated collection and disposal costs, poor infrastructure conditions and poor performance of the public sector. The combination of these factors and the poor capabilities of public agencies in charge of local implementation leads to the failure of such waste management systems (Bernard and Macbeda 2014, Ramos *et al*. 2012).

Moreover, given the economic and socio-institutional volatility on the continent, African governments face tremendous challenges in building the physical infrastructure needed for waste management. This includes the most basic service delivery infrastructure for waste collection and safe disposal, to sanitary landfills and emerging opportunities in source separation, recycling and recovery (**see chapters 3 and 7**). For instance, in Zimbabwe, the economic meltdown in the year 2000 resulted in low fuel supplies which heavily affected waste collection and service delivery (Chikobvu and Makarati 2011). In Somalia, decades of war have torn apart waste management facilities, resulting in dumping in towns (Achankeng 2003).

This chapter focuses on the costs and benefits of waste management, key issues in financing waste management, public versus private sector participation and service provision. It aims to map out and identify the challenges to waste management financing in Africa, the causal effects of such challenges and potential solutions, in order to provide a way forward for policy makers, investors and other stakeholders in the waste management value chain.

8.2 The cost of inaction

The lack of a functioning waste management sector has significant negative externalities in Africa, impacting negatively on public health and the environment (Chalmin and Gailochet 2009). As described in **chapter 5**, waste management is considered one of the most crucial health and environmental problems faced by African governments (Achankeng 2003, Okot-Okumu 2012). Furthermore, uncontrolled dumping and open burning of waste may cause severe land, water (freshwater, groundwater and marine) and air pollution. Poor waste management can damage existing local businesses (e.g. in the tourism sector).

Poor waste management is also a lost economic opportunity for African countries to create a circular economy. Africa generates about 125 million tonnes of MSW per annum with only about 4 per cent diverted from disposal towards recycling (**see chapter 3**). Waste represents a valuable resource: viable secondary materials can be recovered through recycling, for instance, and waste can be used to produce energy or heat (RTPI 2012) (**see chapter 6**). Few African countries actively engage in the global resources recovery business. In addition, the lack of waste management represents a lost opportunity for employment of the poor and increased productivity (**see chapter 6**). Small- and medium-sized waste recycling and recovery companies can not only generate tax returns but also create substantial employment. Zoomlion Ghana, for instance, reports to have employed 200,000 young people since its creation (GhanaWeb 2017).

8.3 Investment needs in Africa

Waste generation is rapidly increasing in Africa (**see chapter 1**) beyond what current administrative, organizational, infrastructural, institutional and financial arrangements can cope with. The United Nations Department of Economic and Social Affairs (UNDESA 2017a, 2017b) estimates that the population of the African continent will grow from approximately 1.2 billion inhabitants in 2015 to almost 2.0 billion by 2040. The urban population is expected to double, from an estimated 470 million people in 2015 to over 1.0 billion people in 2040 (under a medium scenario of urbanization, fertility and mortality rates).

Given the population growth predictions (**Table 8.1**), one can model the future urban MSW generation for Africa based on assumed per capita waste generation rates of 263 kg/capita/year in 2015 to 358 kg/capita/year in 2040 (**Table 8.2**).

The result is an annual waste generation for urban Africa of 124 million tonnes in 2015, growing to 368 million tonnes in 2040 (**Table 8.3**).

Table 8.1 United Nations urban population statistics for Africa (2015-2040)

Urban population in Africa (at mid-year)					
2015	**2020**	**2025**	**2030**	**2035**	**2040**
470 151 015	557 921 020	657 131 025	768 302 030	891 549 035	1 027 128 040

Source: UNDESA (2014, 2017a, 2017b)

Table 8.2 Sub-Saharan Africa urban waste generation per capita (2015-2040)

Urban waste generation (kg/capita/year)					
2015	**2020**	**2025**	**2030**	**2035**	**2040**
263	296	321	336	347	358

Source: Hoornweg *et al*. (2015)

Table 8.3 Estimated African urban waste generation (2015-2040)

Urban waste generation (million tonnes per year)					
2015	**2020**	**2025**	**2030**	**2035**	**2040**
123.7	165.1	210.9	258.1	309.4	367.7

In order to understand the infrastructure investment needed to address these future waste generation volumes, we have used the assumptions of three recent, large infrastructure projects in Africa (**Table 8.4**):

i. Wilaya of Annaba in Algeria (evaluated financially by World Bank 2005)

ii. Kafr El Sheik and Gharbia project of Xervon/Remondis in Egypt (currently under construction)

iii. Reppie waste-to-energy plant in Addis Ababa, Ethiopia (financed and built)

Notably, these projects use two different technology choices typical of developed countries for their estimates: recycling and waste-to-energy.

As expected, the above figures are within the range of SWM costs for lower-middle-income countries (with the exception of the Reppie facility), as presented by Hoornweg and Bhada-Tata (2012) (**Table 8.5**).

Table 8.4 Comparison of project assumptions for waste management in Africa

Criteria	Wilaya of Annaba, Algeria [1]	Xervon/Remondis, Egypt [2]	Reppie WtE, Addis Ababa, Ethiopia [3]
Disposal capacity (T/a)	8 500 000	1 825 000	350 000
Project size (US$)	400 000 000	100 000 000	118 500 000
Cost per disposed tonne (US$)	47.1	54.8	338.6

[1] World Bank (2003; 2005)
[2] COWI (2017)
[3] See Chapter 7 and http://news.xinhuanet.com/english/2017-08/31/c_136571944.htm

Table 8.5 Estimated solid waste management costs by disposal method

Disposal method	Cost of collection and disposal (US$/tonne)			
	Low-income countries	Lower-middle-income countries	Upper-middle-income Countries	High-income countries
Collection	20-50	30-75	40-90	85-250
Open dumping	2-8	3-10	N/A	N/A
Composting	5-30	10-40	20-75	35-90
Sanitary landfill	10-30	15-40	25-65	40-100
Anaerobic digestion	N/A	20-80	50-100	65-150
WtE incineration	N/A	40-100	60-150	70-200

Abbreviations: N/A, not available
Source: Hoornweg and Bhada-Tata (2012)

Using the assumptions for capital expenditures per disposed tonne (**Table 8.4**), one arrives at the following infrastructure investment to address the future tonnages of waste generated in Africa (**Table 8.6**).

i. Based on the case of Algeria (World Bank 2005 estimates), the total minimum investment in urban MSW management infrastructure in Africa of US$5.8 billion would be required. This would grow to US$17.3 billion in 2040.

ii. To fully cover the African continent with technology like that being implemented in Ethiopia, African countries (collectively) would need an investment of US$41.9 billion in 2015, which would grow to US$124.5 billion in 2040.

However, given construction periods and time required for project structuring and financing, one could argue that for public finance and budgeting a lead time of at least 3–5 years would be required. This would exclude the time required to undertake the Environmental Impact Assessments (EIAs), required under national legislation in certain African countries.

The purpose of these calculations is to provide base numbers for discussion. There are, however, a number of constraints associated with these numbers. First, they only account for a reasonable coverage of the urban population, such as an estimated 80 per cent in the case of the Reppie WtE plant. The rural population is not considered. Second, waste management facilities are perceived as durable public infrastructure investments and maintenance costs are not accounted for. Third, inflation and currency fluctuations have been neglected. In addition, the three infrastructure scenarios do not consider an alternative infrastructure option of diverting organic waste away from landfill towards composting or biogas, followed by recovery of mainline recyclables and final disposal/treatment of residual waste. Such an option could divert 50 per cent or more of the MSW away from landfill (**see chapter 3**) without the need for investment in expensive, large-scale, thermal treatment processes.

Given the above assumptions and constraints, the annual investment need can be calculated (**Table 8.7**). The annual investment need will grow from a mere US$391 million per year in the Algeria World Bank (2005) estimate for the period 2015–2020, to US$549 million per year for the period 2035–2040 in today's evaluation. If using the Reppie estimate, one arrives at an annual investment need of US$2.8 billion for the period 2015–2020, which will grow to an estimated US$4.0 billion per year for the period 2035–2040.

Table 8.6 Cumulated estimated infrastructure investment need (urban Africa) (US$ million)

	2015	2020	2025	2030	2035	2040
Wilaya of Annaba	5 819	7 771	9 927	12 148	14 558	17 304
Xervon/Remondis	6 775	9 049	11 558	14 145	16 952	20 149
Reppie WtE	41 868	55 918	71 424	87 409	104 752	124 507

Table 8.7 Annual investment need (urban Africa) (US$ million)

	2015–2020	2021–2025	2026–2030	2031–2035	2036–2040	2040
Wilaya of Annaba	391	431	444	482	549	17 304
Xervon/Remondis	455	502	517	561	639	20 149
Reppie WtE	2810	3101	3197	3468	3951	124 507

To arrive at a minimum investment to account for the rapid urbanization in Africa, one may want to concentrate on the growth of agglomerations in Africa only (UNDESA 2017a). An urban agglomeration is an extended continuous human settlement such as a city or town, including suburbs (UNDESA 2014b). UNDESA (2017a) currently counts 56 urban agglomerations in Africa with a population above one million inhabitants. They alone accounted for a total population of 174 million people in 2015, expected to grow to 282 million people in 2030 according to a medium scenario (**Table 8.8**).

As such, considering the African agglomerations only, one arrives at an estimated cumulated investment need of US$2.2 billion for 2015 growing to US$4.5 billion in 2030, based on the World Bank (2005) estimate, and US$15.5 billion for 2015 growing to US$32.2 billion in 2030 based on the Reppie WtE estimate (**Table 8.9**).

Table 8.8 Population for African agglomerations with over one million inhabitants

	2015	2020	2025	2030
Population	174 581 015	205 231 020	241 906 025	282 759 030

Source: UNDESA (2017a)

Table 8.9 Cumulated estimated investment need (African agglomerations) (US$ million)

	2015	2020	2025	2030
Wilaya of Annaba	2 161	2859	3654	4471
Xervon/Remondis	2 516	3329	4255	5206
Reppie WtE	15 547	20 569	26 293	32 169

Source: UNDESA (2017a)

8.4 Constraints of waste management in Africa

Waste management project finance and implementation face a number of constraints in Africa, and are often considered high risk (Okot-Okumu 2012, Ramos *et al*. 2012, Bernard and Macbeda 2014) owing to:

- Insufficient future cash flow
- Improper evaluation of project life-cycle costs
- Low probability of success during appraisal
- Lack of ability to pay back loans
- Lack of cost control, operational expertise and risk management
- Lack of or inadequate cost recovery options
- Lack of effective governance frameworks
- Administrative and operational flaws, suggesting that even with suitable finance from the central government or funding bodies with no repayment requirements, a project will fail owing to unsuitable institutional, policy and service

There are many reasons for improper evaluation of project life-cycle costs (Alario *et al*. 2002, World Bank 2014), including:

- Under-estimation of the operational costs that will be incurred (which will likely be higher than the capital investment)

- Improperly quantified and categorized waste streams (under-estimation/over-estimation of future waste generation during the project planning phase could lead to overloading of machinery/shortage of waste resources)
- Over-estimation of recoverable costs from tariff payments, recycling or energy production, and reliance on such costs as a means of sustaining operation

Central versus local governments

Waste management in Africa is still mainly governed centrally through provision of national guidelines and policy, although decentralization is increasingly occurring to varying degrees. Property tax constitutes the main source of revenue for waste management for African municipalities. However, the general trend is that collected taxes (including property tax and direct taxes on household refuse collection) are shared between different ministries. The municipality responsible for waste management is allocated its share from this. This means that taxes collected from household refuse are divided between other municipalities and not used solely for waste management, leading to underfunding (UNEP 2016). In South Africa, taxes are not ring-fenced by Government, making for "*little relationship between waste revenue and waste expenditure*" (Madubula and Makinta 2014). Aggregated figures on budget trends in South Africa's Gauteng province in 2009/2010 showed a deficit of R1.0 billion (US$63.6 million), with a budget of R1.2 billion (US$74.7 million) versus expenditure at R2.2 billion (US$138.4 million) (Madubula and Makinta 2014).

East African countries like Uganda and the United Republic of Tanzania have adopted a decentralized environmental management approach, with local authorities in charge of waste management and financing. Local governments often face the dilemma of having limited local funding, however, resulting in a reliance on funding by the central government. This often results in underfunding owing to improper cost evaluation and the low prioritization assigned to local waste management projects by central authorities (Okot-Okumu and Nyenje 2011).

Finally, the inability of the revenue generated to financially sustain the operations and maintenance of the waste management scheme, is both an operational and institutional constraint. Funding for waste management projects needs to be allocated and guaranteed, while operational downtime owing to lack of funds is to be avoided. This frequently requires a high degree of subsidization of costs incurred by the central government or the municipality (Madubula and Makinta 2014).

TOPIC SHEET 5

TOWARDS DISTRIBUTED GRIDS:

A paradigm shift for waste infrastructure in Africa[1]

Background

The function of public infrastructure is to support the economic, social and environmental well-being of society by providing essential services such as potable water, sanitation, energy and waste management. Yet, despite significant annual financial investments to develop new infrastructure and expand existing infrastructure, millions of people in Africa still do not have access to these essential services. Infrastructure commentators consistently call for increased spending on infrastructure; however, the findings of infrastructure condition assessments raise the question of whether the deteriorating condition are not the result of larger, structural flaws in the system.

Review of infrastructure condition assessments

Assessments undertaken in the United States, Canada, the United Kingdom, Australia and South Africa over the past decade all indicate a consistent holding pattern at best, and a downward trend at worst, in the condition of public infrastructure (Fulmer 2009). America's infrastructure scored an overall D+ (where D is 'poor') in the 2017 Infrastructure Report Card, a "nearly failing" grade. The assessment found that US$2 trillion would be needed over the next 10 years to get roads back into shape; US$934 million for electricity; and US$150 million for water and wastewater (ASCE 2017). The report notes that overall, management of solid waste is currently in fair condition. The 2013 and 2009 infrastructure reports also gave infrastructure a D+ score, meaning that despite investments made over the past eight years, the overall condition has not improved. According to the Canadian Infrastructure Report Card (CCA *et al*. 2016), one-third of municipal infrastructure is in fair, poor or very poor condition, "*increasing the risk of service disruption*". In the United Kingdom's Infrastructure 2014 report, declines were seen in two of six sectors (ICE 2014). The report graded waste as "C+" and recommended the creation of *"a policy, regulatory and commercial environment that encourages private investment in infrastructure serving all of the UK's waste streams*".

In South Africa, the Infrastructure Report Card 2017 found that South Africa's infrastructure is generally at risk of failure at an overall rating of "D+" (SAICE 2017). The report rates solid waste management as "C" for waste collection in metropolitan areas and "D" for other areas, and "C+" for waste disposal in metropolitan areas with a "D-" for other areas. According to the report, less than 64 per cent of the general waste disposal sites are licensed.

[1] Topic sheet prepared by Llewellyn Van Wyk

At a global scale, US$3.3 trillion is needed for infrastructure development annually to support projected economic growth (McKinsey 2016). Despite the world spending some US$2.5 trillion a year on transportation, power, water and telecom systems, this has not been enough to avoid significant gaps (*ibid*).

Structural Flaws

Financing model

The infrastructure gap in Africa is estimated to be about US$50 billion per year (AfDB *et al.* 2017). It is beyond the ability of most governments to fund infrastructure from revenue alone. Most infrastructure projects are funded through revenue, borrowing or the issuing of government bonds. South Africa, one of the biggest economies in Africa, is experiencing low economic growth and budget deficits, a picture that is repeated across the continent. For developing and indebted countries, borrowing, where granted, is subject to double-digit interest rates (Williams 2017). While a case can be made for borrowing for once-off large infrastructure projects with definable and predictable economic returns, repeated borrowing for general infrastructure projects increases the interest repayments beyond the affordability levels of developing countries. The South African government deficit for the 2017/18 year is R149 billion, with total debt now at R2.2 trillion, or 50.7 per cent of GDP. The consequence of this is that for every R1.00 collected in tax, R0.13 must be diverted to service debt (National Treasury 2017).

Funding gap

As noted in the Australian Infrastructure Plan, "*infrastructure is generally characterized by long-dated assets for which the operational costs are often many multiples of the funding required in the planning and building phase*" (Infrastructure Australia 2016). In South Africa, the operation and maintenance (O&M) of public infrastructure is funded through service charges (46 per cent), transfers and subsidies (30 per cent), property taxes (14 per cent), and other revenue sources (10 per cent) (Kumar 2017). These income streams are constrained by poor economic growth which affects the Government's ability to increase transfers and subsidies and the consumer's ability to pay more (Infrastructure Australia 2015). Property tax and service charge increases are generally kept in line with inflation, which means that spending on O&M is not increased in real terms. In addition, most of South Africa's 257 municipalities collected less than half of their revenue targets and presented budgets with operational deficits (Ensor 2017).

Given increasing urbanization rates, continued population growth and urban expansion, the existing, ageing infrastructure is placed under significant stress. A continuing process of infrastructure upgrading and expansion and, by implication, debt repayment, is required to provide the essential services to a growing population. The combination of insufficient funding and increased operating stress on infrastructure is highly likely the most significant contributor to the current poor state of infrastructure.

Ageing and outdated technology

Given the circumstances described above, current infrastructure reflects its age in technological terms as well. In Johannesburg, South Africa, one electrical substation that is 75 years old – 30 years past its design life – is supplying the entire inner city (Smythe 2017). This is the case in other countries as well. While the age of infrastructure is concerning, of greater concern is that old infrastructure is operating beyond its design loads, increasing stress on that infrastructure and resulting in greater service failures. Previous generation infrastructure also does not have the efficiency ratios of more contemporary technology.

Lack of management capacity at local government

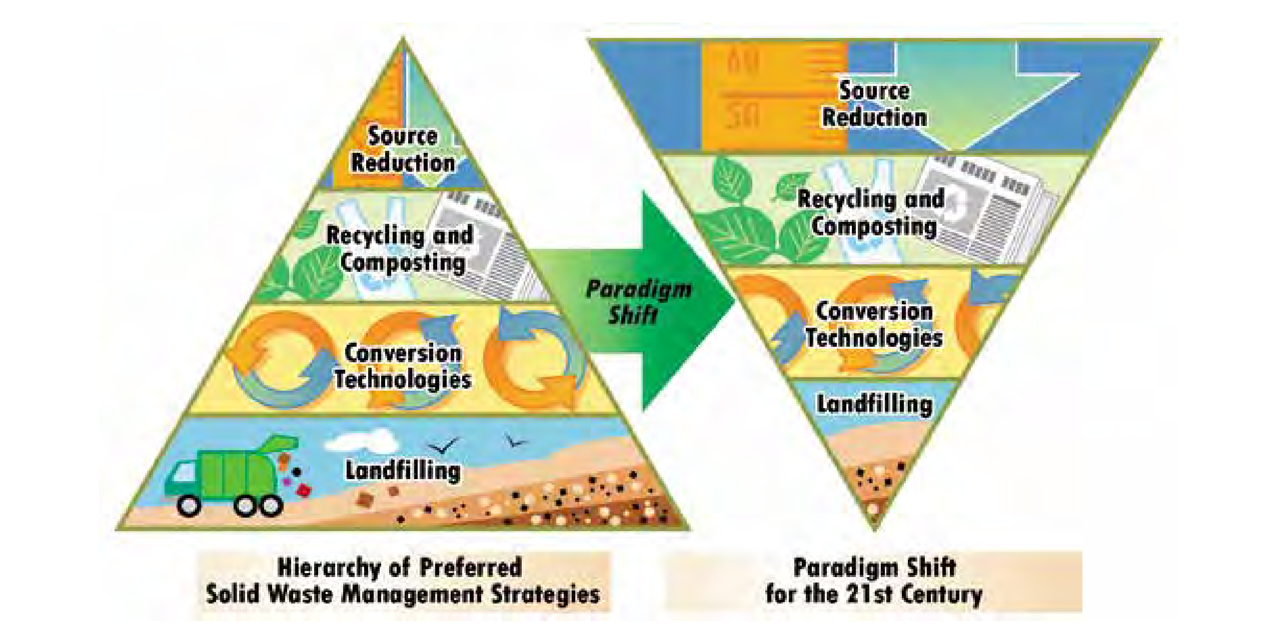
In South Africa, National Treasury has acknowledged the challenge facing municipalities, noting their financial unsustainability and operational inefficiencies (Ensor 2017). Two principal systemic issues underlying this problem, namely inadequate budgets and inadequate skills, have been identified (CIDB 2006). South African municipalities have lost a significant number of qualified municipal managers and engineers in the past twenty years, and it has proved difficult to replace these experienced resources (*ibid*). This coincides with an infrastructure network that has become very complex as a result of the structural flaws outlined above.

An alternative infrastructure development paradigm

If the above structural flaws are valid (as evidence suggests they may well be), then pursuing the current development paradigm of increased spending on centralized infrastructure is unlikely to provide any better results than those demonstrated to date. While it could be argued that few alternatives to public infrastructure development existed in the past, evidence suggests that emerging technologies could change that.

TOWARDS DISTRIBUTED GRIDS:
A paradigm shift for waste infrastructure in Africa[1]

Figure 1 Innovative waste management model



Source: Hauck (2014)

Distributed Grids

Distributed grids involve breaking the centralized grid down into smaller autonomous cells known as microgrids, which allows a community to operate its systems in an autonomous manner. These microgrids are then connected to other microgrids and to the main grid, to form distributed grids. The renewable energy sector, e.g. solar, is a case in point, decentralizing electricity generation from a central, large-scale power plant towards many rooftop mini-plants.

The opportunity now is to extend distributed grids into other infrastructure sectors where existing services and technologies are proving inadequate for meeting the needs of consumers. In the MSW sector, shifting the thinking away from waste disposal to landfill, to waste reduction, reuse, recycling and recovery in line with the waste hierarchy, provides opportunities for the implementation of decentralized "waste" management models.

A typical solid waste microgrid system would consist of source reduction, separation of different fractions of waste, on-site treatment where possible (e.g. composting) and collection and transportation to recycling and resource recovery facilities.

Most studies promoting decentralization of authority for waste management and infrastructure development do so with the view of decentralizing to the local government level, which includes measures to ensure that municipalities have the power, capacity and responsibility to provide the service (Okot-Okumu 2012; Schubeler *et al.* 1996). However, in Uganda, where waste management services are poor or non-existent, communities have developed local, onsite waste management solutions (Okot-Okumu and Nyenje 2011). This is particularly evident in the management of organic waste such as food and garden waste, where households and communities have taken to producing compost owing to poor waste collection services (Rothenberger *et al.* 2006). Organic waste can make up more than 60 per cent of household waste in many East African cities and towns (Okot-Okumu 2012). The diversion of this waste stream into household and community composting alleviates the burden on municipalities, and provides significant opportunities for addressing "indiscriminate" dumping or disposal to uncontrolled dumpsites, common in many African cities and towns.

In Uganda, Kenya and the United Republic of Tanzania, sorted household waste is either reused or recycled at source or sold to a network of itinerant buyers who sell the recyclables to middlemen (Okot-Okumu 2012). In South Africa, an informal network of waste pickers and co-operatives collect recyclable waste from households and sell it to community buy-back centres. However, they have not ventured into organic waste, choosing to rather focus on the higher-value paper and packaging waste (Godfrey *et al*. 2017). Separation of waste at source is important to decentralization of solid waste management, to support maximum value recovery from these waste streams.

Smart grids

Cities have become complex ecosystems. Smart grids, which include a variety of operational and related measures, including smart meters, smart appliances, renewable resources, and resource efficiencies (FERC 2017), are an essential component of this new ecosystem. Smart grids have the ability to shift and balance supply and demand of services. One element common to most definitions is the use of digital processing and communications for the grid, making data flow and information management central to the smart grid (*ibid*). Smart grids operate at a number of scales from the individual property to the urban block, the urban precinct and ultimately to the city. While smart grids have become prominent in energy and water infrastructure, solid waste management systems in Africa are only slowly adopting ICT applications to support and optimize waste services in cities through for instance, the collection of recyclables from households and smart bins.

Public Private Partnerships

PPPs are not new instruments for infrastructure development. Distributed grids redistribute roles and responsibilities between the consumer and service providers, and so depend on partnerships between the public and the private sector. As reported in the American 2017 Infrastructure Report Card, the extensive participation of the private sector in MSW is noteworthy, with an estimated 27,000 organizations, private sector companies and public or quasi-government organizations providing solid waste collection and/or disposal.

Conclusion

This topic sheet was prompted by the question "*Are there alternatives to public sector infrastructure development in Africa, other than the current model of (i) increased spend on (ii) traditional, large-scale, centralized infrastructure?*" Based on the evidence, it is highly likely that the structural fault line is a result of the extent (quantitative) and complexity (qualitative) of the national estate exceeding the ability of the State to manage it. If this is true, it would suggest that alternative models need to be developed to manage the national estate as far as public infrastructure is concerned. Such models would be predicated on decentralizing single grids into discrete, manageable, but interconnected microgrids, supported by new and emerging technologies and processes, smart grids, blue/green infrastructure, an understanding of the city as a complex ecosystem, and the building of strong public/private partnerships with differentiated roles and responsibilities.

In reality, a combination of small- and large-scale waste infrastructure may be required for African countries. Concerns have been raised that small-scale, decentralized technologies may not be able to cope with the expected increase in waste generation in Africa. However, large-scale, centralized technologies in Africa are difficult to finance, O&M costs are often restrictive and facilities, where they do exist, are increasingly failing. A combination of scales provides the opportunity to distribute costs and activities across a range of players and scales, increasing the resilience of African cities in managing their waste.

A decentralized model can however increase the risks associated with waste management, by dispersing the environmental impacts across multiple, diffuse sources that are difficult and costly to monitor with enforcement officers. This will require appropriate legislation, monitoring and enforcement.

8.5 Waste management business models

As noted above, waste management in Africa is currently significantly underfunded, and requires considerable additional funding to improve the way in which waste is managed on the continent. Waste management can be financed through the following financial instruments:

- Taxes (e.g. general taxes, taxes for other municipal services, property taxes)
- User charges, levied on various urban services or industrial services (e.g. industry charges, gate fees)
- Grants from higher levels of government (central, State Governments)
- Favourable term loans for plant facilities (e.g. from the capital market, government/financial institutions, international agencies like the World Bank and the Global Environment Facility Trust Fund, or export banks like the KfW or Chinese Development Bank/ China EximBank)
- Public subsidies (e.g. local government or donor organizations)
- Income from the sale of recyclables, energy and heat

A summary of these sources of financing is provided in **Table 8.10**, along with a description of their key features and problems.

Table 8.10 Sources of waste management financing: Potential problems and opportunities

Source of financing	Description and key features	Potential problems	Opportunities
Taxes	• Taxes, including general taxes, taxes for other municipal services, and local taxes such as a property tax. • Property tax: A percentage of the property tax is used for solid waste services. • Taxes on importers and producers of waste.	• Property tax: Assessments may not be done regularly. Underassessment can occur and collection is inadequate. Increases are not proportional to economic activity, unlike for a sales tax or income tax. • Estimating the actual cost of waste management is difficult, as most of the labour costs for sanitation, street sweeping and related activities are considered as salary. • Import taxes used to protect local producers.	• Some municipalities hope to improve the collection of taxes through computerization and self-assessment. • Tax exemptions or rebates. • Proposed tax in Kenya on imported tyres. • Proposed tax in Togo on industries, hotels and other large enterprises. • Tax on tyres in South Africa. • Proposed tax on paper and packaging, electrical and electronic equipment, and lighting in South Africa.
User charges	• Households pay a monthly fee for the waste to be removed from their premises. • Charges by industrial users or polluters • Landfill taxes and gate fees	• Affordability for African households: There are many poor households who cannot afford to pay the user charge. • Requires an equitable tariff policy with cross subsidization of poorer households. • Gate fees are manipulated by accounting various times for the same waste disposed, thereby exaggerating the amount of waste produced. • High gate fees can result in diversion of waste to informal dump sites or fly-tipping.	• In cities where solid waste collection is franchised to private operators, households pay the fee directly to the operator but the fee is set by the local government. Successfully implemented by the local government in Lagos. • In some countries, the fee is based on waste volume or weight, creating an economic incentive to reduce waste generation and encouraging recycling (pay-as-you-throw).

Table 8.10 Sources of waste management financing: Potential problems and opportunities

Source of financing	Description and key features	Potential problems	Opportunities
Subsidies	• Some government agencies provide subsidies for composting/WtE facilities to generate revenue from the sale of compost or power.	• Subsidies are subject to political interference. • Subsidies may distort market mechanisms.	• Subsidies are used to promote technologies that might not be taken up on purely financial grounds.
Loans	• Commercial loans may be provided for resource recovery or WtE plants. • Segregating recyclables like paper, plastics, metals and glass allows plant owners to generate some revenue by selling to recyclers. • The main purpose of WtE plants is not to produce power per se but to dispose of solid waste. Hence, there is no point in comparing the cost per MW with fossil fuel plants. • The social benefit of a WtE plant is the opportunity cost of not having to incur the cost of disposal in a sanitary landfill, an expensive option in urban areas where the cost of land is escalating. • The power supplied to the grid, merely decreases the cost and provides a source of revenue when loans must be repaid.	• The revenue from the by-products of waste projects does not always cover the capital investment (negative-value products). • Solid waste management, without engaging into the resource recovery business, is an expense with limited or no financial return. • Revenue generation is possible only if the municipality charges a user fee or an earmarked conservancy tax that is high enough to cover the interest cost. • The government and/or municipality may be considered a poor credit risk, leading banks and investors to ask for government guarantees or other security rights.	• There are many recycling businesses in Africa that are commercially viable without any subsidy, where the value of the recovered resource covers capital and operational costs. • Many African cities have grown rapidly, resulting in landfills now being located in the middle of the city (e.g. Abidjan, Côte d'Ivoire). • Recovering the land is not only a tremendous improvement to public health and the environment but also an economic opportunity for the municipality to develop/sell the land, and subsequently for real estate developers.

Table 8.10 Sources of waste management financing: Potential problems and opportunities

Source of financing	Description and key features	Potential problems	Opportunities
Grants	• The primary objective of grants is to improve urban governance through various reform measures that also seek to create accountability at the grass-roots level. • Grants may include providing land and technology support.	• Lack of financial sustainability.	• Grants from development institutions are often an excellent opportunity to fund feasibility studies to build bankable projects to invite private sector finance at a later stage. • International development institutions have access to ample expertise from around the world
Public-private partnerships	• Private sector participation in waste management has been sought to improve efficiency and effectiveness through better management, new investment and better technologies. • Models include service contracts, BOOT (build, own, operate, transfer) for waste treatment and privatization of disposal.	• Complexity of developing a working stakeholder model. • Conflicting interests of private and public partners. Financial viability may be questionable. • Institutional arrangements among private actors, foundations, NGOs and municipalities need to be clarified to reduce the potential for conflict. • Lengthy negotiations	• Use of blue prints available from development institutions. • Access to commercial finance. • Access to private sector technologies and service efficiency. • Project de-risking. • Feed-in tariffs for energy-from-waste.
Carbon financing	• Carbon trading: reducing GHG emissions from solid waste by capturing methane generates certified emission reductions that can be sold in the carbon market. • Clean Development Mechanism: Investing in solid waste disposal may allow for emission reduction which can be sold to a polluter to offset its GHG emissions -effectively.	• Lengthy administrative application process. • Can be used for cost recovery but not for waste management finance.	• Use of blue-prints available from development institutions. • The Paris Agreement calls for the decarbonization of Western and Asian economies.

Source: Adapted from World Bank (1999), Delmon (2015), GIZ (2015)

8.5.1 Financing and revenue models: challenges and solutions

Public sector financing

Taxation has been the preferred solution for waste management revenue generation and financing, similar to electricity and water (Delmon 2015). Usually, the central government collects taxes from businesses and households and then redistributes them to municipal authorities. However, in many African countries, governments lack the facilities and administrative setup to appropriately collect tax. Another issue is that taxes cannot generally cover all the waste management costs. For example, in cities like Douala and Yaoundé in Cameroon, the revenue generated from tax is less than a tenth of waste processing costs, and the remainder is covered by the state (Parrot *et al.* 2009). The obvious alternative would be to raise taxes but in low income African countries this could have severe repercussions.

This system is not financially sustainable in the long run. A major issue is that citizens become accustomed to a reasonably high quality of waste management services, not knowing that it is heavily subsidized by the state (where the state can afford to subsidize) (Parrot *et al.* 2009). Where governments cannot afford to subsidize this difference, waste management services begin to break down, as is the case in many African countries (**see chapter 3**).

Moreover, taxes in African cities tend to be regressive, whereby the tax rate decreases as the amount subject to taxation increases. This affects low income groups disproportionately, which results in them opting out of paying taxes. Taxes also tend to be politically sensitive, as governments are reluctant to increase tax rates at the risk of losing public popularity. As a result, local governments and municipalities are owed large amounts by consumers (households, institutions and businesses). Additionally, taxes in African cities face the problem of inelasticity, meaning that they are incapable of generating revenues in proportional response to inflation, population growth and income increases (UN-Habitat 2010b).

A pragmatic approach would be to tax imported goods with a high potential for generating waste. For instance, the city of Lomé in Togo levies tax fees on major waste generators such as manufacturing industries, hotels and supermarkets. Addis Ababa, Ethiopia, on the other hand, has been experimenting with a household waste collection tax based on water bills, thus ensuring payments for waste management services are in proportion to living standards (Parrot *et al.* 2009).

More recently, the Government of Ethiopia commissioned the Reppie WtE plant, in Addis Ababa, the first such plant on the African continent, with support from Chinese development finance (Cambridge Industries n.d., Xinhua 2017). Chinese development finance/aid has become commonplace across Africa. The concessional loan and the public finance provided by the Government of Ethiopia has financed the construction of the facility (**Table 8.11**) (**see chapter 7**).

Private sector financing

Private sector involvement is considered a major solution for alleviating some of the municipal financial burden experienced across Africa while simultaneously enhancing service efficiency and waste governance. The private sector can be involved through investment, construction of waste management facilities, waste management logistics or operation of waste management facilities. The assumption is that the private sector is more likely to provide higher-quality service at a lower price than the public sector, which lacks incentive and expertise. In this way, municipalities can manage the performance of private contractors through "non-delivery, non-payment", also ensuring greater compliance with environmental or waste legislation.

Two pathways exist for private sector engagement:

i. Contracting out to one large-scale private operator to cover the entire waste management sector and value chain of a municipality, district or city.

ii. Contracting out to a variety of specialized, usually smaller scale and typically local, service providers to cover different aspects of the waste management value chain.

The first pathway is simple, fast and easy to manage but leaves government, local authorities and citizens exposed to the possibility of exorbitant, unnegotiable price tags for waste management (monopoly), and potentially a lack of sufficient investment in, and maintenance of, waste infrastructure and equipment. The second pathway is more complex and time- and resource-consuming but may encourage healthy competition, negotiable prices and incentive to do better.

In both cases, performance is key. Performance, however, can only be enforced through the government's

Table 8.11 Reppie WtE plant, Addis Ababa, Ethiopia

Project characteristics	Details
Type of waste	MSW
Disposal capacity	1,400 tonnes/day or 420,000 tonnes/year, ¾ of the annual production of the city
Electricity production	185 GWh per year
Location	Reppie, Addis Ababa, 5 miles from the African Union Head Quarters
Financing	Government of Ethiopia / Chinese financial institution (not specified)
Owner	Ethiopian Electric Power
Waste disposal partner	Municipality: Addis Ababa City Administration
Owner's engineer	Ramboll Group
Total investment	US$ 95,880,000 + ETB 434,530,557
Commencement date	September 24, 2014
EPC contractor	Consortium of: China National Electric Engineering Corporation and Cambridge Industries
Scope of EPC contractor	Turnkey engineering, procurement and construction
Lead design firm	China Urban Construction Design and Research Institute Co, Ltd
Project development	Part of development program for seven African city WtE facilities

Source: Cambridge Industries (n.d.)

ability to monitor service quality and contract fulfilment, provide incentives for improvement and innovation, and set achievable performance targets to reduce the amount of waste to be handled. Generally, private companies are paid by the government per tonne of waste (or fixed fee), which sometimes includes both management and investment fees. However, as with public institutions, it is often difficult to recoup all of the finances used to cover the full range of waste management services provided to municipalities by private companies. As a result, this often leads, again, to funding intervention by the Government (UNEP 2015).

Below are examples of private sector involvement in waste management projects:

- In 2014, Suez Environment, through its subsidiary Sita Blanca, won a seven year contract, worth €187 million for the management of urban cleaning services in Casablanca. The contract covered five Casablanca districts and was renewed and extended to four additional districts – Alabeda Anfa, Al Fida Mers Sultan, Moulay Rachid and Ben M'Sick - as well as the city of Mechouar. Sita Blanca committed to invest nearly €21 million in a fleet of 109 collection and 28 cleaning vehicles, as well as upgrading facilities. At the beginning of 2014, another subsidiary, Sita Atlas, won the invitation to tender from the Urban Community of Meknes for the rehabilitation of its waste disposal site and for the creation and operation of a disposal and recovery centre. The contract, worth €90 million, covers a period of 20 years. However, in 2017, the City of Casablanca cancelled the contract for the collection of household waste. This rupture followed several months of tensions between the Council and Sita Blanca arising from complaints from Casablanca residents, especially on social networks, about waste management in their city. An audit carried out at the request of the local elected representatives concluded that there were many "failures" on the part of Sita Blanca, who shared the collection of household waste in the economic metropolis of the kingdom with Averda Casa, a subsidiary of the Lebanese group of the same name. The Board also criticized the company for not fulfilling its commitments in terms of investment and acquisition of equipment. This resulted in penalties against Sita Blanca, accentuating its losses, estimated at 130 million dirhams (€12 million) in three years. The Suez subsidiary was temporarily replaced by Casa Prestations, a local semi-public company, until a new service provider could be appointed (Jeune Afrique 2014, La Tribune 2017).

- The Lebanese group Averda entered the Moroccan market in 2012, servicing the cities of Nador, then Berkane, Rabat and Casablanca, to clean, collect, sweep and transform the streets. In 2014, Averda expanded to Angola and in 2015, to the Congo, Gabon and South Africa. In South Africa, Averda acquired Wasteman, a leading waste management group with more than 35 years of experience. Averda also designed and built and now operates a landfill that can hold 6.5 million cubic metres of hazardous waste (Averda 2017).
- During a 2017 visit to France by the prime minister of Niger, Niger authorities signed an agreement with the French water and waste treatment specialist Veolia to develop a waste management policy for the capital, Niamey. The project, part of the Niamey Nyala programme, should lead to a contract for waste collection and a disposal facility (Douet 2017).
- In early 2017, Egyptian authorities announced the establishment of the country's largest-ever waste management project, to be developed by consulting firm COWI and operated by Xervon Egypt S.A.E., a subsidiary of German waste specialist Remondis. The project is focused on discarding of plastic, builders' rubble and other waste on streets and highways. Two densely populated regions, Kafr El Sheik and Gharbia, with some eight million inhabitants, have been chosen as pilots for a comprehensive waste management effort in the country. The project will run for approximately five years to collect and process around 5,000 tonnes of waste per day. The total budget of €50–100 million is financed by German development aid organizations (KfW and GIZ). COWI's consulting contract is worth €6.5 million and involves an international multi-disciplinary team of some 50 staff, including engineers, institutional experts, economists and others. The components covered by the project include: 10–20 collection systems, 5–15 loading stations, 5–10 waste sorting facilities, 3–6 composting plants, 4–6 new/modern landfill sites and closure and clean-up of 20–40 large existing "dump sites" (COWI 2017).

Public-Private Partnerships

A public-private partnership (PPP) refers to the collaboration between the public and private sectors to pool resources and complementary assets to implement public sector projects, supported by the technologies, skills, financial resources and experience available to, or owned by, private sector actors. PPPs are considered an appropriate waste management financing solution for bringing infrastructure to the African continent. To attract private sector investment, however, it is imperative for local authorities to establish strategic frameworks tailor-made to local conditions and based on local stakeholder consultations.

The World Bank (2017) recommends the following elements for successful PPPs: (i) regularizing of waste picker initiatives as part of the PPP; (ii) introduction and promotion of more output-focused contracts for street cleaning and solid waste collection; (iii) involvement of the private sector in treatment and disposal projects to introduce technical innovation through sanitary landfill technology, recycling and in waste-to-energy projects; and (iv) involvement of the private sector in financing capital investment.

A common issue with PPP models is the direct absorption of European models for African projects without any justification or pre-assessment of the local market situation or the competitive, regulatory and socio-economic environment. This direct absorption causes problems owing to the superior technological and financial resources available to European countries (Mbiba 2014). It may also create substantial competition for local companies already struggling to survive. A town's social spatial structure, type of waste, institutional dynamics, socio-economic environment and available resources must be fully considered, both in the formal and informal sector.

Woroniuk and Schalkwyk (1998) suggest a gender division of labour in waste collection and recycling, which has implications for both women's opportunities to participate in the sector and officials seeking ways to improve the system. The system includes: (i) door-to-door itinerant buyers (entirely women) who buy solid waste products from households; (ii) a range of small, medium and big shopkeepers (men) who purchase waste from the buyers; (iii) middlemen who link the shopkeepers with the recyclers; and (iv) recycling or production units run by men that transform products for sale to consumers.

Despite not being based in Africa, such projects might be tailored to local conditions in African societies.

An example of a successful PPP model is Zoomlion Ghana Limited (Zoomlion), a subsidiary of Jospong Group of Companies, which has become a pan-African waste management company since its foundation in 2006. According to Zoomlion, the company today employs a total core staff of 3,000 and manages over 85,000 workers under various forms of PPPs. By 2017, the PPP approach had provided over 200,000 jobs for the youth in Ghana in street sweeping, drain desilting and communal waste management, among other things, to ensure that public places were kept clean. Zoomlion also operates in other African countries, such as Togo, Angola, Zambia, Equatorial Guinea and Liberia, with negotiations under way to start operations in other African countries, such as Sierra Leone and South Sudan. Zoomlion Ghana uses affordable waste management equipment from the Chinese Zoomlion Company Limited, one of the world's and China's largest construction machinery enterprise (GhanaWeb 2017).

An example of a failed PPP is that of Douala, Cameroon. In 1969, Douala became the first city to outsource the management of its MSW, with Yaoundé following ten years later. In 1987, the drive to decentralize led to the transfer of waste management responsibilities not to the urban communities but rather to newly created district councils that covered smaller administrative units. The belief was that this approach would encourage community participation. The district councils were unable to produce the expected service level, however, owing to the limited expertise of the private sector actor's involved and poor management despite sufficient funding. The problem persisted until 1994, when a partnership was formed with the World Bank for an emergency programme to clean up the metropolitan areas and open landfills of Douala and Yaoundé. Yet, this intervention, which was meant to alleviate the economic crisis through labour intensive initiatives, was deemed a failure. The downfall was again associated with poor management primarily by the Ministry of Finance, which had neither the skills nor the manpower to adequately supervise and monitor the waste management system. The failure was not limited to the local government but also to NGOs, emphasizing the fact that rapid urbanization can no longer be handled by unprofessional, uncoordinated service providers. Today, Hygiène et Salubrité du Cameroun (Hysacam), established in 1969, is Cameroon's leading private MSW management company having taken over waste management in the two cities in a PPP model. Based in Douala and Yaoundé, the company also provides waste management services to 12 other towns and cities. Hysacam operates across the entire MSW management chain, from collection through to processing. It has 5,000 employees, owns a fleet of 500 vehicles and 50 heavy machines, and operates two biogas facilities. Its annual revenues amount to CFAF 20 billion (€30.5 million), of which 85 per cent comes from government budgets (Ymelé 2012).

Innovative financing models: Carbon finance

Delmon (2015) estimates that potential annual carbon finance in sub-Saharan Africa could amount to around US$2.6 million per million people for landfill gas recovery, US$1.3 million for composting, and US$3.5 million for recycling. **Table 8.12** provides some examples of successful projects involving carbon financing in Egypt, Morocco, Nigeria and South Africa.

8.5.2 The resource recovery business

The resource recovery business, i.e. waste recycling and recovery, focuses on monetizing urban waste streams. "*Urban mining*" is common in Africa but is usually exercised by informal sector actors (**see chapter 6**). It typically includes the recovery of paper and packaging (plastic, glass, metal) from MSW, C&D waste, e-waste, and waste tyres. The resource recovery business represents an excellent future revenue stream for both public and private sector actors. To date, however, African governments, municipalities and local businesses have lacked the expertise required for professional involvement in this income opportunity. Many valuable secondary resources that could strengthen local economies and be used as collateral for financing waste management are disposed of to dumpsites or, if collected, are shipped overseas to resource-hungry countries such as China and India (**see chapter 6**).

Table 8.12 Innovative Financing Models: Carbon Finance

Country	Project	Description
Egypt	Vehicle scrapping and recycling project	The programme led to the replacement of over 40,000 old taxis in Cairo and helped avoid the equivalent of 130,000 tonnes of carbon dioxide in 2013 and 2014.
Morocco	MSW management program	The programme would not only contribute to mitigating greenhouse gas emissions in Morocco but would also generate local environmental and social benefits like improved air quality by reducing pollution.
Nigeria	Earthcare solid waste composting project	As the first composting activity in Nigeria to be registered with the Clean Development Mechanism, the project was expected to issue about 30,000 carbon credits by the end of 2015.
South Africa	Durban landfill gas-to-electricity project	The project was adding three megawatts of electricity to the Durban municipality and had issued about 181,000 carbon credits.

Source: World Bank (n.d.)

8.6 Recommendations for future action

The requirements and factors for the development of effective waste management systems differ across Africa owing to differences in level of development, degree of urbanization and institutional frameworks. Addressing local conditions through capacity and institution building is paramount to guarantee the financial viability of the waste sector in Africa. The complexities involved in developing and implementing a waste management project in Africa require developers to adopt an approach that includes a variety of different stakeholders. The need to involve all stakeholders from planning through to implementation and execution of waste projects is key to project success (Okot-Okumu and Nyenje 2011, Ramos *et al*. 2012). The following are a number of recommendations.

- *Extended Producer Responsibility*. Many African countries are now exploring EPR as a means of generating revenue from producers of products, as a way of subsidizing waste service delivery and strengthening a local recycling economy. Adopting the "polluter pays" principle for payment of full costs for waste management services is central to the financial viability of a waste management project and the affordability of the costs involved for the communities or individuals concerned, in particular when other cost recovery methods, such as recycling or energy recovery, are uncertain (Madubula and Makinta 2014). EPR is one means of addressing major constraints such as limited budget for waste service delivery, or even funding low-key and appropriate, step-by-step improvements. However, it should not be seen as the only means of financing waste management infrastructure and operations, as EPR costs are typically passed down from producers to consumers, which can have a significant economic impact on communities, especially poor communities (e.g. increasing food prices as a result of EPR fees or taxes on packaging). In South Africa, for instance, it has been suggested that EPR could be in the form of a tax paid by producers directly to the Government (DEA 2016).
- *Financial viability.* Benchmarking, cost control and adequately determining project life-cycle costs for waste management projects are key to guaranteeing financial sustainability. Special attention should be paid to operation costs options in evaluating the viability of waste management services. Too much focus on recovery costs as the sole means of meeting the expectations of service providers should be avoided.
- *Contracting.* Contracts should be medium- to long-term (some authors recommend a minimum of seven years), with shared responsibilities stated explicitly, thus allowing room for customizable and improved services within the private sector. Financial and legal stipulations such as penalties and termination of contracts based on performance are also recommended. Performance-based contracting reduces finance and project management risks, but requires monitoring and enforcement.
- *Holistic approach*. A holistic approach to waste recovery should be established across the full value chain, from importers/manufacturers and retailers through to private/corporate consumers, authorized dealers, repair and refurbishing, large and small recyclers, smelters and refineries, and finally, a controlled landfill (Schluep 2010).
- *Informal sector*. In the absence of a reliable government-run service, many private citizens have resorted to alternative methods of waste disposal. In poorer communities that are unable to pay for formal waste collection, the most common methods of household waste management are waste burning and backyard burying, or dumping (Okot-Okumu and Nyenje 2011). Informal waste-pickers thrive in this environment. Gradually moving resources from the informal sector into the formal sector through contracting out services or offering employment is paramount if social backlash is to be avoided. Special attention should be paid to the role of women working in the informal sector as they are likely to be marginalized when the informal waste management activities become formalized (Van Schoot and Abarca 2010).
- *Tools.* Many development institutions, like the World Bank or the GIZ, offer customized tools such as result-based financing schemes and comprehensive country analysis and technology advice to help cities or countries to improve their MSW services and

outcomes. These tools aim for efficient use of public funds in budget-constrained sectors to stimulate behaviour change, improve the quality of services and allow for funding accountability and transparency (GIZ 2015, World Bank 2014). Training and capacity-building on implementation should be directed at project development and execution.

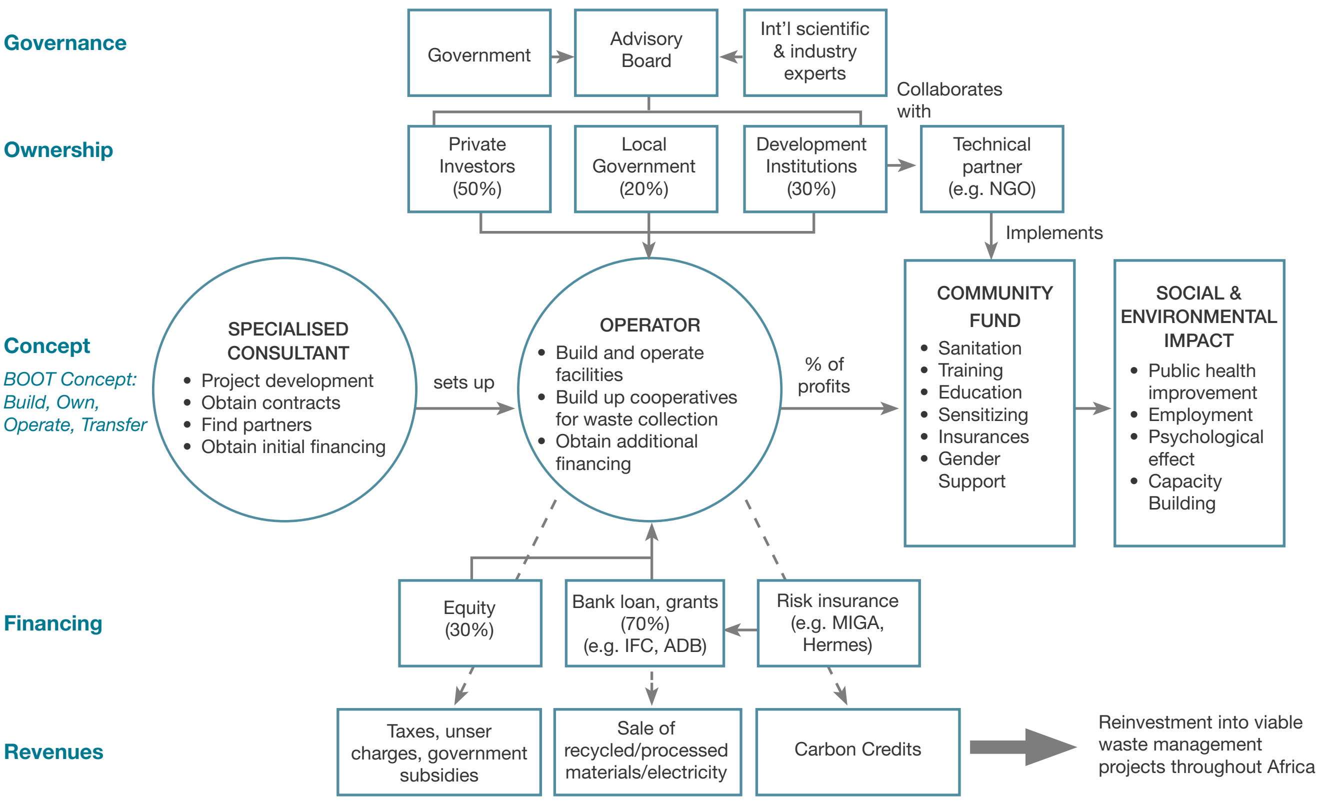
- *Policy environment.* To avoid institutional, financial and operational constraints, authorities and government agencies are called upon to enact enforceable policies and regulatory frameworks that support the improvement of waste management services and attract experienced promoters for good performance. This will ensure accountability and the effective splitting of costs between stakeholders and/or municipalities; however, the transparency of all these relative costs during the planning stages of the project is required to attract interested financiers.

An example of a tailored model for a structured waste management project in Africa is outlined in **Figure 8.1**.

The model, which was developed by the author considering the circumstances of constrained economies, suggests the following potential solutions:

- *Concept.* Project initiation and development, relationship management, contracting, and initial fundraising to build the project may be managed by a specialized, experienced consultant. The objective of the project consultant may be to set up a dedicated special-purpose vehicle to operate the waste management facility, including construction, daily operations, contracting with third parties, working with cooperatives/the informal sector and guaranteeing long-term financial viability.
- *Revenue model.* Different revenue models have been described above, including user charges, taxes, the sale of recycled products and/or energy or heat, and carbon credits. A mixture of these is recommended to reduce dependence on a single source of revenue, increase project viability and act as a form of risk management.

Figure 8.1 Proposed project structure and business model for Africa



Source: Ulf Henning Richter (the author)

- *Financing.* Financing could be provided through equity or debt finance. Equity could come from local private or public investors, dedicated funds or international development institutions like IFC or DFG. Debt finance may be obtained from development institutions, local and international commercial banks, and insured through instruments dedicated to export finance such as MIGA (World Bank), Hermes (Germany) or instruments issued by Sinosure (China). Specific financial arrangements for women must be considered to ensure that they can also access financing. Owing to societal norms and practices, women often do not own land or property that can be used as collateral for loans.
- *Ownership.* Mixed ownership could consist of local and foreign investors pooling private capital and equity capital provided by development institutions, local and foreign banks, and a reasonable stake attributed to local government to align incentives and guarantee waste streams for waste management facilities.
- *Governance.* Governance in the form of an advisory board seat can be provided by national, regional or local governments and/or the attached institutions. Other recommended members include scientific and industry advisors that can provide insights into appropriate technologies and sector expertise.

8.7 Conclusion

Financing waste management in Africa is still in its infancy. More reliable data on waste composition, waste streams and waste quantities is essential to enable structured, innovative financing in African countries and communities. Understanding both the financial and economic costs of waste management remains a tremendous challenge in Africa. The economic, social and environmental costs of not addressing waste management problems in Africa are difficult to quantify but are considerable, in particular in terms of the effects of poor waste management on public health and the environment. Poor financing management is a key constraint for efficient waste management in Africa.

There are a number of problems with the current scenario of waste financing in Africa. Existing models for financing waste management in Africa are limited, aggravated by weak institutional frameworks and poor governance of public resources. There is a huge need for investment finance in the waste sector. However, there are tremendous challenges to and constraints for waste management finance and setting up sustainable revenue models. The waste management sector is perceived as a high-risk investment in Africa. Raising investor confidence is a challenge, particularly in low-income countries. Strengthening the institutional contexts and regulatory frameworks is paramount in reducing perceived sector risk. Sustainable waste management solutions require reliable economic and scientific data to be quantified for project finance.

Project costing and cost recovery is poorly understood by the government agencies in charge of waste management. More tailored schemes need to be applied to diverse geographical and socio-economic conditions. Integrating the informal sector into waste project financing models is key to achieving long-term economic sustainability. Salient issues include conflicts between private and public financing and the accountability of public sector actors.

Finally, successful private sector operators have demonstrated the viability of the waste sector in Africa, as well its potential for local employment and job creation. The recent financing of large-scale infrastructure projects such as the Reppie WtE facility and the Xervon/Remondis project demonstrates that urbanization in Africa provides a great investment opportunity for the sector.

9 Conclusions and the way forward

9 Conclusions and the way forward

What the reader can expect

This final chapter brings together the key messages that have emerged from the preceding chapters of the Africa Waste Management Outlook. These messages provide the basis for a set of recommendations on what needs to be done to address the waste management challenges facing Africa and suggestions on how this can be achieved.

Key messages

- Safe and sustainable solid waste management has obvious environmental, social and economic benefits for Africa. These include reducing or eliminating the environmental and human health impacts associated with poor waste management; minimizing the volumes of solid waste disposed of to land; recovering valuable resources from the waste and reintroducing these into local and regional economies; and improving livelihoods of formal and informal waste sector workers.
- Yet, despite these obvious benefits, African countries continue to dispose in excess of 90 per cent of the waste they generate to land, often to uncontrolled dumpsites with associated open burning.
- On average, 57 per cent of the MSW generated in Africa is biodegradable organic waste, the bulk of which is dumped. Disposal of organic waste results in the generation of greenhouse gases that contribute to climate change, and leachate that has the potential to pollute ground and surface water.
- With an average collection rate of only 55 per cent, MSW collection services in most African countries are inadequate, often only provided to high-income residential communities or central business districts. Indiscriminate dumping of waste in urban areas is common across Africa, creating increased risk of disease, flooding and environmental pollution.
- Recycling has emerged across Africa, driven more by poverty, unemployment and socio-economic need than by public and private sector design. While the African Union has outlined an aspiration that "*African cities will be recycling at least 50 per cent of the waste they generate by 2023*", only 4 per cent of MSW is thought to be currently recycled in Africa.
- Informal waste pickers are active in recovering valuable resources from waste at little to no cost to the public and private sectors. These informal waste pickers save municipalities significant amounts of money by diverting waste away from landfill towards reuse and recycling. They also provide direct benefit to the private sector, by delivering a flow of secondary materials into the recycling economy. They are therefore a valuable link between the service- and value- chains in Africa. However, a large percentage of the recovered resources are exported out of Africa to international end-use markets, resulting in the loss of jobs and resources for Africa.

Key messages (continued)

- Africa is set to undergo a major social and economic transformation over the next century as its population explodes, cities urbanize and consumer purchasing habits change. This is expected to lead to exponential growth in waste generation, which will put considerable strain on already constrained public and private sector waste services and infrastructure. In fact, the rate of growth in waste generation in Africa is expected to be so significant that any decrease in waste generation expected in other regions globally will be overshadowed by Africa.
- Changing consumer behaviour has resulted in increasing plastic consumption in Africa. With growing plastic consumption and weak MSW collection systems, Africa is at risk of increasing leakage of plastic into the environment, resulting in many countries moving to ban plastic bags and other single-use plastic items. If Africa does not put measures in place to mitigate the flow of plastic (and other waste) into the ocean, increasing pollution is likely to negatively impact coastal economies.
- Reliable, extensive and up-to-date waste data remains a critical challenge for Africa, compromising any attempts to meaningfully move waste up the hierarchy away from disposal to prevention, reuse, recycling and recovery. Without reliable data, investment in much needed waste services and infrastructure remains high-risk.
- While data may be limited, preparing this Outlook has highlighted the power of citizen science in documenting the state of waste in Africa, including many of the photos used in this book.

A vision for Africa

"Extending regular and reliable waste collection services to all. Safe disposal of residual waste to sanitary engineered landfills, while maximizing the recovery of secondary resources from these waste streams through social and technological innovations appropriate for Africa."

– Africa Waste Management Outlook 2018

Recommendations: Changing the paradigm of "waste"

There is an urgent need for African countries to address the current waste management challenges and to prepare themselves for the expected growth in waste generation in the coming century. This will require social and technological innovation, and investment in services and infrastructure in the waste and secondary resources sector never before seen in Africa.

There is a long way for Africa to go to achieve the vision of "*safe disposal of residual waste to sanitary engineered landfills, while maximizing the recovery of secondary resources from these waste streams through social and technological innovations appropriate for Africa*". This vision for Africa does not ask countries to do anything that has not been asked of them before. The message that has emerged from the preceding chapters is for governments, in partnership with the private sector, non-governmental organizations and civil society, to provide comprehensive city cleansing services; extend waste collection services to all; eliminate uncontrolled dumping and open burning; and increase waste flows towards reuse, recycling and recovery. However, the reason for achieving this vision for Africa is clearer now than it has ever been, and the authors hope that the preceding chapters have provided a very clear picture of why this needs to be done, and why it needs to be done now.

The reuse, recycling and recovery of end-of-life products has the potential to create significant socio-economic opportunities for Africa. Growing a secondary resources economy in Africa could inject at least an additional US$8 billion every year into the economy from secondary resources that are currently being thrown away as waste to dumpsites and landfills. Africa needs to realize the opportunity that secondary resources represent for the continent. Achieving the vision of this Outlook means that secondary resources could be released back into the African economy, growing and strengthening local manufacturing, creating jobs, addressing unemployment, and building local and regional economies. And if done responsibly and sustainably, at the same time minimizing the environmental and human health impacts associated with the current poor solid waste management practices seen across the African continent.

While there is currently limited understanding or agreement on the appropriate waste technology roadmap to achieve this vision, a combination of small-scale, low-cost, decentralized, community-driven initiatives and larger-scale, higher-cost, centralized public-private initiatives may be required to address current and expected future solid waste management. Rough calculations suggest that rolling out large-scale recycling and recovery technology in Africa, typically used in developed countries, could cost the continent between US$6 billion and US$42 billion in the short-term, increasing to between US$17 billion and US$125 billion in 2040 depending on the alternative waste treatment technologies adopted. The resource value currently locked up in Africa's waste is significant, which should be attractive to public and private sector investors, assuming the technologies are appropriate for Africa, and are not in conflict with the goal of a secondary resources economy.

The African Union has set an ambitious aspiration that by 2023 African cities will recycle at least 50 per cent of the waste they generate. The authors fully support this goal and believe that even higher rates can be achieved by focusing on (i) the diversion of organic waste away from landfill towards composting, bioenergy recovery and higher value product recovery, followed by (ii) refurbishment, repair, reuse and recycling of mainline recyclables such as plastic, paper, metal, glass, tyres and e-waste. It is recommended that an "*African regional strategy for secondary materials management*" be developed, implemented and resourced, with clear actions and goals for countries and cities. A strategy that creates opportunities for both small-scale, bottom-up, community based approaches as well as larger-scale, advanced treatment technologies. A serious debate regarding the appropriateness of large-scale thermal treatment technologies, such as incineration, must be had as part of the development of this strategy, given the high organic waste (moisture) content and high resource value within Africa's waste streams. The success of such a strategy will require an enabling governance environment combined with supporting data, infrastructure, institutional capacity, financial provisions and monitoring and control mechanisms. Measures to reduce the risks associated with investment in Africa must be addressed at the continental and national levels and an enabling environment created for public-private partnerships. The establishment of regional secondary resource economies will be important to such an African strategy, and countries will need to find ways to support and enable such regionality while at the same time ensuring that they do not further facilitate waste trafficking and illegal dumping of hazardous waste in Africa.

What needs to happen

The Africa Waste Management Outlook fully supports the recommendations of the Global Waste Management Outlook, in particular –

1 Bring waste under control

The first priority for Africa is to address the public health imperative, by ensuring that all citizens have access to proper waste management services. Comprehensive, reliable and regular city cleansing and controlled disposal of waste is the foundation of every integrated waste management system.

Action imperatives include –

- Extend *city cleansing services* (street cleaning) across all cities and towns.
- Eliminate "*indiscriminate dumping*" or "fly-tipping" in open spaces.
- Extend affordable and appropriate *waste collection and removal services* to all residents, starting with densely populated areas.
- Eliminate *uncontrolled dumping* and *open burning* of waste.
- Ensure the *controlled disposal* of all waste as a first step towards sanitary engineered landfilling for residual waste.
- Eliminate *illegal trafficking* of hazardous waste.
- Separate hazardous waste from other waste at source, in particular health care risk waste and household hazardous waste.
- Promote *waste prevention* and cleaner production, particularly within business and industry.

Proposed Goal: All citizens have access to adequate waste collection services and environmentally sound management of all waste by 2030. Uncontrolled dumping and open burning of waste has been eliminated.

2 Harness the opportunities of 'waste as resource'

The second priority for Africa, to be addressed in parallel, is to unlock the socio-economic opportunities of waste as resource, by moving waste up the waste management hierarchy away from disposal towards waste prevention, reuse, recycling and recovery.

Action imperatives include –

- Maximize *reuse, repair and refurbishment* of end-of-life products.
- Maximize waste *recycling and recovery.*
- Integrate existing small-scale informal and formal entrepreneurial activities within mainstream waste management.
- Implement appropriate, sustainable *alternative waste treatment technologies* for residual waste that cannot be designed out or sustainably recycled.
- Ensure *social inclusion* in the opportunities created.
- Incentivise the establishment of *local and regional end-use markets* to ensure maximum benefit for the African continent.

Proposed Goal: African countries are diverting at least 50% of the waste they generate towards waste reuse, recycling and recovery by 2030, and measures are in place to encourage waste prevention.

How this needs to happen

Achieving the above objectives may place increased strain on institutions in Africa, both financially and technically. The following, are therefore key to achieving the objectives of this Outlook –

1 Capacity-building and awareness-raising

Awareness:

- There is an urgent need to raise awareness and change public attitude towards waste generation, waste management, uncontrolled dumping and open burning of waste, along with the associated health and environmental impacts.
- This will enable civil society to actively participate in all aspects of waste management in their communities.
- Civil society and non-governmental organizations have an important role to play in empowering communities to engage in sound waste management practices.

Training and education

- Training needs to be focused at two levels –
  - A "bottom- up" approach that involves customized training programmes for different tiers of waste management staff (municipalities and private companies), raising their awareness and providing them with the technical knowledge to implement and manage sustainable waste management programmes and effectively enforce legislation.
  - A "top-down" approach designed to build understanding of the importance of sound waste management at the political and senior government levels.
- Skills in project costing and cost recovery for waste services and infrastructure in government agencies in charge of waste logistics and management must be strengthened.
- Institutions such as UNEP and the South African Ministry of Science and Technology have already launched initiatives to introduce graduate courses in waste management in a number of African universities. Graduates will be equipped with advanced know-how to tackle waste issues in an integrated manner.
- These initiatives should encourage other African universities and training institutions to follow suit to help promote sound waste management throughout the continent, through various modalities of training and education.

Partnerships and collaboration

- Partnerships between governments and private sector organizations could be a positive approach to building robust waste services and infrastructure for tackling waste problems.
- Governments need to explore how such partnerships are incentivized through such things as an enabling policy environment, economic incentives and land allocations.
- Collaboration with developed countries is important to accelerate appropriate technology and knowledge transfer, guided by the needs of Africa, not technology vendors.

Informal sector integration

- The informal sector, as major actors in MSW collection and recycling, should be recognized and supported. Formal and informal waste management systems must be integrated.
- Government, NGOs and private companies have a role to play in linking the informal sector with markets for secondary materials
- As with the formal sector, the informal sector should be enabled through appropriate training, including health and safety training.

2 Improved evidence for informed decision-making and implementation of solutions

Data collection and analysis

- Measures must be put in place to facilitate regular collection, verification and analysis of data on the amount, sources, types and composition of solid waste (both general and hazardous) generated, recycled and landfilled.
- The use of weighbridges should become standard practice to facilitate regular reporting of reliable waste data.
- This data and information should be freely available and used for, among other things, benchmarking, planning, monitoring and evaluation, and research purposes.
- Data must be collected on the economic, social and environmental costs of not addressing waste management (cost of inaction).
- Reliable data on waste composition, waste streams and waste quantities is essential to enable structured and innovative financing in African countries and communities.

Research, development and innovation capability

- Greater investment in research, development and innovation (RDI) needs to be made at the regional and national level to give effect to various waste RDI strategies in Africa, including the AU-EU Agenda.
- The African Union and the European Union published a document entitled "*Building a joint European and African research and innovation agenda on waste management: Waste as a resource: recycling and recovery of raw materials* (2014-2020)" (EU 2014) aimed at boosting collaborative research and innovation in solid waste management between Africa and Europe.
- Research partnerships between African research institutions, and between African and other international research institutions, need to be strengthened, by creating funding opportunities for collaboration.

3 Strengthened policies, monitoring and enforcement capacities

Legislation and enforcement

- Waste policies and legislation must be introduced where absent and strengthened where weak.
- Where waste legislation does exist, it needs to be harmonized across the region to ensure that weaknesses in legislation in one country are not exploited; recognizing that what works well in one country or one municipality may not necessarily work well in another.
- Fragmentation in legislation needs to be addressed and mechanisms should be created to manage implementation and effective enforcement.
- Governments should put in place favourable policies and appropriate incentives to promote waste reuse, recycling and recovery.
- Waste separation-at-source should be promoted to make waste recycling and recovery easier and affordable, and to ensure collection of clean recyclable waste streams with higher value.
- Strong institutions and an enabling governance environment that facilitates partnerships between government, the private sector, civil society, consumers and the informal sector need to be put in place.
- The transboundary movement of waste into Africa needs to be controlled through the domestication of international and regional conventions and treaties, to prevent Africa from being an easy target for illegal dumping of hazardous waste from outside the continent. At the same time, responsible, controlled movement of waste and secondary materials between countries in Africa needs to be supported to ensure safe management, treatment and disposal of waste and secondary resources at appropriate facilities and the development of regional secondary resource economies.
- The adoption of advanced policy instruments such as economic instruments, including EPR, need to be considered and implemented where appropriate.

4 Appropriate services and technologies

Appropriate services and technologies

- While a large range of alternative waste treatment technologies are available on the market, waste services and infrastructures must be carefully chosen in terms of their sustainability and appropriateness for local conditions, and should be implemented progressively. Cities and towns should start with low-technology, low-capital, labour-intensive and culturally acceptable technologies. Services and technologies that work well should be demonstrated.
- Culturally, there is a high tendency for waste reuse in Africa. This behaviour should be encouraged and maintained; single-use products should be discouraged where appropriate and where end-use markets do not exist.
- Facilities for the safe treatment and disposal of health care risk waste are urgently needed in Africa. This includes improving health care waste management bodies through introducing legal and institutional frameworks specifically designed for health care waste.
- The shift from uncontrolled dumping to sanitary engineered landfilling of residual waste must be a priority for the continent. The resultant increase in disposal costs at sanitary engineered landfills will create opportunities for the adoption, adaptation and localization of alternative waste treatment technologies in Africa. This will in turn create numerous opportunities for job creation and income generation, including the integration of informal actors involved in waste collection and sorting.
- Certain municipal waste streams such as organic waste, construction and demolition waste, and paper and packaging waste, provide immediate opportunities for diversion from landfill towards value recovery.

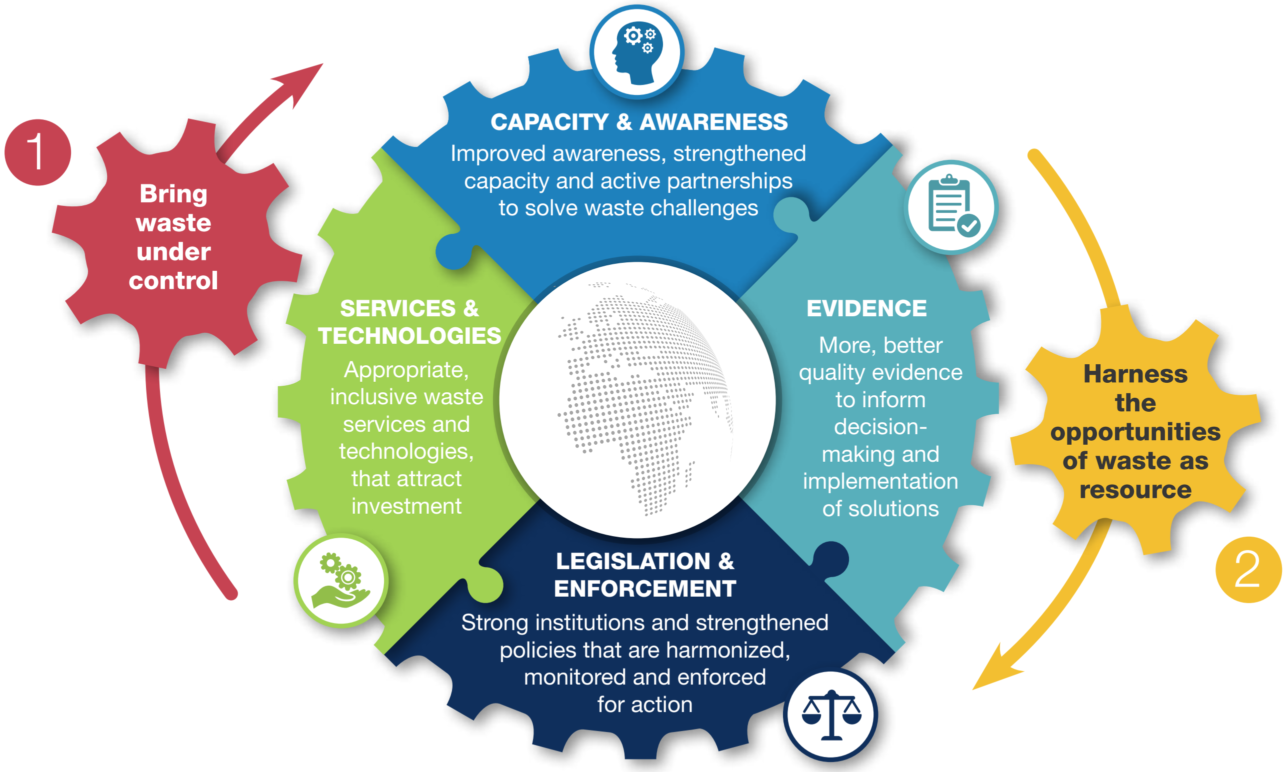
Promoting investment

- African countries must create an enabling environment that attracts private investors into the waste sector. This includes reducing the risks associated with investment in Africa and raising investor confidence. Favourable regulations and policies must be explored, and institutions and governance strengthened. Moreover, mechanisms should be created to improve regional markets to achieve sufficient economies of scale for investment.
- The financial sustainability of waste management projects must be assessed before implementation, including ongoing operation and maintenance costs.
- Schemes must be tailored to diverse geographical and socio-economic conditions.

THE SOLUTIONS

What needs to happen

Achieving the objectives of the Outlook may place increased strain on institutions in Africa, both financially and technically. The following, are therefore key to bringing about change:



TOPIC SHEET 6

WASTE MANAGEMENT: An entry point to sustainable development in Africa[1]

Solid waste management (SWM) has direct links to many global issues such as public health, climate change, ocean plastic, poverty, food security and sustainable production and consumption. As a cross-cutting issue, environmentally sound SWM is therefore a strong entry point to achieving a range of Sustainable Development Goals (SDGs) for Africa (Rodić and Wilson, 2017). The Global Waste Management Outlook (UNEP 2015) has made significant strides in highlighting the cross-cutting nature of SWM and its impact on the SDGs, which as Rodić and Wilson (2017:2) point out, should "*emphasize the importance and increase the political priority of SWM*".

The challenge for Africa, staged to undergo major growth and socio-economic transformation over the next century, is to find the balance between development, resource conservation and environmental and human-health protection. This places responsible consumption and production (SDG 12), or sustainable resource use, at the centre of Africa's developmental objectives (**Figure 1**) (Godfrey 2017).

According to Lenkiewicz and Webster (2017) "*Making progress in addressing waste management issues will contribute directly to 12 out of the 17 Sustainable Development Goals*", but has indirect links towards achieving all 17 SDGs (**Figure 2**). Lenkiewicz (2016) goes so far as to say that "*The Sustainable Development Goals cannot be met unless waste management is addressed as a priority*". SDG 11 (Sustainable cities and communities) and SDG 12 (Responsible consumption and production) are particularly pertinent for SWM in Africa (**Figure 2**).

Africa will achieve the SDGs "*much more effectively once we recognize waste management as a powerful driver of sustainable development.*" (Lenkiewicz 2016). **Figure 2** outlines just some of the opportunities for addressing each of the 17 SDGs through SWM measures, and links the reader to the respective sections of the Outlook.

Figure 1 Africa's challenge of achieving its developmental objectives while minimizing impacts on the environment

Source: Godfrey (2017)

1 Topic sheet prepared by Linda Godfrey

WASTE MANAGEMENT:
An entry point to sustainable development in Africa[1]

Figure 2 Solid waste management: A key to delivering on the Sustainable Development Goals

KEY:
■ = direct link to waste
no = target that explicitly requires a basic level of waste management
□ = indirect link

	1 Access for all to basic waste collection services	2 Stopping uncontrolled dumping and open burning	3 Managing all waste properly, particularly hazardous waste	4 Reducing waste and creating recycling jobs	5 Halving food waste from markets, shops and homes, and reducing food losses in the supply chain	6 Governance' factors which underpin sustainable waste management
1 No poverty	1.4			■	□	
2 Zero hunger				□	■	
3 Good health and well-being	■	■	■			
4 Quality education				□		
5 Gender equality	□	□		□		
6 Clean water and sanitation	■	6.3	■			
7 Affordable and clean energy			■		□	
8 Decent work and economic growth	■			■		
9 Industry, innovation and infrastructure			□	■	□	
10 Reduced inequalities	□	□				
11 Sustainable cities and communities	11.1 11.6	11.6	11.6	■	■	
12 Responsible consumption and production		■	12.4	12.5	12.3	
13 Climate action		■	■	■	■	
14 Life below water	■	■	■	□		
15 Life on land	■	■	■	□		
16 Peace, justice and strong institutions						■
17 Partnerships for the goals						■

Source: Adapted from Lenkiewicz (2016), Lenkiewicz and Webster (2017), Rodić and Wilson (2017)

Waste and the SDG aspirations for Africa
Access to basic waste collection services for all. Creating new income opportunities in waste prevention, reuse, recycling and recovery **(see chapters 3, 6 and 7)**
Preventing food losses and waste along the food supply chain and greater use of organic waste **(see chapters 3 and 5)**
Reducing human health impacts associated with uncontrolled dumping and open burning of waste; and informal picking of waste **(see chapter 5)**
Improved education and awareness to drive waste behaviour change and responsible waste management
Supporting women, particularly marginalised women, along the waste value chain and across the hierarchy; since women often bear most of the impact of poor waste management
Reducing the environmental impacts of poor waste management on fresh water resources, e.g. litter, nutrient pollution, blocking of stormwater drains, flooding **(see chapter 5)**
Harnessing the bioenergy opportunities from organic waste **(see chapters 6 and 7)**
Creating decent work for all in the waste sector, especially informal waste pickers. Harnessing the opportunities of waste prevention, and “waste as resource” in creating new economic opportunities **(see chapters 6 and 7)**
Driving innovative approaches to product design (minimise waste generation) and harnessing technological and social innovation in waste reuse, recycling and recovery **(see chapter 7)**
Reducing the impact of SWM, since the poorest are harmed the most by poor waste management **(see chapter 5)**
Ensuring access to waste services for all and improved waste collection and disposal, as better SWM is vital for healthy and resilient communities **(see chapters 3, 6 and 7)**
Shifting from waste to resource management to ensure more efficient use of resources, as we drive towards a circular economy **(see chapters 6 and 7)**
Reducing methane, CO_2 and black carbon generation from dumping and open burning of waste. Indirect emissions displaced by using secondary resource **(see chapter 5)**
Reducing the impacts of land- and ocean-based pollutants on the ocean and sea life, such as marine litter, micro-plastics. Extending collection to all and eliminating uncontrolled dumping would reduce waste, such as plastics entering the oceans **(see chapters 3 and 5)**
Reducing the impacts of poor solid waste management on land from things like uncontrolled dumping or poor landfill design and operation **(see chapter 5)**
Appropriate development, implementation and enforcement of waste policy, and good governance structures; producer responsibility **(see chapters 4 and 8)**
Working together: formal and informal, wealthy and poor, public and private **(see chapters 4, 6, 7 and 8)**

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