3 State of solid waste management in Africa

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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 recycling and associated opportunities. In general, waste recycling is not a priority for most municipalities. 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 management 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]

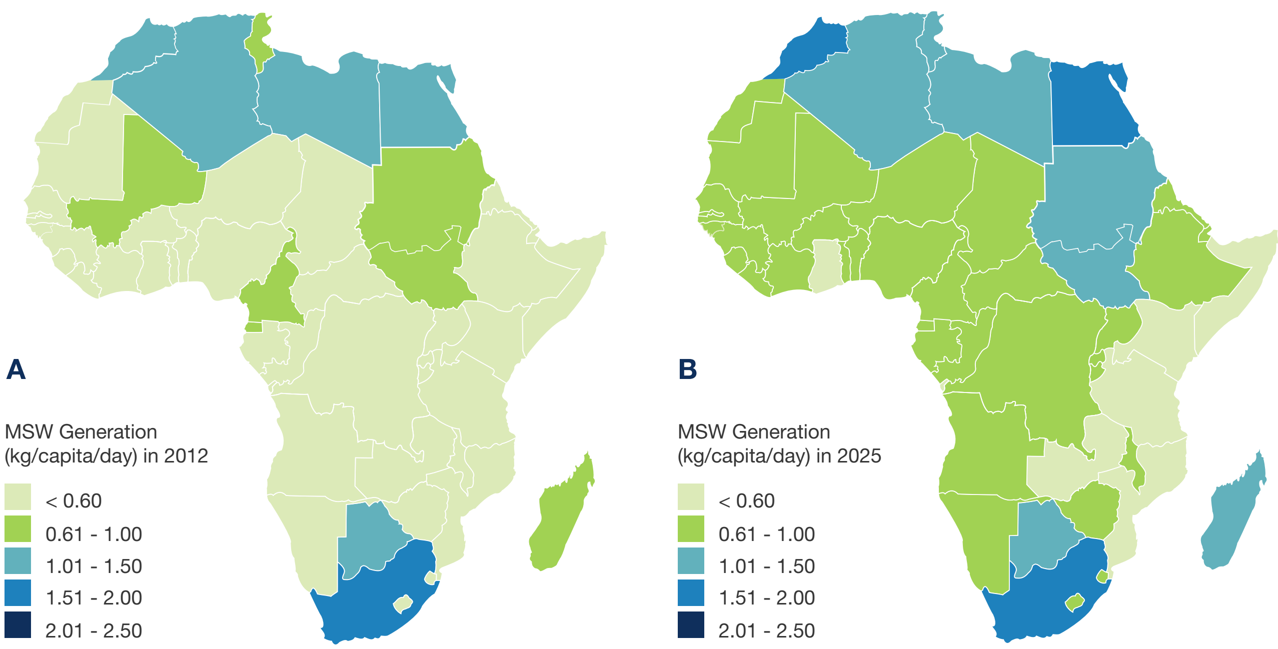
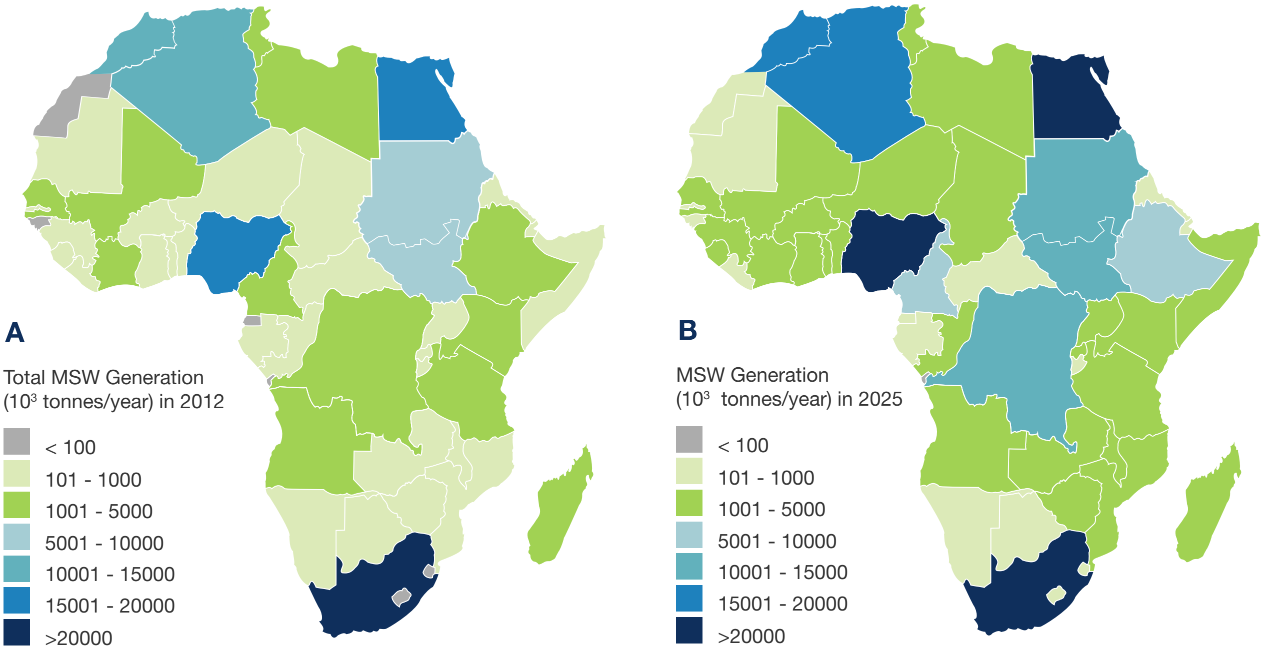
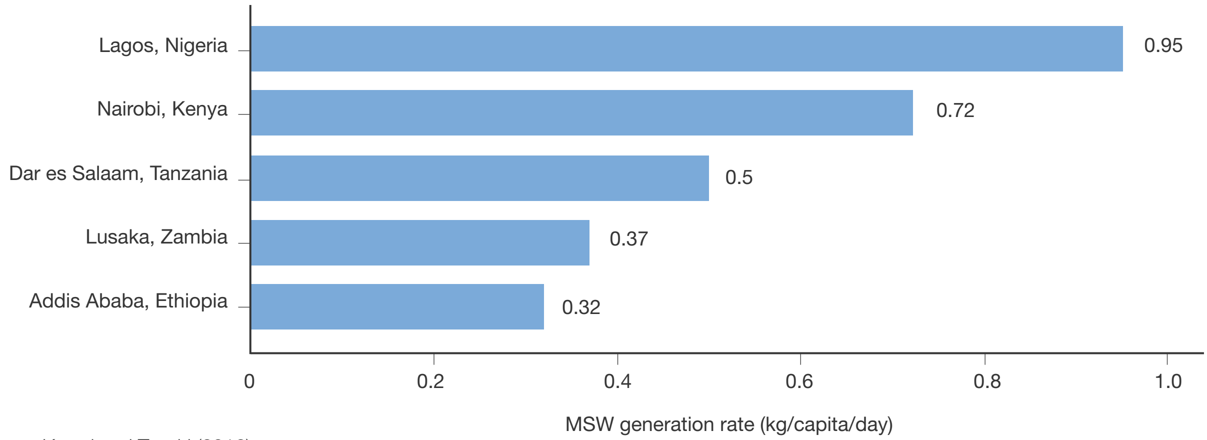


Figure 3.2 Total MSW generation (10^3 tonnes/year) of African countries in 2012 (A) and 2025 (B)[3]



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

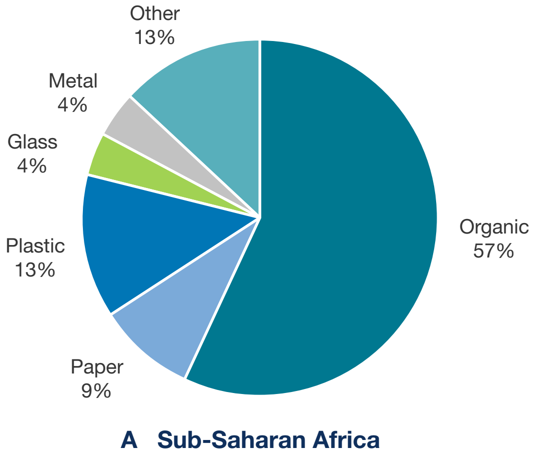
The composition of waste has direct implications for how it is collected and disposed of (Hoornweg and Bhada-Tata 2012). The composition of MSW is commonly expressed in terms of the proportion of organic, paper, plastic, glass, metal and other materials (**Table 3.1**) (Hoornweg and Bhada-Tata 2012).

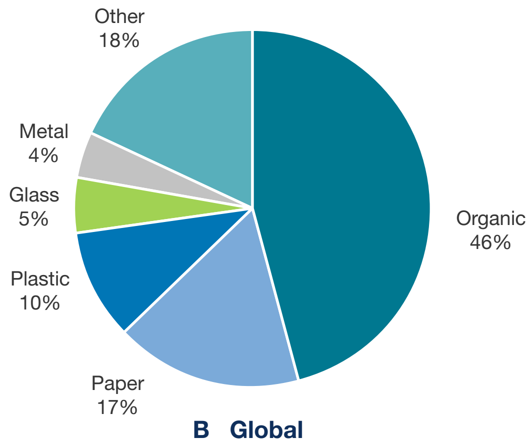
According to the World Bank (Hoornweg and Bhada-Tata 2012), organic waste constitutes 57 per cent of the total MSW generated in sub-Saharan Africa (**Figure 3.4**), considerably higher than its proportion of the total global MSW (relative to the other waste streams). Plastic as a percentage of MSW for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

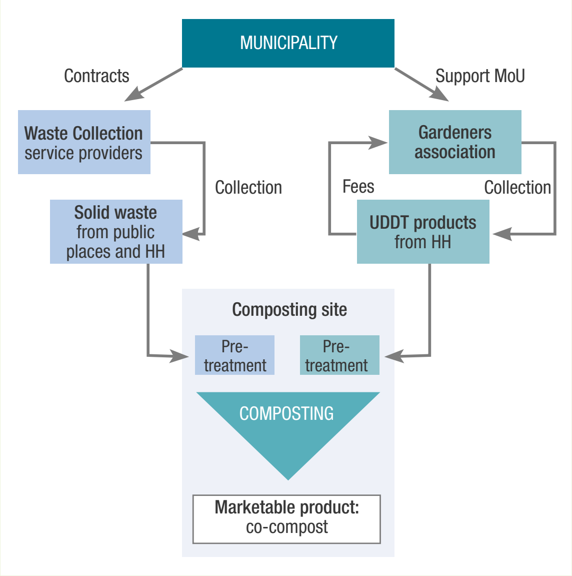
Lokossa is the capital city of Mono Department in southwest Benin, with a population of 77,065. Commissioned by the German Federal Ministry for Economic Cooperation and Development, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), organised a pilot project in Lokossa in 2011 to identify 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

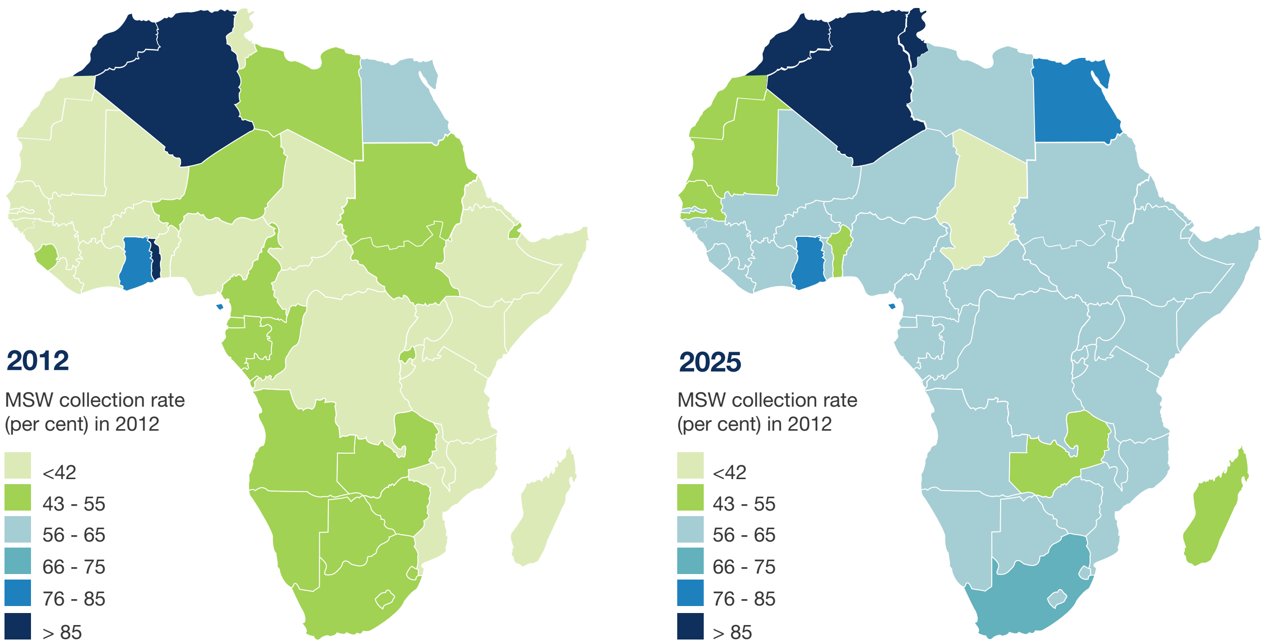
Collection rate[4]

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]

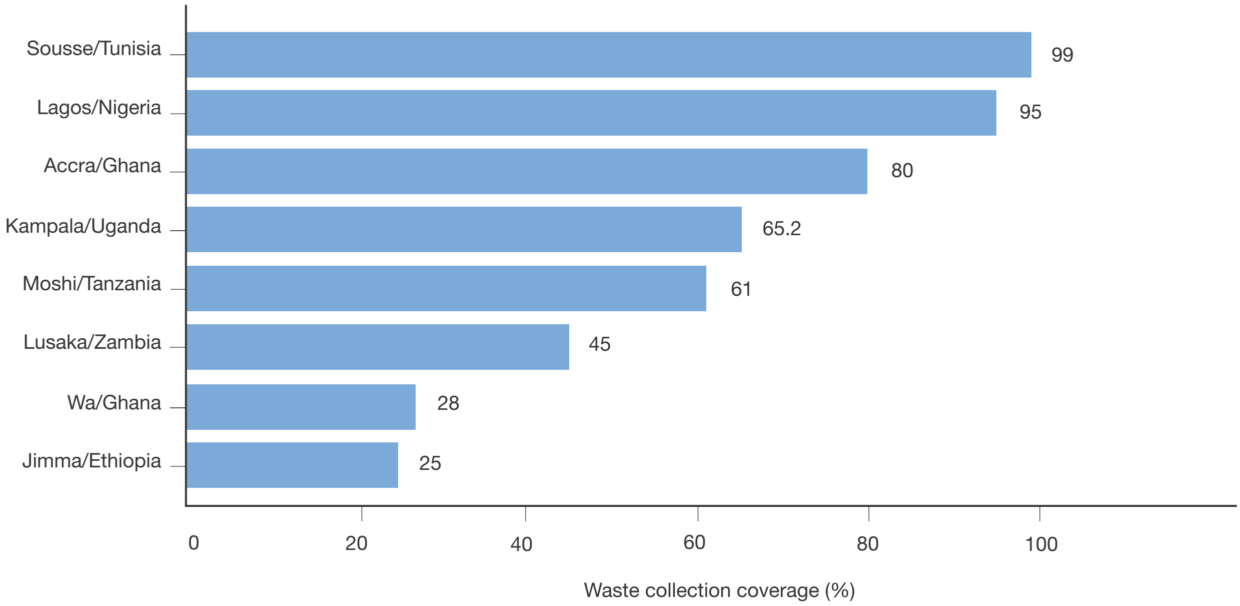


4 Where "collection rate" refers to the ratio of total waste collected to total waste generated.

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

<table>
<tr><th>City</th><th>City area</th><th>Primary collection</th><th>Collection point</th><th>Secondary collection</th><th>Transfer station</th></tr>
<tr><td rowspan="4">Maputo, Mozambique</td><td>Inner city</td><td colspan="2">1.1–2.5 cubic metre containers</td><td colspan="2">Motorized communal collection</td></tr>
<tr><td>Residential inner city</td><td colspan="4">Motorized door-to-door collection, one step</td></tr>
<tr><td>Suburban areas</td><td>Manual block collection</td><td>Large containers</td><td colspan="2">Trucks</td></tr>
<tr><td>Rural areas</td><td>Self service</td><td>Unmanaged drop off point</td><td colspan="2">Motorized communal collection</td></tr>
<tr><td rowspan="2">Qena, Egypt</td><td>Urban areas</td><td>Manual block collection</td><td>Collection trucks</td><td colspan="2">Trucks</td></tr>
<tr><td>Semi-urban areas</td><td colspan="4">Motorized door-to-door collection, one step</td></tr>
</table>

Source: Adapted from GIZ (2014)

Collection and transport infrastructure

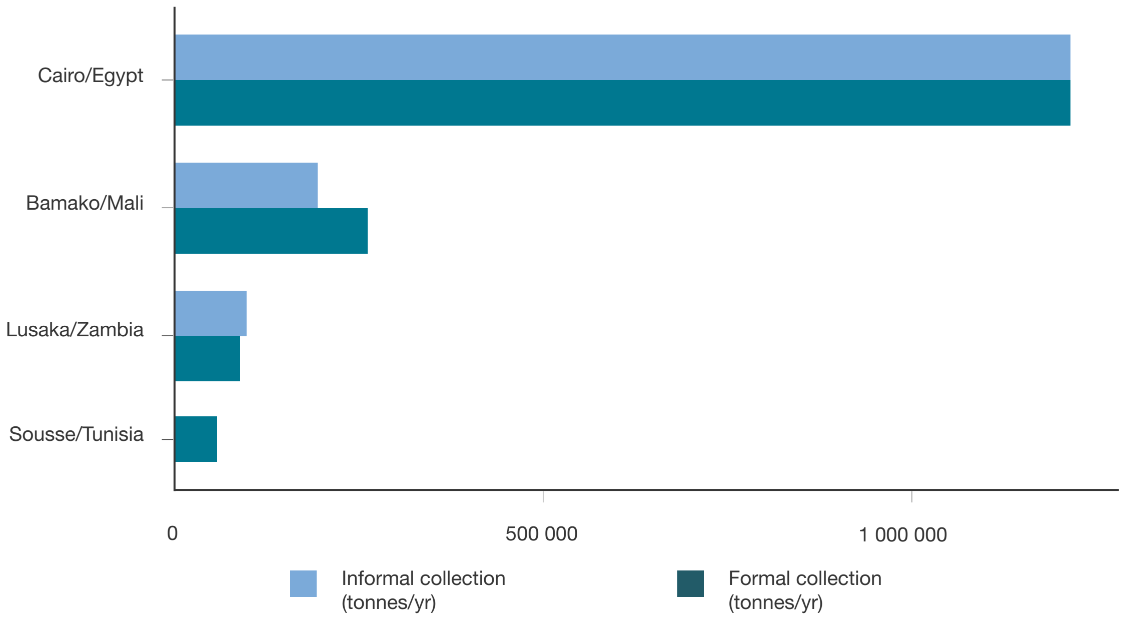
In African cities, good road infrastructure can often only be found in the city centres, with the roads in suburbs being of a poorer standard (GIZ 2014). As a result, the waste service delivery model or method may be different for different urban settings, and within and between cities and towns (**Table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

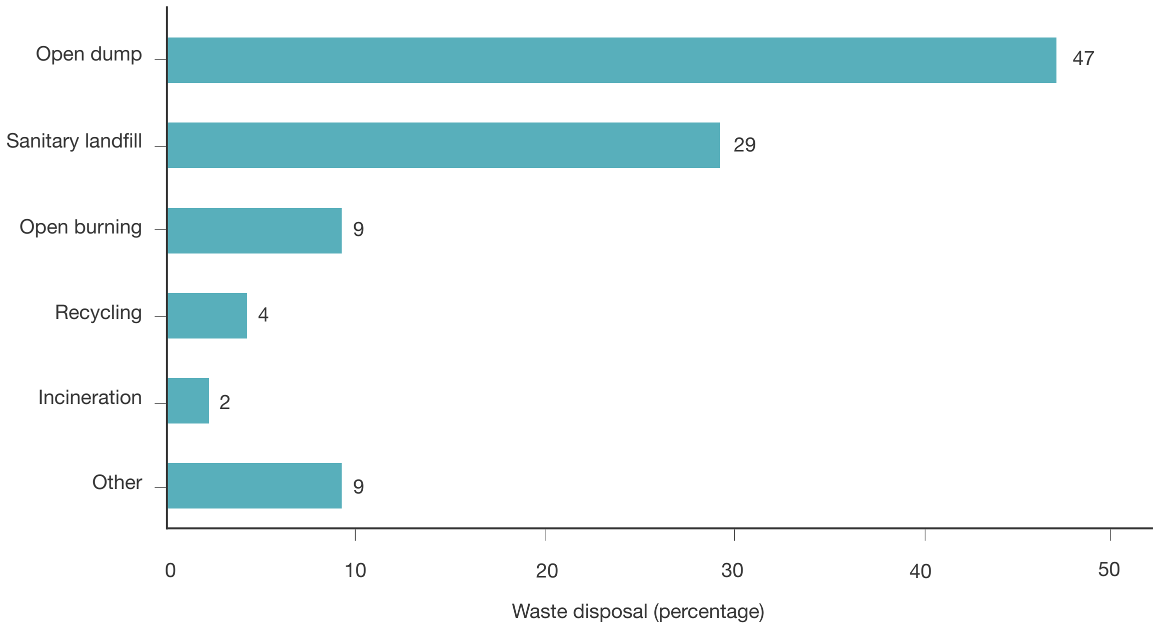
Data related to the quantity and composition of waste is still lacking, especially for rural areas. Thus, research is needed to accurately quantify solid waste generation and composition. This data needs to be made available in a national database for solid waste planning purposes.

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).

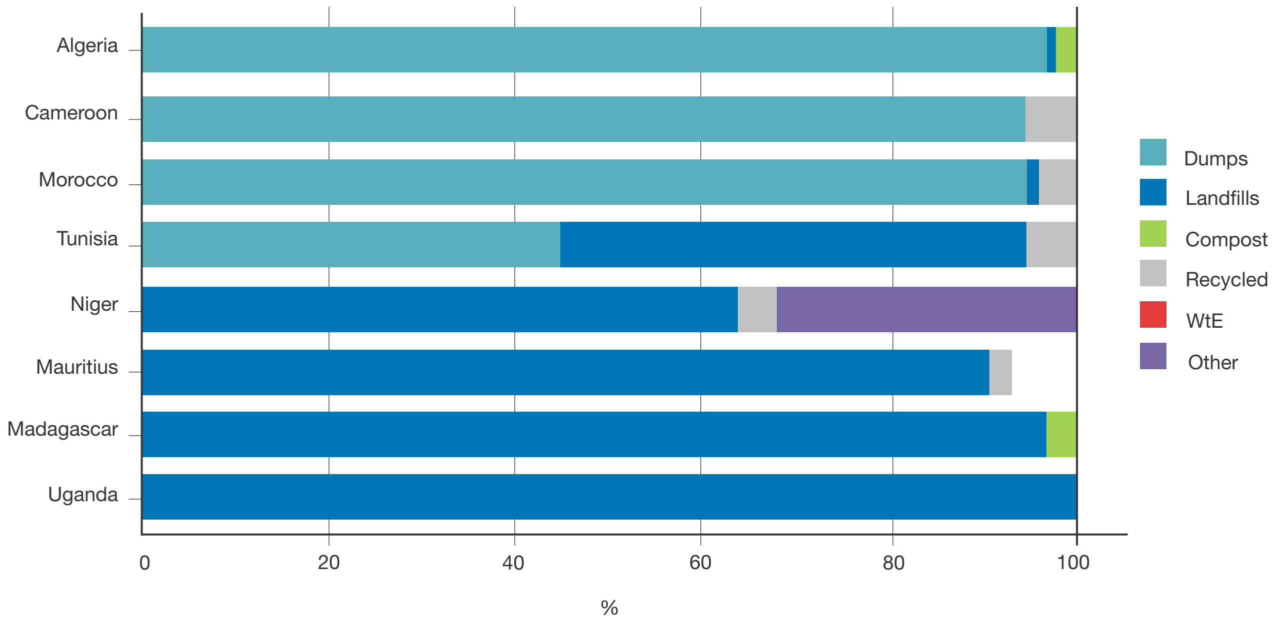
Open dumping involves indiscriminate disposal of waste with no plans for environmental protection (Johannessen and Boyer 1999). The waste in open dumps is left untreated, uncovered and unsegregated, with no groundwater protection or leachate recovery (Henry *et al*. 2006, Mwesigye *et al.* 2012, Mohammed *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

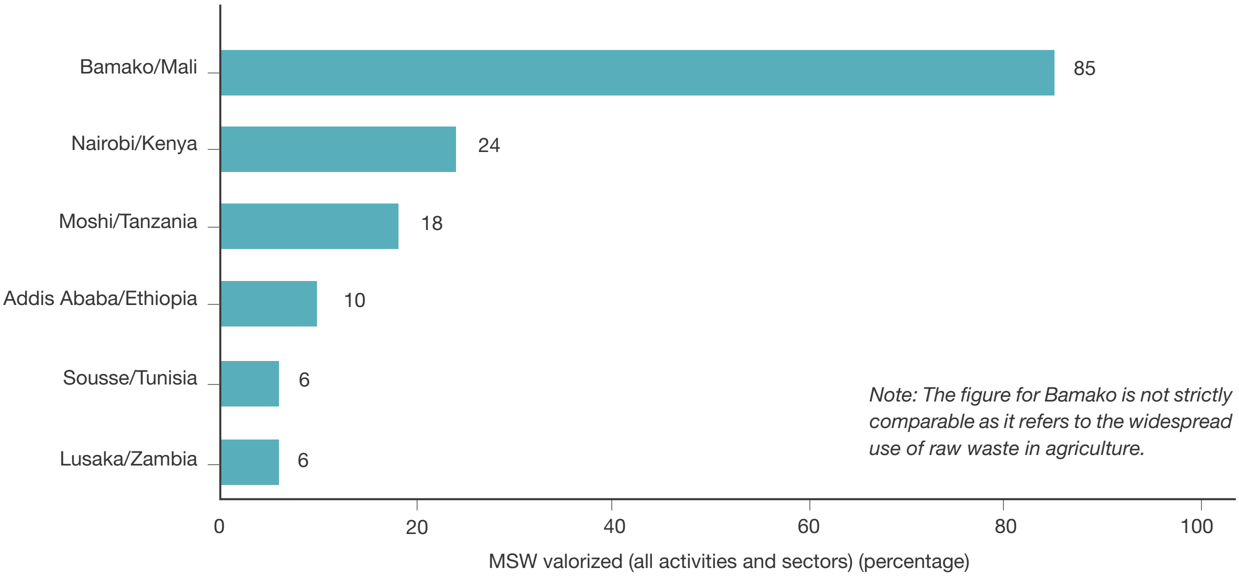
The average MSW recycling rate in Africa is only 4 per cent (**Figure 3.8**), lower than the average recycling rate of most countries of the Organization for Economic Cooperation and Development (OECD), which was 30 per cent in 2013 (OECD 2015a, 2015b). There are only a few formal recycling systems in 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

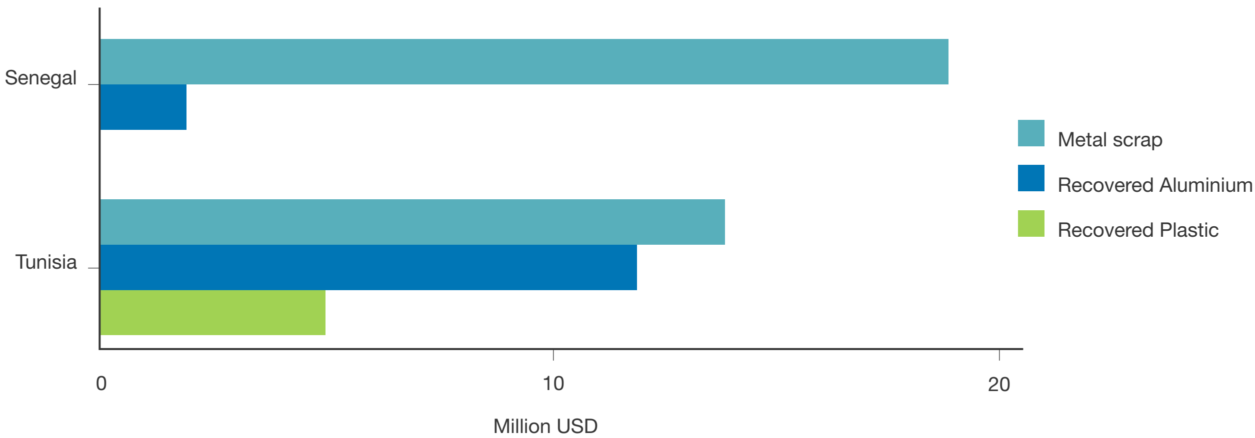


Source: UN-Habitat (2010), Regassa ***et al***. (2011)

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).

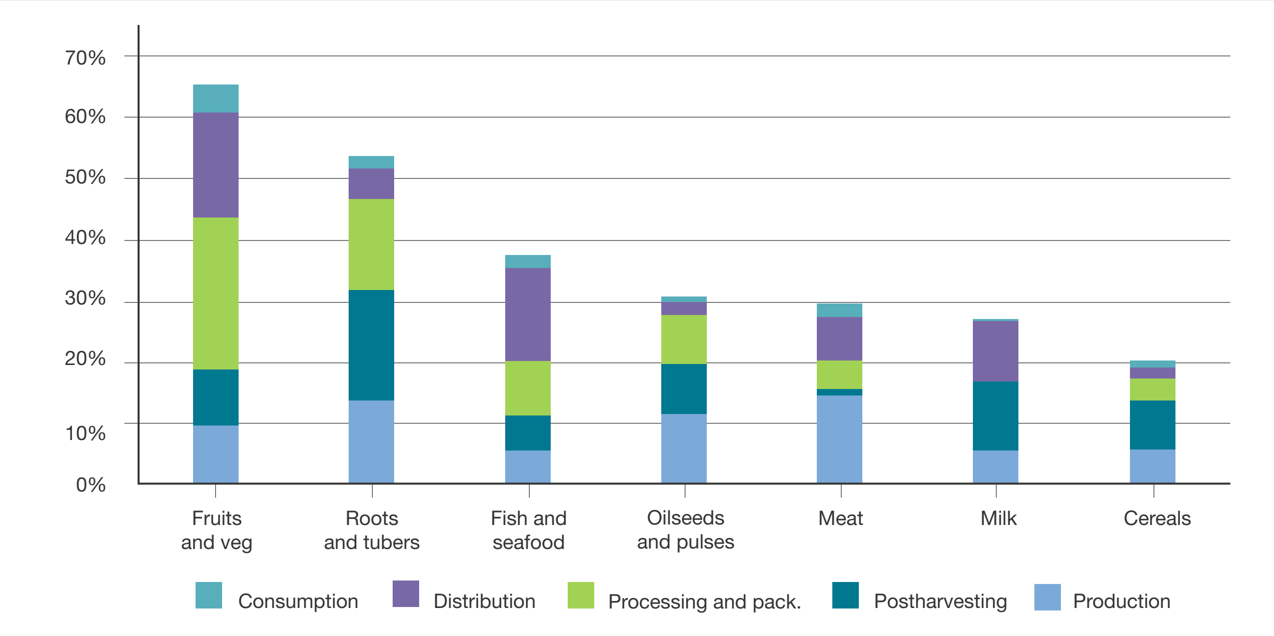
1 Topic sheet prepared by Kidane Giday Gebremedhin, Suzan Oelofse and Linda Godfrey.

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

TOPIC SHEET 1

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

(Garfí *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).

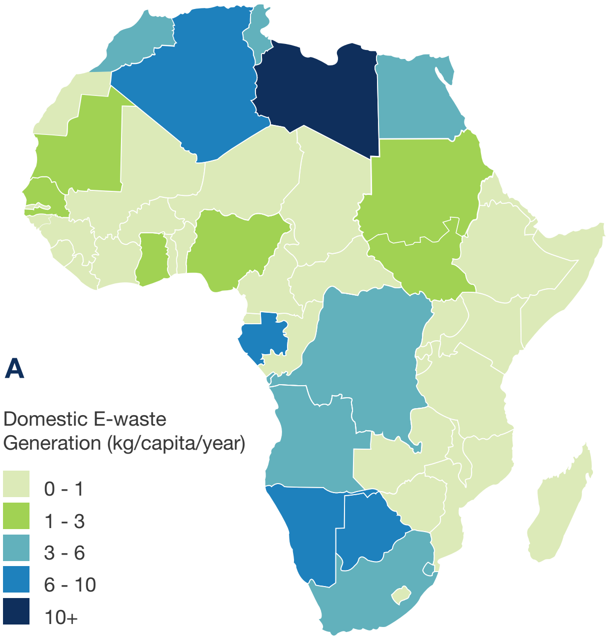
Hazardous waste generated in Africa is also increasing as a result of emerging waste streams such as e-waste, health care risk waste (HCRW) and obsolete agricultural chemicals. Freezing of transboundary movements of hazardous waste at borders in Africa has resulted in the stranding of toxic waste in 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.

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

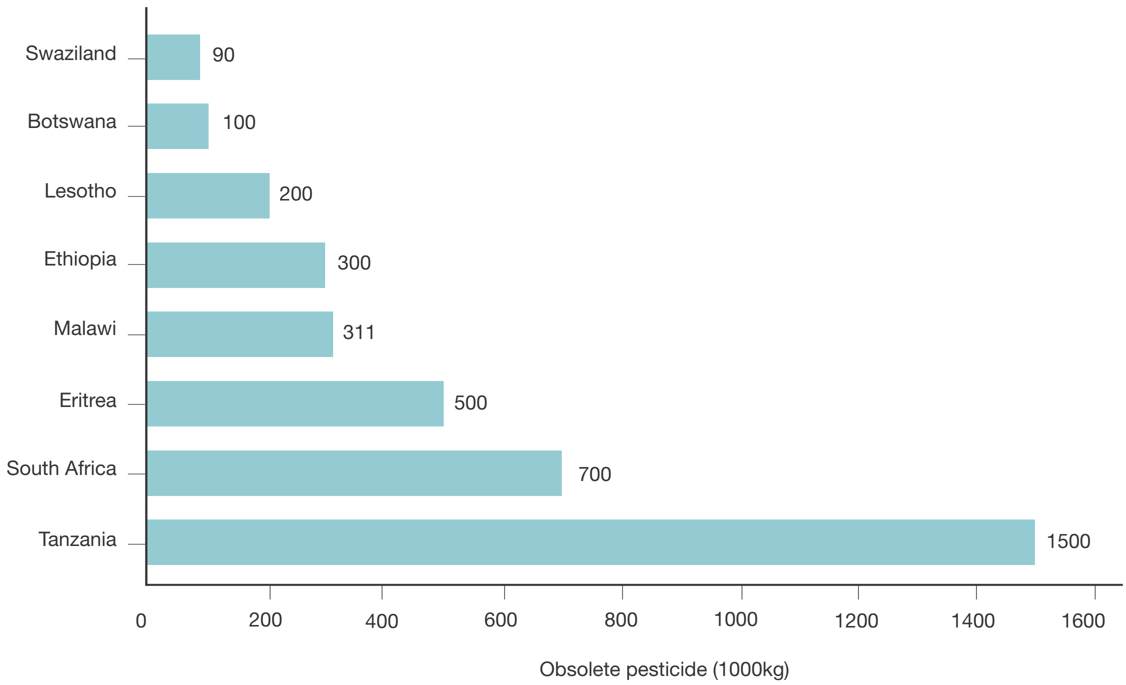
Little is known about the management of HCRW, or medical waste, in Africa. Udofia and Nriagu (2013) estimated that 282,447 tonnes of HCRW per year was generated from an estimated 67,740 health care facilities operating across Africa. Owing to the improved living standards of people in many African countries, 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.