TOPIC GUIDE:

Solid Waste Management

Mansoor Ali and Veronica Di Bella

April 2016

About Evidence on Demand and Professional Development

Evidence on Demand supports the professional development of Climate, Environment, Infrastructure and Livelihoods Advisers at DFID. Technical Competency Frameworks for the advisory groups guide the support provided. Evidence on Demand also supports crosscutting or development competencies that cover areas of technical knowledge and skills needed by advisers to effectively deploy their core technical skills and knowledge in development policy and operations.

The Evidence on Demand team is led by a DAI (which incorporates HTSPE Limited) and IMC Worldwide Limited Joint Venture. Both firms are established development consultancies with considerable experience in managing resource centres. The Joint Venture is backed by a core consortium of specialist organisations. The consortium provides technical support for developing quality assured resources, answering helpdesk enquiries and supporting consultancy services. Please go to the Evidence on Demand website (www.evidenceondemand.info) for further details.

Disclaimer

This Topic Guide has been produced by Evidence on Demand with the assistance of the UK Department for International Development (DFID) contracted through the Climate, Environment, Infrastructure and Livelihoods Professional Evidence and Applied Knowledge Services (CEIL PEAKS) programme, jointly managed by DAI (which incorporates HTSPE Limited) and IMC Worldwide Limited.

The views expressed in the Topic Guide are entirely those of the authors and do not necessarily represent DFID's own views or policies, or those of Evidence on Demand. Comments and discussion on items related to content and opinion should be addressed to the author, via enquiries@evidenceondemand.org.

Your feedback helps us ensure the quality and usefulness of all knowledge products. Please email enquiries@evidenceondemand.org and let us know whether or not you have found this material useful; in what ways it has helped build your knowledge base and informed your work; or how it could be improved.

DOI: http://dx.doi.org/10.12774/eod_tg.april2016.alimetal

First published April 2016

Contents

EVIDENCE ON DEMAND
CLIMATE & ENVIRONMENT
INFRASTRUCTURE | LIVELIHOODS

List of Figures

List of Tables

List of Boxes

About Topic Guides

Welcome to the Evidence on Demand series of Topic Guides. The guides are produced for Climate, Environment, Infrastructure and Livelihoods Advisers in the UK Department for International Development (DFID). There will be up to 40 Topic Guides produced 2013–2016.

The purpose of the Topic Guides is to provide resources to support professional development. Each Topic Guide is written by an expert. Topic Guides:

- Provide an overview of a topic;
- Present the issues and arguments relating to a topic;
- Are illustrated with examples and case studies;
- Stimulate thinking and questioning;
- Provide links to current best 'reads' in an annotated reading list;
- Provide signposts to detailed evidence and further information;
- Provide a glossary of terms for a topic.

Topic Guides are intended to get you started on an unfamiliar subject. If you are already familiar with a topic then you may still find a guide useful. Authors and editors of the guides have put together the best of current thinking and the main issues of debate.

Topic Guides are, above all, designed to be useful to development professionals. You may want to get up to speed on a particular topic in preparation for taking up a new position, or you may want to learn about a topic that has cropped up in your work. Whether you are a DFID Climate, Environment, Infrastructure or Livelihoods Adviser, an adviser in another professional group, a member of a development agency or non-governmental organisation, a student, or a researcher we hope that you will find Topic Guides useful.

Tips for using Topic Guides

I am going to be under the spotlight. How can a Topic Guide help?

The Topic Guides, and key texts referred to in the guides, cover the latest thinking on subject areas. If you think that a specific issue might be raised when you are under the spotlight, you can scan a Topic Guide dealing with that issue to get up to speed.

I have just joined as an adviser. Where should I start?

Topic Guides are peer reviewed and formally approved by DFID. They are a good starting point for getting an overview of topics that concern DFID. You can opt to be alerted to new Topic Guides posted on the Evidence on Demand website through Facebook, Twitter or LinkedIn. New publications of interest to advisers will also be announced in Evidence on Demand quarterly e-bulletins.

I don't have much time. How long should I set aside for reading a Topic Guide?

The main text of a Topic Guide takes around three hours to read. To get a good understanding of the topic allow up to three hours to get to grips with the main points. Allow additional time to follow links and read some of the resources.

I need to keep up my professional development. How can Topic Guides help with this?

Topic Guides, while providing an overview and making key resources easy to access, are also meant to be stretching and stimulating. The annotated reading lists point to material that you can draw on to get a more in-depth understanding of issues. The Topic Guides can also be useful as aide mémoires because they highlight the key issues in a subject area. The guides also include glossaries of key words and phrases.

I would like to read items in the reading list. Where can I access them?

Most resources mentioned in the Topic Guides are readily available in the public domain. Where subscriptions to journals or permissions to access to specialist libraries are required, these are highlighted.

I have a comment on a guide. How can I provide feedback?

Evidence on Demand is keen to hear your thoughts and impressions on the Topic Guides. Your feedback is very welcome and will be used to improve new and future editions of Topic Guides. There are a number of ways you can provide feedback:

- Use the Have Your Say section on the Evidence on Demand website (www.evidenceondemand.info). Here you can email our team with your thoughts on a guide. You can also submit documents that you think may enhance a Topic Guide. If you find Topic Guides useful for your professional development, please share your experiences here.
- Send an email to the Evidence on Demand Editor at enquiries@evidenceondemand.org with your recommendations for other Topic Guides.

EVIDENCE ON DEMAND
CLIMATE & ENVIRONMENT
INFRASTRUCTURE | LIVELIHOODS

Abbreviations and acronyms

ADB	Asian Development Bank
CBO	Community-based Organisation
CDM	Clean Development Mechanism
CWG	Collaborative Working Group
DANIDA	Danish International Development Agency
DDT	Dichlorodiphenyltrichloroethane
DFID	Department for International Development
GDL	Gender Division of Labour
GDP	Gross domestic product
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GPS	Global Positioning System
HCW	Healthcare waste
HIC	High-income country
HIV/ AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
IPCC	Intergovernmental Panel on Climate Change
ISWM	Integrated Solid Waste Management
JICA	Japanese International Cooperation Agency
KAWWS	Karachi Administration Women Welfare Society
LIC	Low-income country
MDGs	Millennium Development Goals
MIC	Middle-income country
MSW	Municipal Solid Waste
NAMA	Nationally Appropriate Mitigation Action
NGO	Non-Governmental Organisation
PCB	Polychlorinated Biphenyl
POP	Persistent Organic Pollutant
PPP	Public-Private Partnership
SDG	Sustainable Development Goal
SWM	Solid Waste Management
UN	United Nations

UNEP	United Nations Environment Programme
WEDC	Water, Engineering and Development Centre
WHO	World Health Organization
WIEGO	Women in Informal Employment: Globalizing and Organizing

Summary

‘*By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management.’* Target 11.6, Sustainable Development Goals

11.6 Target has been included in the Sustainable Development Goals in recognition of the scale of the challenge of waste management. Currently, 1.3 billion tonnes of municipal waste are generated globally annually. City governments in developing countries have limited capacity to provide the services necessary to manage this volume of waste. The challenge will become greater. Waste generation is expected to increase to 2.2 billion tonnes by 2025 and there are limited prospects for investment in the sector.

This Topic Guide presents a case for improved solid waste management in developing countries and the potential contribution of the sector to the Sustainable Development Goals. The guide, which is organised into five sections, includes evidence from the literature, both published and grey, and from the experience of the authors.

After an initial introduction to the sector and an explanation of some key terms (**Section 1**), **Section 2** focuses on waste generation and on the stages involved in solid waste management. This section also includes a paragraph which describes the issue of healthcare waste management.

Section 3 discusses the potential contribution of improved solid waste management to the Sustainable Development Goals and analyses the impact of improved solid waste management on selected priority sectors for DFID: public health and a cleaner living environment; natural environment; urbanisation; climate change; citizen’s participation and good governance; vulnerable groups; livelihoods; and occupational health and safety.

Section 4 proposes six strategic areas for improving solid waste management in developing countries, which could be adopted and promoted by international development organisations and donors. The strategic areas are selected according to their relevance to achieving the Sustainable Development Goals, as well as their relevance to the particular challenges and impacts, considered in the previous sections.

Section 5 highlights gaps and challenges in the sector where further knowledge and research is needed. For instance, gaps and challenges include the necessity of setting up initiatives to support data collection and validation in order to enhance service planning, implementation and monitoring.

The guide is completed by a glossary, an annotated list of selected bibliographical references and a list of additional references.

.

SECTION 1

Introduction

1.1 Solid waste and the purpose of this Topic Guide

This Topic Guide is produced at an important juncture, as the United Nations Sustainable Development Goals (SDGs) are being agreed, including Target 11.6:

'*By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management.'*

This target has been included in recognition of the 1.3 billion tonnes of municipal waste generated globally annually. City governments in developing countries have limited capacity to provide the services necessary to manage this volume of waste. The challenge is only going to become greater, with waste generation expected to increase to 2.2 billion tonnes by 2025 (Halbach, 2013) and limited prospects for investment in the sector. In addition to Target 11.6, improved solid waste management (SWM) is also seen to contribute to a further 40 other SDG targets.

This Topic Guide focuses on solid waste from cities, which is often the responsibility of city governments. This guide excludes waste from large industries, mining, agricultural activities and major demolition sites as typically these wastes will be governed by different legislation and fall under the management of other municipal or national systems. If a developing country has regulations, policies and budgets related to solid waste, the focus is often on municipal waste.

In addition to health and environmental benefits, improved SWM can also be important in promoting local business, creating jobs, strengthening local governance and improving overall city environments, potentially attracting investment. The purpose of this guide is to present a case for improved SWM, which DFID advisers and partners can use to support decision-making, participation in meetings and promoting DFID involvement in sector initiatives and the development of new programmes and policies.

1.2 Solid waste and municipal waste

What is solid waste?

An item is viewed as waste as soon as it is perceived to have no value for the owner. The term solid waste is generally used to describe waste in its solid state, such as household refuse which is disposed of by the producers and needs collection, treatment and safe disposal. Alternative terms include refuse, waste and garbage.

What is municipal solid waste?

Definitions of municipal solid waste (MSW) vary between countries. A working definition is:

'…*waste generated by households, aste 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.*' (UN-Habitat, 2010).

This working definition implies that parallel waste management systems will exist within an urban area, one for municipal solid waste run by, or on behalf of, the municipality, and others

for industrial, construction and demolition, healthcare, end-of-life vehicles and some other non-domestic waste, which may be classed as hazardous (UN-Habitat, 2010).

The existence of parallel waste streams is not often the case in cities in developing countries. The urban waste stream in those cities often includes construction and demolition waste, in particular from small sites, and some categories of hazardous waste, such as those produced by small industries and healthcare facilities. Where open defecation is common, municipal solid waste can also include human excreta.

SECTION 2

The solid waste management sector

This section describes the solid waste management sector in more detail. It identifies the waste streams that contribute to municipal solid waste (MSW) and discusses how they are managed in cities and towns in the developing world. Particular focus is given to:

- The role of the different sector actors such as municipalities, private citizens, non-governmental organisations (NGOs) and community-based organisations (CBOs), at each stage of the solid waste management chain;
- Current practices prevalent in developing countries; and
- The key linkages that exist between the different stages of solid waste management and other functions of cities and towns.

2.1 Waste generation

Waste generation and trends

MSW generation rates (see Section 6 - Terminology) vary widely within and between countries. The rate of MSW generation depends on a variety of factors, including income levels, socio-cultural patterns and climatic factors (UNEP, 2015). It is generally accepted that high-income countries generate more than 1 kilogramme (kg) per person per day of waste. In contrast, low- and middle-income countries typically produce less than 0.5 kg per person per day. In many cities in the developing world, data on waste generation are unreliable and seldom capture informal activities or system losses (UN-Habitat, 2010).

It is clear, however, that the rate of MSW generation is rapidly increasing, especially in developing countries. For example, MSW generation rates across Asian and Pacific countries increase by 3–7% per year (Visvanathan and Glawe, 2006). Current projections for urban population size and urbanisation suggest that Africa, and particularly Sub-Saharan Africa, may become the dominant region in terms of total waste generation by 2080. Most of this will be generated in mega-cities (UNEP, 2015).

The challenge of providing basic MSW management services to such rapidly growing cities, which are already under-served, is enormous. In the light of this, it is important to understand how available data have been collected and how the data can be used to design appropriate solid waste management systems, especially when the quantity and composition of waste changes with changes in urban demographics, populations, economies, seasons and the social makeup of urban environments (Bolaane and Ali, 2004).

Waste composition

Waste composition affects the physical characteristics of the waste, including density, moisture content and calorific value[1]. This in turn affects waste management options and the choice of technology for collection, recycling, treatment and disposal (UNEP, 2015). In spite of the high variability and low reliability of source data, a comparison of typical waste

[1] Calorific value can be defined as the amount of heat released by a unit weight or unit volume of a substance during complete combustion

composition with a country's income level shows some common patterns (UNEP, 2015). The findings include:

- The organic fraction is significantly higher in lower-income countries (LICs), averaging 46–53% of total material, compared with an average of 34% in high-income countries (HICs);
- The percentage of paper waste is suggested to be directly proportional to income levels, rising steadily from 6% in LICs, to 11–19% in middle-income countries (MICs) and 24% in HICs;
- Plastic waste does not have a significant correlation with income level, ranging from 7–12% in all countries, irrespective of economic status;
- Other recyclable materials (i.e. metal, glass and textiles) increase slightly as incomes rise, from 6% in LICs to 12% in HICs.

Box 2.1 - Emerging waste streams: the case of e-waste (adapted from UNEP, 2015)

E-waste (i.e. discarded electronic devices) is the fastest-growing waste stream as a result of increased consumer demand, perceived obsolescence due to rapid developments in technology and new electronic devices. The situation is compounded by the short design life of certain products and failure to design products for appropriate disposal, including reuse and recycling. LICs and MICs often lack the legislation, standards and infrastructure necessary to manage e-waste effectively, including handling and treatment of waste. Informal collection practices, followed by unsafe recovery and recycling methods, are commonplace. In addition, part of the export trade in e-waste could be classified as waste trafficking, rather than legitimate trade. The Agbogbloshie dump in Accra[1], Ghana, is perhaps the world's largest e-waste dump and receives 192,000 tonnes of e-waste annually. There is evidence that amounts of e-waste from high- and middle- income countries are disposed of at the Agbogbloshie dumping site (Amoyo-Osei et al., 2011), but quantities are unknown.

[1] Pictures of Agbogbloshie dumping site are available at: www.theguardian.com/environment/gallery/2014/feb/27/agbogbloshie-worlds-largest-e-waste-dump-in-pictures

Box 2.2 - Emerging waste streams: the case of disaster waste (adapted from UNEP, 2015)

Disasters and conflicts create tremendous amounts of waste, in particular large amounts of debris, and construction and demolition waste. Several recent large earthquakes and a war zone have yielded an estimated 1-30 million tonnes of disaster waste per incident. Debris clearance and waste management are among the highest priorities following a disaster because of the need to provide access, rescue survivors, retrieve dead bodies and address urgent public health and environmental issues.

During an emergency response the priorities include (i) the separation of hazardous waste from human and animal remains and (ii) the identification of disposal sites. During the early recovery phase, the priorities shift to (i) reinstating systems for the management of MSW and healthcare waste, and (ii) identifying opportunities for reuse and recycling to improve waste management.

2.2 Stages of solid waste management

Solid waste management has four stages: waste generation, waste collection including transport, waste recycling and waste disposal. Figure 2.1 shows how each of these stages apply to waste generated at household level.

After an item is discarded by its owner it can be (i) reused at domestic level (e.g. for animal feed or small-scale agriculture); (ii) collected through a primary collection system; (iii) taken to a communal collection point by the owner or by a private or municipal collection service; or (iv) sold to local recycling facilities (so-called 'merchants' in the diagram). From the communal collection point, where waste from street sweeping and drain cleaning is often also disposed, waste is then either transferred to a final disposal site through a system of secondary collection or sorted by waste pickers and sent to a recycling facility. Waste pickers often also operate at disposal sites and re-direct part of the waste stream to recycling facilities, either directly or through middle-men. It is also important to note that in some cities waste is collected by trucks that take it directly from households to disposal sites or recycling facilities. Similar processes are applicable to waste produced by commercial activities and institutions.

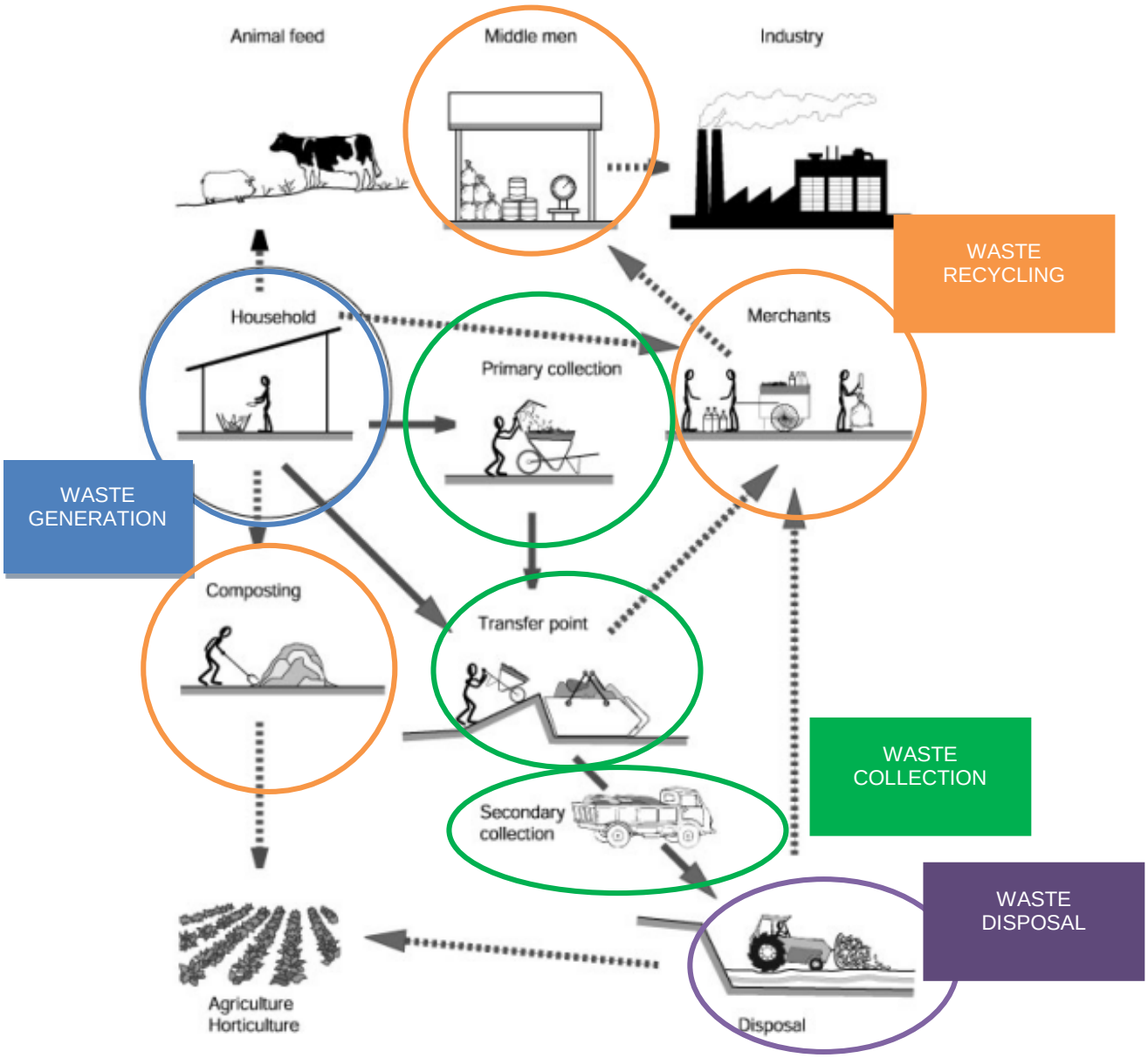

Figure 2.1 – Stages of solid waste management (adapted from Zurbruegg, 2003)

Each of these stages is linked with other sectors and municipal functions, as described in more detail in the following sections. For instance, poor systems of waste collection can lead to waste accumulating in the urban drainage system that results in flooding; this in turn can affect transport infrastructure and have a knock-on effect on businesses and livelihoods. Similarly, large quantities of biodegradable waste can create landfill gas, increasing greenhouse gas emissions and contributing to climate change.

The integrated solid waste management (ISWM) approach (see Box 2.3) has been accepted as a way to identify all the dimensions that need to be considered in improving SWM services.

Box 2.3 - Integrated solid waste management (ISWM)

ISWM is a systems approach that recognises three important dimensions that need to be addressed when improving a solid waste management system. The dimensions, shown in Figure 2.2, correspond to three key questions:

1. Who are the stakeholders that need to be involved in the management of waste?

2. What are the waste system elements that need to be considered to effectively and efficiently manage waste? and

3. What are the aspects necessary to achieve the desired results?

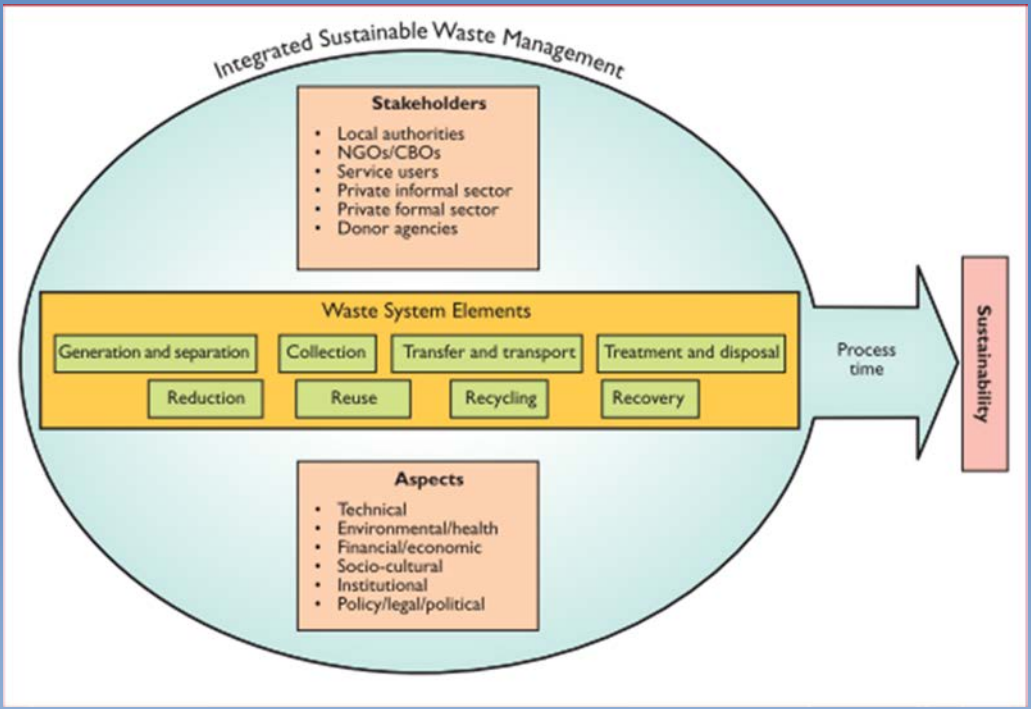

Figure 2.2 – Integrated Solid Waste Management Framework (UN-Habitat, 2010)

2.3 Waste collection and transport

Challenges and links to other sectors

In many cities in the developing world, less than one-third of the waste generated in urban areas is removed from residential areas by municipal authorities (Coffey and Coad, 2010). While the proportion of waste collected in major cities may be more than 50%, in smaller provincial towns the proportion is likely to be much lower. Almost invariably, low-income housing areas are neglected or inadequately served (Coffey and Coad, 2010).

In the absence of a regular solid waste collection service, waste is often dumped in open spaces, on roads, and along watercourses and drainage systems. Uncollected waste has an impact on a number of city functions (Table 2.1).

Table 2.1 – Links between solid waste collection and other functions of a city

Functions	Factor	Examples and data
Public health	Uncollected waste becomes a breeding ground for disease vectors (flies, mosquitoes and rats)	Evidence suggests that the incidence of diarrhoea among children who live in households that dispose of waste within the household environment is twice as high compared to the incidence among children living in areas where waste is collected regularly. In addition, the prevalence of acute respiratory infections is six times higher (UN-Habitat, 2010).
Transport infrastructure and drainage	Uncollected waste blocks open drains and access roads	Recent annual floods in Kampala and other East African cities are reported to have been the result of plastic bags blocking drainage systems[2] (UN-Habitat, 2010).
Tourism and business	Cities with less effective SWM attract less business or fewer tourists	It has been estimated that there has been a loss of US$23 million a year as a result of a decline in tourism in Tangier, Morocco due to pollution on local beaches (UN-Habitat, 2010). The Chairman of Nigeria's House of Representatives Committee on Environment stated that unhealthy and poor environments cost the Federal Government of Nigeria 10 billion Naira (about 50 million US$) a year (UN-Habitat, 2010).
Governance	Cleaning of cities linked to political/ sport events	Mali instigated a clean-up campaign in 2002 for the Coupe d'Afrique de Nations football championship (UN-Habitat, 2010).
Finance	Inefficient collection methods use a high percentage of municipal budgets	Inefficient waste collection systems can demand as much as 32% of a municipal budget (Coffey and Coad, 2010).

Who is responsible for a waste collection service?

Solid waste collection is a municipal responsibility, meaning that it falls under the jurisdiction of local authorities. However, it is generally accepted that city, municipal and metropolitan institutions consider waste transportation in vehicles as their main responsibility and not

[2] Uganda has not conducted official estimates of the economic losses caused by the floods.

primary collection services (i.e. removal of waste from households). This gap in service provision is increasingly being filled by the informal sector and by local initiatives. Informal waste services are more established in South Asia, but are also an emerging sector in many cities across Africa. Community groups and NGOs are playing important roles in promoting local enterprises, which may involve extra pay for municipal sweepers, local activists either facilitating or managing collection, or small contractors providing local services (Ali and Cotton, 2001).

Practices and technologies for waste collection

Simple equipment, such as handcarts, tricycles and animal carts, and associated labour-intensive methods are commonly used for primary collection in cities in LICs and MICs.

Problems of coordination between primary and secondary collection often result in waste being left at communal collection points for a long time. Primary collection is often labour-based, whereas secondary collection is typically mechanised. This disconnect leads to waste at collection points being exposed to animals, disease vectors, waste pickers and citizens (see Figure 2.2).

Evidence suggests that breakdowns of collection vehicles are common, with up to 60% of a vehicle fleet out of operation at any one time in many cities. This can be exacerbated by slow rates of repair, which delay the return of vehicles to service (Coffey and Coad, 2010).

Figure 2.2 – Uncontrolled waste at a collection point in Sittwe, Myanmar, now attracting animals (source: Di Bella, 2014)

2.4 Waste disposal

Challenges and links to other sectors

Waste generated by 3 billion people worldwide is still not disposed of at controlled waste disposal facilities (UNEP, 2015). Uncontrolled disposal is still the norm in most developing countries; 48 out of the 50 biggest dumping sites in the world are in Africa, Asia and Latin America/Caribbean. Those sites pose a serious threat to the environment and human health, affecting the daily life of 64 million people (UNEP, 2015).

Table 2.2 details the impacts of uncontrolled disposal on a number of sectors and city functions.

Who is responsible for a waste disposal service and how is it funded?

The estimated capital and recurrent costs for the development of a sanitary landfill range between US$5 and US$20 per tonne of waste (Cointreau, 2008). As a result, cities in the developing world often require strong donor support, typically in the form of bilateral cooperation to improve dumping sites (UN-Habitat, 2010). Examples include (UN-Habitat, 2010):

- Dhaka, Bangladesh, and the Japan International Cooperation Agency (JICA);
- Lusaka, Zambia, and the Danish International Development Agency (DANIDA); and
- Managua, Nicaragua, and the Spanish Agency for International Cooperation for Development (AECID).

Table 2.2 – Links between solid waste disposal and other sectors or functions in a city

Function	Issue	Examples and data
Environment	Pollution of surface water and groundwater	In Lagos (Nigeria) heavy metals (Pb, Cd, Mn and Fe) were found in water samples collected from 44 wells located within 25 metres of six dumping sites in concentrations higher than WHO and national standards for drinking water (Oluyemi, 2009).
	Soil pollution	Higher concentrations of polychlorinated biphenyls (PCB) and dichlorodiphenyltrichloroethane (DDT) were found in areas surrounding dumping sites in Asia than in control sites (Minh et al., 2006). PCBs and DDT are persistent organic pollutants (POPs) and have negative effects on human health.
	Smoke from uncontrolled open burning	The uncontrolled burning of household waste is among the main sources of air pollution in Cameroon and a major source of toxic substances, in particular where PVC and hazardous and toxic wastes are burnt (Forbid et al, 2011).
Climate change	Landfill gas contains methane and carbon dioxide	Methane emissions from landfills contributed to 700 million tonnes CO_2 equivalent in 2010 (Bogner et al., 2007).
Urbanisation	Uneconomical use of available space and devaluation of properties	Jam Chakro, located in the city of Karachi in Pakistan is one of the largest dumpsites in the world, extending over 202 hectares (UNEP, 2015).
Occupational health and safety/ livelihoods	Inhaling of hazardous smoke and dust from waste burning Direct contact with hazardous waste disposed with MSW	The Agbogbloshie dump in Accra, Ghana is used to dispose of local MSW and e-waste. This has had serious health implications for the approximately 10,000 scavengers that earn their income from sorting and recycling the waste (UNEP, 2015).
Public health	Uncontrolled burning of waste Contamination of water sources	There is evidence from Egypt that 89% of the population living in communities downwind from uncontrolled disposed sites suffered from respiratory disease (UN-Habitat, 2010).

Improving practices and technologies for waste disposal

Phasing out uncontrolled disposal practices is one of the first objectives in improving MSW management in developing countries (UNEP, 2015). Sanitary landfilling is commonly considered the most cost-effective system of solid waste disposal for most urban areas in African and Asian countries. Composting solid waste costs 2-3 times more than sanitary

landfill, and incineration costs 5-10 times more, in terms of investment costs (Jaramillo, 2003; Cointreau, 2004).

Box 2.4 - From open dumping to sanitary landfilling in Dhaka, Bangladesh

Matuail landfill site is a successful example of how an open dump[3] was transformed into a sanitary landfill (the first ever in Bangladesh) by adopting a step-by-step approach, which used simple and locally available materials, technical guidelines and available construction techniques. The steps, which were undertaken at Matuail landfill, included: site preparation (i.e. levelling and grading); provision of a system for the collection and treatment of leachate; and development of a system for capturing landfill gas.

The sanitary landfill was opened in 2007. The landfill operates 24 hours a day, receiving about 2,000 tonnes of waste daily. Over 350 trucks arrive, get weighed and unload their waste each day. Heavy equipment, including excavators and bulldozers, are used to unload, spread and compact the waste across the site. Leachate and landfill gas are managed on the site.

Figure 2.3 - Matuail sanitary landfill

Source: Dr Tariq Bin Yousuf, SWM Department, Dhaka City Corporation

It is unfortunately common to see sanitary landfills becoming (or reverting back to) open dumping sites due to the lack of skills and funds to operate, maintain and finance the improved systems. Jam Chakro is a large international donor-funded landfill site in Karachi, which, when opened in 1996, was intended to be carefully managed by the Karachi municipal authorities. However, within weeks of opening it was overtaken by informal-sector waste workers. Their waste sorting and recycling work, which involves burning waste, has been responsible for serious environmental degradation and poor waste management (Rouse, 2006).

The first steps for phasing out uncontrolled disposal practices include:

- Identifying a designated site for solid waste disposal;
- Preparing the site;
- Developing an operating plan;

[3] See the following link for pictures of the dumping site: http://jessicamudditt.com/2011/02/04/dhakas-largest-waste-site-photographs-of-matuail-landfill/

- Training staff at the site;
- Procuring operating equipment;
- Ensuring a reliable and regular system for the transport of waste to the designated disposal site; and
- Recording all waste disposed at the site by registering and weighing. Methods to incentivise this include, for example, the provision of showers for drivers at the landfill site and the provision of trucks with global positioning system (GPS) devices.

2.5 Healthcare waste

What is healthcare waste?

The term healthcare waste (HCW) includes all the waste generated within healthcare facilities, research centres and laboratories related to medical procedures. In addition, it includes waste originating from healthcare at home (Chartier et al., 2014). Between 75% and 90% of the waste produced by healthcare facilities is non-hazardous general waste, generated mostly from administrative, kitchen and housekeeping activities at healthcare facilities. It includes packaging and waste generated during maintenance of healthcare buildings. The remaining 10–25% of healthcare waste is regarded as hazardous and may pose a variety of environmental and health risks (see Box 2.4) and requires careful management. Healthcare waste is sub-categorised as sharps, infectious waste, pathological waste, pharmaceutical waste, hazardous chemical waste, radioactive waste and non-hazardous general waste (Chartier et al., 2014).

How is HCW managed?

In developing countries, hazardous HCW (HHCW) rarely receives attention; rather, it is handled as part of the municipal waste stream (Appleton and Ali, 2000). Disposing of HHCW is often left to the individual healthcare facility, which may have neither the budget nor the capacity to manage it properly.

Limited low-cost technology options are available for the treatment of HHCW in low-income countries. Incineration is one of the most common options, ranging from extremely sophisticated, high-temperature operating plants to very basic combustion units, frequently used in LICs (Chartier et al., 2014). Other processes often adopted in LICs include autoclaving, chemical processes and containment processes (i.e. safe burial inside premises of healthcare facilities or encapsulation and landfilling in municipal disposal sites) (WHO and IT Power, 2005).

Only the hazardous fraction of healthcare waste (10–25%), HHCW, needs special treatment. Measures should first be followed to minimise and reuse waste items where it is safe to do so. Autoclaving is used for sterilising reusable sharps (Chartier et al., 2014). Unusable waste material should preferably be treated to reduce the volume and the potential health and environmental impact during subsequent transport and disposal. Final disposal should be in a suitably constructed and controlled site (Chartier et al., 2014).

The effective management of HCW requires a thorough understanding of the quantity and composition of waste produced, and an efficient and cost-effective strategy for managing it. If segregation of hazardous and non-hazardous categories is not conducted at source, the whole stream will have to be managed as if it is hazardous and will require more complex and more expensive technologies for transport and disposal.

Box 2.5 - What are the risks associated with a poor management of HCW

Very little evidence is available on the health impacts of exposure to healthcare waste, particularly in the case of developing countries (Chartier et al., 2014). Healthcare workers and waste handlers are the first to be exposed to the risk from poorly managed healthcare waste, but patients and visitors at healthcare facilities can be at significant risk as well. It is estimated that more than two million healthcare workers are exposed to percutaneous injuries with infected sharps every year and those might lead to contracting hepatitis and HIV infections (Prüss-Üstün et al., 2005). In the year 2000, sharps injuries to healthcare workers were estimated to have caused about 66,000 hepatitis B, 16,000 hepatitis C, and between 200 and 5,000 HIV infections among healthcare workers (Prüss-Ustun et al., 2005). Scavengers on waste disposal sites are also at significant risk from used sharps (although these risks are not well documented) (Chartier et al., 2014).

SECTION 3

The potential contribution of improved solid waste management to international development goals

This section looks at the impact of poor SWM and how addressing it can contribute to the agreed international development agenda. It considers the impact the Millennium Development Goals (MDGs) have had on improving SWM practices and the role of SWM in the Sustainable Development Goals (SDGs). It also considers the role of SWM in crosscutting issues and agendas, and identifies potential entry points for improving SWM systems. Overall, this section explains the importance of improved solid waste management to achieve development goals.

3.1 Improved SWM and its contribution to international development

Each day, an estimated 1.3 billion tonnes of waste globally are disposed of in close proximity to households, creating a significant risk to public health from contaminated water supplies, vector-borne diseases and other hazards. In urban environments, where waste collection has received attention and has improved, waste is often disposed of outside city limits with no further treatment or control. This exacerbates environmental and public health risks by contaminating soil and water sources, and by air pollution caused by smoke from waste burning and contaminated dust. Poor waste management systems are also evidence of weak governance, as they demonstrate the inability of local governments to provide basic services (UNEP, 2015).

Despite the potential contribution of improved solid waste management to the development agenda, it did not feature explicitly in the Millennium Development Goals (MDGs). As a crosscutting sector, improving solid waste management is relevant to key development priorities, including health, employment and the environment. Table 3.1 summarises the contribution that improved solid waste management made to the MDGs (Gonzenbach and Coad, 2007).

Table 3.1 – Contribution of improved solid waste management to the Millennium Development Goals

Millennium Development Goals	Contribution of solid waste management
Goal 1. Eradicate extreme poverty and hunger	Provided employment opportunities for the poorest
Goal 2. Achieve universal primary education	Provided opportunities to deliver education for thousands of children involved waste picking
Goal 3. Promote gender equality and empower women	Provided opportunities to strengthen the role played by women
Goal 4. Reduce child mortality	Improved working conditions for mothers

Millennium Development Goals	Contribution of solid waste management
Goal 5. Improved maternal health	Reduced exposure of pregnant women to chemicals in hazardous waste in the community and in the waste sector
Goal 6. Combat HIV/AIDS, malaria and other disease	Segregated hazardous healthcare waste, eliminated breeding sites for disease vectors
Goal 7. Ensure environmental sustainability	Reduced waste generation, improved efficiency in collecting, handling and disposing of waste, reduced greenhouse gas (GHG) emissions, improved urban environment
Goal 8. Develop global partnership for development	Promoted partnerships for technology transfer and enhanced fair and decent work ethics

Source: Adapted and summarised from Gonzenbach and Coad (2007)

Improved solid waste management had a strong contribution to Goals 5 and 6, while it also contributed to other Goals. There is no systematic study available to bring this evidence together.

The United Nations SDGs, which were agreed in 2015, included GOAL 11, Target 6 which states:

'By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.'

In addition to this target, improved solid waste management has the potential to contribute to a further 40 SDG Targets. A summary of the potential contribution of improved solid waste management to SDG Goals and Targets is presented in Table 3.2, based on a detailed analysis, which is included Annex 1.

Table 3.2 – Contribution of improved solid waste management to relevant Sustainable Development Goals

SDG Goal	Description	Potential contribution of solid waste management
1	End poverty in all its forms everywhere	Improved SWM for small and medium towns and slum areas, where the majority of poor people live without basic services, can provide employment and income-generation opportunities.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Sustainable composting projects have the potential to contribute to improving food production and to increasing the area of land available for agriculture by minimising uncontrolled dumping of waste.
3	Ensure healthy lives and promote well-being for all at all ages	Improved SWM can reduce the localised dumping of waste in urban and rural environments, improving the environment for all (High Potential).
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Improved SWM can reduce the number of school-age children involved in waste picking and collection enabling them to go to school.

SDG Goal	Description	Potential contribution of solid waste management
5	Achieve gender equality and empower all women and girls	Improved SWM can improve working conditions for women in the waste sector, giving them a greater voice and ownership of work and income.
6	Ensure availability and sustainable management of water and sanitation for all	Improved disposal to reduce the uncontrolled disposal of waste in watercourses reduces pollution and contamination of surface water and groundwater resources (High Potential).
7	Ensure access to affordable, reliable, sustainable and modern energy for all	Improved SWM can provide energy-generation opportunities, including landfill gas.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Improved SWM can be used to support improved working conditions of waste workers and access to education and human rights.
9	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation	Allow opportunities for introduction of new technologies for waste recycling, minimisation and reduction.
10	Reduce inequality within and among countries	It can promote sector regulation and equitable service provision in low-income communities.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	It can be used to enhance services for low-income areas and improve waste disposal practices, eliminating waste burning and promoting recycling (High Potential).
12	Ensure sustainable consumption and production patterns	Improved SWM can be used to promote projects focused on waste minimisation, reduction, recycling and safe disposal.
13	Take urgent action to combat climate change and its impacts	Waste reduction, recycling and reuse, in combination with improved transportation and disposal in controlled landfill sites, can reduce greenhouse gas emissions.
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Improved SWM can be used to reduce waste, especially plastics, dumped in watercourses, reducing waste concentrations in the world's oceans.
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Improved SWM can be used to improve working conditions and access to human rights for waste workers, and improve sector accountability and transparency in a sector considered to be one of the most corrupt in developing countries.

SDG Goal	Description	Potential contribution of solid waste management
17	Strengthen the means of implementation and revitalise the global partnership for sustainable development	It can be used to promote knowledge exchange, research and training between countries.

Source: Compiled by the authors based on the UN Sustainable Development Goals

Improved solid waste management will make a contribution to 17 SDGs. It will contribute strongly to Goals 3, 6, 11 and 12, and it will make an indirect contribution to other goals, depending on the context, policies and practice. The global focus will be on improved collection services and elimination of open dumping by 2020, followed by more concrete efforts to reduce, recycle and reuse waste by 2030. An overall policy shift from a linear economy to a circular economy is required to achieve high impact on the SDGs through the pathway of improved solid waste management (Wilson, 2016).

3.2 Improved SWM, public health and a cleaner living environment

Introduction

Poor solid waste management is a risk to public health (Hardoy, Satterthwaite and Cairncross, 1990). There is significant evidence available that demonstrates how poor storage, collection and disposal practices create health risks (Flintoff, 1984; Satterthwaite 2015). Health benefits from improved solid waste management can make an important contribution to achieving SDGs 1 and 3. This section explains the importance of improved solid waste to protecting public health and to maintaining a cleaner living environment for citizens.

Health risks of poor solid waste management

Exposed solid waste can be a breeding ground for rats, flies and cockroaches. All these disease vectors have a significant role in the spread of a number of communicable diseases, including cholera, typhoid and plague. UN-Habitat (2010) reports that the incidence of diarrhoea among children living in households where waste is disposed of in close vicinity to the household is twice as high as the incidence in households where waste is collected regularly. Waste also holds standing water, providing a breeding medium for mosquitoes, leading to the spread of diseases such as malaria, dengue fever and Zika. Malaria is common in many cities and dengue fever is endemic in more than 100 cities around the world (Satterthwaite, 2015). In settlements where adequate sanitation is not available, faecal matter and urine may also be mixed with municipal waste; this can create a high risk for people living in near to waste accumulations and for waste workers. Uncollected waste is also often disposed of in drains and on flood plains, which can be a major cause of floods during rainy seasons, especially in in urban areas in developing countries, exposing people to contaminated water.

Uncontrolled disposal sites in developing countries pose a number of environmental and human health risks. The risks are mainly from the burning of waste, dust blown from disposal sites and large quantities of leachate seeping into the environment, impacting on sources of drinking water, land for crop production and water bodies for aquaculture. The 50 largest uncontrolled disposal sites in the world are located in developing countries in Asia, Africa and Latin America (UNEP, 2015). Of these, 20 also receive hazardous waste, of which 7 receive electronic waste. There is an estimated population of 0.83 million living within 10 kilometres of these sites, which are estimated to have received 2.5 million tonnes of waste over the last 17 years.

Population at risk

In 1994, in Surat, India, an outbreak of the plague killed 56 people, with a total of 693 cases identified and an estimated US$1 billion lost in trade (Furedy, 1995). Communities living close to waste disposal sites and those working on the sites are at a higher risk of poor health due to increased exposure, as are communities living in areas where waste collection services are poor. These affected people are also most likely to have low incomes. Women and children are at disproportionally higher risk from exposed waste due to socially ascribed roles and increased exposure, as discussed in Section 3.7.

Waste workers and waste pickers are particularly exposed to serious health hazards due to their direct contact with waste, including cuts and infection from sharps, broken glass, etc. and inhalation of hazardous smoke from waste burning - an issue that also affects nearby communities.

Opportunities from improved solid waste management

Improved solid waste management is fundamental to the protection of public health, but it unfortunately receives little attention, except during and/or after disease epidemics. For example, there were many positive initiatives aimed at improving waste management practices after the Ebola outbreak in West Africa in 2014-15, which killed more than 7,000 people (Perella, 2015). Public opinion plays a key role in improving waste management. Research in the UK suggests that there were significant changes to the way healthcare waste was managed after the public observed waste on beaches and the media started reporting it. This is not an ideal method for triggering changes, but it is a reality for this neglected sector. However, it is important to use disease outbreaks as a driver to initiate and sustain changes, to develop response systems and to invest in improved solid waste management. A recent donor-funded project in Lusaka, Zambia, used the outbreak of cholera in urban and peri-urban low-income communities to extend waste collection services to affected unserved areas. It was reported by Wilson (2007) that this intervention led to the elimination of cholera in the area.

3.3 Improved SWM and the natural environment

Waste, and in particular plastic waste[4], significantly contributes to the pollution of oceans, seas and other sensitive habitats. Improvements in the management of solid waste could therefore contribute to achieving SDG 15.

Impacts of SWM on the environment

The so-called 'Great Pacific Garbage Patch'[5] is an area of waste covering more than 600,000 square kilometres (km^2) in the North Pacific Ocean (see Figure 3.1). Four-fifths (80%) of that waste actually comes from land-based activities, while the remaining two-fifths (20%) comes from cargo ships, boats and offshore oil rigs (National Geographic, 2015).

[4] Plastics make up the majority of marine debris because of their wide use and due to the fact that they do not biodegrade, but break into small pieces.

[5] The video at the link below shows the formation of the Great Pacific Garbage Patch: http://www.greenpeace.org/international/en/campaigns/oceans/fit-for-the-future/pollution/trash-vortex/

Figure 3.1 – An image of the Great Pacific Garbage Patch (National Geographic, 2015)

Microplastics (small pieces of plastic waste) are the main component of the vortex. Around 10% of current yearly production of plastics are estimated to enter the sea, though there is no agreement on the actual quantities (UNEP, 2015). The main impact of this plastic is on marine fauna, which can become entangled in it or ingest it. Entanglement can lead to the death of sea turtles, cetaceans, pinniped species and invertebrate taxa; UNEP (2015) found that 200 species were affected by entanglement in 2014. Ingestion leads to a series of problems for seabirds, fish and even zooplankton, including physical harm and bioaccumulation of organic chemical compounds[6]. In 2006, 70% of dead marine turtles in the Egyptian Red Sea were likely to have died as a result of ingesting plastics (HEPCA, 2015). The capital cost of the impact of plastics on marine ecosystems is estimated to be at least US$13 billion a year (UNEP, 2015). Other sensitive natural habitats, such as wetlands, coastal environments and mountains, are also impacted by poor management of solid waste.

[6] Some organic chemical compounds, such as phthalates, bisphenol A and polybrominated diphenyls function as endocrine disruptors (i.e. they interfere with the body's endocrine system and produce adverse development, reproductive, neurological and immune effects). Bioaccumulation is the accumulation of a substance in various tissues of an organism.

Box 3.1 - Banning plastic bags: experiences from developing countries (adapted from UNEP, 2015)

Bans on plastic bags have had varying degrees of success in developing countries. In some cases, bans are difficult to enforce on powerful industries or retailers. In other cases, even when the authorities are committed to enforcing a ban, like in Rwanda, implementation remains problematic as adequate alternative packaging is often lacking. This has led to smuggling of bags from abroad and continued use. Examples of states that have banned plastic bags include: Bangladesh, which banned thin[1] plastic bags in 2002; Mumbai and the entire state of Maharastra in India, which banned the manufacture, sale and use of thin plastic bags in 2005; the state of Kerala, which banned plastic bags under 20µm thickness in 2003 and has been very active in enforcing the regulation; and Kenya, Mauritania and Rwanda, which have banned plastic bags of specified thicknesses.

Ireland is an example of where a combination of a levy introduced in 2003 and intensive and sustained public awareness campaigns resulted in an impressive 94% reduction in the use of plastic bags over a very short period. In the UK the 5p levy, which has recently been introduced on plastic bags, is expected to create a £70 million windfall for the support of environmental charities (The Guardian, 2015).

[1] Thin plastic bags cannot be reused, can be ingested by animals (even leading to their death) and degrade more easily to microplastic.

How can the impact be reduced?

The impact of plastic waste on the environment can be reduced through interventions aimed at increasing recycling and improving waste collection and disposal, including:

- In the production chain, interventions could extend producer responsibility and the redesign of plastic items;
- In terms of behavioural change, interventions could aim to reduce littering. Clean-up campaigns are good for raising awareness, but they are costly and not a long-term solution;
- Interventions at policy level, such as banning plastic bags, have had mixed results in developing countries (see Box 3.1);
- Identification of sources and routes of used plastics into the sea or other sensitive environments. This can help in understanding of the impact of tourism, or industries that generate plastic waste, on the natural environment. This, however, is outside the scope of this Topic Guide.

3.4 Improved SWM and urbanisation

Introduction

Demand for improved solid waste services is higher in urban areas than in rural areas (Wilson, 2007) as volumes are higher and more concentrated, and uncollected waste is easily visible (Shanghai Manual, 2012). The high population density of urban environments exacerbates the health risks from uncollected and exposed waste. Hence improved solid waste management is a high priority for many citizens and city administrations. This section

considers the impact of urbanisation on solid waste and the implications if improved SWM is not championed and introduced. It considers current thinking on urbanisation, and the challenges and the opportunities. Improved solid waste management in urban areas makes a direct contribution to UN SDG Goal 11, *'Make cities and human settlements inclusive, safe, resilient and sustainable'*.

Improved solid waste management and urbanisation

Approximately 54% of the global population – 3.9 billion people – live in urban areas, of which 2.7 billion live in developing countries (Satterthwaite, 2015). The trend of greater urbanisation will continue, with 66% of the world population expected to be living in urban areas by 2050. Nearly half of the world's urban population of 3.9 billion, live in settlements of less than 500,000 inhabitants. However, urbanisation is also seen in the increase in the number of mega-cities. In 1990, there were ten "mega-cities" with 10 million inhabitants or more. By 2014, there were 28 mega-cities worldwide, home to 453 million people or about 12% of the world's urban dwellers, with 16 located in Asia, 4 in Latin America, 3 each in Africa and Europe, and 2 in North America. By 2030, the world is projected to have 41 mega-cities with 10 million inhabitants or more (UNDESA, 2014). Providing solid waste services to the urbanising world is one of the most important challenges faced today.

A well-managed city provides a clean environment for its citizens. This is necessary to protect public health. Improved solid waste management is a high priority of urban citizens, as uncollected waste is exposed and attracts attention. Due to the high densities of city populations, the exposure of waste increases the risk of the spread of vector-borne diseases by flies, rats and cockroaches. Waste ending up in drains is considered to be a major cause of urban floods (Satterthwaite, 2015).

An estimated 900 million people live in informal settlements or slum areas around cities. This represents 33% of the urban population in developing countries. In African cities, an average 70% of the urban population live in informal settlements (Satterthwaite, 2015). Most slum areas lack adequate services, such as water, sanitation and a waste collection service. Solid waste is often disposed of in drains and open spaces, causing flooding and standing water, which is a major cause of water-related diseases, including malaria, dengue fever, typhoid and other diarrheal diseases. The majority of slum dwellers do not receive waste collection services due to the following reasons:

- The legal status of the slums and land is often unclear;
- City governments may not have systems for taxing slum dwellers or charging municipal fees;
- The physical characteristics of urban slums, especially narrow streets, do not allow access for municipal waste collection services, which typically rely on vehicles; and
- Slum dwellers are often not organised to enable them to demand essential services.

An improved waste management system can improve the image of a city, helping to attract investment, and can offer a healthier living environment. This objective is the focus of SDG Target 11.6**.**

3.5 Improved SWM and climate change

The solid waste and wastewater sectors produce between 3% and 5% of total greenhouse gas (GHG) emissions. The waste sector is in a unique position to move from being a minor source of global emissions to becoming a major reducer of emissions. Global emissions could be cut by 15% to 20% by interventions in the solid waste management sector (UNEP, 2015), significantly contributing to SDG 13.

Contribution of SWM to climate change

Total GHG emissions from SWM in developing countries were considered likely to grow by 84% by 2025 compared to the early 2000s (Cointreau, 2006). The largest source of GHG

emissions from the SWM sector is methane[7] from landfill disposal (Bogner et al., 2007). Carbon dioxide emissions from the incineration of waste such as plastic and synthetic textiles, and transportation of waste is the second largest source of GHG, but this is minor in comparison with methane from landfill. (Bogner et al., 2007). Open burning also contributes to GHG emissions, but data on this aspect are not collected (UNEP, 2015).

Box 3.2 - Climate impact of the informal sector in India

A recent report on the climate impact of the informal waste management sector in India estimates that activities in Delhi alone equate to savings of around 962,000 tonnes CO_2e[8] a year (Chintan, 2009). This figure was calculated based on the recovery of paper, plastics, metals and glass and is likely to be an underestimate of potential savings, due to the model adopted. The report compares the GHG savings attributed to the informal recycling sector in India with the estimated GHG reductions anticipated from several waste-to-energy projects and a composting plant currently registered as Clean Development Mechanism (CDM) projects (see Box 3.3) (Chintan, 2009). While recycling by the informal sector could save 962,133 tonnes CO_2e per year, the waste-to-energy and composting plants are estimated to save only 262,791 and 33,461 tonnes CO_2e a year respectively. This comparison is very relevant as waste-to-energy projects often conflict with the informal sector, limiting waste pickers' access to recyclable materials and constraining their livelihoods (Chintan, 2009).

Source: UNEP, 2010

How can the impacts of SWM on climate change be mitigated?

A 10% to 15% reduction in global GHG emissions could be achieved through interventions in the collection, recycling and disposal of waste. This reduction could increase to 15% to 20% by including waste prevention. Potential interventions that have already been applied in developing countries include:

- Recovery of landfill gas, though this process is expensive and can be difficult to operate in developing countries;
- Reduction in the quantity of putrescible waste disposed of in landfill sites, for example by promoting composting and anaerobic digestion;
- Recycling and using secondary materials in industrial production, which reduces GHG emissions by reducing direct energy consumption in the production process and by avoiding extracting, processing and transporting primary raw materials. This includes also recycling by the informal sector (see below); and
- Waste minimisation, which far outweighs the benefits of any recycling process.

[7] Methane has a much higher climate warming potential than carbon dioxide.

[8] CO_2e = Carbon dioxide equivalent

Box 3.3 - Clean Development Mechanism (CDM)

The CDM of the Kyoto Protocol, which expired at the end of 2015, was a funding mechanism which incentivised developing countries to reduce GHG emissions (Bogner et al., 2007). Carbon credits, which could be counted towards buyers' GHG reduction obligations, were traded on the market and monitored, verified and registered on the UN registry. Energy recovery from landfill gas has been widely implemented in developing countries through the CDM. Because the carbon credits were directly linked to greenhouse gas emission reductions actually achieved and verified, there was a direct financial incentive for cities to operate their donor-funded sanitary landfills as designed. The annual carbon credits provided a revenue stream to pay for both operations and the interest charges on the capital the following year. For this reason, CDM was actively promoted by a number of international financial institutions as an early form of 'output-based financing' (UNEP, 2015). The CDM has also provided funds for the development of plants for anaerobic digestion and composting, for example in Bangladesh (UNEP, 2015).

3.6 Improved SWM, citizens' participation and good governance

Introduction

Poor solid waste management is an indicator of dysfunctional local government. Piles of waste, waste blocking drains, waste trucks that are out of operation and indiscriminate dumping of waste outside the city as final disposal indicate dysfunctional local government. Many cities in developing countries, and especially low-income areas within those cities, have visible signs of poor waste management (Ahmed and Ali, 2004). This section discusses the importance of citizens' participation and good governance in improved solid waste management, especially the potential contribution of improved solid waste management to good governance.

Citizens' participation

Current waste management systems in countries around the world are the product of a gradual learning process starting from problem recognition. This often begins as a result of a crisis, with the systems taking shape through the formulation of policy and translation into legislation, accompanied by the development of physical infrastructure and facilities to tackle the waste problem (UNEP, 2015). Strategic ways of progressing from planning to implementation, with the participation of citizens and other stakeholders, are not common. On the other hand, solid waste operations rely significantly on the participation of citizens, even in places where the service is better organised. Citizens' participation is required in the following areas, though their involvement is not restricted to these:

- Maintaining a waste bin inside the house;
- Handing over waste to a collection service or taking it to a collection point;
- Separation of waste before disposal; and
- Waste-conscious behaviour to generate less waste (for instance through responsible shopping), reuse and recycling.

Citizens are quick to react if the waste collection system is poor and appreciate improvements. News media are quick to include photos of waste piles, if readers are likely to react. Overall, improved solid waste management provides an important opportunity to develop positive relationships between citizens and local governments, leading to other outcomes such as

improved taxation, accountability and accountable local governance systems. For example, in Dhaka, Bangladesh, and Ciudad Sandino, Nicaragua, positive outcomes have been achieved through the involvement of community groups by municipal corporations (Olley, 2007 and Yousuf, 2007).

Citizen initiatives

When local government fails to provide a satisfactory service, citizens may decide to take initiatives to address the gap in services. There are many examples of community-based organisations (CBOs) that have been formed to supplement poor services provided by official or government agencies. Local organisations may collectively hire waste collectors or make arrangements with local politicians for waste transfer points. They may also encourage citizens to recycle more. These organisations have a stronger voice than individuals, and are able to negotiate further improvement with local governments. Collective action puts pressure on politicians and can bring about improvements more effectively. By creating a feeling of unity among citizens and empowering them, improvements in the provision of solid waste management services can also be associated with other community issues, leading for instance to more accountability and less corruption. CBOs are often constrained by the lack of finance and continuous political support. Many, perhaps most, of the community-based self-help projects are initiated by women. The case of the Karachi Administration Women Welfare Society (KAWWS) illustrates how upper-income women took the initiative of organising a collection service in their neighbourhood (WEDC, undated).

In some cases, citizens also organise to address city wide challenges, such as the Supreme Court Action in India, which started because of collective action by citizens' groups (Da Zhu et al., 2008). In Asia, community groups have taken legal action against municipal governments to address inadequate service provision and there have been instances where courts of justice have ruled in favour of citizens. Similarly, there are examples of *Suo Motu* action in cities in India and Pakistan, which has led to the development of solid waste guidelines in India, known as Supreme Court Guidelines (Da Zhu et. al., 2008). Even though not implemented in all the states, these guidelines provide a strong basis for citizens, civil society organisations and media to demand improvement in service provision (Satyamev, 2014). With the increase in television channels and popularity of social media, citizens receive news within a very short time. The waste-related news is sometimes about improved SWM services in the city.

Box 3.4 - Clean Development Mechanism (CDM)

In 2000, more than 130 local CBOs (also known as local initiatives) were operating in Dhaka, addressing solid waste management issues and covering 15% of the population. The number of CBOs has grown since then and Dhaka City Corporation (DCC) has started a system to encourage and support CBOs. Most of the CBOs used their own funds to invest in equipment and made a surplus from collection fees to pay for maintenance. A similar model was adopted by CARWAN, a women-initiated CBO in Faisalabad, Pakistan. This initiative was supported by the DFID-funded Faisalabad Area Upgrading Project.

Source; WEDC Synthesis Note on 'The Role of Community-based organisations in solid waste management (2000) and personal communication with the staff of Dhaka City Corporation (2012).

Citizens' complaints

Despite the potential of improved solid waste management to build relationships between citizens and local governments, the sector has not been used strategically to improve governance. In the absence of adequate services, citizens are often unaware of complaint

procedures. In some cases, decisions are made not to complain due to a lack of confidence in achieving positive change. A complaints system has the potential to raise awareness of and address citizens' needs, and can be further used to develop appreciation and understanding of the waste management system. Listening to citizens' complaints and addressing them is an important component of good governance. Improved solid waste management, therefore, provides an opportunity for improving city governance. This could then turn into a number of positive outcomes, including providing a tax base for the city.

3.7 Improved SWM and vulnerable groups

Introduction

This section considers the role of vulnerable groups in SWM, looking at key vulnerabilities and specific concerns that need to be addressed. Consideration of the role of vulnerable groups includes issues of gender, age and disability, and recognition of the important contribution improved solid waste management could make to SDG Goals 5 and 10, which are concerned with equality.

This section explains the typical role women, girls and other vulnerable groups play in solid waste management. It highlights the areas in which care is needed while making changes and it suggests how an enhanced role by vulnerable groups could improve the effectiveness of solid waste management. It is important that any improvements in solid waste management deliver equitable positive impacts for all groups, including vulnerable groups. There is little evidence available on the impact of solid waste management on less able persons and elders. The chapter therefore focuses on women and girls, looking at their role in decision-making and waste-related work.

Women and girls as decision-makers

Improved solid waste management requires that citizens make the right choices in consumption and waste handling. These choices reflect the overall behaviour of the society. At the household level, women make important decisions which have a knock-on impact on the quantity and composition of solid waste that needs to be managed at a city level. They make decisions about what to purchase, how much to cook or prepare, and how to dispose of waste and surplus. These decisions include what to buy, when and where; in this respect there is an opportunity to influence purchasing, promoting options such as low-waste products, recyclable materials, less packaging etc. If the majority of women have an understanding of the environmental impact of their decisions, then there is the potential to significantly reduce the quantity of waste at a city level. This understanding has led to programmes that are often directed at women and are designed to raise awareness of waste impacts. The role of women as decision-makers in the purchasing of food and household goods is important, but their role should not be restricted to the household only.

In solid waste management, women, girls and children have socially ascribed roles and responsibilities. This includes the distribution of work between males and females. Effective interventions in improving SWM could change these roles from one generation to the next. For example, women and men assign different values to improved solid waste management and they may have different solutions in mind when considering what improved systems may look like. In solid waste management practice, there are tasks conventionally performed by women. For instance, women often segregate waste at home. In some countries, they may keep waste that has value and sell it to waste buyers (Ali, 1996). Prices are negotiated and, for the seller, this income may represent an independent income, which they are able to keep and use according to their own priorities. Promoting initiatives such as this could enhance gender equality and could provide an important incentive to segregate waste in cultures where women do not have a share in, or control over, household income. In developing programme interventions, it is important to recognise the roles which women and girls could play towards

improving solid waste management and to consider how to use this potential when planning and designing waste systems at city level.

Work of women and girls

Women and girls play important roles in all the stages of solid waste management, as identified and discussed in the WEDC Framework of Gender Division of Labour (GDL) (WEDC, undated). The roles of women and girls in solid waste management are summarised in Figure 3.2 and include: purchasing food for the household, paid and unpaid work related to waste, other income-generation activities, and involvement in social organisations and collective action. It is important to recognise that these roles are culture-specific and could change with time. For example, a working daughter may expect better support from other members of her family on waste segregation and recycling as compared to her mother.

Solid waste collection systems in many countries are not mechanised and rely on unskilled workers. Four-fifths (80%) of waste pickers in India and more than half (50%) the street sweepers in many Asian cities are women (WIEGO, 2015). These women are typically from the poorest communities and possibly of underprivileged ethnicity. As waste systems are modernised and mechanical systems are introduced, these women are likely to be impacted by a loss of jobs and independent revenue streams. As many of these jobs are in the informal sector, there will, most probably, be no social security net for them. Therefore, any attempt to introduce mechanisation or to reduce the labour force should be preceded by a gender impact analysis and ensure suitable alternative livelihoods. In countries where waste picking is common, a large proportion of waste pickers are girls and children. As such, improvements in the working conditions of waste pickers could bring much-needed benefits to women and girls**.** Figure 3.2 explains the activities in waste systems in Asian cities which have a substantial participation of women, and their dependency on male-dominated roles.

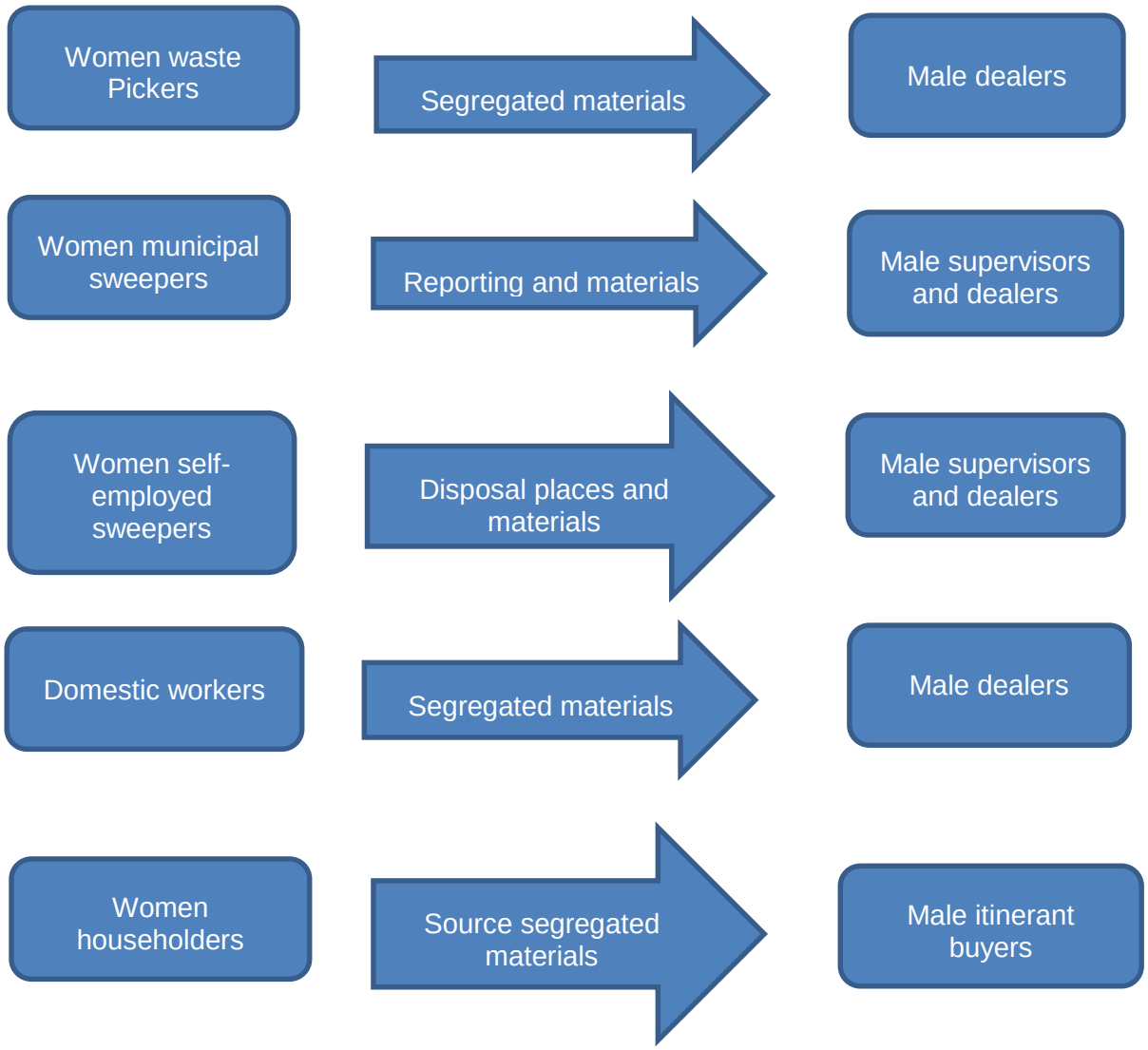

Figure 3.2 – Role of women and girls in solid waste management

Improved solid waste management

Women and girls play important roles in solid waste management systems. Any improvements must carefully consider and develop a strong understanding of these roles if effective strategies are to be developed and implemented without a disproportionate negative impact on women. Efforts should be made to understand existing good examples of primary collection systems managed by women's groups and to consider how to integrate these into plans for improved solid waste management. For instance, if the majority of women segregate waste in order to generate income, then it is important to develop recycling programmes that build on this practice. It is also important to plan carefully the transition to improved solid waste management systems, so that any adverse impact on women, girls and other vulnerable groups can be mitigated. Positive features that could be incorporated include initiatives such as charging fees, introducing simple technologies and providing access to low-income areas.

3.8 Improved SWM and livelihoods

Introduction

Waste, and work related to managing waste, are an important source of income and employment for the poor. Improving solid waste management can offer a means for enhancing the quality of jobs for those working in the sector. It can also be used to promote investment in and expansion of local businesses, thus creating further employment opportunities. An estimated 2–5% of the urban work force is involved in the waste sector (WIEGO, 2015; Cointreau, 2006). Most of these jobs are poorly paid and provide limited opportunities for developing the skills and education necessary for other work. Furthermore, many municipalities see themselves as responsible for waste collection and transportation and often do not encourage the development of informal waste services, and hence livelihoods, to cover areas where no service is currently provided. This section discusses the potential of improved solid waste management to enhance livelihoods, along with the roles played by key stakeholders and the challenges and opportunities.

Waste services and livelihoods

Improved solid waste management has the potential to enhance jobs and to provide the poor with additional income. In the formal waste sector, many of the municipal jobs, including collection services, recycling and separation of waste, already provide employment for people on low incomes. City municipalities in developing countries often employ a large number of workers to sweep the streets and keep up-market areas, commercial districts and key roads free from waste. A large proportion of these workers may be female; in the city of Karachi, Pakistan, which has a population of 16 million, there are approximately 18,000 sweepers, of whom 55% are female. These sweepers are provided with basic equipment and safety gear and often work in dangerous conditions on the sides of busy roads.

Municipal services often do not extend primary collection services into low-income areas. This service gap in waste collection is typically filled by self-employed informal waste collectors, who enter into verbal contracts with households and provide waste collection services. There is evidence (Ali, 1996) to suggest that, in Asia, these sweepers enter into informal agreements with households and shopkeepers to collect waste and dispose of it, bolstering their formal income. In large cities, this is an important source of livelihoods for the poor (Ali and Cotton, 2001). Most of the peripheral areas of the city and some inner parts are served by these groups. In Dhaka, more than 200 local enterprises collect waste from households and the city corporation has now started a system of licensing them (Personal Communication with the staff of Dhaka City Corporation, 2010).

In many cities of Asia, Latin America and Africa, households segregate valuable items from waste and store them for later sale, with established prices for different types of waste (Ali, 1996). The segregation is typically carried out by the women of the household, either housewives or elderly female members, and provides an important source of income (Beall, 1997a). In high-income groups, this segregation is carried out by domestic help, who prefer to take waste of value away and sell it. In addition to routine segregation, anything of value, such as old furniture and electrical equipment is sold on. This practice provides raw material for the recycling industry or, after repair or reconditioning, affordable goods for the poor, minimising the volume of waste sent to landfill. The habit of waste segregation and the tendency to see waste as a commodity are positive attitudes and should be used to improve the sector. These informal systems should be protected; often efforts to modernise may undermine them. For example, the introduction of large waste collection vehicles may encourage a habit of disposing of large and bulky items through the municipal system, cutting off reuse or recycling and impacting on informal waste sellers and buyers.

Beyond the primary collection stage, waste has less value as the most valuable items will have already been segregated. Even so, this waste is sorted at secondary collection points by pickers and any remaining re-saleable components segregated. These materials are traded through a separate chain of dealers and recyclers, different from those who deal in material derived from household recycling. A similar process takes place at the final disposal site (Rouse, 2006). In cities, where the climate is dry, waste is regularly burnt to separate out

metals. Waste is also burnt to bake clay tiles and pots; waste is bought from collection trucks before they go to the disposal site and used to fill depressions containing the clay products that are to be baked. While this practice is particularly damaging to the environment and human health from toxic smoke released from poorly burnt waste, it is a source of income that needs to be considered when looking at options to improve solid waste management systems. Waste picking at disposal sites, especially where waste includes healthcare waste, is considered hazardous. In a number of countries, there are initiatives to stop waste picking at final disposal sites. In other places, this work has been regulated and made safer, through education and health awareness. For example, Chintan, a civil society organisation in India (http://www.chintan-india.org/) regularly negotiates better conditions for waste pickers with the local authorities.

Reducing risks and protecting jobs

There are potential risks and hazards associated with some of the practices of waste segregation, reuse and recycling. Mixed waste could contain pharmaceutical and infectious waste and sharps, which could pose serious risks to waste pickers. Waste picking at the landfill sites may put informal workers in close proximity to heavy machinery, increasing the risk of accidents. Waste picking on unstable landfill sites has led to fatalities, caused by the collapse of waste cliffs. For example, in Payatas, more than 300 people, including waste pickers, died due to a landslide in a waste dump in July, 2000 (Koelsch, undated). Smoke and dust is a health risk faced by many waste pickers operating at disposal sites. If large numbers of children are involved in waste picking, concern is raised about their education, health and social care. It is important to analyse the risks and hazards of informal waste-related work, before proposals to integrate it are introduced.

Solid waste management departments usually operate under municipalities, which further report to ministries of local government or ministries of public health. While solid waste provides an important livelihood for the urban poor, governments often wish to restrict access by the informal sector. Municipal staff and consultants are not encouraged to think creatively to strengthen or formalise existing local initiatives and practices. Waste pickers are often harassed by the police and attempts made to prohibit their activities, without considering alternatives. There are also good examples of extending education and health services to pickers to gradually move them out of hazardous work. Some civil society organisations also provide safety gear to waste pickers. In case of Mutail Landfill, Dhaka (Private Communication, 2015), drivers of collection vehicles are given the incentives of a free wheel wash, free tea/coffee and shower facilities at the disposal sites; this has resulted in a larger number of trucks unloading at the official site.

3.9 Improved SWM and occupational health and safety

Between 2% and 5% of the urban workforce is involved in the waste sector (WIEGO, 2015). The majority has poor working conditions and is exposed to significant risks on a daily basis. Even the minimal regulatory framework that exists in most developing countries for occupational health and safety is often not enforced (Cointreau, 2006). Improving the working conditions of both formal and informal waste workers could contribute to SDG 4.

Occupational health and safety: waste workers

The most common health and injury issues for workers in the solid waste management sector and their potential causes are presented in Table 3.3.

In Mexico, the average life expectancy of waste workers is only 39 years compared to an average life expectancy of 69 years for the rest of the population (UN-Habitat, 2010). The relative risk of infections and parasites is three to six times higher for solid waste workers than for the control baseline populations, while acute diarrhoea occurs ten times more often (UN-Habitat, 2010). Pulmonary problems have an incidence 1.4 to 2.6 times higher for solid waste workers than for the control baseline populations. Headache, nausea and vomiting are

mentioned as other frequent effects (UN-Habitat, 2010). Brazilian waste collectors averaged 9.5 lost working days a year because of occupational accidents, 91% of which occurred among workers employed on a task or piece rate basis (Cointreau, 2006; Poulsen et al., 1995). Most health issues can be significantly reduced by improving the occupational conditions of waste workers, with the positive side-effect of also increasing awareness of occupational health in other sectors.

Table 3.3 - Most common health and injury issues for workers in the solid waste management sector (Adapted from Cointreau, 2006 and UN-Habitat, 2010)

Injury	Cause
Back and joint injuries	Lifting heavy waste-filled containers and pushing equipment
Respiratory illness (incidence 1.4 to 2.6 times higher than control population)	Inhaling particulates during waste collection; working in smoky and dusty conditions at open dumps
Infections (risk 3 to 6 times higher than for control population)	Direct contact with contaminated material, dog and rodent bites, or eating waste-fed animals
Puncture wounds (potentially leading to tetanus, hepatitis and HIV infections)	Injuries with infected sharps within premises of healthcare facilities, during transport to disposal sites or from broken glass or jagged metal at open dumping sites
Injuries at dumps	Surface subsidence, underground fire and landslides
Headaches and nausea	Anoxic conditions where disposal sites have high methane, carbon dioxide and carbon monoxide concentrations
Heavy metal poisoning	Burning of materials or items containing lead or other heavy metals, such as batteries, paints and soldered items

Occupational health and safety: waste pickers

The working environment of waste pickers is hazardous as it combines unhygienic conditions with a high risk of accidents. The overlap of living and working environments, and the lack of even minimal basic infrastructure for clean water and sanitation cause additional dangers. Young waste pickers, who represent a high proportion of waste pickers globally, are especially susceptible because of the greater vulnerability of children (Cointreau, 2006).

Tuberculosis, bronchitis, asthma, pneumonia, dysentery, parasites, malnutrition, skin infections and lesions, burning eyes and diminished vision are among the diseases frequently reported by informal collectors according to studies conducted in the Philippines and in India (Cointreau, 2006). In South Africa and Brazil, organising waste pickers and improving working conditions, for example by setting up picking zones (South Africa) and picking belts (Brazil), (Fergutz et al., 2011), significantly improve their health and general living conditions.

How can the health of workers and waste pickers be improved?

- Training and upgrading work arrangements can greatly improve the working conditions of both formal and informal workers;
- Providing water and sanitation facilities at places of work, including disposal sites, contributes to increased hygiene standards;

- Providing protective clothes, gloves, boots and masks, and delivering training on why to wear them, reduce the risk of diseases;
- Developing medical surveillance standards and protocols, including vaccination protocols, leads to an improvement in the health of workers and waste pickers;
- Developing training materials on occupational health, injuries and road safety can reduce the number of accidents; and
- Choosing collection and disposal equipment that minimises the contact between workers and waste also reduces health hazards, in particular when accompanied by improved management of healthcare and other hazardous waste. International development agencies that provide solid waste management machinery and facilities could specify relevant health and safety conditions for municipalities to meet, encouraging cities to give more attention to this issue.

SECTION 4

Improving solid waste management

This section proposes six strategic areas for improving solid waste management in developing countries, which could be adopted and promoted by international development organisations and donors. The strategic areas are selected according to their relevance to achieving the SDGs as well as their relevance to addressing the particular challenges and impacts considered in the previous sections.

Table 4.1 summarises the six proposed strategic areas and provides justifications for each.

Table 4.1 - Strategic areas for development focus

Strategic area	Justification
Drivers and political economy in the solid waste management sector	Citizens' perception of the performance of politicians can be influenced by the status of solid waste management within their communities. In addition, solid waste is one of the largest public employment sectors, providing livelihoods for large numbers of urban poor. Therefore, the sector has considerable impact on political economy, and so be an important driver for change. Traditionally, improved solid waste management was driven only by concerns for public health, and was justified by evidence of the impact of poor solid waste management on public health presented earlier. However, this focus solely on public health has not achieved expected improvements. Understanding the political economy of the sector in any particular location, along with the drivers for sector change, is important for developing successful interventions. Effective sector analysis and political economy studies can help make projects and investments relevant and effective.
Developing capacity in SWM	There is a critical need for SWM in rapidly expanding cities and for extension of services within small and medium towns, which often are not served. This will require the capacity of local institutions, the private sector and international development partners to be enhanced, with a focus on those service elements that are missing, including: ▪ Affordable solid waste services for low-income populations; ▪ Affordable technologies and systems, such as landfills, healthcare waste incinerators and transfer stations; ▪ Technologies and systems to increase recycling; and ▪ Technologies and systems to reduce carbon emissions and generate energy.
Investing in SWM	SWM has traditionally attracted low levels of investment. It is often not prioritised by national governments or international investment, leading to services that struggle to improve and are unable to meet the obligations defined by the Sustainable Development Goals. The

Strategic area	Justification
	solid waste sector needs to be developed to the point where it is seen as an attractive area for increased investment. This requires security in a pipeline of bankable projects and confidence in the return on investment. Donors have a role to play, providing preparation support and guarantees or other support for private investment.
Increasing private-sector participation	There is evidence that participation of the private sector in SWM benefits sector performance (see Section 4.4). The first stage in increasing private-sector participation is the adoption of a legislative framework, which supports and regulates private sector participation. This then needs to be followed by building the capacity of both public and private actors. Development agencies have a key role to play in both these stages. After that, the support from development agencies should look to focus on initiatives that promote private-sector involvement, such as small and medium enterprises in waste collection and recycling, and participation of bigger players in composting, disposal and treatment of healthcare waste.
Promoting accountability and transparency	Improved solid waste management enhances governance, improving the public's perception of local governments. Solid waste is a challenging sector to demonstrate accountability and transparency, but can be used to promote dialogue and stability, with local governments as the service providers and the public as service users.
Research and knowledge development	There is a distinct lack of consistent evidence demonstrating the benefits of improved SWM to the public, the environment and in development. This constrains dialogue on the need for SWM and results in the sector being ignored. A greater evidence base is needed to understand key issues, needs and target groups as well as approaches to improving solid waste management. Donors have a key role to play in developing the evidence and dissemination of the knowledge necessary to advocate, develop, implement and operate improved SWM. Section 5 details key research gaps that require support.

A commitment by all international organisations to supporting the six strategic areas will produce sustainable improvements in solid waste management in developing countries and will significantly contribute to the achievement of the SDGs.

4.1 Drivers and political economy in the SWM sector

Programmes for improved solid waste management need to be well informed with an understanding of political processes at local, city and national levels. Processes include formal and recognised political processes[9], as well as informal and unrecognised decision-making processes. An understanding of political interests, stakeholders, drivers and entry points is

[9] Political process includes support, resistance and neutrality, often without articulated reasoning. It depends solely on political priorities and, in many cases, not on any evidence, policy or rational analysis.

extremely important (DFID, 2009). A thorough analysis of a particular political system can facilitate external investment in solid waste management, ensuring more effective interventions with better local support and understanding of how to build sector capacity. An analysis will also help in resisting political pressures and addressing governance issues concerning the relationship between citizens and government institutions. An analysis provides a greater understanding of power, decision-making and relationships between institutions (Edelmann, 2009). This section presents an understanding of the drivers and the political economy of solid waste management.

Investing in political economy analysis is essential and should be a pre-requisite of any project looking to improve solid waste management.

The general public typically considers solid waste management to be an important aspect of a cleaner local environment and therefore improved solid waste management can significantly contribute to positive public opinion of a city government. Citizens' perceptions of their local government can depend on the performance of solid waste services (UNEP, 2015), including street sweeping, regular collection services and keeping public spaces clean.

Solid waste management plays an important role in enhancing a city's image, especially large cities. Reputation can be important for city politicians, as it can impact on the city's economy. Evidence suggests that mayors regularly prioritise improved solid waste management and actively look for ideas and investment to improve service provision. Improved solid waste management is extremely important to those who work directly with the voting public, such as local councillors. Local councillors and activists are often heavily involved in monitoring solid waste management operations, as they are the first contact point for disgruntled citizens. Recognising the importance of this service, some representatives also personally oversee the local operations of solid waste collection and the management of municipal staff.

Programmes to improve solid waste management should build on the existing political economy and involve politicians in planning, implementation and monitoring.

Finally, political considerations are important in solid waste management as the sector involves a large number of manual workers, both in the formal and informal sector. Many of the formal workers are members of trade unions. Any intervention or change of the system may be supported or rejected by these groups, which could lead to strike action or silent protest. These groups are important stakeholders and have leadership that should be recognised and involved in decision-making.

An understanding of the political economy will help in identifying the drivers and entry points for interventions. This understanding can be used to make a case for improved solid waste management. It is important to consider here that a change could be motivated by a number of possible drivers. An analysis of the context will inform the choice of the most effective driver. Table 1 illustrates key drivers and their potential to bring changes.

Table 4.2 - Ability of drivers to achieve change in solid waste management

Driver	Description	Potential vehicles
Public health crisis	A public health crisis where one of the causes is poor waste management	Immediate attention to improvements; resource allocation and political priority
Emergency and disaster	A disaster and emergency in which waste is a central issue	International attention; external expertise; additional resources
Commercial interest	Motivation to earn an income and profit through waste-related activities	New and extended services; cost recovery; innovation and new technologies
Civil society actions	A collective action or campaign by a group of citizens	Receive political attention; attract media; raise awareness
Court of law	Citizens or a court of law intervene to address poor waste management services	Mobilising government; attracting media attention and raising awareness
Media	Media attention on solid waste issues	Political attention, public outcry,

Development partners have a role to play in facilitating interventions by providing support for understanding viable drivers for change, as well as undertaking analysis of political economies. This support can be extended to help develop strategies for improving services and facilitating discussion between stakeholders.

4.2 Developing capacity for improved solid waste management

This section focuses on how to build capacity within the sector, looking at traditional SWM institutions, policies and regulations. It considers how to improve traditional systems with current trends in thinking.

Municipal institutions require enhanced capacity to deliver improved solid waste management. These capacities must be able to:

- Meet the needs of increasing populations;
- Provide service coverage to all areas, especially low-income areas;
- Manage increased waste quantities;
- Deal with changing waste types, such as increased packaging;
- Develop partnerships, especially with the private sector;
- Meet citizens' expectations of a cleaner environment;
- Invest and recover costs;
- Improve working conditions of workforces involved in the delivery of SWM services; and
- Develop and implement programmes for waste reduction and recycling.

Traditionally, solid waste management departments have been introduced to protect public health; departments mainly delivered through manual labourers whose primary function was to remove waste from residential areas (Ali and Cotton, 2001). Current solid waste management requires skills in procurement, operation and maintenance of machinery, development of landfill sites, waste-to-energy systems and planning for international procurement. Therefore, building municipal capacity in these skills should be adopted as a strategy for supporting improved solid waste management.

Donors' investment in solid waste management must provide for a component of institutional capacity, with clearly defined outcomes and resource allocation.

The aim of enhanced capacity and institutional strengthening is improved service performance in the sector. Municipal authorities in developing countries may have some successful projects, but the overall culture does not support knowledge and learning. Staff are often perceived to be corrupt and transfers between departments are common, affecting institutional knowledge. Municipal authorities can often not afford trained or qualified staff and so are forced to rely on external consultants (Ali, 1996). Without improving the culture of local authorities, training and publications are of limited use. Ideally, improving the culture of local authorities needs to be seen as part of a long-term strategy and not constrained within time-bound projects.

Regular institutional reviews can reveal gaps and opportunities within municipal institutions. Enhanced capacity in the form of knowledge, skills and experience of the staff involved is necessary to deliver sustainable improvements in solid waste management. This comes from training, working with others and exposure to good practices. Staff learn from successful projects, but may learn even more from mistakes (Coad, 2010). With the availability of internet, video conferencing, Skype and webinars, capacity development in any subject is relatively easy and participants do not necessarily need to travel to acquire training. Opportunities to create and support international networks to learn and share are important. In the waste sector for developing countries, learning and training materials are being developed by the World Bank, Asian Development Bank, WASTE Netherlands, the Water, Engineering and Development Centre (WEDC) Loughborough University UK, EAWAG Switzerland and SKAT Switzerland.

The Swedish International Development Co-operation, British Council, Danish Aid and GIZ have offered a range of training courses for professionals in developing countries. Similarly, national institutions like the International Training Network, Bangladesh, have played a key role in conducting training for national staff. Most of the large projects concerned with improved solid waste management come with a training grant. Finally, it is important to recognise that enhanced capacity of international organisations to work for improved solid waste systems is also important. The Collaborative Working Group in Solid Waste operates a network of sector practitioners and delivers a number of popular knowledge products. This network had achieved a number of outcomes among international organisations in developed and developing countries (SKAT, 2016).

Box 4.1 - Collaborative Working Group (CWG) on Solid Waste Management in Low- and Middle-Income Countries

The CWG started in 1995 as a network of practitioners, with support from the Swiss Agency for Development and Co-operation (SDC), the Urban Management Programme (UMP) of UN-Habitat and the World Bank. The purpose of CWG is to raise the profile of SWM with decision-makers at city, national and international levels; to serve as a centre of expertise and knowledge on integrated and sustainable SWM in low- and middle-income countries, to build regional capacity for improved and sustainable SWM, and to develop and disseminate new knowledge products on SWM. The network continued for more than 15 years, organised a number of workshops and published more than ten publications, including workshop proceedings and papers. The CWG is being hosted currently at SKAT, Switzerland. Due to financial constraints, its activities have been restricted. Knowledge and learning have been prioritised by a number of funders and CWG has a great potential to serve as the centre of knowledge, learning and experience sharing in solid waste management.

Source: http://www.cwgnet.net/

4.3 Investing in solid waste management

Improved solid waste management in developing countries requires substantial investment, which has been a low priority[10] to date. All the major reviews advocate for urgent additional investment (for example, Lerpiniere et al., 2014; UN-Habitat 2010), but very few have suggested projected and detailed estimates, especially for developing countries. It is estimated that solid waste services absorb 1–2% of GDP[11] (Cointreau, 2006). In many lower-income countries, municipalities already spend 20–50% of their operational budgets[12] on solid waste management, yet only manage to provide services for less than half their citizens. This is evidence of a major service gap. Many developing countries would require relatively large investments in final disposal facilities[13], to bring coverage up from the current capacity to manage even 25% of the generated waste (Le Courtois, 2012). Investment is needed for expanding service provision to medium- and small-sized cities, where a significant proportion of the global urban population lives.

The sector also needs targeted investment in recycling programmes and improved methods for cost recovery.

Brazil has improved solid waste services in the last 20 years, but only 65% of its municipalities are able to collect user charges and recover costs on their investment. The remaining 35% of the municipalities do not charge for solid waste services.

The global solid waste market is estimated at US$410 billion a year, excluding informal-sector activities. In the developing world this market is estimated at US$46 billion a year[14]. Evidence demonstrates that an additional investment of US$100 billion a year is required to fill the

[10] http://www.gdrc.org/uem/waste/swm-fogawa1.htm

[11] http://siteresources.worldbank.org/INTUSWM/Resources/FinanceForSW.pdf

[12] http://www.worldbank.org/en/news/feature/2014/10/30/how-to-finance-solid-waste-management

[13] http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/waste.htm

[14] http://www.unep.org/greeneconomy/Portals/88/documents/ger/GER_8_Waste.pdf

service gaps in developing countries (UNEP, 2011). However, investing successfully in solid waste management is considered challenging, despite their being good business potential[15]. Some of the challenges are discussed in Sections 3 and 5. The solid waste sector needs new ways of financing to promote affordable technologies and improve methods of recovering user charges.

Development partners have an important role to play in increasing finance in the solid waste management sector, advocating for increased financing and lobbying for targeted financing to contribute to multiple targets on the SDG agenda. For example, promoting investments in waste reduction and recycling would also contribute to reducing greenhouse gas emissions, reducing their impact on climate change, as well as increasing pro-poor employment opportunities and livelihoods.

Solid waste has seen relatively small investment; for example, in 2012, total development finance was US$230 billion, and the share of finance for solid waste management only US$510 million (Lerpiniere et al., 2014). Between 2003 and 2014, an estimated US$4 billion was committed to solid waste management development initiatives. Low-income countries have not received much of this assistance and the majority of this financing has gone to middle-income countries, including China, India, Turkey and Argentina. The focus of the investments has shifted from technology transfer to the development of capacity and skills. The focus has been on municipal solid waste management as compared to industrial and rural waste. The funders see poor governance, regulations, institutional structures and difficulties in engaging the private sector as the key constraints to channelling further development assistance. Germany, the Asian Development Bank and Japan are the top three agencies that support waste-related projects.

Development partners can promote pro-poor investments to extend service coverage to low-income areas in large cities. They have a role to play in promoting programmes that build the capacity of service providers in small and medium cities, and in providing support through technical assistance projects, to help developing countries attract additional funds from new sources, such as the Clean Development Mechanism.

New ways of financing the sector need to be developed, such as through the Clean Development Mechanism. One good example is a special initiative called Nationally Appropriate Mitigation Actions (NAMAS) funded by international donors and supported by the UN Framework Convention on Climate Change[16]. Examples of projects supported by the NAMAS initiative include feasibility studies and pilot projects in Latin America with support from the Center for Clean Air Policy, US and Canada. The projects divert organic components of waste from upstream to reduce methane and carbon dioxide generation at the final disposal.

4.4 Promoting private-sector participation

Role of the private sector in SWM

There is evidence that improved solid waste management could be achieved through the involvement of the private sector. Many cities around the world have implemented public-private partnerships, some more successfully than others. In many cities of Asia, small private-sector operators are already involved in waste collection and recycling activities (Coad, 2005).

[15] https://www.deginvest.de/DEG-Englische-Dokumente/PDFs-Download-Center/Private-Sector-Focus_Financing-of-MSWM.pdf

[16] http://unfccc.int/focus/mitigation/items/7172.php

The table below presents how the private sector has been involved in the different stages of SWM.

Table 4.3 – Role of the private sector in the stages of SWM

Stage	Type of involvement	Examples and data
Collection	- Individual entrepreneurs and micro- or small enterprises involved in primary collection and street sweeping - Medium and large companies involved in secondary collection and transportation	- Safi Youth Group is providing primary collection services to more than 1,000 households in Mombasa, Kenya (UN-Habitat, 2010), which were not provided with any system of collection; - In New Delhi, waste collected by the informal sector is delivered to a large private-sector operator who provides secondary collection from communal bins (UN-Habitat, 2010).
Treatment and resource recovery	- Individual entrepreneurs and micro- and small enterprises are involved in recycling and sale of materials such as plastic, metals and glass - Medium and large enterprises involved in the operation of waste-to-energy plants	- In Surat (India), a private contractor started extracting and selling metals from waste and producing compost in 2009. The activity closed in 2013 due to financial losses (UNEP, 2015); - In the city of Wenzhou (China), a local private contractor entered into a contract in 2003 with the municipality to finance, build, operate and transfer a waste-to-energy incineration plant. Recovery of the investment was expected to take 12 years, while the contract duration is 25 years (UNEP, 2015).
Disposal	- Medium and large enterprises involved in the operation of sanitary landfills	- Already in the 1990s private firms customarily operated landfills in Latin America under concessions of 10-30 years and in the South African province of Guateng under 5-year contracts (Johannessen and Boyer, 1999).

In addition, the private sector can play a significant role in the collection, treatment and disposal of healthcare waste (Johannessen et al., 2000). For example, Malaysia is divided into three HCW management zones and each zone has contracted a private company for 15 years. Private companies are responsible for providing bins and bags for collection, and collection and storage of HCW within healthcare facilities, transport and treatment through incineration in (Johannessen et al., 2000). In the Philippines 200 medical centres and hospitals send their hazardous waste to a single privately-built high-temperature incinerator (UNEP, 2015).

How can donors support the involvement of the private sector?

The diagram below presents the steps that should be undertaken in order to define the most appropriate financing model for the provision of SWM services, and thus for the involvement of the private sector in the financing or delivery of the service.

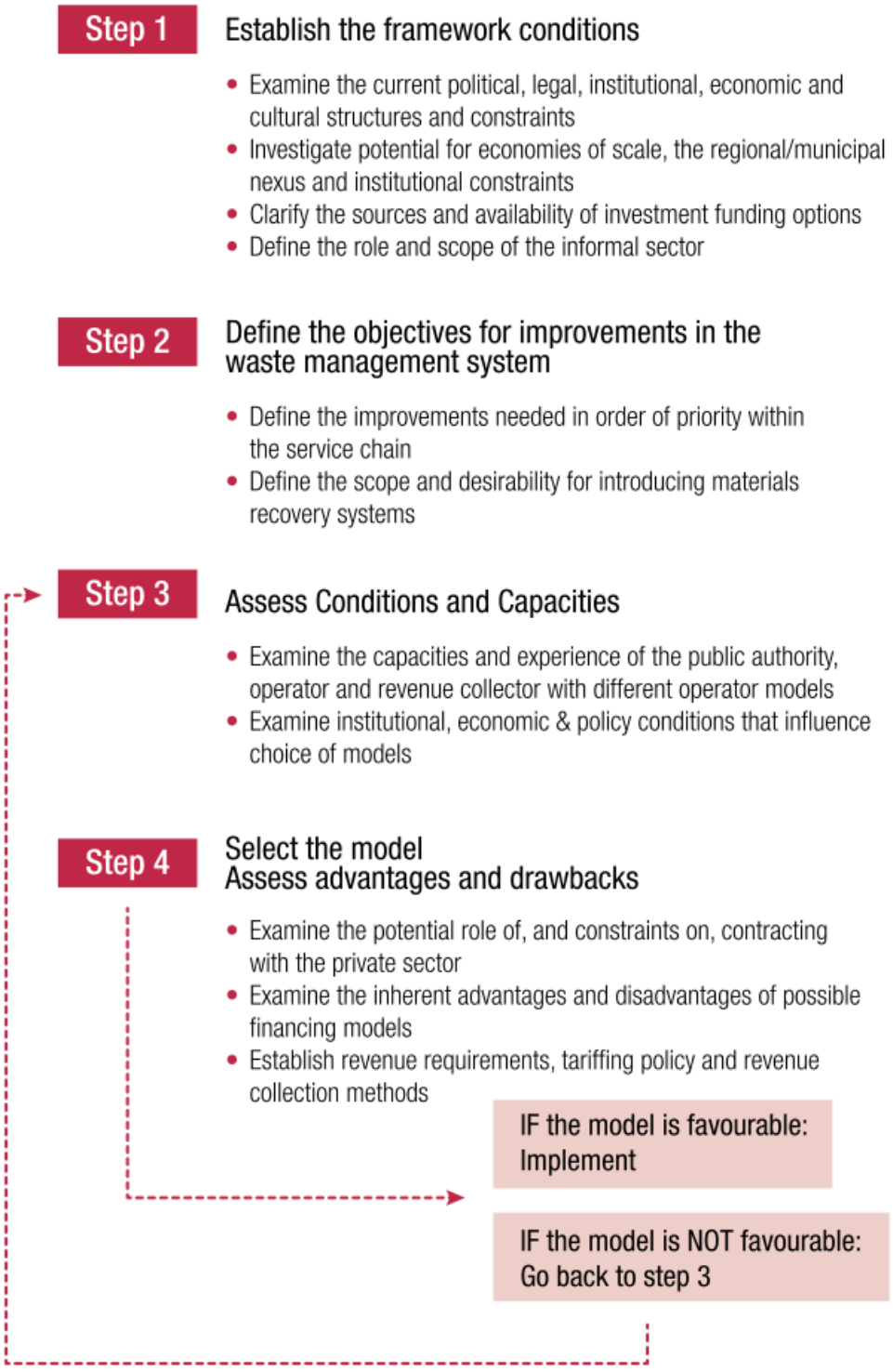

Figure 4.1 - Steps for selecting an appropriate financing model for SWM (UNEP, 2015)

Development partners have a role to play in supporting local government throughout this process. International donors could also advise local governments in the review of their legislation, which often restricts the involvement of private-sector actors. Donors could also fund capacity building for both local governments and the private sector. This would provide the private sector with political and financial backing, which is necessary for the successful implementation of partnerships between the private and public sector (UNEP, 2015).

After those initial stages, development agencies should focus on initiatives that promote private-sector involvement, such as small and medium enterprises in waste collection and treatment and participation of bigger players in composting, disposal and the comprehensive management of healthcare waste. Experience shows that supporting smaller-scale enterprises, cooperatives or individuals working as door-to-door waste collectors, waste pickers or itinerant waste buyers, or those operating recycling or composting facilities, can be beneficial to both the local economy and the service users (UNEP, 2015).

4.5 Promoting sector accountability and transparency

Improved solid waste management is important for citizens and contributes directly to good governance, improving the relationship between the state and the general public. Development partners, such as DFID, can play an important role in promoting further sector accountability and transparency and it is suggested that the focus should be on three areas:

- Identification of the current methods of public involvement in solid waste management, and promoting and supporting further initiatives to involve citizens in the planning and implementing of new programmes, especially in waste collection and recycling;
- Support for governments to improve access to information for citizens about programmes for improving solid waste management. This can include the creation of opportunities for the public to influence activities and plans; and
- Supporting the promotion of accountability by supporting public access to information on budgets and expenditures. This includes creating opportunities for citizens to participate in and influence the budgeting process, complaints procedures and transparency systems by which governments can be held to account.

Citizens participate in the solid waste sector with roles in waste segregation, recycling, reuse, transportation and disposal (WEDC, undated). They also pay taxes and/or charges for waste collection services. This participation is often overlooked in new programmes aimed at improving solid waste management systems. In some cases, new programmes undermine existing positive behaviours. Efforts to enhance sector accountability and transparency should recognise, protect and enhance this involvement of the general public and informal waste sector, integrating positive behaviours into any new initiatives.

A key aspect of accountability is participation. An analogy could be drawn from Community Led Total Sanitation (CLTS) when citizens take the responsibility to declare their area Open Defecation Free (ODF). In the same way, citizens are capable of organising collection systems, if their participation is supported by providing regular transport of the collected waste.

Promoting participation in solid waste management could also be used to promote other basic services, such as sanitation, water and energy supply.

Public participation should not be restricted to collection only and should be promoted in other stages of solid waste management. This can be done through information sharing and consultation, including providing information about new programmes, budgeting, expenditure and planning. In many developing countries, there are no complaints systems for customers to complain about poor services, or if there are the perception is that nothing will change if a complaint is made. Establishing and using a complaints mechanism is an important component of enhancing sector accountability.

4.6 Research and knowledge development

Section 3.1 discussed the contribution of improved solid waste management to the United Nations Sustainable Development Goals. The agreed SDGs includes Target 11.6, stating

'By 2030 reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.'

In addition, improved solid waste management contributes to a further 40 SDG Targets, and directly contributes to 17 Goals. These are summarised in Table 3.2. To achieve these goals, the solid waste management sector needs capacity development, investment and research. This section summarises key issues and major gaps in research to support the strategies presented in Sections 4.1 to 4.5.

Institutional set-ups and privatisation

As discussed in Section 4.2, capacity strengthening is needed in existing institutions, especially municipal authorities[17]. Research is required to understand the institutional effectiveness and potential institutional arrangements needed to achieve the goals of improved solid waste management. Proposals to develop new institutions will analyse the potential of using the private sector to generate efficiency, create employment and to lower costs. Current institutions responsible for delivering solid waste management are often outdated and ineffective. Research is required to analyse the new institutional set-ups that have been trialled and to capture their strengths and weaknesses for replication in other administrations.

Waste data and information

There is a global gap in waste-related data, including information on quantities, composition, and collection and disposal rates. Global policy relies on estimates, most of them outdated. There is a need to support global monitoring programmes on waste data and information to inform policy, but also to monitor progress against the SDGs, which will be how programmes will be seen as part of a global strategy. Models available from the water and sanitation sector, such as the Joint Monitoring Programme, could be adapted for this purpose.

Landfilling

Controlled disposal is a neglected stage in many developing countries. There are many reasons for this, including lack of knowledge and research about affordable systems for disposal and options for landfill gas capture. Good quality knowledge and research on waste disposal options, including case studies of successful projects, could make an important contribution to the sector. This research will contribute directly to SDG Target 11.6.

Waste collection in low-income areas

Many cities are not able to provide reliable and regular waste collection in low-income areas. While on average, 40% of city populations live in slum areas (Satterthwaite, 2015), the systems and technologies in use in other parts of the city are often not always suitable for low-income areas. Knowledge and research could contribute to changing this situation, especially within the framework of the SDGs concerned with improved health and local environment.

Waste and climate change

Financing for solid waste management could be partly generated from carbon financing. Evidence is emerging to support this conclusion, but there are not enough data for a

[17] The term *municipal authorities* has been used to include city governments, municipalities and other forms of government institutions responsible for solid waste management.

comprehensive understanding of the potential of this financial source. Knowledge and research programmes on this topic could contribute to change the situation.

Data about new and emerging streams

Data and information about new waste streams, such as electronic waste, are lacking. Recently, concerns were raised about the increasing streams of waste from old mobile phones, computer monitors and television sets. Certain existing streams seem to be increasing. Concerns were raised about the excessive quantities of food waste. Further research is needed to understand trends in waste composition in areas targeted for interventions. Globally, there needs to be an understanding of the international movement of waste for recycling and final disposal, as seen with the e-waste imports into Ghana (Box 2.1). Such data and information are necessary to benefit improved solid waste management and for achieving global improvements in waste management.

SECTION 5

Common issues and gaps

In the process of preparing this Topic Guide, a range of gaps have been identified that would benefit from further attention from the international development sector. These are listed below and build on the major research gaps discussed in Section 4.6. Generation of new knowledge to address these issues would benefit the sector and enhance the contribution to the SDG Agenda:

- Most of the municipalities in developing countries have poor data on the state and performance of their solid waste management services. Basic information on aspects such as waste quantities, waste characteristics, collection rates, unit costs, performance indicators, disposal quantities, seasonal variations and recycling rates is critical to ensuring quality services, but is typically outdated and based on estimates from project design. Initiatives to support data collection and validation would enhance service planning, implementation and monitoring.
- The provision of waste services is inequitable across cities in the developing world. High-income and commercial areas usually receive better services than low-income areas, which are often served irregularly or not at all. This approach disguises the true state of service provision, and efforts need to be made to ensure equitable service provision before new investments are committed.
- Solid waste management is a sector in which user fees are often non-existent and cost recovery is poor. This raises a number of questions about the operation, maintenance and sustainability of projects funded by external investments - for instance, from the private sector. This is an area where research is needed to understand the drivers and successful mechanisms for cost recovery.
- Carbon financing is seen as an opportunity to generate much-needed investment for the sector. Recent projects have been funded through various climate facility funds to reduce carbon emissions from improved solid waste management. This alternative funding source is an opportunity, but greater understanding is needed on how to share information and initiatives, and to remove bottlenecks to facilitate project development.
- Although not within the specific scope of this Topic Guide, there is a range of issues concerned with the management of waste from healthcare facilities and industries. Many of these facilities are within city limits, meaning healthcare and industrial wastes enter municipal waste streams. This topic has received little attention in the past and it is an area where more knowledge and applied research are needed.
- Climate change and climate-related weather events may have an impact on waste composition and systems of waste disposal, including the stability of waste disposal sites, moisture content in waste, and the impact of urban floods on waste collection and disposal. Greater understanding of the potential impact of climate change on improved solid waste management is needed if new initiatives and projects are to be resilient in a changing climate.

SECTION 6

Terminology

Composting – Process of converting the biodegradable portion of solid waste into a humus-like product, which can be used as a soil conditioner or for landfill cover.

Community-based organisations – Groups of citizens residing in a community and organised in order to achieve a common goal, such as better waste collection in their neighbourhood.

Clean Development Mechanism (CDM) – A mechanism to fund projects to reduce carbon emissions. Agreed under the Kyoto Protocol (2007) through which certified emissions reductions can be traded in the market.

Decentralisation – Decentralisation of federal government functions so that they are closer to citizens, often involving the transfer of decision-making and resources to local levels of government, including municipal authorities.

Generation rate - Quantity of materials discarded over a period of time (usually expressed as the weight of waste discarded by one person in a day) that enters a waste stream before composting, incinerating, landfilling or recycling.

Hazardous waste – Waste that is dangerous or potentially harmful (because it is corrosive, explosive, inflammable, toxic, infectious or radioactive) to health or the environment. It derives mainly from particular industries but can also derive from certain healthcare wastes and discarded commercial products, like cleaning fluids or pesticides.

Healthcare waste - All the waste generated by healthcare facilities, research centres and laboratories from medical procedures. It also includes the same types of waste originating from minor and scattered sources such as waste produced in the course of healthcare undertaken in the home. Hazardous categories only constitute between 10% and 25% of the healthcare stream.

Infectious waste – Components in waste which are known or expected to contain pathogens capable of causing infections.

Informal sector in waste – Organisations and individuals which are not officially registered and carry out waste-related activities purely for the generation of income.

Incineration – Controlled burning of waste in a purpose-built facility. Most of the combustible material is converted into carbon dioxide. Most large incinerators are intended to reduce air pollution from gaseous emissions.

Landfilling – Controlled disposal of waste on land, supported with infrastructure and services to reduce and monitor any adverse environmental impact.

Landfill gas – Gas generated by the decomposition of biodegradable waste within a landfill site. It contains methane and carbon dioxide.

Leachate – Liquid that drains from a landfill. It varies widely in composition depending on the age of the landfill and the type of waste that it contains. It usually contains both dissolved and suspended material, making it highly polluting.

Nationally Appropriate Mitigation Action (NAMA) – A mechanism to assist national governments to develop climate-change mitigation projects, including those concerned with waste.

Primary collection – Collection from properties or small communal bins, which is carried out manually or by means of small vehicles, and unloading of the waste at larger communal storage facilities or transfer stations.

Privatisation of solid waste – Handing over responsibilities and operations of waste-related services from the public to the private sector.

Public-private partnership (PPP) – An arrangement between the government and private sector to operate a waste-related service, which may involve sharing the risks and joint investment, and combines the strengths of the public and private partners.

Recycling – The process of transforming waste materials into raw materials for manufacturing new products, which may or may not be similar to the original product.

Resource recovery – The extraction and utilisation of materials and energy from waste.

Sanitary landfill – Engineered disposal facility designed, constructed and operated in a manner that minimises impacts to public health and the environment. Sanitary landfills, as the preferred option for waste disposal in developing countries, undergo thorough planning right from the selection of the site up to post-closure management.

Secondary collection – Commonly defined as the collection of waste from communal storage facilities, transfer stations or open spaces and transportation to the final disposal or treatment site.

Segregation - Discarding different categories of waste into different containers so that they are never mixed.

Separation – Extraction of particular items or materials from mixed waste for the purpose of recycling or improving the feedstock for a treatment or recycling process.

Transfer station – A purpose-built facility to transfer waste from small to larger vehicles. Useful in places where conditions in the collection area favour the use of small vehicles and where the distance to the disposal or treatment site favours the use of large vehicles.

Waste management data – This term often refers to common data collected, including generation rates, and waste composition, density and moisture content. Other data and information may also be included, depending on the purpose, such as operational data and costs.

Waste management hierarchy – A list of the acceptable methods of managing waste according to their desirability from an environmental perspective. The best method is to reduce the quantity of waste that is generated, followed by measures that reuse the waste in its current form. The list continues until the least desirable method, which is sanitary landfilling. The hierarchy is often presented diagrammatically in the form of a pyramid.

Waste reduction – All means of reducing the amount of waste that is discarded. This ranges from legislation to product design to local programmes aimed at keeping some waste categories out of the waste stream.

SECTION 7

Annotated bibliography

This reading list provides primary references for the Topic Guide.

Coad A. 2005. Private Sector Involvement in Solid Waste Management – Avoiding Problems and Building on Successes'. Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries, SKAT, Switzerland.

This brochure introduces a study of experiences of private-sector participation in solid waste management in Africa, Asia and Latin America. It presents guidance information relevant to the preparation for and the implementation of private-sector participation, including for instance a clear description of the steps that must be taken and of the questions that must be answered when developing a strategy for involving the private sector.

Coffey M. and Coad, A. 2010. Collection of Municipal Solid Waste in Developing Countries. UN-Habitat. Nairobi.

This book aims at assisting those who influence public and private-sector investments in solid waste collection systems in developing countries. The purposes of the report are (i) to provide information that can lead to the development of reliable and affordable solid waste collection systems; (ii) to provide technical information for the design and manufacture of alternative vehicles that are well suited to local production, operational capacities and physical conditions.

Gonzenbach B. and Coad, A. 2007. Solid Waste Management and the Millennium Development Goals. Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries. SKAT Switzerland

This booklet gives an overview of the contribution of solid waste management to achieving the objectives that were set up in the Millennium Development Goals. It ends with a call for more human and financial resources in order to achieve higher standards and wider coverage in the provision of solid waste management services.

Satterthwaite D. 2015. Urban Poverty, Urban Pollution and Environmental Management. DFID Topic Guide, Evidence on Demand and International Institute of Environment and Development (IIED), London.

This Topic Guide covers chemical pollutants and disease-causing agents in the home, workplace and wider city. It also includes consideration of GHG emissions in urban areas; most are not pollutants in the sense of having a direct impact on human health or ecological resources but they are the main drivers of climate change. It also discusses the links between solid waste management and urban poverty, pollution and environmental management.

United Nations Environment Programme (UNEP). 2015. Global Waste Management Outlook. United Nations Environment Programme and International Solid Waste Association. Vienna, Austria.

The Global Waste Management Outlook presents an in-depth assessment of global waste management. It reflects the collective body of recent scientific knowledge and draws on researches undertaken by the United Nations. It includes an analysis of trends, and governance and financial mechanisms. It also offers policy advice on the way forward.

UN-Habitat. 2010. Solid Waste Management in the World's Cities - Water and Sanitation in the World's Cities 2010. Earthscan, London, ISBN 978-1-84971-169-2 hardback.

This publication presents 20 case studies from cities around the world. Through those case studies, it aims at showcasing the good work done on solid waste management. It also looks at what drives changes in solid waste management and helps decision-makers understand how a solid waste management system works.

SECTION 8

References

8.1 References

Ali, M. (1996) 'Integration of formal and informal systems in solid waste management', PhD thesis, Loughborough: Loughborough University.

Ali, M and Cotton, A. (2001) *Sweeping Business – Developing Entrepreneurial Skills for Solid Waste Management*. Loughborough: Water Engineering and Development Centre, Loughborough University.

Ahmed, S. and Ali, M. (2004) 'Partnerships for solid waste management in developing countries: linking theories to realities', *Habitat International* 28, pp.467-479.

Appleton, J. and Ali, S. M. (2000) 'Healthcare or Health Risks? Risks from Healthcare Waste to the Poor', WELL

Beall, J. (1997a) 'Thoughts on poverty from a South Asian rubbish dump – gender, inequality and household waste', *IDS Bulletin* 28(3), pp.73-90.

Bogner, J. et al. 2007. 'Waste management', in Metz, B. et al. (eds.) *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Cambrige and New York, NY: Cambridge University Press, Chapter 10 .Available at: https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch10.html. (16/03/2016).

Bolaane, B. and Ali, M. (2004) 'Sampling household waste at source: lessons learnt in Gaborone', *Waste Management and Research* 22, pp.142-148.

Chintan, (2009) *Cooling Agents: An Analysis of Climate Change Mitigation by the Informal Recycling Sector in India*, New Delhi: Chintan. Available at: http://www.chintan-india.org/documents/research_and_reports/chintan_report_cooling_agents.pdf. (16/03/2016).

Coad, A. (2005) *Private Sector Involvement in Solid Waste Management – Avoiding Problems and Building on Successes*, St. Gallen: Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries.

Coad, A. (2010) *Solid Waste Management: Improved Capacity = Less Waste*, St. Gallen: CWG.

Coffey, M. and Coad, A. (2010) *Collection of Municipal Solid Waste in Developing Countries,* Nairobi: UN-Habitat.

Cointreau, S. (2004). *Sanitary Landfill Design and Siting Criteria*, Infrastructure notes, Washington, DC: The World Bank, (updated November 2004). Available at: http://www.google.com/#sclient=psy&hl=it&q=cointreau%2C+sanitary+landfill+design+and+siting+criteria%2C+world+bank&aq=&aqi=&aql=&oq=&gs_rfai=&pbx=1&fp=88c83f0dfac83c0b. (16/03/2016).

Cointreau, S. (2006) *Sustainable Solid Waste Systems in Developing Countries*, Washington, DC:The World Bank.

Cointreau, S. (2008) *Landfill ER Revenues versus Landfill Costs*, Washington, DC: The World Bank. Available at: http://siteresources.worldbank.org/INTUWM/Resources/340232-1208964677407/Cointreau.pdf. (16/03/2016).

Da Zhu et al. (2008) *Improving Municipal Solid Waste Management in India – A Sourcebook*. Washington, DC: The World Bank.

Department for International Development (DFID). (2009) *Political Economy Analysis – How to Note*, A DFID Practice Paper. London: DFID.

Edelmann, D. (2009) *Analysing and Managing the Political Dynamics of Sector Reforms: A Sourcebook on Sector-level Political Economy Approaches*, London: Overseas Development Institute. Available online at: http://www.odi.org.uk/resources/download/4323.pdf. (16/03/2016).

Fergutz, O., Maria Dias, S. and Mitlin, D. (2011) 'Developing urban waste management in Brazil with waste picker organizations', *Environment and Urbanization* 23, pp.597-608.

Flintoff, F. (1984) *Management of Solid Wastes in Developing Countries*. Geneva: World Health Organisation.

Forbid, G. T. et al. (2011). 'Open waste burning in Cameroonian cities: an environmental impact analysis'. *Environmentalist*, 31: 254-262

Furedy, C. (1995) 'Plague and garbage; implications of the Surat outbreak for urban environmental management in India', Paper presented at the Learned Societies Conference 2015, International Research Centre South Asia Council Meeting, Montreal, 4–6 June 1995..

Gonzenbach, B. and Coad, A. (2007) *Solid Waste Management and the Millennium Development Goals*, St. Gallen: Collaborative Working Group on Solid Waste Management in Low and Middle Income Countries.

Guardian, The (2015) 'England's shoppers say goodbye to free plastic bags'. Available at: http://www.theguardian.com/environment/2015/oct/05/englands-shoppers-say-goodbye-to-free-plastic-bags

Halbach, T. (2013) *International Trends in Solid Waste Handling*. Paper presented to Solid Waste Management and Recycling Export Roundtable. Department of Soil, Water, and Climate Carlson School of Management, University of Minneapolis, 14 March 2013.

Hardoy, J., Satterthwaite, D. and Cairncross, S. (1990) *The Poor Die Young*, London: Earthscan Publications Ltd.

HEPCA (2015) 'Solid Waste Management Overview' Available at: http://www.hepca.org/conservation/solid-waste/

Jaramillo, J. (2003) *Guidelines for the Design, Construction and Operation of manual sanitary landfills – A solution for the Final Disposal of Municipal Solid Wastes in Small Communities*, Lima: Pan American Center for Sanitary Engineering and Environmental Sciences.

Johannessen, L.M., and Boyer, G.(1999). 'Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America'. The World Bank

Johannessen, L. M. et al (2000) 'Healthcare waste management guidance note'. The World Bank.

Koelsch, F. (No date) *The Stability Problems of Landfills – The Payatas Landslide*. Available at: http://www.dr-koelsch.de/Phillie_01_Payatas.pdf. (16/03/2016).

Le Courtois, A. (2012). 'Municipal Solid Waste: turning a problem into resource'. Available at: www.ccacoalition.org/fr/file/642/download?token=6X4BelUO

Lerpiniere, D. et al., 2014. *A Review of International Development Co-operation in Solid Waste Management*, Report from the ISWA Globalisation and Waste Management Task Force, Vienna: ISWA. Available at: https://www.iswa.org/fileadmin/galleries/Task_Forces/TFGWM_Report_Review_International_DCSWM.pdf. . (16/03/2016).

Minh, N. H. et al. (2006) 'Contamination by persistent organic pollutants in dumping sites of Asian developing countries: implication of emerging pollution sources', *Archives of Environmental Contamination and Toxicology* 50(4), pp.474-481

Muller, M. and Schienberg, A. (No date) *Gender and Urban Waste Management*, Gouda: WASTE Available at: http://www.gdrc.org/uem/waste/swm-gender.html. (16/03/2016).

National Geographic (2015) *Great Pacific Garbage Patch*. Available at: http://education.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/ (16/03/2016).

Olley, J. (2007) 'Tools for successful ISWM in Ciudad Sandino, Nicaragua', *Waterlines* 25(4), DOI: 10.3362/0262-8104.2007.017

Oluyemi, E. A., et al., 2009. 'Potential groundwater contamination with toxic metals around refuse dumps in some parts of Lagos metropolis, Nigeria'. Toxicological and environmental chemistry, 91 (5): 933-940

Perella, M. (2015) *Ebola Waste Task Force Responds to the Challenge*, Salisbury: Recycling and Waste World. Available at: http://www.recyclingwasteworld.co.uk/in-depth-article/ebola-waste-task-force-responds-to-challenge/74143/. . (16/03/2016).

Poulsen, O. M. et al.(1995) 'Sorting and recycling of domestic waste. Review of occupational health problems and their possible causes', *Science of Total Environment* 168 (1), pp. 33-56

Prüss, A. et al. (eds.). (1999) *Safe Management of Wastes from Health-care Activities*, Geneva: World Health Organization.

Pruss-Ustun, A. et al. (2005). *Estimation of the global burden of disease attributable to contaminated sharps injuries among health-care workers*. Available at: http://www.who.int/quantifying_ehimpacts/global/7sharps.pdf (16/03/2016)

Rouse, J. (2006) 'Seeking common ground for people: livelihoods, governance and waste', *Habitat International* 30, pp.741-753.

Satterthwaite, D., (2015) *Urban Poverty, Urban Pollution and Environmental Management*, London: Evidence on Demand and International Institute of Environment and Development (IIED).

Satyamev, J. (2014) Implement the Government of India's Solid Wastes (Management and Handling) Rules. Available at: http://www.satyamevjayate.in/dont-waste-your-garbage/actnow-on-waste-management.aspx. (16/03/2016).

Shanghai Manual, 2012. *A Guide for Sustainable Urban Development in the 21st Century*, New York, NY: United Nations Department of Economic and Social Affairs.

SKAT. (2016) CWG - Collaborative Working Group on Solid Waste Management. St. Gallen: SKAT. Available at: http://www.skat.ch/networks/prarticleblocklist.2005-11-24.9405244085/skatnetworkblock.2005-10-20.1830969522/prarticleblock_direct_view. . (16/03/2016).

United Nations Department of Economics and Social Affairs (UNDESA). (2014) *World's Population Increasingly Urban with More than Half Living in Urban Areas*, New York, NY: UNDESA.

United Nations Environment Programme (UNEP) (2011) 'Waste – Investing in energy and resource efficiency'. Available at: http://www.unep.org/greeneconomy/Portals/88/documents/ger/GER_8_Waste.pdf

United Nations Environment Programme (UNEP). (2015) *Global; Waste Management Outlook*, Vienna: UNEP and International Solid Waste Association.

UN-Habitat. (2010) *Solid Waste Management in the World's Cities – Water and Sanitation in the World's Cities 2010*, London: Earthscan.

Visvanathan C. and Glawe V. (2006) *Domestic Solid Waste Management in South Asian Countries – A Comparative Analysis*, Presentation at 3 R South Asia Expert Workshop, Kathmandu, 30 August–1 September 2006. Available at: http://www.unep.org/ietc/OurWork/WasteManagement/tabid/56239/Default.aspx. . (16/03/2016).

Water, Engineering and Development Centre (WEDC). (No date) *Synthesis Notes in Solid Waste Management*. Loughborough: WEDC, Loughborough University.

WEDC (2000) Synthesis Note on 'The Role of Community-based organisations in solid waste management.

Wilson, D. (2007) 'Development drivers for waste management', *Waste Management & Research* 25, pp.198-2007.

Wilson, D. (2016) *Sustainable Waste Management in Developing Countries*. Presentation at DFID on 22 February, 2016.

World Health Organisation and IT Power (2005) 'Waste Disposal – Guidelines on How to Construct, Use, and Maintain a Waste Disposal Unit'. Available at: http://www.path.org/publications/files/TS_waste_disposal_guide.pdf

Yousuf, B. (2007) 'Dhaka's community based waste collection programme', *Waterlines* 25(4), DOI: 10.3362/0262-8104.2007.018.

Zurbruegg, C. (2003) *Urban Solid Waste Management in Low-Income Countries of Asia. How to Cope with the Garbage Crisis*, Presentation to Scientific Community on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session, Durban, November 2002. Available at:

http://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SWM/General_Overview/Zurbruegg_2003_Crisis.pdf. . (16/03/2016).

8.2 Bibliography

Abul, S. (2010) 'Environmental and health impact of solid waste disposal at Mangwaneni dumpsite. Swaziland', *Journal of Sustainable Development in Africa* 12(7), pp.64-77.

Abu-Qdais, H. (2011) *Public Private Partnership in Solid Waste Management: Opportunities and Challenges in Jordan*, Presentation to Regional Forum on Integrated Solid Waste Management, Beirut, April 2011, Tunis: SWEEP-Net.

Alam, R. et al. (2008) 'Generation, storage, collection and transportation of municipal solid waste –a case study in the city of Kathmandu, capital of Nepal', *Waste Management* 28, pp.1088-1097.

Ali, M. (2004) *Sustainable Composting: Case Studies and Guidelines for Developing Countries*, Loughborough: Water Engineering and Development Centre, Loughborough University.

Ali, M. (2007) *Governance in Solid Waste Management*. Editorial in Waterlines Special Issue, Rugby: Practical Action Publishing.

Ali, M. et al. (1999) *Down to Earth*. Loughborough: Water Engineering and Development Centre, Loughborough University.

Ali, N. and Sion, H. (2014) 'Solid waste management in Asian countries: a review of solid waste minimisation (3'r) towards low carbon', *IOP Conference Series: Earth and Environmental Science* 18(2014), 012152.

Allen, A., Davila, J. and Hofmann, P. (2006) *Governance of Water and Sanitation Services for the Peri-urban Poor*. London: The Bartlett Development Planning Unit, University College. Available at: https://www.bartlett.ucl.ac.uk/dpu/latest/publications/dpu-books/Allen_Davila_Hofmann_2006_WSS_PUI_book.pdf (. (16/03/2016).

Allen, C. and Jossias, E. (2011) *Mapping of the Policy Context and* Catadores *Organizations in Maputo, Mozambique*, Manchester: WIEGO. Available at http://wiego.org/sites/wiego.org/files/publications/files/Allen-Jossias_WIEGO_OB6.pdf . (16/03/2016).

Asian Development Bank. (2013) *Solid Waste Management in Nepal. Current Status and Policy Recommendations*, Metro Manila: ADB. Available at: http://www.adb.org/publications/solid-waste-management-nepal-current-status-and-policy-recommendations . (16/03/2016).

Asian Development Bank. (2014) *Solid Waste Management in the Pacific Institutional Arrangements*, Metro Manila: ADB. Available at: http://www.adb.org/publications/solid-waste-management-pacific-institutional-arrangements. (16/03/2016).

Astrup, T., Fruergaard, T. and Christensen, T. et al. (2009a) 'Recycling of plastic: accounting of greenhouse gases and global warming contributions', *Waste Management & Research* 27, pp.763-772.

Astrup, T., Møller, J. and Fruergaard, T. (2009b) 'Incineration and co-combustion of waste: accounting of greenhouse gases and global warming contributions', *Waste Management & Research* 27, pp.789-799.

Athena Infonomics. (2012) *Public Private Partnerships in Municipal Solid Waste Management – Potential and Strategies*, Chennai: Athena Infonomics.

Azni, I., Inanc, B. and Hassan, M. (2004) 'Overview of waste disposal and landfills/dumps in Asian countries', *Journal of Material Cycles and Waste Management* 6, pp.104-110.

Ball, J. Grobbelaar, L. and Cissé, O. (2007). Scavenging on landfills and dumpsites: an African perspective. Paper presented at the International Eurowaste Waste Management Conference 5–9 October 2007, S. Margherita di Pula (Cagliari), Italy.

Beall, J. (1997b) 'Households, livelihoods and the urban environment: social development perspectives on solid waste management in Faisalabad, Pakistan', PhD thesis, London: London School of Economics and Political Science.

Bogner, J. et al. (2008). 'Mitigation of global greenhpp.ouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report', *Waste Management and Research* 26, 11-32.

Boldrin, A. et al. (2009) 'Composting and compost utilization: accounting of greenhouse gases and global warming potentials', *Waste Management & Research* 27, pp.800-812.

Chandnak Surya, P. (2010) *Trends in Solid Waste Management; Issues, Challenges and Opportunities*. Tokyo: UNEP.

Chartier, Y et al. (eds.). 2014. *Safe Management of Wastes from Health-care Activities. Second Edition*, Geneva: WHO. Available at: https://noharm-global.org/articles/news/global/new-who-handbook-healthcare-waste-management. . (16/03/2016).

Chatam-Stephens, K. et al., (2013) 'Burden of diseases from toxic waste sites in India, Indonesia and the Philippines in 2010', *Environmental Health Perspectives* 121(7), p.p791-796.

Coad, A. (1994) *Managing Medical Wastes in Developing Countries. Report of a Consultation on Medical Wastes Management in Developing Countries*, Geneva: World Health Organization.

Coad, A. (2011) *Collection of Municipal Solid Waste Key issues for Decision-makers in Developing Countries*, *Nairobi:* UN-Habitat.

Cointreau, S. (1994). *Private Sector Participation in Solid Waste Services in Developing Countries – Volume I: The Formal Sector. Urban Management Programme*, Washington, DC: The World Bank.

Cointreau, S. (2006b) *Occupational and Environmental Health Issues of Solid Waste Management – Special Emphasis on Middle- and Lower-Income Countries*, Urban papers, Washington, DC: The World Bank Group.

Cointreau, S. (2015) *Transfer Station Design Concepts for Developing Countries*, Washington, DC: The World Bank. Available at: http://siteresources.worldbank.org/INTUSWM/Resources/463617-1202332338898/transferdesignoptions.pdf. . (16/03/2016).

Collivignarelli, C. et al. (2011) 'Techno-economic evaluation for the improvement of MSW collection in Somaliland and Puntland', *Waste Management & Research* 29(5), pp.521-31

Department for Environment, Food and Rural Affairs (DEFRA). (2004) *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes*. London: Defra Publications.

Di Bella, V. (2011) *Healthcare Waste Management in Developing Countries*. Rugby:. Practical Action Publications. Available at: http://practicalaction.org/low-cost-medical-waste-incinerator/comment:4f23daed-8e58-4425-a583-4cd90ae4f5bb. . (16/03/2016).

Di Bella, V., Ali, M. and Vaccari, M. (2012) 'Constraints to healthcare waste treatment in low-income countries - a case study from Somaliland', *Waste Management & Research* 30(6), pp.572-575.

Dias, S. and Fernandez, L. (2012) 'Waste pickers – a gendered perspective', in UNDP (ed.) (2012) *Powerful Synergies – Gender Equality, Economic Development and Environmental Sustainability*, New York, NY: UNDP, pp.163-166. Available at: http://www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/Powerful-Synergies.pdf. (. (16/03/2016).

Diaz, L., Savage, G. and Eggerth, L. (2005) 'Alternatives for the treatment and disposal of healthcare wastes in developing countries', *Waste Management* 25, pp.626-637

Harris, D., Kooy, M. and Jones, L. (2011) *Analysing the Governance and Political Economy of Water and Sanitation Service Delivery*, London: Overseas Development Institute.

Hasan, A. (1998) *Community Initiatives: Four Case Studies from Karachi*, Karachi, City Press. Available at: http://arifhasan.org/books/community-initiatives-four-case-studies-from-karachi. . (16/03/2016).

Heller, L and Catapreta, A. (2003) 'Solid waste disposal in urban areas and health – the case of Belo Horizonte, Brazil', *Waste Management & Research* 21, pp.549-556.

Hoornweg, D. (2013) *Municipal Solid Waste; Global Trends and the World Bank Portfolio*, Oshawa, ON: University of Ontario, Institute of Technology.

Hunt, C. (1996) 'Child waste pickers in India – the occupation and its health risks', *Environment and Urbanization* 8(2), pp.111-118.

International Solid Waste Association (ISWA). (No date) *Key Issue Paper on Waste Prevention, Waste Minimization and Resource Management*, Vienna: ISWA. Available at:

http://ec.europa.eu/environment/resource_efficiency/pdf/ISWA%20International%20Solid%20Waste%20Association.pdf. . (16/03/2016).

Khatib, I. (2011) 'Municipal solid waste management in developing countries: future challenges and possible opportunities', in Kumar, S. (ed.) (2011) *Integrated Waste Management – Volume II,* Rijeka: InTech. Available at: http://cdn.intechopen.com/pdfs-wm/18479.pdf. . (16/03/2016).

Massoud, M. and El-Fadel, M. (2002) 'Public-private partnerships for solid waste management services', *Environmental Management* 30(5), pp.621-630.

Mbongwe, B. et al. (2008) 'Healthcare waste management: current practices in selected healthcare facilities, Botswana', *Waste Management* 28, pp.226-233.

Medina, M. (2005) 'Serving the unserved: informal refuse collection in Mexican cities', *Waste Management & Research* 23(5), pp.390-397.

Niyas, M. and Muneera, F. (2012) *Public-Private Partnership (PPP) in Solid Waste Management. Literature Review of Experiences from Developing Countries with Special Attention to Sri Lanka*, Trondheim: Norwegian University of Science and Technology.

Oduro-Kwarteng, S. (2009) 'Institutional arrangements for private sector involvement in urban solid waste collection: case study of five cities in Ghana', in Shaw, R (ed.) (2009) Proceedings of the 34th WEDC International Conference on Water, Sanitation and Hygiene: Sustainable Development and Multisectoral Approaches, Addis Ababa, Ethiopia, 2009, Loughborough: CAB Direct, pp.542-549.

Organisation for Economic Development and Co-operation (OECD). (2008) Inventory of international initiatives related to sustainable materials management. Paris: OECD Working Group on Waste Prevention and Recycling. Available at: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=env/epoc/wgwpr%282007%294/final. . (16/03/2016).

Pariatamby, A. (2013) 'MSW management in Malaysia. Changes for sustainability', in Masaru, T. and Pariatamby, A. (eds.) (2013) *Municipal Solid Waste Management in Asia and the Pacific Islands*, Singapore: Springer Verlag, pp.195-232.

Plummer, J. (2002) *Focusing Partnerships. A Sourcebook for Municipal Capacity Building in Public-Private Partnerships*, London: Earthscan.

Practical Action Nepal. (2008) Best Practices on Solid Waste Management of Nepalese Cities. Kathmandu: Practical Action.

Rathi, S. (2006) 'Alternative approaches for better municipal solid waste management in Mumbai, India', *Waste Management* 26(10), pp.1192-1200.

Rego. R. 2005. Waste collection and diarrhoea in young Brazilian children. Available at: http://www.eldis.org/id21ext/h9rfr1g1.html

Research Triangle Institute, 2004. How to Develop an Effective Waste Collection Program - A Primer for Solid Waste Collection in Manado, North Sulawesi, Indonesia. Available at: http://pdf.usaid.gov/pdf_docs/Pnacy593.pdf. . (16/03/2016).

Schuebeler, C. (1996) *Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries*, Washington, DC: The World Bank. Available at: http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/conceptualframework.pdf. . (16/03/2016)..

Sharholy, M. et al. (2008) 'Municipal solid waste management in Indian cities – a review', *Waste Management* 28, pp.459-467.

Snel, M. (1999) 'Integration of the formal and informal sector—waste disposal in Hyderabad, India', *Waterlines* 17, pp.27-29.

UN General Assembly. (2014) *Report of the Open Working Group of the General Assembly on Sustainable Development Goals,* New York, NY: UN. Available at: http://www.un.org/ga/search/view_doc.asp?symbol=A/68/970. . (16/03/2016).

UN-Habitat. (2009) *Guide to Municipal Finance. The Human Settlement Financing Tools and Best Practices Series*, Nairobi: UN-Habitat.

United Nations Development Programme (UNDP). (2010) *Nepal: Public-Private Partnership in Solid Waste Management Contributing to MDGs 1 and 7 in Biratnagar*. New York, NY: UNDP.

United Nations Environment Programme (UNEP). (2007) *Assessment of Solid Waste Management in Liberia*, Nairobi: UNEP. Available at: http://postconflict.unep.ch/publications/Liberia_waste.pdf. . (16/03/2016).

United Nations Environment Programme (UNEP). (2010) *Waste and Climate Change – Global Trend and Strategy Framework*, Osaka: UNEP.

United Nations Environment Programme Global Environmental Alert Services (UNEP GEAS). (2013) *Municipal Solid Waste: Is It Garbage or Gold*, New York, NY: UNEP GEAS. Available at: http://www.unep.org/pdf/UNEP_GEAS_oct_2013.pdf. (16/03/2016).

United States Environmental Protection Agency (US EPA). (2009) *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practice*. Washington DC: US EPA.

Van de Klundert, A. and Lardinois, I. (1995) *Community and Private (Formal and Informal) Sector Involvement in Municipal Solid Waste Management in Developing Countries*, Gouda: WASTE. Available at: http://www.gdrc.org/uem/waste/swm-finge1.htm. . (16/03/2016).

Visvanathan, C. (2012) *Public Private Partnership in Waste Management through IPLA: What does Private Sector Want?* Presentation at the IPLA Global Forum on Zero Waste, Seoul, 4–5 September 2012. Available at: http://www.uncrd.or.jp/content/documents/01_Visu-AIT.pdf. . (16/03/2016).

WASTE and SKAT. (2010) *Economic Aspects of Informal Sector Activities in Solid Waste Management*, Eschborn: GTZ and CWG.

WASTE. (2010) *Start Your Waste Business*, Gouda: WASTE. Available at: http://www.waste.nl/sites/waste.nl/files/product/files/solid_waste_entrepreneurship_guide_december2011_final_reduced.pdf. . (16/03/2016).

Wilson, D., Vellis, C. and Cheeseman, C. (*2014) 'Role of informal sector recycling in waste management in developing countries', Habitat International* 30, pp.797-808.

Women in Informal Employment: Globalizing and Organizing (WIEGO). (2015) *About WIEGO*, Cambridge, MA: WIEGO. Available at: http://wiego.org/wiego/about-wiego. . (16/03/2016).

World Bank. (2013) *Morocco: Improving Municipal Solid Waste Management through Development Policy Operations*, Washington, DC: The World Bank Group. Available at: www.worldbank.org/en/results/2013/05/22/morocco-improving-municipal-solid-waste-management-through-development-policy-operations. . (16/03/2016).

World Health Organization, Regional Office for Europe. (2000) Starting Healthcare Waste Management in Medical Institutions – A Practical Approach. Copenhagen: WHO Regional Office for Europe.