



# RAPID DESK- BASED STUDY:

Evidence to Support improved  
Solid Waste Management in  
Sierra Leone

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## Introduction

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Evidence on Demand was requested by DFID to undertake a rapid desk-based study to provide evidence for supporting the improvement of solid waste management in Bo City, Sierra Leone. The work is specifically intended to help supporting strategic and economic appraisals for a potential DFID intervention.

This study has involved a review of selected literature (published in the last 10 years or of particular interest for the intervention), dealing with issues and benefits linked with solid waste management worldwide and, specifically, in developing countries. An in-depth internet search has been carried out of academic literature and grey sources. However, it should be noted that, given the time available for this study (three days for research and two days for report writing), an exhaustive review of the literature is beyond the scope of this work.

The study has been structured in order to clearly analyse some of the key drivers of solid waste management interventions (public health, environmental protection, economic drivers and social drivers). A fifth driver (institutional driver) is discussed in Section 1 and 2 of the report, but the literature available on this topic is very limited and therefore not incorporated in the report annotated bibliography (Section 3). The available literature largely describes impacts of solid waste management on public health and environment, whereas the available literature on economic and social drivers is more limited.

**Section one** of this report sets out and analyses the key findings of the literature and is structured as follows:

- **public health;**
- **environmental protection;**
- **economic drivers;**
- **social drivers;**
- **institutional drivers.**

**Section two** summarises these findings and draws out the evidence to support solid waste management interventions in Bo City, Sierra Leone.

**Section three** presents an annotated bibliography.



# SECTION 1

## Key findings

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### 1.1 Public health


Public health concerns led to the emergence of formalized waste collection systems in the nineteenth century and remain a key driver in developing countries (Wilson, 2007). The link between solid waste management and public health includes three relevant sub-subjects: health of local communities; health of workers in the waste sector and health of informal collectors (scavengers).

**Health of local communities: Numerous studies demonstrate how poor waste management impacts on the health of local communities and how those effects have led government throughout the world to support interventions on solid waste management.**

A well-documented case showing the potential impacts of uncollected solid waste and emergency of diseases is the outbreak of plague in Surat (India) in 1994 (Ross, 2011; UN-Habitat, 2010; Wilson, 2007). Uncollected solid waste blocking drains caused a major flood which in turn led to an outbreak of a plague-like disease. Over 100 plague-suspected patients were reported, with the final death toll of 56 people. This public health crisis stimulated new initiatives to collect the waste and clean up the city. Within a year after the plague, the level of daily solid waste collection increased from 30 to 93 per cent. Market areas, major roads and litter-prone spots are cleaned twice a day. Surat is now identified as one of the cleanest cities in the region (UN-Habitat, 2010). Similarly, a landslide at the Payatas dumpsite in Quezon City in the Philippines in July 2000, which killed 200 people, catalysed the political process that resulted in the passage of one of the most complete and progressive solid waste management laws in Asia (UN-Habitat, 2010).

A positive example is offered by a recent donor-funded project in Lusaka, Zambia, which extended waste collection to the urban poor in an unserved peri-urban community. Wilson (2007) reported that this intervention led to the elimination of cholera in the area.

The effect of poor waste management on the health of communities is detailed in numerous studies. Cointreau (2006) focuses on diseases derived from vectors in contact with solid waste and diseases from eating undercooked meat of animals in contact with solid waste. Among the diseases from vectors in contact with solid waste, Cointreau (2006) reports: an increase in the cases of dengue fever and malaria where waste that holds water (i.e., tyres, cans) remains uncollected and creates mosquito breeding sites; a greater prevalence of hanta virus, plague and leptospirosis (and potentially lassa fever) arising from exposure to the droppings and urine of rodents breeding and feeding in uncollected solid waste and open dumps, and a spread of bacterial infections by houseflies that have come in contact with faecal matter in solid waste. For instance, UN-Habitat (2010) reports twice as high diarrhoea rates among children living in households where garbage is dumped in the yard compared to houses where waste is collected regularly. Among the diseases from eating undercooked meat of animals in contact with solid waste, Cointreau (2006) reports an increase in the rates of trichiniosis where pigs and bears feed on solid waste (undercooked meat contains



whipworm) and a greater prevalence of taeniasis where pigs, beef and dogs feed on solid waste containing human and animal faecal matter.

Respiratory diseases are also frequently cited as an outcome of uncontrolled burning of solid waste. UN-Habitat (2010) reports that in a small city in Egypt, 89 per cent of villagers living downwind of the burning dumpsite were suffering from respiratory disease. Forbid (2011) clearly describes the effects of burning of household waste on health and air pollution (see following paragraph). Air pollution from open burning can irritate eyes and lungs, obscure visibility and increase the health impact for people already suffering by respiratory problems. UN-Habitat (2010) reports that prevalence rates of acute respiratory infections among children living in households where garbage is burned in the yard can be six times higher compared to houses where waste is collected regularly.

In Freetown (Sierra Leone), residents of two streets have complained about dirt-related sickness due to the presence of unmanaged solid waste, as reported by Gogra (2010). One of the residents remarked that the increase in the number of mosquitoes and flies has led to a significant increase in the rates of malarial- and diarrhoeal-related deaths in the communities.

Several studies also address the effect of special waste streams (and in particular, healthcare waste and hazardous waste) on human health. Those streams are often co-disposed with municipal solid waste in developing countries. For instance, Chatam Stephens et al. (2013) estimates that more than 8 million people were at risk of exposure to one of eight industrial pollutants at 373 toxic waste sites in three Asian countries in 2010, resulting in 828,722 disability-adjusted life year (DALYs), a value comparable to the incidence of malaria and outdoor air pollution in those countries.

**Health of workers in the waste sector: The results of two comprehensive reports analysing the relationship between exposure to solid waste and increased health and injuries risk are discussed below.**

Cointreau (2006) states that ‘there appears to be a global relationship (not yet precisely quantified) between exposure to solid waste and increased health and injury risk. The risk is greatest in developing countries where the contact between the solid waste worker and waste is greatest and the level of protection is least.’ Even though this study reports that data on health and accident consequences is inadequate in most high-income countries and almost non-existent in developing countries, it also discusses some of the most commonly reported occupational health and injury issues in solid waste management. They include back and joint injuries from lifting heavy waste-filled containers and driving equipment; respiratory illness from ingesting particulates during waste collection and from working in smoky and dusty conditions at open dumps; infections from direct contact with contaminated material, dog and rodent bites, or eating waste-fed animals (as discussed above); puncture wounds which can lead to tetanus, hepatitis and HIV infection; injuries at dumps due to surface subsidence, underground fires, and (land)slides; headaches and nausea from anoxic conditions where disposal sites have high methane, carbon dioxide, and carbon monoxide concentrations; and lead poisoning from burning of materials with lead-containing batteries, paints and solders. The work concludes that most of these health issues can be significantly reduced by improving occupational conditions of waste workers, with the positive side-effect of also increasing awareness of occupational health in other sectors.

UN-Habitat (2010) supports the conclusions drawn by Cointreau (2006); it reports that ‘while standards and norms for handling municipal solid waste in industrialised countries have reduced occupational impacts significantly, the risk levels are still very high in most developing countries’. For instance, in Mexico the average life expectancy of waste workers



is only 39 years compared to an average life expectancy of 69 years of the rest of the population. 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. Pulmonary problems have an incidence 1.4 to 2.6 times higher. Respiratory disorders, headache, nausea and vomiting are mentioned as other frequent effects. The exposure to hazardous waste can also cause cancer, birth defects, metabolic problems and failure of organs. Additional particular occupational risks, for instance related to the handling of wastes and containers, are strongly influenced by the use of personal safety equipment and by the type of infrastructure available.

### **Health of informal collectors: Several studies analyse the implications of solid waste handling on the health of waste pickers worldwide.**

Both UN-Habitat (2010) and Cointreau (2006) underline how the working environment of waste-pickers is very critical because it combines unhygienic conditions and risks of accidents, and the overlap of living and working environments, provided with minimal basic infrastructure for clean water and sanitation, causes additional dangers. Young waste-pickers, which represent a high proportion of waste pickers globally, are especially susceptible because specific risks are added to the general vulnerability of children.

Tuberculosis, bronchitis, asthma, pneumonia, dysentery, parasites, malnutrition, skin infections and lesions, eye burning and diminished visions are among the diseases frequently reported by informal collectors according to studies conducted in the Philippines and in India (Cointreau, 2006). Afon (2009) divides the risk effects of scavenging activities in Lagos (Nigeria) in six categories: occupational accidents (e.g. cuts); physical risk (e.g. explosions of waste piles); chemical risk (e.g. inhaling toxic gases); psychological risks (e.g. stigmatisation and lowering of self-esteem); biological risk (e.g. infections); and general hazard (e.g. bites and stings from animals and insects).


Several studies also highlight how the health status of waste pickers is actually a public health concern. For instance, Ezeach (2009), basing his conclusions on a study conducted in Nigeria, underlines that waste pickers could be potential pathways for the transmission of various communicable diseases to the general public. Examples from South Africa and Brazil shows that organizing waste-pickers and provide improved working conditions (e.g. picking zones (South Africa), and picking belts (Brazil; Fergutz et al., 2011)) significantly improve their health and general living conditions.

## **1.2 Environmental protection**

There is a rich literature documenting the impacts of poor solid waste management practice on the environment in general and on specific environmental components, including water, soil and air. The pollution of the environment produces direct effects on public health, as described above. Climate change is also emerging as a key driver in both developed and developing countries.

### **Broad environmental issues: Several studies describe the environmental impacts of improper collection and disposal of solid waste worldwide.**

UN-Habitat (2010) and Appleton et al. (2000) report that uncollected waste is often dumped in an uncontrolled manner throughout the cities, clogging drains, blocking roads and occupying vacant plots of land. This, as well as being unaesthetic, causes problems of flooding and increased traffic congestion. For instance, the annual floods in Kampala are blamed, at least in part, on plastic bags, which block sewers and drains. The accumulation of



waste also offers very good conditions for the propagation of germs, insects, rats and other diseases vector, whose effects on human health have already been described above.

Uncontrolled or open dumping can also lead to major landslips, like the ones occurred in Bandung (Indonesia) in 2005, Payatas, Metro Manila (Philippines) in 2000 (Wilson, 2007) and Bogota (Colombia) in 1996.

In Freetown (Sierra Leone), residents use gutters and other unofficial sites for dumping waste, resulting in choked waterways/streams that flow down to the sea (Gogra, 2010). Waste is then frequently washed up onto the beaches, negatively affecting the landscape. Moreover, uncollected waste becomes soggy and smelly during the rainy season.

**Water pollution: Numerous studies analyse the effects of waste disposal on groundwater and surface water.**

Leachate and surface runoff from land disposal facilities affects down-gradient ground and surface water quality, often used also for drinking purposes in developing countries (Cointreau, 2006).

Examples of water contamination are well-documented worldwide (Kjeldsen et al, 2002). Examples from the African continent include case study work conducted in South Lunzu Township Malawi (Palamuleni, 2002) and in Lagos, Nigeria (Oluyemi, 2009). Both surface and ground water in South Lunzu township, where indiscriminate disposal of waste is practiced, were characterised by high levels of faecal coliforms and faecal streptococci. In Lagos heavy metals (Pb, Cd, Mn and Fe) were found in water samples collected from 44 wells located within 25 m radius from six dumping sites in concentrations higher than WHO and national standards for drinking water.

**Soil pollution: Several studies have been conducted recently in Asia on the impact of improper waste disposal on soil.**

Enguchi et al. (2013) reports the results of the analyses conducted on the soil of six dumping sites in Asia, where municipal waste is co-disposed with electronic waste. They resulted in contamination of the site by brominated flame retardants (BFR). BFR are characterised by the potential for bioaccumulation and adverse effects on humans and wildlife. In particular, polybrominated diphenyl ethers (PBDEs), which have adverse physiological effects including endocrine disruption and interference with neurobehavioral development, were detected in all the dumping site soils at significantly higher levels than those in their reference sites.

Minh et al. (2006) found higher concentrations of polychlorinated biphenyls (PCB) and dichlorodiphenyltrichloroethane (DDT), which are persistent organic pollutants (POPs) negatively affecting human health, in dumping sites in Asia than in control sites. The dumping sites selected were located close to human habitats, creating risks for the local community, as well as for waste pickers.

**Air pollution: Several studies discuss the pollutants released in the atmosphere due to open burning or waste degradation processes taking place at uncontrolled disposal sites.**

Inadequately controlled land disposal facilities release volatile compounds, methane and carbon dioxide into air. Apart for the effects on climate change produced by methane and carbon dioxide (see below), volatile organic compounds are likely to influence cancer incidence, birth defects and infant mortality in particular among waste pickers (Cointreau, 2006).





Uncontrolled burning of household waste is among the main sources of air pollution in Cameroon and a major source of toxicants, in particular due to the open dumping of hazardous and toxic waste (Forbid, 2011). Average pollutant emission from open burning is very high compared to controlled municipal waste combustion and generates very high pollution levels. Sub-stoichiometric combustion of mixed waste rich in plastic packaging and waste electric and electronic equipment, like waste burning taking place at open dumping sites, produces a variety of polymeric materials including BFR, which when burnt release toxic PBDEs or dioxins, terephthalic acid, furans and various greenhouse and acidic gases, smoke, and dust.

In particular, burning e-waste, a category of waste that is becoming more and more common in developing countries due also to the increased rate of export of e-waste from developed countries, produces potential environmental contaminants, such as dioxins, furans, polycyclic aromatic hydrocarbons, PHAHs and hydrogen chloride (Robinson, 2009).

**Climate change: Climate change is emerging as a key driver for solid waste management worldwide. Some publications analyse how the management of waste, and in particular its disposal, can generate greenhouse gases and affect global warming.**

Data show that the management of municipal solid waste and wastewater contribute about 3 per cent to current global anthropogenic greenhouse gas emissions. One forecast suggests that without mitigation this could double by 2020 and quadruple by 2050 (UN-Habitat, 2010).


Open dumping contributes to climate related issues: open or low-temperature burning generates air pollution (of which one of the most toxic is dioxin) and emits particulates fine particles and carbon dioxide; methane is released from the anaerobic digestion of organic materials disposed at dumping sites (UN-Habitat, 2010). It has to be noted that methane has 21 times the global warming impact of carbon dioxide on a weight basis over a 100-year time horizon, and thus is a powerful global warming agent (Johannessen, 1999), but could be reduced to carbon dioxide if collected and utilized for e.g. power generation.

### 1.3 Economic drivers

A limited number of studies consider the economic implications of a poor system of solid waste management. These studies range from discussing the economic implications of environmental and public health issues to analysing direct links between solid waste management and other economic sectors (e.g. tourism, provision of infrastructure, and farming). As reported by Cointreau (2005), it is also important to note that many surveys conducted by the World Bank have demonstrated that willingness to pay increases after services have been improved.

**Economic costs of environmental and public health issues: Evidence of the costs of environmental and public health issues derived from bad solid waste management practices is limited, but few relevant examples and case studies exist.**

UN-Habitat (2010) reports interesting data linking environmental and public health issues to economic costs. For instance, the city of Surat (India), as a result of the outbreak of plague already described at Paragraph 1.1, incurred in a daily loss of about USD 17.2 million during the plague period and a total loss amounting to about USD 400 million, whereas the environmental costs of water contamination from improper waste disposal in Nigeria was estimated to about USD 86 million per year.



Other economic costs of the impact of poor solid waste management practices on public health can be linked to the reduction of productivity and life length, as quantified by the DALY factor (see Paragraph 1.1 and Chatam Stephens (2013) for more details).

**Effects on other economic sectors: Economic implications of unimproved systems of solid waste management on other sectors are documented but seldom quantified.**

UN-Habitat (2010) and Wilson (2007) report that a dirty and unhealthy city will make it difficult to attract businesses and foreign investment and promote tourism. UN-Habitat (2010) reports that in Tangier, Morocco, pollution of beaches by solid wastes was cited during the late 1990s as the leading cause of tourism decline that cost hotels in the area US\$23 million per year in lost revenues.

Poor practices of solid waste management have also been shown to impact on farming activities. This is well-known, but not very well documented. One of the key issues is the mortality of cattle and grazing animals arising from the ingestion of plastic bags. UN-Habitat (2010) highlights the particular case of cows in Mali to demonstrate this issue.

Inadequately collected and improperly managed solid waste can also generate significant local externalities affecting improvements made on other types of infrastructure. For instance, in Costa Rica, the electric utility company has had so many problems with plastic litter clogging the turbines of their hydroelectric plants that they are financing plastics recycling in the catchment area behind their dams (UN-Habitat, 2010). Several studies, including Appleton et al. (2000) and Cointreau (2005), also mention how improperly disposed solid waste can increase traffic congestions (e.g. for the presence of overflowing containers along the streets) and affect transport infrastructure.

## 1.4 Social drivers

A limited number of studies have analysed the relationship between solid waste management and social drivers at the community level<sup>1</sup>, whereas more information is available regarding the social implications for the informal sector.

A study conducted in Ghana (Owusu, 2010) describes how poor waste management can lead to disputes within the community, affecting its social cohesion. Moreover, an unpleasant living environment, where open spaces are often used for the unregulated disposal of solid waste, can reduce the opportunities for children of companionship, recreation and social living and can lead to stigmatization of that community by other communities.

Wilson (2007) highlights how the ability of making a living by recovering saleable materials from waste is still a key driver for the informal sector in many parts of the world. The informal sector is one of the links between solid waste management and the Millennium Development Goal aimed at reducing world poverty by 50% by 2015. This is strengthened by the considerations made by Ross (2010), reporting that improved waste management programmes along with steps to provide alternative employment for waste pickers can immediately enhance the quality of life of this part of society. As well as living and working in precarious conditions (as described in the previous paragraphs), a study conducted on a dumping site in Nigeria (Afon, 2009) describes cases of violence between different groups of informal collectors and underlines the risk of sexual harassment of female waste-pickers.

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<sup>1</sup> In this context “relationship between solid waste management and social drivers at community level” refers to the impacts and benefits that different practices of solid waste management can have at community level. This does not refer to the involvement of communities in the provision of solid waste management services.



## 1.5 Institutional drivers

Limited evidence could be found in the literature on how institutional commitment can drive (or oppose to) improvements in the solid waste management sector. However, Wilson (2007) mentions institutional and responsibility issues as an underpinning of a group of drivers; as UN-Habitat (2010) reports 'if a city is dirty, the local administration is written off as ineffective'.

A study conducted by Parizeau et al. (2008) in Siem Reap (Cambodia) illustrates how the loss of a political champion and a lack of cooperation by a private waste collection company derailed the financing of a community-based solid waste management project despite the presence of other favourable conditions for its success, such as the support from local residents, schools and religious authorities. Johannessen (1999) describes how the management of a landfill suddenly worsened after the change in the local administration in the responsible municipality. This landfill initially provided a good example of landfill management, but the new authorities did not allocate funds to pay the contractor, who in the end abandoned the landfill, and the landfill was returned into an open dump.

Other examples can be drawn from the experience of the authors. The shift from dumping site to sanitary landfill was obstructed by the decision of the mayor of a municipality in Somaliland to use the soil stored for constructing the landfill embankments to build a road. On the contrary, the commitment of the mayor of Morogoro Municipality (Tanzania) resulted in efficient waste collection from the town. The Municipality took over the responsibility to remove the waste from dedicated waste collection points where waste was dropped by organized CBOs provide the waste collection service to their community (against a fee).



# SECTION 2

## Summary

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This section summarizes the key findings of the literature review. Social and institutional drivers are incorporated into one single paragraph due to the limited availability of documented evidence.

### 2.1 Public health

Public health concerns led to the emergence of formalized waste collection systems in the nineteenth century, and remain a key driver in developing countries. Some major crises in the public health sector, which were attributed to the presence of uncollected waste, have been major drivers of change. Examples cited include significant improvements in solid waste management in Surat, India and Quezon City, the Philippines.

The effect of poor waste management on the health of communities is documented in numerous studies. Diseases derived from vectors in contact with solid waste (e.g. bacterial infections, dengue fever, hanta virus, leptospirosis, plague and potentially also lassa fever); diseases from eating undercooked meat of animals in contact with solid waste (trichionosis and taeniasis), and respiratory illness are reported as the primary effects on community health. If hazardous waste is disposed of together with municipal waste, carcinogenic effects have also been recorded.

Waste management malpractices heavily affect the health of people working in the waste sector, in particular that of informal collectors in developing countries where there is a greater degree of direct exposure to the waste. Higher levels of infections, respiratory diseases, as well as injuries are reported among those workers compared to workers in other industrial sectors.


### 2.2 Environmental protection

There is a rich literature documenting the impacts of poor solid waste management practice on the environment in general and on specific environmental components, including water, soil and air.

The issues of drain clogging (and consequently floods), traffic congestion, the blight of vacant plots of land and landslips due to the presence of unmanaged waste are well documented in the literature. Moreover, uncollected waste also negatively affects the landscapes aesthetic appearance.

Leachate and surface runoff from land disposal facilities have the potential to pollute down-gradient ground and surface water. Evidence for this is widely described in the literature.

Brominated flame retardants and several types of persistent organic pollutants have been detected in the soils of uncontrolled disposal sites. Those contaminants have adverse physiological effects on human bodies, including endocrine disruption and interference with neurobehavioral development.



Emissions from open burning of waste are frequently mentioned among the main source of air pollution in developing countries. They include dioxin and fine particles, which, together with methane released from the anaerobic decomposition of waste, contribute to pollution and global warming and climate change.

## 2.3 Economic drivers

The economic costs of environmental and public health issues attributable to a poor management of solid waste have been documented in few studies. They include economic losses due to the loss of lives, and the reduction of productivity and life length due to the spread of waste-related diseases.

Poor waste management also impacts on a number of economic sectors, including tourism (e.g. affected by pollution of coast and seas) and farming (e.g. cattle affected by the ingestion of plastic waste). It can also negatively affect investments in other infrastructure, such as transport and facilities for energy production.

## 2.4 Social and institutional drivers

Social effects of poor practices of waste management include reduced social cohesion, fewer opportunities for children for companionship and recreation, and the stigmatisation of communities. Negative social impacts also affect the informal sector (e.g. violence and risk of sexual harassment).

Political and institutional commitment is necessary for an actual improvement in the management of solid waste. Limited evidence is available in the literature on this topic, but this has been experienced by the authors and other experts in the solid waste management sector.



# SECTION 3

## Annotated Bibliography

Sources are rated in the following bibliography as 1, 2 or 3. Sources rated '1' are those most relevant to the current study that are also of high analytical quality, which stakeholders might want to prioritise if they have limited time for reading of the literature. Studies rated '2' are also relevant and of generally good quality. Those rated '3' are of more marginal relevance, or may have unclear methodology or be more than ten years old, but are included because they address some key dimension of the TORs, not adequately covered by other sources. It should be noted that this rating system is not a judgement of academic quality, but focuses primarily on relevance for the current purpose.

| Study  | Research Design and Methodology         | Synopsis and Relevance  | Drivers/ Issues in SWM |             |           |        |
|--|---|---|------------------------|-------------|-----------|--------|
|  |   |   | Health                 | Environment | Economics | Social |
| 1. Abul, S., 2010. 'Environmental and health impact of solid waste disposal at Mangwaneni dumpsite, Swaziland'. <i>Journal of Sustainable Development in Africa</i> , 12 (7): 64-77                                      | Empirical case study,<br>2              | The study aims at assessing the impacts of Mangwaneni dumping site on the health of the nearby community. The author identifies higher incidence of malaria and diarrhoea.                                | ✓                      |             |           |        |
| 2. Afon, A., 2012. 'A survey of operational characteristics, socioeconomic and health effects of scavenging activity in Lagos, Nigeria'. <i>Waste Management &amp; Research</i> , 30 (7): 664-671                        | Primary and Empirical survey<br>2       | This article presents the findings of a study conducted among the scavengers working at a dumping site in Lagos. The author analyses socio-economic, operational and health conditions of the scavengers. |                        | ✓           | ✓         | ✓      |
| 3. Appleton, J., et al., 2000. 'Success and sustainability indicators – a tool to access primary collection schemes. Case study: Khulna, Bangladesh'. Water, Engineering and Development Centre, Loughborough University | Secondary and Empirical case study<br>3 | This study reports indicators of success and sustainability in the implementation of primary collection schemes. The indicators are also applied to the case study of Khulna, Bangladesh.                 | ✓                      | ✓           |           |        |



| Study   | Research Design and Methodology | Synopsis and Relevance   | Drivers/ Issues in SWM |             |           |        |
|---|---------------------------------|--|------------------------|-------------|-----------|--------|
|   |                                 |  | Health                 | Environment | Economics | Social |
| 4. Chatam-Stephens, K., et al., 2013. 'Burden of diseases from toxic waste sites in India, Indonesia and the Philippines in 2010'. <i>Environmental Health Perspectives</i> , 121 (7): 791-796        | Empirical case studies<br>2     | The study analyses the disease burden, in terms of disability-adjusted life year (DALY), affecting communities living nearby toxic waste disposal sites in three Asia countries. The authors estimated that more than 8 million people (828,722 DALYs) living close to 373 sites suffered diseases, disabilities or death from exposure to industrial contaminants. This estimate is comparable to the estimated effects of air pollution and malaria in these countries.                            | ✓                      |             |           |        |
| 5. Cointreau, S., 2005. 'Solid Waste Management Conceptual Issues on Cost Recovery, Financial Incentives, and Intergovernmental Transfers'. Informal concept note.                                    | Secondary<br>2                  | This paper analyses financial options and experiences. The author discusses responsibilities and costs for solid waste management services.  |                        | ✓           | ✓         |        |
| 6. Cointreau, S, 2006. 'Occupational and Environmental Health Issues of Solid Waste Management – Special Emphasis on Middle- and Lower-Income Countries.' <i>Urban Papers</i> , The World Bank Group. | Primary and Secondary<br>1      | This paper discusses both occupational health risks to workers and environmental health risks to residents and workers. The paper strongly focuses on diseases and injuries likely to occur to workers in the different phases of solid waste management, but it also describes the links between poor waste management and vector-borne/ animal-feeding diseases.   | ✓                      |             |           |        |
| 7. DEFRA, 2004. 'Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes'. Defra Publications.   | Secondary<br>3                  | This article presents the findings of studies conducted in the UK regarding health and environmental effects of waste management. The authors conclude that present-day practice for managing municipal solid waste has at most a minor effect on human health and the environment. However, they highlight that this is linked with the benefits of collection and disposal of the waste and that if waste were not collected, treated and disposed, they would become a source of disease, odours, | ✓                      |             |           |        |



| Study   | Research Design and Methodology                             | Synopsis and Relevance  | Drivers/ Issues in SWM |             |           |        |
|---|---|---|------------------------|-------------|-----------|--------|
|   |   |   | Health                 | Environment | Economics | Social |
|   |   | litters and pests.  |                        |             |           |        |
| 8. Diaz, L. F., et al., 2005. 'Alternatives for the treatment and disposal of healthcare wastes in developing countries'. <i>Waste Management</i> , 25: 626-637                   | Secondary 2   | This paper presents and discusses some of the most common treatment and disposal methods utilized in the management of infectious healthcare waste in developing countries.   | ✓                      |             |           |        |
| 9. Eguchi, A. et al., 2013. 'Soil contamination by brominated flame retardants in open waste dumping sites in Asian developing countries'. <i>Chemosphere</i> , 90 (9): 2365-2371 | Empirical survey 2  | This article discussed the finding of a study conducted on waste dumping sites in Asian countries. The study aimed at identifying the presence of brominated flame retardants (able to cause negative effects on environment and human health) in the soils of those dumping sites. | ✓                      | ✓           |           |        |
| 10. Ezeah, C., et al., 2009. 'Evaluation of Public Health Impacts of Waste Scavenging in Abuja Nigeria, Using Q Methodology'. ISWA World Conference 2009                          | Primary Empirical case study 2                              | The aim of this paper was to evaluate the public health and environmental implications of waste scavenging in Abuja.  | ✓                      | ✓           |           |        |
| 11. Fergutz, O., et al., 2011. 'Developing urban waste management in Brazil with waste picker organizations'. <i>Environment and Urbanization</i> , 23: 597-608                   | Secondary 2   | After describing the waste pickers and the city and national associations they have created, this paper describes the recycling industry and gives some examples of better methods of recycling.  | ✓                      |             | ✓         | ✓      |
| 12. Forbid, G. T. et al., 2011. 'Open waste burning in Cameroonian cities: an environmental impact analysis'. <i>Environmentalist</i> , 31: 254-262                               | Secondary, Field Observation, and Unstructured Interviews 1 | The author describes the effects on human health and the environment of open burning practices, which are commonly adopted at dumping sites in Cameroonian cities.  | ✓                      | ✓           |           |        |
| 13. Gogra, A. B., et al., 2010. 'A Situational Analysis of Waste Management in Freetown, Sierra Leone.' <i>Journal of American Science</i> , 6 (5): 124-135                       | Secondary and Empirical case study 1                        | This paper gives an overview of the state of solid waste management in the city of Freetown and highlights social and environmental issues due to a poor waste management system.   |                        | ✓           |           | ✓      |





| Study   | Research Design and Methodology | Synopsis and Relevance  | Drivers/ Issues in SWM |             |           |        |
|---|---------------------------------|---|------------------------|-------------|-----------|--------|
|   |                                 |   | Health                 | Environment | Economics | Social |
| 14. Heller, L, Catapreta, A, 2003. 'Solid waste disposal in urban areas and health – The case of Belo Horizonte, Brazil'. <i>Waste Management &amp; Research</i> , 21: 549-556.         | Epidemiological study<br>2      | This article presents the results of a study conducted in order to analyse the association between the presence of a sanitary landfill and the health of the neighbouring population. The study revealed little relationship between the presence of the sanitary landfill and the health of the population.  | ✓                      |             |           |        |
| 15. Johannessen, L.M., and Boyer, G., 1999. 'Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America'. The World Bank.                           | Empirical case studies<br>3     | The report documents observations from visits to landfills in Africa, East Asia and Pacific, and Latin America and Caribbean regions. Specifically, it identifies emerging features, practices, and improvements in the final disposal of solid waste. Also discussed are trends in the regulatory area, private sector involvement, tipping fees, and the impact of waste pickers on sanitary landfills. |                        | ✓           | ✓         |        |
| 16. Johannessen, L. M., et al., 2000. 'Healthcare waste management guidance note'. The World Bank.  | Secondary<br>3                  | This paper synthesise the knowledge about healthcare waste management with a particular focus on developing countries. Of interest for the report are mainly the consequences of improper management of healthcare waste on public health and environment.  | ✓                      | ✓           |           |        |
| 17. Kinnaman, T. C., 2009. 'The economics of municipal waste management'. <i>Waste Management</i> , 29: 2615-2617   | Secondary<br>3                  | The paper reports the findings of a restudy, which analysed the available literature on the cost of solid waste management in both developed and developing counties. The conclusion is that more research is needed to understand the robustness of the key findings.  |                        |             | ✓         |        |
| 18. Kjeldsen, P. et al., 2002. 'Present and Long-Term Composition of MSW Landfill Leachate: A Review'. <i>Critical Reviews in Environmental Science and Technology</i> , 32 (4):297–336 | Secondary<br>3                  | This article describes how leachate composition varies in the different phases of the life of a landfill.   |                        | ✓           |           |        |



| Study   | Research Design and Methodology  | Synopsis and Relevance   | Drivers/ Issues in SWM |             |           |        |
|---|--|--|------------------------|-------------|-----------|--------|
|   |  |  | Health                 | Environment | Economics | Social |
| 19. Minh, N. H. et al., 2006. 'Contamination by Persistent Organic Pollutants in Dumping Sites of Asian Developing Countries: Implication of Emerging Pollution Sources'. <i>Archives of environmental contamination and toxicology</i> , 50 (4): 474-481 | Empirical survey<br>2  | The objective of this paper is to elucidate contamination by persistent organic pollutants (POPs) in dumping sites in Asia. The concentration of POPs (e.g. DDT, PCBs and HCHs) in the soil of the dumping sites resulted much higher than in the control sites, creating risks for the local community and for waste pickers.   | ✓                      | ✓           |           |        |
| 20. Oluyemi, E. A., et al., 2009. 'Potential groundwater contamination with toxic metals around refuse dumps in some parts of Lagos metropolis, Nigeria'. <i>Toxicological and environmental chemistry</i> , 91 (5): 933-940                              | Empirical survey<br>2  | This article presents the findings of a study conducted on six waste dumping sites within Lagos metropolis aimed at analysing the presence of nine heavy metals. The results showed elevated concentrations of most heavy metals among the ones selected.  |                        | ✓           |           |        |
| 21. Owusu, G, 2010. 'Social effects of poor sanitation and waste management on poor communities: a neighbourhood-specific study of Sabon Zongo, Accra'. <i>Journal of Urbanism</i> , 3 (2): 145-160.  | Secondary, Focus group discussions, Interviews and Empirical Survey<br>1 | The author argues that poor sanitation and solid waste management in poor communities have social implications, as well as health and environmental ones. The author describes how poor waste management can lead to disputes within the community, affecting its social cohesion. Moreover, an unpleasant living environment, where open spaces are often used for the unregulated disposal of solid waste, can reduce the opportunities for children of companionship, recreation and social living and can lead to stigmatization of that community by other communities. |                        |             |           | ✓      |



| Study   | Research Design and Methodology                     | Synopsis and Relevance   | Drivers/ Issues in SWM |             |           |        |
|---|---|--|------------------------|-------------|-----------|--------|
|   |   |  | Health                 | Environment | Economics | Social |
| 22. Palamuleni, L. G., 2002. 'Effects of sanitation facilities, domestic solid waste disposal and hygiene practices on water quality in Malawi's urban poor areas: a case study of South Lunzu Township in the city of Blantyre'. <i>Physics and Chemistry of the earth</i> , 27 (11/12): 845-850 | Questionnaires, Interviews and Empirical Study<br>3 | The study presented in this article analyses the effects of poor sanitation and indiscriminate disposal of waste on surface and ground water in a peri-urban area. The relevance to the present study is limited because the author did not discern the effects of poor solid waste management from the ones of poor sanitation.               |                        | ✓           |           |        |
| 23. Parizeau, K. et al. (2008). 'Budget sheets and buy-in: financing community-based waste management in Siem Reap, Cambodia'. <i>Environment and Urbanization</i> , 20:445-463   | Questionnaires, Interviews and Empirical Study<br>2 | The case study presented in this article illustrates how the loss of a political champion and a lack of cooperation by a private waste collection company derailed the financing of a community-based solid waste management project despite the presence of other favourable conditions for its success.                                      |                        |             | ✓         | ✓      |
| 24. Robinson, B. H., 2009. 'E-waste: An assessment of global production and environmental impacts'. <i>The science of the total environment</i> , 408 (2): 183-191  | Secondary<br>3                                      | The review presented in this article aims to assess the global production of e-waste, the contaminants and contaminant fluxes associated with e-waste and the likely environmental impacts of those contaminants.  | ✓                      | ✓           |           |        |
| 25. Ross, D. E., 2011. 'Safeguarding public health, the core reason for solid waste management'. <i>Waste Management &amp; Research</i> , 29 (8): 779-780   | Secondary<br>2                                      | The author argues that core objective of all solid waste management programmes, the protection of public health, is rarely cited when promoting an intervention on solid waste management. The article also reports cases from both developed and developing countries of the spread of diseases due to an improper management of solid waste. | ✓                      |             |           |        |



| Study   | Research Design and Methodology               | Synopsis and Relevance   | Drivers/ Issues in SWM |             |           |        |
|---|---|--|------------------------|-------------|-----------|--------|
|   |   |  | Health                 | Environment | Economics | Social |
| 26. Saffron, L, et al., 2003. 'The human health impact of waste management practices – A review of the literature and an evaluation of the evidence'. <i>Management of Environmental Quality: An International Journal</i> , 14 (2): 191 - 213. | Secondary<br>3                                | This article presents an appraisal of the epidemiological evidence concerning the public health implications of five waste management processes (namely, incineration, landfilling, composting, sewage discharges and landspreading of sewage sludge). According to the results of this study, even though more than 220 papers had been published about the hazards to health from landfill sites (the most relevant practice to this report), there was a complete lack of exposure data, which undermined the statistical relevance of those studies. | ✓                      |             |           |        |
| 27. Sankoh, F. P. and Yan, X., 2013. 'Problems of solid waste management in developing urban cities: a case study of Freetown, Sierra Leone'. <i>American Journal of Environmental Protection</i> , 2(5): 113-120                               | Primary, Interviews and Empirical Survey<br>3 | This article gives an overview of the waste management system in Freetown and highlights the problems identified by the local population.  |                        | ✓           |           |        |
| 28. UN-Habitat, 2010. 'Solid Waste Management in the World's Cities – Water and Sanitation in the World's Cities'. Earthscan  | Case studies<br>1                             | This book aims at providing a look at how cities do and do not succeed in the solid waste management sector. The book combines experience and case studies with analysis of 20 city profiles. Drawing from those case studies, the authors identify key drivers in solid waste management and describe how each of the drivers is dealt with in the reference cities and globally.   | ✓                      | ✓           | ✓         |        |



| Study  | Research Design and Methodology     | Synopsis and Relevance   | Drivers/ Issues in SWM |             |           |        |
|--|-------------------------------------|--|------------------------|-------------|-----------|--------|
|  |                                     |  | Health                 | Environment | Economics | Social |
| 29. WASTE, Skat, GTZ, 2010. 'Economic Aspects of the Informal Sector in Solid Waste Management – Main Report'.             | Primary Empirical case studies<br>2 | The study focuses on analysing informal economic activities in two closely related sub-sectors, the informal service sector, and the informal valorisation sector. The main purpose of the study is to inform policymaking related to upgrading and modernising solid waste systems in low- and middle-income countries.   |                        | ✓           | ✓         | ✓      |
| 30. Wilson, D. C., 2007. 'Development drivers for waste management', <i>Waste Management &amp; Research</i> , 25: 198-207. | Secondary<br>1                      | This article explores the drivers for development in waste management. The author identifies six broad groups of drivers (namely for developing countries, public health, environmental protection, resource value of waste, institutional and responsibility issues, and public awareness) and argues that there is no one single driver. The balance between these six groups has varied over time and will vary between countries depending on local circumstances. | ✓                      | ✓           | ✓         |        |