

Nexus Brief, Nr. 6, February 2019

Climate Change & Environment

Urban Municipal Solid Waste Management



Key Messages

In developing countries and countries in transition, the generation of municipal solid waste (MSW) is increasing significantly due to population growth, economic development and urbanisation. Increasing quantities of MSW and inadequate management of MSW lead to increasing greenhouse gas (GHG) emissions, negative impacts on public health and environmental degradation. Methane generated from de-composing organic waste is the solid waste sector's largest contributor to GHG emissions in these countries, and is the result of inadequate management of food and green waste. The food and green waste category represents about 55% of total waste in developing and transitional countries.

Typically, the cities in these countries are not clean, waste collection rates are generally low, formal waste services do not extend to all parts of all communities, and the informal sector removes a large fraction of recyclables. Open dumping and open burning are still common practice. If current MSW management

practices continue, GHG emissions will increase, as well as impacts on the environment and human health.

A sound MSW management is, therefore, increasingly important, and the most promising approach is an adequate combination of institutional, technical, financial, organisational and communication activities:

- Implementation and enforcement of an appropriate regulatory framework and MSW management strategy at the municipal level
- Use of sanitary landfills as a sound MSW treatment option
- Sound treatment of organic waste
- Proper tariffs and a reliable fee collection system
- Reliable and efficient waste collection services for all areas of the city
- Targeted, tailor-made communications to specific groups
- Engagement with the informal sector

Context

Why this Nexus brief

This Nexus brief sheds light on the complex interactions between waste, climate change and the environment, and reviews the current challenges and opportunities in handling urban MSW in developing countries and countries in transition.

MSW in the context of climate change and environment

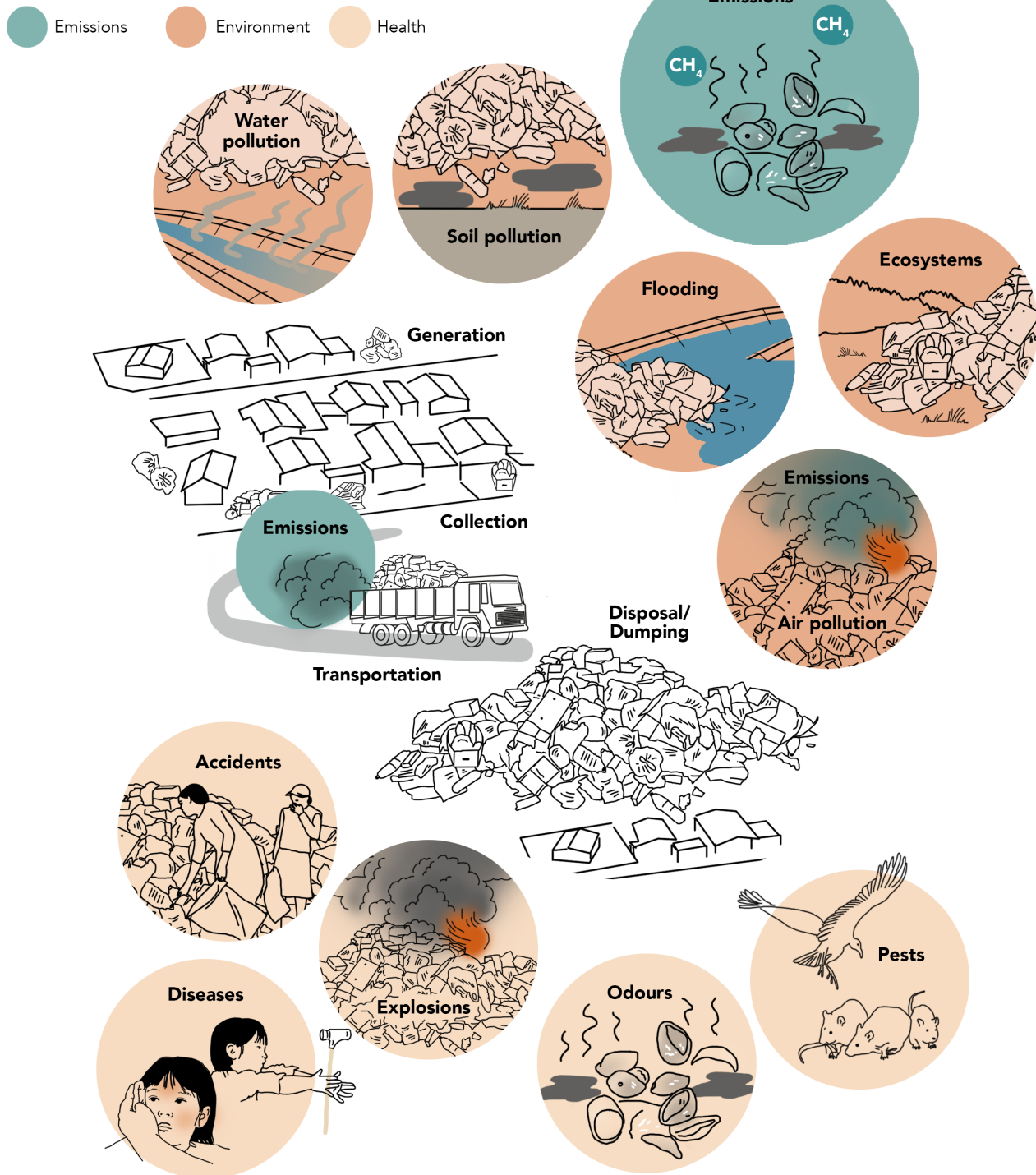
The increasing quantities and inadequate management of municipal solid waste, and especially the increasing numbers of dump sites and uncontrolled landfills in developing countries and in countries in transition, are leading to higher GHG emissions, negative impacts on public health and environmental degradation. Particularly the open decomposition of organic fractions is creating diseases, nuisance odours

and methane gas emissions, which affect people living near waste dumps or landfill sites by contaminating or polluting air, water and soil ecosystems. This can jeopardize the use of important water resources for irrigation or human consumption.

MSW can affect the release of GHG emissions in multiple ways. Most importantly via methane emissions in landfills due to the decomposition of organic matters in waste. Methane with its high global warming potential, is the most dominant GHG within the waste sector and produced for many years, before waste is decomposed completely. Furthermore, GHG emissions result from burning of waste. In addition, the collection and transport of MSW relies on the use of fossil fuels, and comes with the price of emissions.

Figure 1: Impact on climate, environment and human health

Source: CSD Engineers, adapted by Zoi.



The improper collection, disposal or treatment of waste can lead to disease, accident and injury. The workers, waste pickers and individuals who live near disposal sites, especially children, are the most affected. In addition to being the main source for foul odours, the decomposition of the organic part of municipal solid waste provides a breeding ground for insects, rodents, vermin and scavenging animals, and produces gases that may form explosive mixtures. The health effects associated with improper waste

management include diarrhoea, respiratory infections and gastrointestinal parasites.

Contaminated rain water leaking through waste in uncontrolled conditions can contaminate groundwater and surface water, and open burning can release dioxin emissions and other air pollutants. Open waste dumping can contaminate soils and decrease the abundance of vegetation, and in some areas can block drainage channels and thereby contribute to flooding.

Facts & Figures

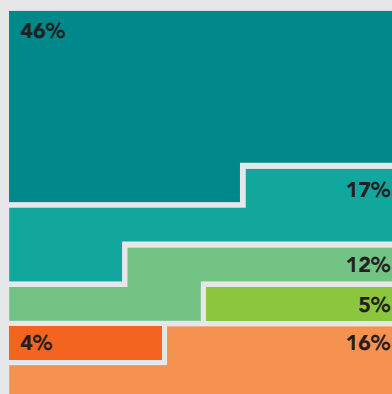
Increasing amounts of Municipal Solid Waste and a large proportion of organic material

About 2 billion tonnes of MSW is generated globally per year, with at least 33% of that not managed in an environmentally safe manner (WB 2018). Population growth, economic development and urbanisation lead to an increase in MSW generation. Global MSW is expected to grow to 3.4 billion tonnes per year by 2050. MSW will increase especially in developing countries and countries in transition. Daily per capita waste generation in developed countries is projected to increase by 19% by 2050, whereas waste in developing countries and countries in transition is expected to increase by 40 percent per capita (WB 2018).

MSW is generated in private households, and in smaller quantities from businesses, small industries and commercial activities. The composition of MSW varies by the degree of urbanisation and development and the socio-economic status of households. The organic fraction tends to be highest in low-income countries (around 57%) and lowest in high-income countries (36%). Globally, organic waste is about 46% of total solid waste (Figure 2).

Figure 2: Global solid waste composition

Source: World Bank 2018



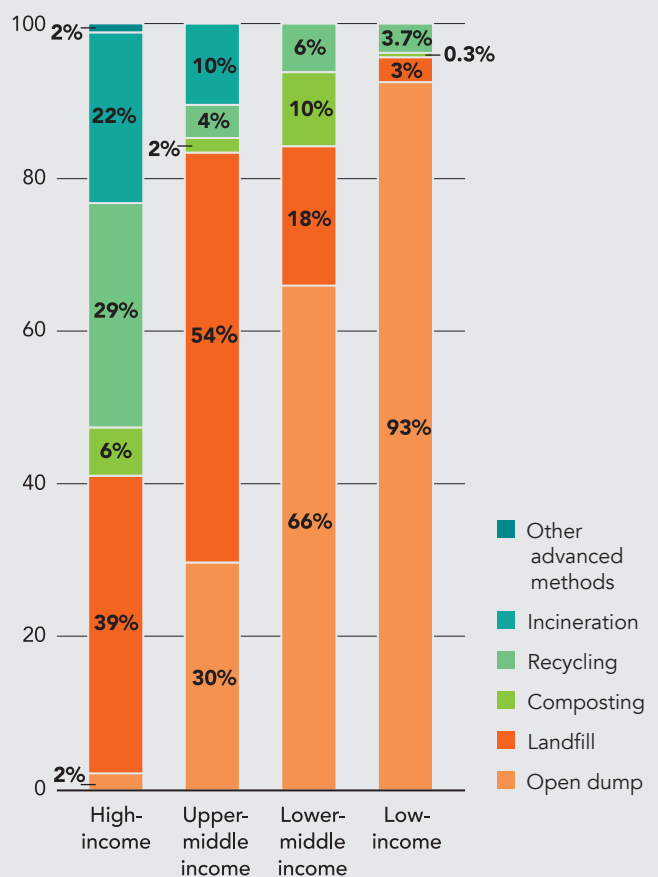
- Organic (food, green and wood)
- Paper and cardboard
- Plastic
- Glass
- Metal
- Other (including rubber and leather 2%)

Changing waste disposal patterns related to wealth

Waste disposal patterns differ substantially by income level and region. Where controlled landfills are not yet available in lower-income countries, open dumping on roads, open land or in waterways is common, and as a result, methane emissions, water and soil pollution and health impacts are significant. Constructing sanitary landfills is typically the first step towards sustainable waste management. The wealthier a country becomes, the more emphasis it gives to recycling and incineration as final disposal methods.

Figure 3: Disposal methods by country income

Source: World Bank 2018

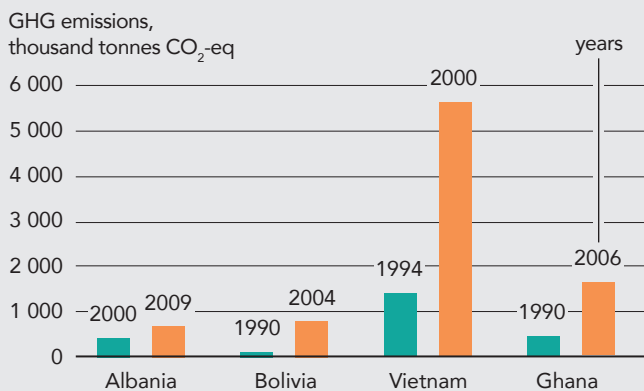


Increasing GHG emissions from solid waste disposal

During recent years, the annual GHG emissions associated with solid waste management increased significantly in many countries due to the increasing amount of waste. The World Bank projects that the 1.6 billion tonnes of CO₂-equivalent emissions estimated for 2016 will increase to 2.6 billion tonnes by 2050 (WB 2018). Emissions from open dumps and unmanaged landfills account for about 5% of the total global GHG emissions (WB 2018). Figure 4 shows the growth in GHG emissions from solid waste disposal for selected countries and years according to the United Nations Framework Convention on Climate Change reporting format.

Figure 4: GHG emissions from land disposal of solid waste, selected countries and years

Source: UNFCCC



Today's challenges in managing municipal solid waste

Among the numerous ways to mitigate GHG emissions while improving environmental conditions and public health are waste reduction, improved waste collection, reuse of products and recycling, and organic waste management and treatment. Where the provision of water and sanitation is a struggle, waste remains a low priority, and in rapidly urbanising cities of the developing world, basic MSW management services are often inadequate and fail to cover the entire area. In cities in developing countries or countries in transition, waste collection rates are generally low, cities are not clean and the informal sector removes a large proportion of the recyclables. Open dumping and burning are still common practices in cities with low waste disposal budgets and a lack of trained workers. Sanitary landfills, which have the proper control and treatment of leachate and facilities to capture gases are largely absent.

The proper treatment of organic waste remains a challenge. Globally only 5.5% of waste is composted, and in low-income countries only 0.3% (WB 2018). The segregation of organic waste for treatment in composting or biogas plants would improve the situation significantly.

The following table summarises the challenges and barriers to the sound management of solid waste in developing countries.

Challenges and barriers to the sound management of solid waste

ORGANISATIONAL & TECHNICAL	ECONOMIC	SOCIAL & ENVIRONMENTAL	REGULATORY
<ul style="list-style-type: none"> • Infrastructure, equipment and trucks in poor conditions • Poor performance of service providers (public or private) • Lack of organization of the informal sector • Poor capacity to plan and operate a waste management service (public or private) efficiently 	<ul style="list-style-type: none"> • Lack of funding for infrastructure (landfills, waste treatment systems) • Cost of waste collection, transportation and final disposal • No market for waste-derived products • Difficulties in setting tariffs that cover costs and in collecting fees to finance the service (full cost recovery) 	<ul style="list-style-type: none"> • Lack of awareness regarding waste issues • Poor acceptance of recycling products • Low institutional capacity • Difficulties in finding qualified workers and staff because of the low image and reputation of the waste sector 	<ul style="list-style-type: none"> • Lack of enforcement • Lack of appropriate policies and regulations • No plan or strategy for the waste sector

Key issues

The development and sustainable operation of a sound solid waste management system is a complex undertaking that entails institutional, technical, financial, organisational and communication components. The circular economy approach – where the aim is to recover waste for reuse and recycling – is expected to achieve efficient economic growth while minimizing environmental and climate impacts. This approach is gaining momentum especially in developed countries and at the same time facing strong economical and structural challenges. In order to move towards a sustainable global future, however, developing countries and countries in transition also need to adopt the circular economy approach and find adequate organizational and business models.

Key issue 1: Implementing and enforcing an appropriate regulatory framework and MSW management strategy at the municipal level

The implementation of good MSW management practices starts with strategies, laws and regulations, and the legal framework for waste management is a challenge for many countries. Some countries have weak laws, and some have many, often contradictory laws that set high and expensive standards that do not reflect the realities of what is achievable in the short and mid-term. The Eastern European countries, for example, aiming at integrating into the EU reflect EU directives in their legal frameworks without regard to the financial limitations. Even where a strong legal framework exists, enforcement is often a missing element. When the development of the legal framework is the result of a participatory process, the sector can identify the appropriate measures needed to assure implementation and enforcement.

Another common challenge is the lack of clarity on shared responsibilities. Where waste management is a relatively new function, the division of responsibilities at the national level is often nebulous and involves more than one ministry with imprecise mandates. This situation generates both overlaps and gaps in the distribution of responsibilities: in Albania, both the Ministry of Environment and Tourism and the Ministry of Infrastructure and Energy are involved, and in

Peru, the Ministry of Environment and the Ministry of Health, for example. The analysis and reallocation of responsibilities requires a strong political willingness at the highest governmental levels.

The daily field operations associated with waste management fall to the municipal level, and most countries delegate waste management to local government, but waste management also requires important infrastructure, such as transfer stations or landfills, which, for reasons of efficiency and economy of scale, need to be managed at least at a regional level. Who should plan, finance, operate, control and supervise these facilities? Should the central or regional government be responsible for these or is it the responsibility of the municipalities?

In brief, implementing and enforcing an appropriate regulatory framework is a long-term process that requires time and political willingness. Improving the technologies and the legal framework step by step with consideration of the limits and opportunities of the country is a good strategy. Each step needs the integration of the technical, financial, social and institutional points of view. Closing all the dumpsites in a country in two years may not be feasible, even if the law requires it. Alternatives and intermediate steps that contribute to the reduction of GHG emissions and to the improvement of the environmental situation are needed.

Key issue 2: Reducing the number of open dumps and developing sanitary landfills as a sound MSW treatment option

Open dump sites are the cheapest and easiest way to handle municipal solid waste, but the adverse climate, environmental and health effects of dumping come with their own costs. The implementation of strictly controlled sanitary landfills, as a first step, can address many of the serious environmental and health risks related to open dumping. The right location with properly designed infrastructure – shape, slope and water and gas management features – and the operation of the site by trained staff are key elements in assuring the safe disposal of waste at an affordable cost.

In low-income countries, sanitary landfills with gas capture and treatment and leachate treatment are the most appropriate short-term option for managing municipal solid waste. Incineration is a good technology, but a state-of-the-art incineration is expensive to build and to operate – about USD 100-250 per tonne – and is generally not affordable in low-income countries, even when the energy produced by these plants can be sold.

Key issue 3: Providing sound treatment of organic waste

The segregation and separate collection of organic waste enables the sound treatment of organic waste. Biodegradable waste can either be composted or treated in biogas plants where anaerobic digestion converts the waste into biogas that can be used for cooking, heating, lighting or generating electricity. In both cases the organic fraction is converted in a soil conditioner or soil fertiliser that can be applied in agriculture or gardening.

The composting and biogas treatments of organic waste are widely and successfully applied in Switzerland and elsewhere in Europe where in many cases governments subsidise the schemes. Both practices decrease the amount of biodegradable waste in the waste flow and in landfills, thereby diminishing the health risks, environmental pollution and GHG emissions. They also reduce the costs of the disposal facilities and prolong the useful lives of sites. The general conditions in many cities strongly favour the implementation of centralised, low-tech composting plants employing simple technologies that use low-cost, locally available materials. The development and operation of digestion plants, however, are generally difficult to realize in developing countries and countries in transition. Before choosing and implementing one of these technologies, a comprehensive feasibility study should carefully assess the costs, the benefits, the technical capacities and the demand of the market for the products.

Key issue 4: Setting affordable tariffs and implementing a reliable fee collection system

Regardless of whether the waste management service provider is private or public, the fee level has to cover all costs to be sustainable. The fee shall cover invest-

ment costs for collection, transportation and waste treatment facilities as well as operation, maintenance, reinvestment, administration, communication and any other costs. The services shall be financed according to the “polluter pays” principle, a commonly shared good practice in theory, but difficult to implement in practice because of affordability, and acceptance. Financing the services through the collection of fees is standard good practice and the main challenge of the local governments. The fee system should pay special attention to vulnerable groups and in particular to the poorest families. Cost models and guidelines can assist municipalities in calculating the costs and fees, which the municipal budget should reflect. Such models allow for standardisation of the cost calculation and therefore facilitate comparisons and benchmarking.

Efficient fee collection is another challenge where updated population registers are unavailable or proper municipal billing systems are absent. In most cases fee collections do not cover the costs, and subventions are necessary. A proven strategy where the legal framework allows it is to include waste fees on the water or electricity bill. This facilitates the process for the citizens (one bill) and for the authority (one system). The bill must clearly indicate the different fees separately and the transparency of the financial streams must be guaranteed.

Key issue 5: Providing reliable and efficient waste collection services

Choosing the collection frequency and points, the truck itineraries, and the right containers and trucks is not a trivial task, and these logistical choices are crucial preconditions to establishing a reliable and cost and climate efficient service.

Each municipality needs to find appropriate and cost-efficient solutions. Unfortunately, a lack of knowledge often leads to inefficient and costly choices, the most common of which is the selection of inadequate trucks with weak waste loading capacities. Figure 5 demonstrates how equipment choices for waste collection dramatically affect the operation costs. Inefficient equipment reduces the possibilities of serving a given area on a given budget.

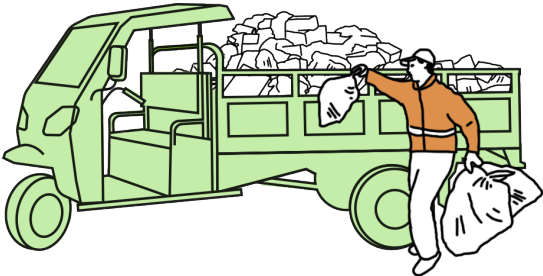
In Shkodra, in northern Albania, the planning of optimised itineraries for the trucks and the use of

Figure 5: Good value for money by choosing the right equipment

The cost per tonne accounts for fuel, maintenance, staff compensation and amortization. Compactor trucks have higher purchase prices, but lower costs over the life of the vehicles.

Trimotos

BOB¹ 3 000 (EUR 365) per tonne



Open trucks

BOB 700 (EUR 85) per tonne



Compactor truck

BOB 120 (EUR 15) per tonne



bins instead of a door-to-door collection showed the potential to reduce the cost of the service by 40%. In Bolivia, an SDC project, Gestion Ambiental Municipal (GAM) made a comparative assessment of different municipalities, and benchmarked the costs for each tonne of waste collected.

Transport costs become relevant when the disposal or treatment facility is located some distance from the centre of the municipality. Transfer stations that are carefully designed and located allow for significant cost reductions. The system should enable source segregation of organic waste for treatment through composting. Proper separation can encourage further use of organic waste, and should start with larger producers (markets, gardeners, restaurants, food processors) and eventually include households.

Key issue 6: Improving awareness through tailor-made communications targeting specific groups

A waste management system can only be successful when the waste generators are involved, so citizens need to understand the waste cycle and their responsibilities in it. Building this capacity and raising awareness are crucial in creating the conditions for the behaviour changes necessary to move towards sound waste management. Active participation is needed with regard to reducing waste, stopping illegal dumping and open burning, starting composting, respecting the collection days and collection points and paying the fees for the service.

In the GAM project in Tolata, Bolivia, an awareness raising strategy involving schools, "environmental brigades", workshops, door-to-door information campaigns and various other activities has produced observable changes in behaviour. Waste is no longer dumped or burned, and families have started composting at home or separating their organic waste for further treatment at a small municipal composting site.

Still, education and capacity building in the sector need to be strengthened. Too many municipal waste management staff lack the basic knowledge to plan, manage, operate or monitor the service, and too few waste management training courses are available for basic and professional education.

1 BOB=Bolivian Boliviano

Key issue 7: Engaging the informal sector

Waste pickers – typically poor and vulnerable – work in a parallel, informal waste market under poor safety, health and hygiene conditions. The challenges in formalising this informal sector start with strong cultural resistance from both municipalities and waste pickers, but solutions and success stories can be found.

A new model in Bangalore, India, for example, aims to help waste pickers become recycling managers. Households, apartment buildings, offices, malls and educational institutions donate their dry waste, which waste pickers collect on cargo bicycles on a weekly basis. The pickers then provide well-sorted recyclable material to processors and recycling companies. A GAM project is implementing a similar model in Villamontes, Bolivia.

Successful models minimise municipal interventions and facilitate the work of the waste pickers. Such interventions include:

- The provision of personal protection equipment
- Regulations that encourage big producers to sort their dry waste and donate it once a week
- The establishment of collection sectors, authorised waste pickers and fixed collection points

The collection, transport and sale of waste must remain the responsibility of the formalised waste pickers. Such schemes improve the social conditions of the recyclers and reduce their exposure to health hazards.

Relevance for Development Cooperation

Swiss development cooperation can take advantage of Switzerland's longstanding experience and reputation for excellence in waste management. The decentralised Swiss system offers many interesting waste management cases and lessons, and Swiss interventions in the sector are much in demand.

Swiss development cooperation is active in regions with insufficient MSW management.

Weak waste management is often a result of insufficient governance practices. Improving a basic service with high visibility among the citizens is an opportunity for Swiss development cooperation to strengthen local governance capacities.

The environmental impact of waste management can be significantly reduced, even with relatively low investments. Initial steps can include purchasing collection equipment; developing the planning, operation and monitoring functions; strengthening communications with citizens; improving the finances; and upgrading the disposal sites. Such steps can dramatically improve the situation. Moving forward requires a continuous effort related to governance but also larger investments in infrastructure.

Although much has been achieved, waste challenges remain, and the work of development cooperation is far from done. In order to achieve its ambitious climate change and sustainable development targets, the Swiss development cooperation must further intensify its activities with a focus on improving resource efficiency and improvements in the following areas:

- **Building capacity**

Most countries have insufficient institutional waste management training courses for technicians and professionals, and demand for such training is strong. Swiss projects and institutions have developed material, training courses and e-tools.¹

- **Adapting technologies**

Governments need support in the implementation of proven technical and cost-efficient

solutions for collection and transportation, sanitary landfills and centralised composting plants, and for applying cost-benefit analysis in selecting the right technology.

- **Strengthening regulatory frameworks and institutions**

The strengthening of legal and institutional frameworks can build on Swiss experience and lessons from the field.

- **Financing the service**

Municipalities need support in the calculations of the costs for services and in the development of procedures to guarantee funding through fee collections.

- **Creating an environment that encourages the involvement of the private sector**

The private sector is an important actor in waste management and can be active at different levels. Swiss assistance can help build capacity, create clear regulatory frameworks and assure that the finances contribute to the development of an enabling environment for the private sector.

Supporting municipalities in Bolivia in building a sustainable waste management system

In Bolivia, the GAM programme supports 15 municipalities in three different regions on sanitation issues. In one of these municipalities, Tolata, the lack of regular collections made open dumping the state of the art, and at the beginning of the project in 2014, a riverside municipal open dump was causing severe water and air pollution.

The project supported the transformation of the site into a safe and controlled dumpsite operated by trained technicians. This transitional solution fills a gap until a planned regional landfill is constructed. The intervention drastically reduced the impact on the environment and the exposure of the population to air and water pollution.

¹ Particularly relevant is the course on "Municipal Solid Waste Management in Developing Countries", which received excellent feedback from Africa and South America (<https://www.coursera.org/learn/solid-waste-management>)

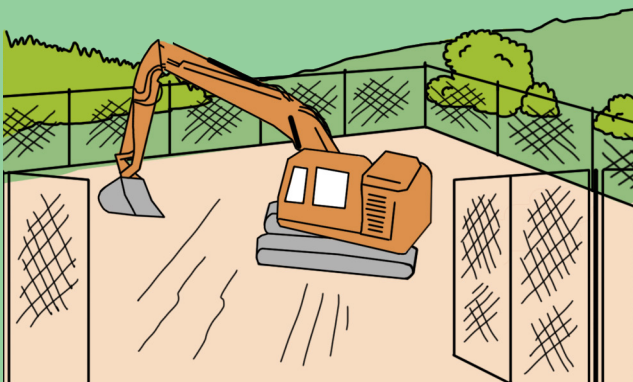
In parallel, the municipality has created a specialised unit in charge of waste management with trained staff and a clear definition of roles, responsibilities and tasks. Collection trucks have been purchased and collection routes have been optimised. These measures, plus the promotion of composting and the separation of biowaste at home, result in lower GHG emissions.

Strong political willingness to move things ahead and a fruitful collaboration between the municipal staff and the technical experts resulted in the implementation of these changes in a short time.

Figure 6: Open dumpsite in 2015



Figure 7: Controlled dumpsite in 2018



Pilot activities under the CapaCITIES project to reduce GHG emissions in the waste sector in India²

The SDC Capacity Building for Low Carbon and Climate Resilient City Development project (CapaCITIES), has implemented various pilot programmes to reduce GHG emissions in Indian cities. In Coimbatore, Udaipur and Siliguri, the project identified the solid waste management system as a fragile urban system consisting of door-to-door collection of waste and final disposal in the disposal plant at Vellore. The waste is not segregated to the fullest extent possible, the disposal plant is not functioning sufficiently and around the plant is a large open dump. The CapaCITIES project promoted doorstep collection of segregated waste through an intensive community awareness effort and the training of municipal staff. This segregation scheme increases the efficiency of the biodegradable waste processing plant and reduces methane emissions from the organic waste that otherwise decomposes in open dumps.

TakaTaka Solutions: Improving Resource Efficiency in Waste Management in Kenya³

In Kenya, a country with strong population growth, waste management represents one of the greatest challenges. The TakaTaka project implemented by foundation myclimate focused on Nairobi where approximately 2,400 tonnes of waste are generated every day, with only 38% of the waste being collected and less than 10% being recycled. In environments where the waste is deposited in landfills, Taka Taka Solutions, a waste disposal company, pursued an alternative approach through sorting, recycling and composting. The first objective was to improve efficiency in internal operations. The second was to expand the range of TakaTaka Solutions' services to include sustainability assessments. The affordable and eco-friendly services are intended to benefit low-income residents in particular. Other outcomes included a decrease in the amount of waste deposited in landfills – and the corresponding environmental benefits – and an increase in the quantity of available compost. The project demonstrates the possibility of achieving a 95% recycling rate and that waste collection can be implemented in a cost-effective way. In 2018, TakaTaka Solutions became the largest waste disposal companies in Kenya with profitable services.

² CapaCITIES: <http://capacitiesindia.org/com-factsheets/>

³ TakaTaka Solutions: <http://www.repic.ch/repic-en/projects/completed-projects/resource-efficiency/myclimate-kenya>

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