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Backstopping SDC Climate Change and Environment (CC&E) Network

Observatory Brief: Innovative approaches to tackle the waste challenge

1. Background, Scope

To collect, recycle, treat and dispose of ever increasing quantities of municipal solid waste especially in fast-growing urban areas are challenges for many developing countries. The different ways of handling this waste is associated with direct impacts on human health, environmental degradation of air, soil and water and climate change, affecting in particular poorer and marginalized communities.

This observatory brief gives an introduction to the current challenge of handling municipal solid waste in urban areas, focusing on cities in lower and lower middle income countries in the priority countries of SDC[1].

2. The waste challenge

Increasing quantities of municipal solid waste (MSW) and increasing numbers of (uncontrolled) dumps and landfills in lower income (LI) and lower middle income (LMI) countries lead to impacts on public health, environmental quality and greenhouse gas (GHG) emissions. Therefore, solid waste that is not properly handled is of growing concern and importance. Particularly the open decomposition of organic fractions of MSW is responsible for diseases, odour nuisance and methane gas emissions, which affects people living near waste dump or landfill sites by contaminating or polluting air, water (surface/ground) and soil ecosystems (see Annex B).

Annual GHG emissions from the waste sector increased significantly in many countries, for example in India (230% between 1994 and 2000) or in Mali (300% between 1995 and 2000).[2] The main GHG sources from the waste sector are methane emissions from disposal sites. Organic, biodegradable components which are the dominating fraction in MSW (contributing to more than 50%) are a significant contributor of GHG emissions as well as other health and environment issues.

It therefore is a big challenge to reduce the amount of organic waste disposed in open dumps or uncontrolled landfills together with other waste fractions. A significant part of the mentioned problems can be solved if organic components are managed and treated appropriately (i.e. fully decomposed or stabilized). The main barriers that prevent appropriate reuse or recycling of MSW are the lack of awareness, the lack of law enforcements, reservations towards recycling products as well as difficulties to find qualified workers and staff because of the image and reputation of the waste sector.

3. Innovative approaches

In Switzerland, the waste sector was designed at the basis of a set of key principles over the last decades:

- Principle of the 3 R's (reduce, reuse, recycle)
- Waste segregation at source / source management
- Restricted landfilling of non-biodegradable, inert waste and other waste that is neither suitable for recycling nor for biological processing

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[1)] Benin, Burkina Faso, Great Lakes, Horn of Africa, Mali, Mozambique, Niger, Tanzania, Chad, Southern Africa, Northern Africa/Palestine, Bangladesh, Hindukush (Afghanistan/Pakistan), Mekong, Mongolia, Nepal, Bolivia, Cuba, Haiti, Central America

[2] See UNFCCC: http://unfccc.int/di/DetailedByParty.do

Several innovative concepts can be derived from the principles and experiences in Switzerland. For instance, while composting or anaerobic digestion of the organic fractions in MSW are widely applied in Switzerland and Europe, they are not common in LI and LMI countries. Both practices decrease the amount of biodegradable waste in the waste flow and in landfills, which diminishes health risks, environmental pollution and GHG emissions. Furthermore, they reduce costs of the disposal facilities and prolong the life spans of sites [9]. With both practices, the key for success lies in a proper source separation of organic waste that is collected from households, markets and companies as well as in public education and awareness rising.

However, the application of high-tech solutions is generally not feasible in LI and LMI countries. The general conditions in many cities strongly favours the implementation of decentralized, small-scale composting or digester systems. These are less technology-dependent and more feasible than centralized, large-scale systems. In this context, we speak of low-tech, meaning simple technologies which use locally available materials and cause low costs.

3.1 Composting of MSW

Composting is the conversion of biodegradable waste in a soil conditioner or soil fertilizer that can be applied in agricultural areas or in gardens. In the following we present an example of an innovative and successful composting project implemented in Mali:

The project started on the initiative of the Rotary Club of Bali Ubud in 2008 as a community empowerment project and is now run by a partnership between myclimate and the local Waste Sorting Temesi Foundation. 85% of the waste in the area derives from organic material and can be composted. The project's composting plant processes 60 tons of waste from 500'000 inhabitants per day that would previously have been dumped. The compost is ultimately used for landscaping, recreational and tourism (hotels) purposes, but still the sale of the compost poses a severe problem, since fertilisers are subsidised at a rate of 92%. However, the process avoids methane emissions which leads to a considerable reduction of GHG emissions (72'998 t CO2e over 10 years) that can be sold to the voluntary carbon market. Besides that, the project contributes to the following:

- Reducing waste volume to landfills by 90% and thereby extending the useful life span of landfills
- Reducing hazardous smoke and toxic seepage from former landfills, reducing pests
- Improving long-term living conditions for inhabitants due to reduced air and water pollution
- Capacity building in the community by operating an educational centre
- Alleviating poverty by creating on-site job opportunities
- Recovering non-renewable resources

3.2 Community or Neighbourhood Composting

Community composting is an opportunity for apartments, offices and residential areas to deal with the high amount of organic waste. It requires the participation of all involved households. An example from Bangalore in India is shown in the movie "The garbage story" (see Annex A).

3.3 Anaerobic digestion of organic MSW

Anaerobic digestion converts biomass waste into biogas, which can be used for cooking, lighting or electricity and heat generation. The digestate is a fertilizer that can be applied in agricultural areas and gardens. As a treatment option for organic solid waste, anaearobic digestion is successfully applied in Europe – although in many cases supported by governmental subsidy schemes. The organic solid waste

can either be treated in a batch-system (dry fermentation) or in a tank (liquid fermentation, requires additional liquids like wastewater, faecal sludge or freshwater[3]). For examples see Annex A.

3.4 Other innovative approaches

Other innovative approaches to reuse MSW have been identified (see Annex C for further information):

- **Empowering the informal sector: Donate dry waste / hire your recycling manager.** A new model operated in Bangalore (India) aims to empower rag-pickers (informal sector) to turn into recycling managers by granting them access to structured work and dignified livelihood. Households, large apartments, offices, malls or educational institutes donate their dry waste, which is collected by rag-pickers with cargo bicycles on a weekly basis. Waste pickers then provide well-sorted recyclable material to processors and recycling companies. The wet waste is converted to biogas and compost.
- **Prevent food waste and raise public awareness.** Events recover food waste and thereby reduce organic waste in MSW (see Annex C: Disco Soup in Nairobi). Disco Soup is a global grass root movement to educate people about the food waste problem.

4. Summary and conclusion

The amount of urban MSW in LI and LMI countries is increasing. Being the dominant fraction in MSW, the organic fraction plays an important role regarding health, environmental and climate change impacts. Composting and anaerobic digestion of the organic part of MSW are widely applied systems in Switzerland and Europe, but not in LI and LMI countries. The following success factors are required to spread those systems in LI and LMI countries as well:

- Regulation and enforcement to reuse and recycle materials
- Availability of enough biomass waste and the right mix of it
- Acceptance of the products (demand side and market development4)
- Community based involvement of population to get acceptance and participation
- Use of the products: gas for cooking, heat by nearby industry, subsidized feed-in tariff for electricity
- Operation of low-cost technologies that create job opportunities
- Focus on city district and specific waste fraction, start with small (pilot) facilities, later expand to full-scale facilities
- Additional financing through GHG crediting market mechanisms or international climate finance

[3] In comparison to rural biogas plants which work with animal manure
[4] Market for the products is necessary (selling compost/digestate to fertilizer companies, farmers, hotels, etc.)

5. ANNEX

Annex A: Further reading / links to projects and literature

Literature

[1] Bogner et Al. Waste Management, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press

[2] Improving Municipal Solid Waste Management in India, World Bank, 2008

[3] UNFCCC, Greenhouse Gas Inventory Hands-on Training Workshop WASTE SECTOR

[4] Municipal solid waste management challenges in developing countries – Kenyan case study, Rotich K. Henry et Al, Jilin University, 2005

[5] Open dumping of municipal solid waste and its hazardous impacts on soil and vegetation diversity at waste dumping sites of Islamabad city, Syeda Maria Ali et Al., 2014

[6] Municipal Solid Waste Characteristics and Green and Clean Energy Recovery in Asian Megacities, K. Laohalidanond, 2015

[7] What a waste - A global review of solid waste management, World Bank; D. Hoornweg, P. Bhada-Tata, 2012

[8] Collection of Municipal Solid Waste in Developing Countries, United Nations Human Settlements Programme (UN-HABITAT), Manus Coffey & Adrian Coad, 2010

[9] Solid Waste Management in Developing Countries, Chris Zurbrugg, SANDEC / EAWAG, 2003

[10] Anaerobic Digestion of Biodegradable Solid Waste in Low- and Middle-Income Countries, Overview over existing technologies and relevant case studies, EAWAG, 2007

[11] Anaerobic Digestion of Biowaste in Developing Countries, Practical Information and Case Studies, EAWAG, 2014

[12] Renewable Energy and Waste Management in Ghana, REPIC Final Report, EAWAG, 2012

[13] Decentralised composting in Dhaka, Bangladesh, production of compost and its marketing, Zurbrügg, C., 2002

[14] Waste Concern: A Decentralized Community-based composting through public-private-community partnership, United Nations Development Programme, 2011

Link to projects

Composting of MSW

- MSW Composting in Dhaka: In Dhaka, Bangladesh there has been implemented successfully a community-based decentralized composting project with low-cost technique for the treatment of MSW. The plant is operated since 2008 and has an input capacity of 100 tons of organic waste per day. The organic waste is converted into compost using a labour intensive composting procedure. The plant does offer job opportunities for the urban poor. Essential for acceptance by consumers was the approval from the Bangladesh Agriculture Research council for acceptance of their product for agricultural purposes and policy support from Ministry of Agriculture. Due to the revenues from large bulk buyers of compost - the product is mainly sold to fertilizer producing companies - and the carbon market (CDM), the project is financial successfully. The project has been the first CDM of its kind (composting). https://cdm.unfccc.int/Projects/DB/SGS-UKL1134142761.05/view
- Composting in Bali: https://www.myclimate.org/fileadmin/myc/klimaschutzprojekte/indonesien-7117/klimaschutzprojekt-indonesien-7117-project-story.pdf

Compost plant in Bali (source: myclimate)

- EAWAG Project Composting in Java: https://www.eawag.ch/en/department/sandec/projects/mswm/forward-from-organic-waste-to-recycling-for-development/

Community composting

- **"The garbage story", Bangalore, India:** https://savitahiremath.com/category/community-composting/
- Community Composting Options (India): https://drive.google.com/file/d/0BwQo5juPlyjLakN3Vm9rN1V5ZEE/view
- Community composting in Bangalore, India: http://www.igotgarbage.com/content/Community-Composting-0202160918/0

Anaerobic digestion of organic solid waste

- Biogas project dry fermentation EAWAG Ghana: http://www.repic.ch/repic-de/projekte/abgeschlossen/biomasse/eawag-ghana/
- Biogas plant at the University of Cape Town: http://www.biogaspro.com/about-us/agama-biogas-projects/item/agama-biogaspro-at-uct.html?category_id=13
- Biogas project anaerobic co-digestion with faecal sludge in Vietnam: http://www.eawag.ch/en/department/sandec/projects/ewm/purr-partnership-for-urban-resource-recovery-comprehensive-management-of-biosolids-from-wastewater-and-faecal-sludge-treatment/

Annex B: Municipal Solid Waste: Why relevant?

Origin of urban Municipal Solid Waste

Urban Municipal Solid Waste is usually from households, but also from business, small industries and commercial activities. Additionally hazardous waste from hospitals and clinics may find its way to MSW, when MSW-management is not appropriate or regulation and enforcement is missing.

Amount of MSW today and in the future

Population growth, economic development/prosperity and urbanization lead to an increase in MSW generation rate. Higher income and higher populated countries generate higher amounts of MSW. Projections for 2025 shows that for Lower Income (LI) countries the urban MSW generation per capita is increasing from 0.6 to 0.86 kg/capita/day and for Lower Middle Income (LMI) countries from 0.78 to 1.26 kg/capita/day [8].

Characteristic of MSW

The composition of urban MSW is depending on urbanization, development and socio-economic status of households and can be divided into the following components [2]: organics, paper, plastic, glass, metal and others[5]. Apart from these fractions, MSW may contain human and animal excrement as well as hazardous chemical pollutants and sharps [2]. In Indian cities, the major fraction of MSW in the year 2000 was compostable material (40-60%) and inerts (30-50%). The percentage of recyclables (paper, glass, plastic and metals) was very low due to the activity of rag pickers who segregate and collect the materials at generation sources, collection points and disposal sites. The MSW composition by country as listed in the knowledge Paper “What a waste“, shows that the organic fraction is the most important part with often more than 50% of weight of wet waste[6].

Collection and Disposal of MSW

In Lower Income (LI) and Lower Middle Income (LMI) countries, the waste collection rates are generally low, the informal sector removes a large fraction of recyclables and formal service does not extend to all parts of the communities. Open dumping is still common in many cities [8] due to the low budget for waste disposal and non-availability of trained manpower. Landfilling is often uncontrolled.

Health and environmental problems related to MSW Management

Especially in rapidly urbanizing cities of the developing world, the municipalities are often unable to provide even the most basic services of MSW-Management. The following problems and issues occur:

Public Health

Solid waste that is not properly separated, collected, handled and disposed can lead to disease and injury, especially among workers, children or rag pickers, who handle waste or individuals who live near or on disposal sites. Especially the organic part is responsible for:

- Breeding ground for insects, rodent vectors, vermin and scavenging animals
- Spreading of diseases: air- and water-borne diseases; diarrhoea and respiratory infections, infections with gastrointestinal parasites, worms, and related organisms
- Odour nuisance / foul odors and unsightliness

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5) includes ceramics, textiles, leather, rubber, bones, inerts, ashes, coconut husks, bulky wastes, household goods

6) For example the organic fraction has the following share at MSW: Nepal 80%, Bangladesh 71%, Cuba 69%, Pakistan 67%, Vietnam 60%, Nigeria 57%, Benin 52%, Lao PR 46%, Guatemala 44% [8]

- Gases on dumpsite may form explosive mixtures
- Accident risks and injury

Environment

Waste that is not properly collected and disposed can lead to the following environmental problems:

- Contributing to flooding (when dumped in the streets and in drains)
- Contamination of groundwater and surface water by leakage
- Air pollution from burning
- Deteriorating soil quality and decrease in vegetation abundance from open waste dumping

Climate change

The problem of open dumping and uncontrolled landfill is that methane is produced for many years (before waste is decomposed completely). In addition, carbon dioxide and volatile organic compounds are produced. Particularly in countries with cities that have more than one million inhabitants the main source of Greenhouse gas emissions from the waste sector is methane (CH4) emissions from land disposal / solid waste disposal sites, where organic matter in wastes is decomposed[7].

[7] According to [1] the major GHG emissions from the waste sector are landfill CH4 and, secondarily, wastewater CH4 and N2O

Annex C: Other innovative approaches

Empowering the informal waste sector: Donate dry waste / Hire Your Recycling Manager

- http://www.igotgarbage.com/content/Donate-Dry-Waste-0930284195/0
- http://www.igotgarbage.com/content/Hire-Your-Recycling-Manager-01447914436/0

Household composting and urban gardening

Individual composting / household composting is an interesting option for city dwellers who have the possibility to use the soil conditioner for their own horticulture / urban gardening on balcony or terrace gardens. There have been identified a bunch of different systems (bin, buckets etc.) in India. If everybody would composts at home, around 50% of the waste problem would be solved.

- http://www.swachagraha.in/individual-composting
- http://www.igotgarbage.com/content/Compost-At-Home-01500226509/0

Prevent food waste

Technology can prevent food waste in developing countries: Better cold storage, education about food handling and improved infrastructure…

- https://www.theguardian.com/sustainable-business/2014/dec/18/technology-prevent-waste-food-developing-countries

Creating a platform to recover food waste. Example recovering food waste in Nairobi:

- http://www.thinkeatsave.org/index.php?option=com_content&view=article&id=373