CLIMATE SMART GOVERNANCE

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SECTOR - 3

CLIMATE CHANGE AND SOLID WASTE MANAGEMENT

TRAINING MODULE
(2017-2020)

CLIMATE CHANGE AND SOLID WASTE MANAGEMENT

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1. SOLID WASTE MANAGEMENT AND CLIMATE CHANGE

The activities of human create waste, which are handled, stored, collected and disposed of, which may pose risks to the environment and to public health. The quantity and complexity of generated solid waste have been increased due to economic development, urbanization and improved living standards in cities.

In different cities of developing countries an improper management of solid waste has been reported. Due to improper solid waste management, waste has become one of the pollution sources and caused diverse environment impacts as well as harmful towards human health and safety. The global nature of Municipal Solid Waste (MSW) includes its contribution to GHG emissions, e.g. the methane from the organic fraction of the waste stream, and the increasingly global linkages of products, urban practices, and the recycling industry (Gupta, Yadav & Kumar, 2015).

1.1 Link between Solid Waste Management and Greenhouse Gases

The rising levels of greenhouse gases in the Earth's atmosphere causing the changes in our climate, and some of these changes can be traces to solid waste.

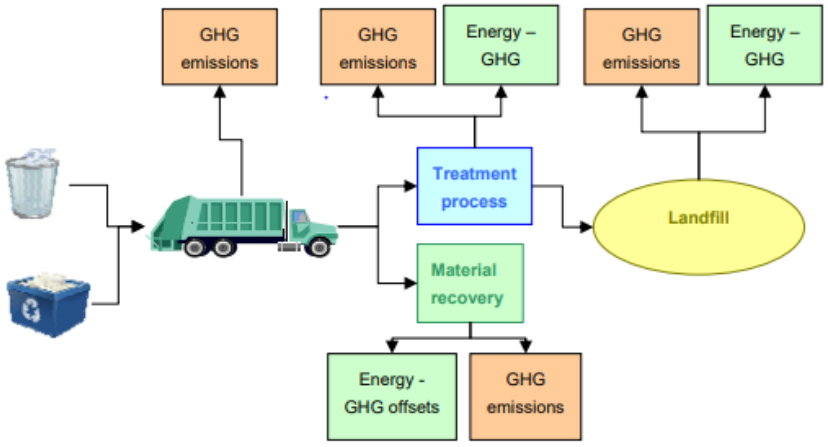


Figure 3.1: Waste management system and GHG emissions
Source: United Nations Environment Programme [UNEP], (2010) http://www.unep.or.jp/ietc/Publications/spc/Waste&ClimateChange/Waste&ClimateChange.pdf

The manufacture, distribution, and use of products as well as management of the resulting waste, all result in greenhouse gas emissions. Illustrations showing increase and decrease in GHG emissions as follows (United States Environmental Protection Agency [EPA], 2016):-

Increased GHG emissions

Harvesting trees, extracting oil and ore, and transporting these raw materials emit greenhouse gases.

Waste generation and recycling delay the need to extract some raw materials, lowering greenhouse gases emitted during extraction.

Decreased GHG emissions

Increased GHG emissions

Manufacturing products releases greenhouse gases during processing and as energy is expended.

Waste prevention means fewer products are made, and making products from recycled materials require less energy. Both lower greenhouse gases emissions.

Decreased GHG emissions

Increased GHG emissions

Burning waste in an incinerator emits greenhouse gases.

Waste prevention and recycling reduce the amount of waste sent to incinerator, lowering the greenhouse gases emitted when waste burns.

Decreased GHG emissions

Increased GHG emissions

Greenhouse gases are emitted as waste decomposes in landfills.

Waste prevention means fewer products are made, and making products from recycled materials require less energy. Both lower greenhouse gases emissions.

Decreased GHG emissions

1.2 Climate Change Impacts on Solid Waste Management

Climate change could result in changes in temperatures, cloud cover, rainfall patterns, wind speeds, and storms: all factors that could impact future waste management facilities' development and operation (Ahmed, 2012).

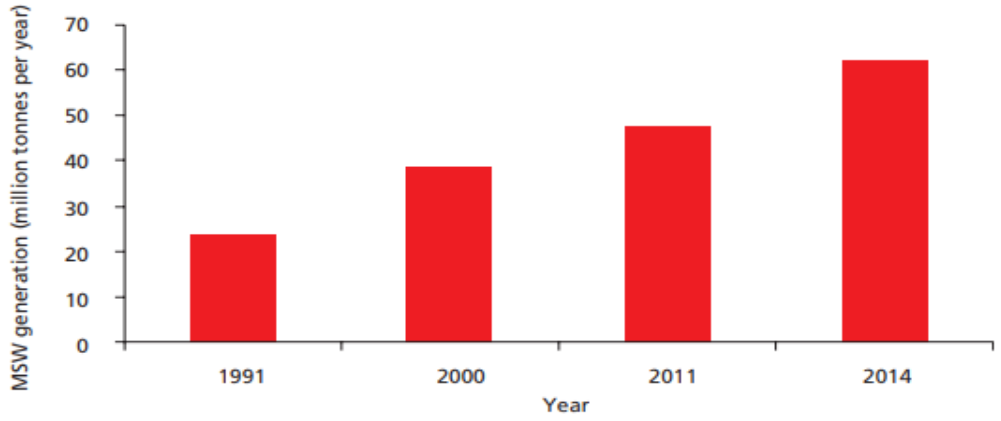
	Collection	Processing	Disposal
Temperature Change	• Increased odor and pest activity requiring more frequent waste collection • Overheating of collection vehicles requiring additional cooling capacity, including to extend engine life.	• Overheating of sorting equipment	• Altered decomposition rates • Increased maintenance and construction costs due to thawing permafrost • Increased risk of fire at disposal sites
	• Greater exposure of workers to flies, which are a major cause of infectious disease (flies breed more quickly in warm temperatures and are attracted to organic waste)		
Precipitation Change	• Flooding of collection routes and landfill access roads, making them inaccessible • Increased stress on collection vehicles and workers from waterlogged waste	• Increased need for enclosed or covered sorting facilities.	• Increased flooding in/around sites • Increased leachate that needs to be collected and treated • Potential risk of fire if conditions become too dry and hot
Sea Level Rise	• Narrowed collection routes • Potentially increased waste in a concentrated areas as people crowd into higher elevations within an urban area	• Damage to low-lying processing facilities • Increased need for sorting and recycling to minimize waste storage needs	• Deterioration of impermeable lining • Water infiltration of pit leading to possible overflow of waste
	• Permanent inundation of collection, processing and disposal infrastructure		
Strom Surge	• Temporary flooding of and diminished access to roadways, rails, and ports for waste collection, sorting and disposal • Closure of facilities due to infrastructure damage		
Extreme Wind	• Dispersal of waste from collection sites, collection vehicles, processing sites, and landfills • Reduced access to collection and landfill access routes due to damage and debris		

Figure 3.2: Climate change impacts on Solid waste management infrastructure and services (United States Agency International Development [USAID], 2012)

2. INDIA'S SOLID WASTE SCENRIO

Municipal solid waste management is a leading environmental concern in India. The rapid rise in urbanization, industrialization and population led to the escalation in municipal solid waste generation rate in Indian cities and towns. Mismanagement of municipal solid waste can cause adverse environmental impacts, public health risk and other socio-economic problem. (Gupta, Yadav, Kumar, 2015).

The Planning Commission Committee report, 2014 chaired by K Kasturirangan found that 62 million tonnes of MSW was produced per year, which is based on an average of 0.45 kg per capita per day for India's urban population. According to a latest Central Pollution Control Board (CPCB) report, 2016, some 52 million tonnes of waste each year, or roughly 0.144 million tonnes per day is being produced in India, of which roughly 23 per cent is processed—taken to landfills or disposed off using other technologies (Down to Earth, 2016).



Source: Compiled from research papers and available documents (DEA and CPCB)

Figure 3.3: Solid waste produced in India

In 2008, India produced 48 million tonnes of solid waste as per one estimate. By 2016, this had risen to 52 million tonnes

Burning garbage is classified as the third biggest cause of greenhouse emission in India—apart from the impact on human health, the effect on land, water and food pollution is a matter of grave concern. Burning releases carbon monoxide, nitrogen oxide, sulphur dioxide, and carcinogenic hydrocarbons, apart from particulate matter into the air,

resulting in India releasing 6% of methane emissions only from garbage (compared to a 3% global average).

It is estimated that 1,400 sqkm of landfill area would be required for dumping India's increasing volumes of municipal solid waste by 2047; this space is roughly equal to the combined area of three out of top five most populous cities in India: Hyderabad, Mumbai and Chennai.

Leachate from rotten garbage contains heavy metals and toxic liquid; with such emissions ending up either absorbed into the soil or flowing into water bodies today, the entire food chain can be affected when this contaminated water is utilized for agriculture, human consumption and animal consumption (Swaminathan, 2018).

In most developed and developing countries with increasing population, prosperity and urbanization, it remains a major challenge for municipalities to collect, recycle, treat and dispose of increasing quantities of solid waste, especially in a changing climate (Ahmed, 2012). Therefore, there is a need for proper management plan.

3. WASTE MANAGEMENT: REDUCTION IN CO_2 EMISSIONS

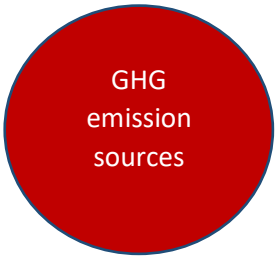
In response to increasing concentrations of greenhouse gases (GHG), the earth's climate system is changing. GHGs are emitted through a variety of human activities including electricity production, transportation, agriculture, and industry (i.e. processing and manufacturing of goods (Institute for Tribal Environmental Professionals, 2015).

Waste generation does not result in positive impacts on climate. Waste treatment and disposal can have both positive and negative climate impacts. Therefore, an increasingly key focus of waste management activities is to reduce GHG emissions (UNEP, 2010).

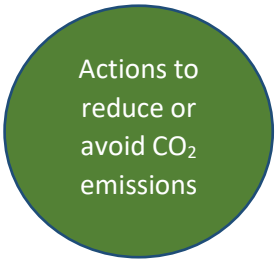
Following process and action can be taken at these processes to reduce emission in SWM (International Solid Waste Association [ISWA], 2009):

a) Collection and Transportation

Waste collection inevitably involves the use of vehicles and consumption of fuel. There are extensive variations in both fuel types and consumption levels; hence the amount of fuel used for each collected tonne of waste can vary according to the collection system used.



- CO_2 from fossil fuel and electricity consumption



- ✓ Rationalization of collection operations and improvement of fuel efficiency
- ✓ Use of alternative fuels such as biodiesel, bioethanol or biogas
- ✓ Development of alternative means of transport such as rail or water
- ✓ Implementation of driver training programmes

b) Recycling

On the basis of relevant materials; metals, paper, plastic, glass or wood, there are an extensive range of technologies available for solid waste recycling. By reducing the amount of waste which must be disposed of and by providing a substitute for the use of raw materials in product manufacturing, recycling saves GHG emissions. To avoid the GHG emissions linked with extraction, transportation to the production site, many industries use recycled materials and energy use involved in

recycling may take place at source (e.g. in households) or after collection in centralized facilities designed according to material recovery priorities. These are important factors to be considered in estimating GHG reduction.

GHG emission sources

- CO_2 from fossil fuel consumption for transport and recycling activities and electricity consumption.

Actions to reduce or avoid CO_2 emissions

- ✓ Increasing the recovery rate of material.

c) Composting

The process of composting can take place in windrows or in closed vessels, under a roof or in the open air. Studies which have assessed GHG emissions from composting activities have shown that technology and operational practices employed as well as the waste types received affects emissions. In addition to emissions related to electricity consumption, both methane and/or nitrous oxide have been detected in varying levels.

GHG emission sources

- CO_2 from fossil fuel combustion and electricity consumption
- CH_4 and N_2O emissions from processes.

Actions to reduce or avoid CO_2 emissions

- ✓ Increase compost production and use low emitting treatment technologies
- ✓ Improve process efficiency and convert methane from anaerobic digestion to energy while minimizing fugitive emissions.

d) Incineration

A controlled combustion of solid waste in modern furnaces equipped with up to date pollution controls is referred as Incineration of waste. While reducing volumes of residual waste to be sent for disposal, it is an effective method of converting waste into energy. Where it is technically and economically viable, incineration processes can provide very high energy efficiencies and associated GHG emission reductions from waste management, by using the power generated for electricity and heat and thereby reducing consumption of fossil fuels.

GHG emission sources

- ➢ CO_2 from fossil fuel combustion and electricity consumption;
- ➢ CO_2 from waste combustion (fossil C)

Actions to reduce or avoid CO_2 emissions

- ✓ Substitute energy produced from fossil fuels by thermal energy and electricity from waste combustion.
- ✓ Recovery of metals from bottom ashes for recycling.

e) Landfilling

The disposal sites where waste is placed in lined sections and degraded while producing CO_2 and methane; a potent greenhouse gas referred as Landfilling.

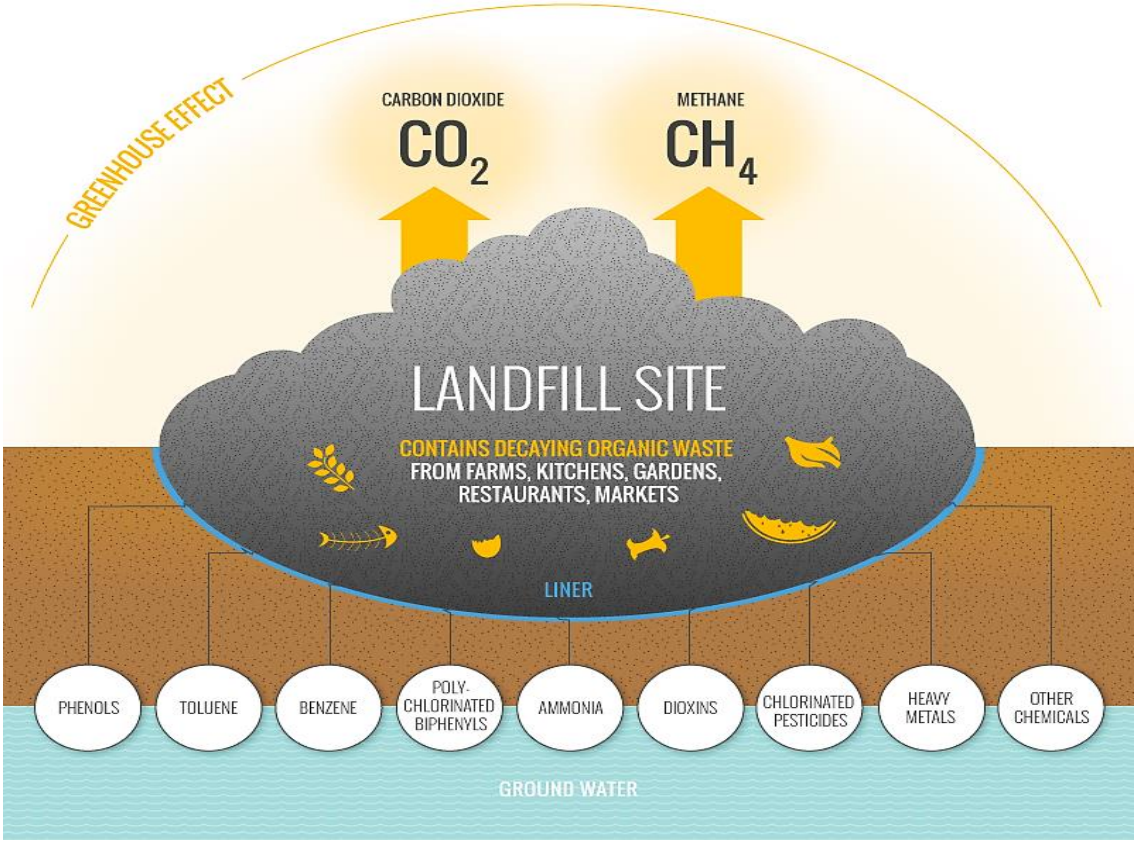


Figure 3.4: Pollutants releasing from landfill sites

GHG emission sources

- CH_4 from anaerobic decomposition of organic waste
- CO_2 from fossil fuel combustion and electricity consumption
- N_2O from leachate treatment

Actions to reduce or avoid CO_2 emissions

- ✓ Installation of active landfill gas collection and treatment systems
- ✓ Use of landfill gas as a fuel to produce electricity or thermal energy
- ✓ Engineered landfill capping to control fugitive emissions

f) Mechanical Biological Treatment (MBT)

MBT is a mix of mechanical operations and biological processes aimed at one or more of the following:

- Diverting and stabilizing biodegradable materials before landfilling
- Recovering recyclables e.g. metals
- Producing high-calorific fuels for energy recovery by thermal processing.

GHG emission sources

- ➢ CO_2 from fossil fuel combustion and electricity consumption
- ➢ CH_4 and N_2O from biological treatment of organic waste
- ➢ CO_2 from combustion (e.g. RDF) of fossil waste components
- ➢ CH_4 releases from landfilling of organic waste residuals.

Actions to reduce or avoid CO_2 emissions

- ✓ Increased diversion of biodegradables from landfilling.
- ✓ Production of RDF that substitutes fossil fuel

Another way is waste prevention and recycling-jointly referred to as waste reduction-help us better manage the solid waste we generate. But preventing waste and recycling also are effective strategies for reducing greenhouse gases. Reducing and recycling solid waste can help to curb the emission of greenhouse gases in four important ways:

- **Reduced emissions from energy consumption** – Typically, the manufactured of goods using recycled materials are less energy intensive. Even more energy can be saved by reusing items (i.e. water bottles or travel mugs) as it reduces the need to manufacture disposable goods.

- **Reduced emissions from incinerators** – Recycling and reuse of materials eliminates what would otherwise be burned in waste incinerators, thus mitigating greenhouse gas emissions.

- **Reduced methane emissions from landfills** – Recycling and waste prevention reduces materials reaching to landfills, which produce large amounts of methane through the decomposition process.

- **Increased storage of carbon in trees** – Trees sequester (absorb and store) carbon dioxide from the atmosphere. To keep more trees in the ground, one can recycle the paper, which as a result can help to re-stabilize the climate system (Institute for Tribal Environmental Professionals, 2015).

ISWM is a strategic approach to manage MSW in a sustainable manner by considering all aspects of MSWM viz. generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency.

4. INTEGRATED SOLID WASTE MANAGEMENT

The Integrated Solid Waste Management (ISWM) system is based on the 'waste management hierarchy', with a focus to reduce the amount of waste being disposed, while maximizing resource recovery and

efficiency. Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of processes and technologies. The preferred waste management strategies within the hierarchy include:

- **Reduction and reuse at source:** The most preferred option for waste management is to prevent the generation of waste at various stages including at product design stage, production, packaging, use and reuse stages of a product. Waste prevention helps reduce handling, treatment, and disposal costs and reduces various environmental impacts such as leachate, air emissions and generation of greenhouse gases.

- **Waste recycling:** Recovery of recyclable material resources through a process of segregation, collection and re-processing to create new products is the next preferred alternative.

- **Waste to composting:** The organic fraction of waste can be composted to improve soil health and agricultural production adhering to FCO norms.

- **Waste-to-Energy:** Where material recovery from waste is not possible, energy recovery from waste through production of heat, electricity, or fuel is preferred. Biomethanation, waste incineration, production of Refuse Derived Fuel (RDF) and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted "Waste to Energy" technologies.

- **Waste Disposal:** Remaining residual wastes at the end of the hierarchy, which are ideally comprised of inerts, are to be disposed in sanitary, lined landfills, which are constructed in

accordance with stipulations of the MSW Management and Handling Rules, 2014.

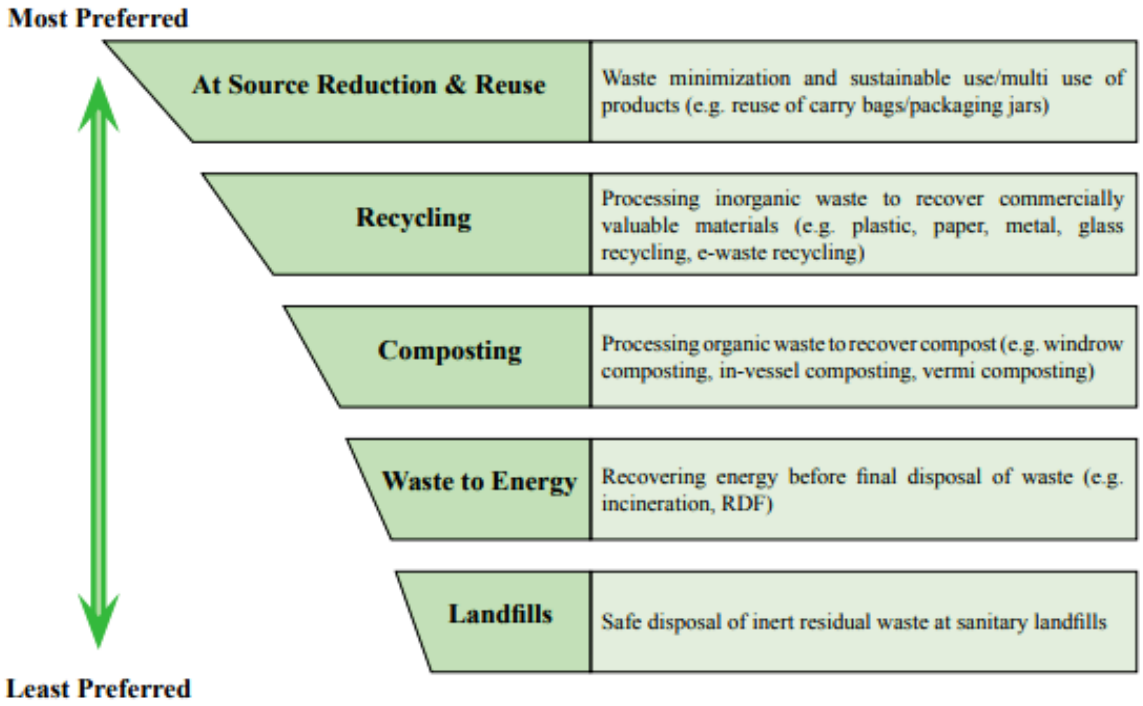


Figure 3.5: ISWM hierarchy

The ISWM hierarchy ranks waste management strategies according to their environmental benefits

The ISWM concept, as defined is closely associated to the 3R approach (Reduce, Reuse, and Recycle), which is also focused at optimizing the management of municipal solid waste from all the waste-generators (households, commercial and institutional establishments, parks and gardens, construction and demolition activities, urban agriculture, safety and healthcare facilities) and involving all the stakeholders (waste generators, service providers, informal sector, regulators, government, and community/neighborhoods). The adoption of the 3R concept helps to minimize the amount of waste to be handled by the municipal authority minimizing the public health and environmental risks associated with it (Central Public Health & Environmental Engineering Organization [CPHEEO]-GIZ, 2014).

5. CASE STUDIES

Study 1: Waste Management in Mexico City

The Bordo Poniente dump, just outside Mexico City, used to be one of the world's largest landfill sites, covering 370 hectares and containing 70 million tons of garbage. It was closed in 2011 and the city committed to a full, environmentally-appropriate landfill site closure process. In the years leading up to its closure, the city implemented comprehensive collection programs for recycling and organic waste in order to drastically reduce the need for new landfill space. Since being shut down, the Bordo Poniente landfill has been putting the off-gassing from that 70 million tons of garbage to good use, by building a biogas electricity plant. Experts estimate that the city will be able to reduce greenhouse gas emissions by to 1.4 to 2 million tonnes during the first year of biogas utilization alone (Somerville, 2016).

Study 2: Australia: Bin that help in Segregation, Recycling and Composting

SmartBelly bins treats most of its garbage by segregating the waste at the collection point and then undergoes process of composting, treating most of its waste. Bigbelly (SmartBelly or BigBelly) bins automatically create extra space for garbage when the bin is full. More garbage space means fewer collection trips, lower costs and fewer emissions. One of the major advantages of these bins is that they connect individual bins to garbage collectors that results in a more efficient management of waste (NDTV, 2017).

6. GOVERNMNET INITIATIVES IN INDIA

i Solid Waste Management Rules, 2016

The Union Ministry of Environment, Forests and Climate Change (MoEF&CC) announced the new Solid Waste Management Rules (SWM) in 2016. These substituted the Municipal Solid Wastes (Management and Handling) Rules, 2000, which have been in place for the past 16 years. The new rules are now applicable beyond municipal areas and have included urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, special economic zones, places of pilgrimage, religious and historical importance, and State and Central Government organizations in their ambit.

Salient features of SWM, 2016

- **Source Segregation:**

In order to channelize the waste to wealth by recovery, reuse and recycle, new rules have mandated the source segregation of waste. Waste would now have to be segregated into three streams- Biodegradables, Dry (Plastic, Paper, metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellants, cleaning agents etc.) by waste generators before handing it over to the collector.

The rules mandate that all resident welfare and market associations and gated communities with an area of above 5,000 sq m will have to segregate waste at source into material like plastic, tin, glass,

paper and others and hand over recyclable material either to authorized waste-pickers and recyclers or to the urban local body.

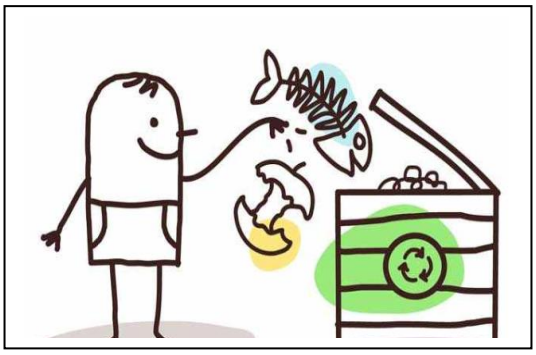
- **Collection and disposal of sanitary napkins**

For effective management of sanitary waste like diapers and sanitary pads, it has been made mandatory for the manufacturers under the new rules to provide a pouch or wrapper for disposal whenever they sell their products to the customer.

- **Collect Back scheme for packaging waste**

As per the rules, brand owners who sale or market their products in packaging material which are non-biodegradable, should put in place a system to collect back the packaging waste generated due to their production.

- **User fee for collection**



The new rules have given power to the local bodies across India to decide the user fee. Municipal authorities will charge user fees for collection, disposal and processing from bulk generators. As per the rules, the generator will have to pay **"**User Fee" to the waste collector and a "Spot Fine" for littering and non-segregation, the quantum of which will be decided by the local bodies.

- **A Bin is a must for Street Vendors**

All street vendor should keep appropriate containers or bins for waste's storage generated by them such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruits etc. They are also responsible for their own waste and should deposit their waste at a waste storage depot or container or vehicle as reported by the local authority.

- **Waste Processing and Treatment**

According to the new rules, it has been recommended that the processing, treatment and disposal of bio-degradable waste should be done through composting or bio-methanation within the buildings as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority. The developers of Special Economic Zone, industrial estate, industrial park have to allot at least 5 per cent of the total area of the plot or minimum 5 plots/ sheds for recovery and recycling facility.

All local bodies having a population of 1 million or more within two years, will have to be set up waste processing facilities. For census towns with a population below 1 million or for all local bodies having a population of 0.5 million or more, common, or stand-alone sanitary landfills will have to be set up in three years' time. Also, common, or regional sanitary landfills to be set up by all local bodies and census towns with a population under 0.5 million will have to be completed in three years.

- **Revision of parameters and existing standards**

As per the new rules, the landfill site shall be 100m away from a river, 200m from a pond, 500m, 200m away from highways, habitations, public parks and water supply wells and 20 km away from airports/airbase. Emissions standards are completely amended and include parameters for dioxins, furans, reduced limits for particulate matters from 150 to 100 and now 50. Also, the compost standards have been amended to align with Fertiliser Control Order.

- **Involvement of Rag pickers**

The new rules help in the integration of ragpickers, waste pickers and *kabadiwalas* from the informal sector to the formal sector by the state government.

- **Guidelines for Local Authorities**

All local bodies are required to set up few by-laws regarding waste management, segregation of waste within their society. They are also required to set up a system in place so as the process of waste segregation can be followed smoothly by all waste generators. They are also required to promote the idea of composting, waste segregation and waste management through different educative campaigns.

- **The process of monitoring**

The government has also established a Central Monitoring Committee under the chairmanship of Secretary, MoEF&CC to monitor

the overall implementation of the rules effectively. It is advised that the committee comprising of various stakeholders from the central and state governments will meet once a year to discuss and monitor the implementation of these rules (Bhatia, 2017 and Sambyal, 2017).

ii) E - Waste (Management and Handling) Rules, 2011

It has been notified on May, 2011 and came into effect from May, 2012, with primary objective to reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling. The Rules apply to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as detailed in the Rules.

iii) Batteries (Management & Handling) Rules, 2001

It deals with the proper and effective management and handling of lead acid batteries waste. The Act requires all manufacturers, assemblers, re-conditioners, importers, dealers, auctioneers, bulk consumers, consumers, involved in manufacture, processing, sale, purchase and use of batteries or components thereof, to comply with the provisions of Batteries (Management & Handling) Rules, 2001 (Vaish & Mehta, 2017).

7. WAY FORWARD

Few more years are required to further see the drastic change in the working of waste management systems in India. Although, the SWM Rules, 2016 abate the hopes in pushing for adoption of a decentralized

mechanism for solid waste management. However, it would be challenging to see how segregation at source shall work on the ground. There is a need of planning massive awareness campaign in association with communities, NGOs, students and other stakeholders to push for better implementation of these rules. The Rules need to focus on making solid waste management a people's movement by taking the issues, concerns and management of solid waste to citizens and grass-roots.

8. FUTHER READINGS

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