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# Municipal Solid Waste Management: Issues, Challenges, Opportunities and Policies

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# How we define waste?

**It is a material, substance, or by-product which is eliminated or discarded, as no longer useful or required after the completion of a process.**

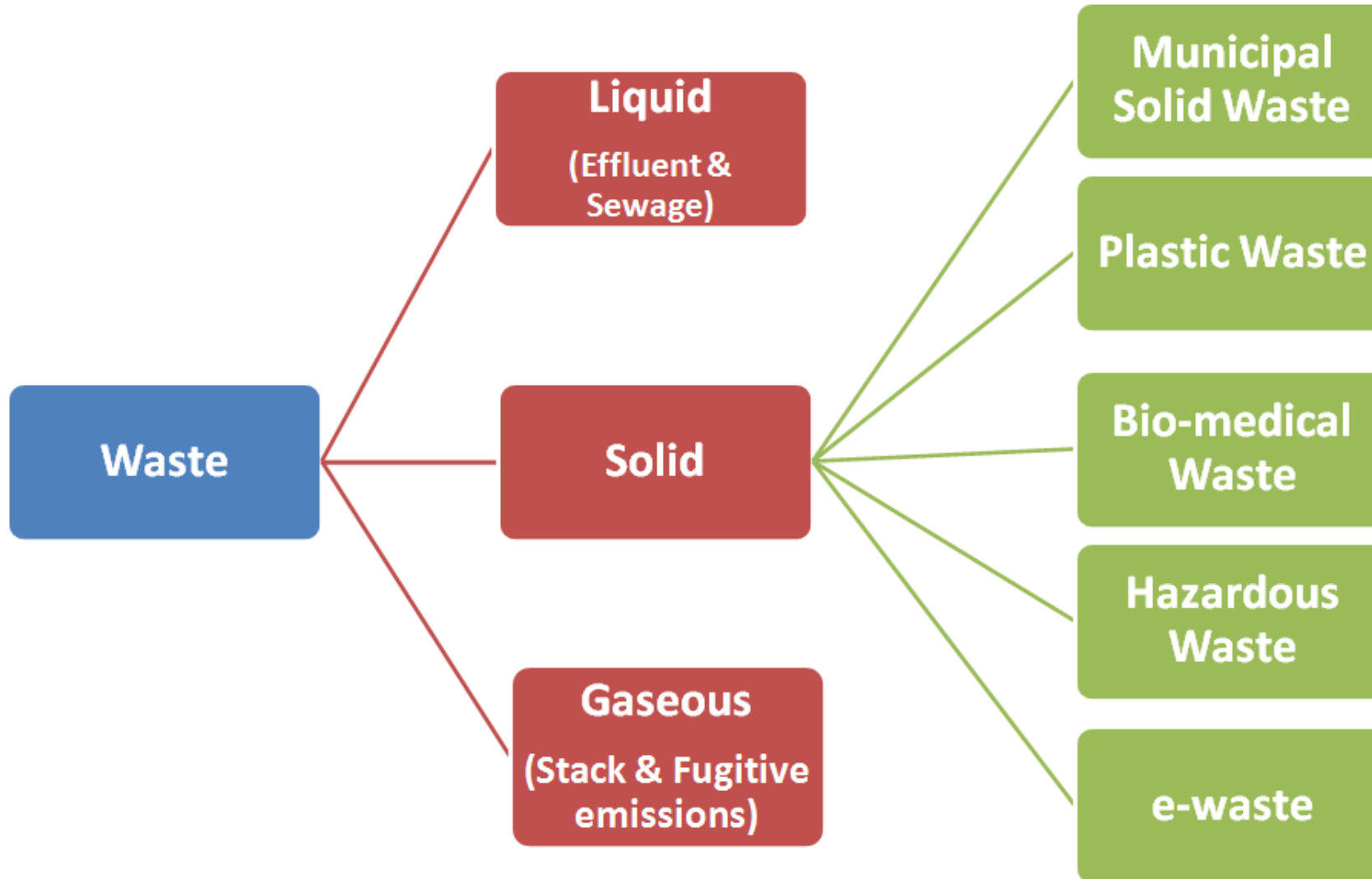


**“Waste is merely raw material  
in the wrong place”**

**- Frederick A Talbot in his book  
“ *Millions from Waste*” 1920**

**It is not WASTE until it's WASTED**

# TYPES OF WASTES



# Municipal solid waste (MSW)

The **Municipal Solid Wastes (Management and Handling) Rules, 2000** has defined MSW as commercial and domestic wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.



# MSW generation: A global overview

- Growing global population, rapid urbanization and economic development have led to increased MSW generation.
- In the year **2012**, approximately **1.3 billion tons** of MSW were generated globally.
- This amount has been predicted to rise to approximately **2.2 billion tons** by the year **2025**.
- The per capita generation of waste (kg/person/day) in case of developed countries is more (**USA: 2 kg/person/day**, **Australia: 1.77 kg/person/day**) compared to developing countries (**India: 0.37 kg/person/day**).
- However, the waste management options in developed countries have moved towards efficient waste management scenarios involving exploiting more energy and materials from waste stream and minimizing environmental pollution.

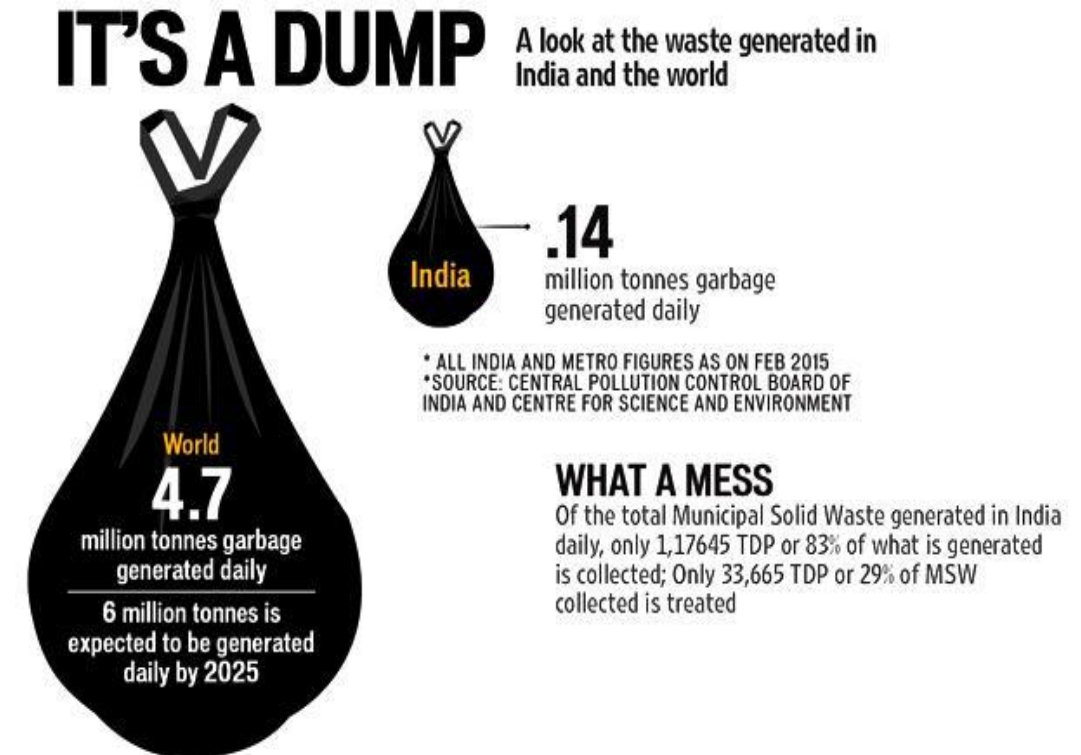


# Waste Generation in India

India is growing; and so are the mountains of waste its cities and villages are generating.

CPCB Report, 2015:

India produces approximately **52 million tonnes** of waste each year (**0.144 million tonnes** per day).



**Table 1** Major cities of India and per capita waste generation data (2010-2011)

Source: Census of India 2011, CPCB Report 2011.

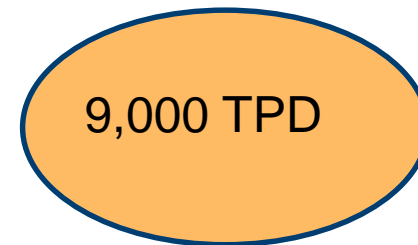
city	*population (2011) × 10 <sup>6</sup>	#total waste generated in tonnes per day	waste generation (kg per capita per day)
Ahmedabad	6.3	2300	0.36
Hyderabad	7.7	4200	0.54
Bangalore	8.4	3700	0.44
Chennai	8.6	4500	0.52
Kolkata	14.1	3670	0.26
Delhi	16.3	5800	0.41
Mumbai	18.4	6500	0.35

**Table 2** Waste generation per capita in Indian cities

Source: Kumar et al., 2017

population	waste generation rate (kg per capita per day)
cities with a population <0.1 million (eight cities)	0.17–0.54
cities with a population of 0.1–0.5 million (11 cities)	0.22–0.59
Cities with a population 1–2 million (16 cities)	0.19–0.53
Cities with a population >2 million (13 cities)	0.22–0.62

Delhi MSW generation (2016)

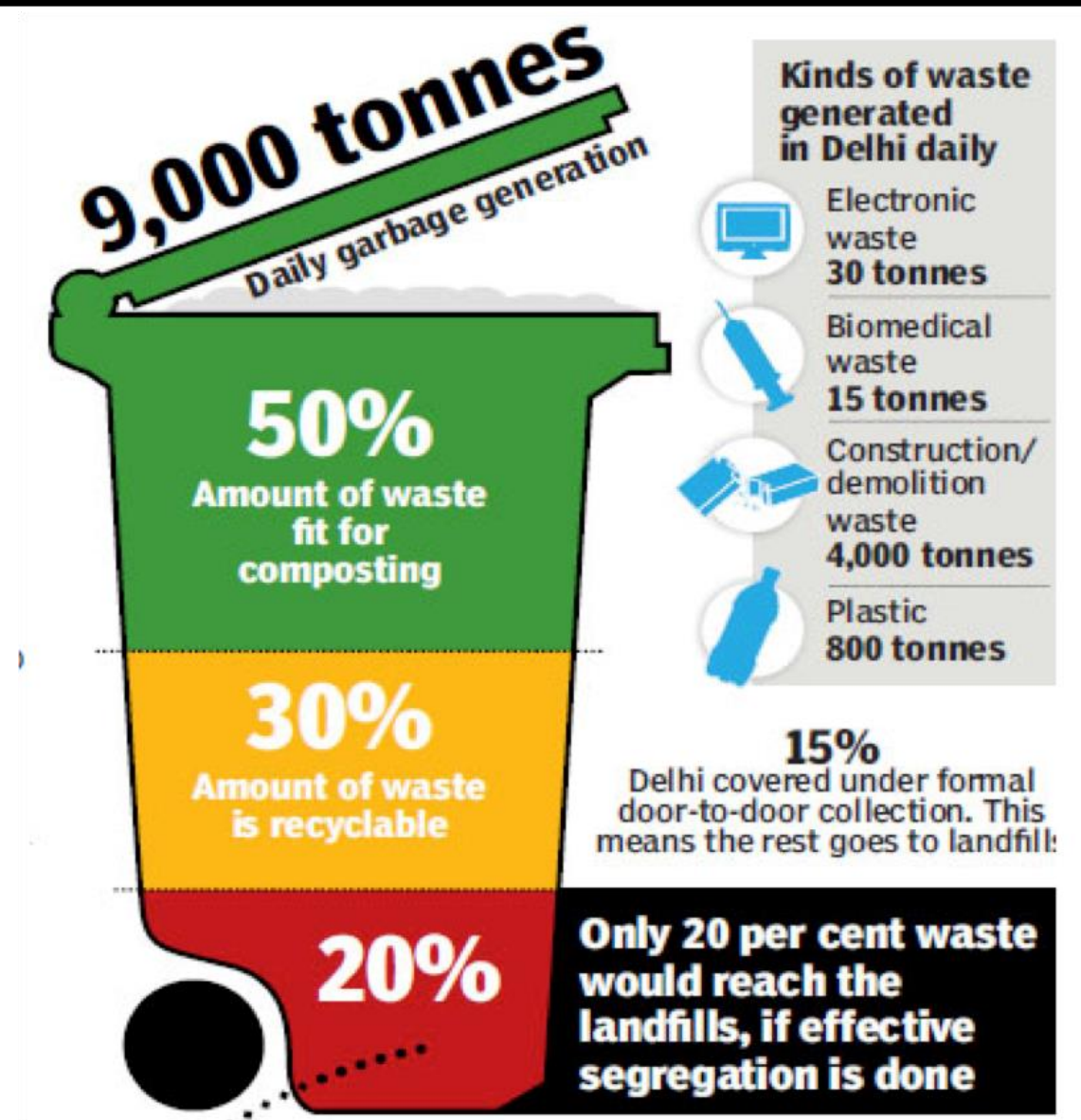


Projected Delhi MSW generation (2021)



The World Bank estimates that by 2025 solid waste generation in India will rise by **243 per cent.**

# Waste Composition in India



**CPCB (2015) estimates**

**90 %** Indian cities

**dispose their waste**

**in landfills.**

# Landfill sites pose big threat to Delhi

By **Balshah Adak** in New Delhi

A HUGE environmental hazard looms over the Capital as the city's three landfill sites — Okhla, Bhalswa and Ghazipur — continue to accumulate garbage beyond their shelf life.

A study done by Jawaharlal Nehru University's Department of Environment shows that the groundsoil of these three sites harbour organic pollutants exceeding the permissible limits by up to 158 times.

These sites were found to be high on compounds like aliphatics, terpenoids, benzene, ketones, pharmaceuticals and phenolics which do not degrade with time, enter the food chain quickly and cause a variety of health issues such as hormone disruption, reproductive disorders, learning disabilities, heart diseases, diabetes and cancer.

Additionally, Ghazipur was found to accumulate compounds which are more cytotoxic, that is human cell killing, in nature. On the other hand, Okhla contained more of genotoxic compounds which cause alteration in cell DNA.

The researchers fear that the contaminated liquid emanating from the garbage, called leachate, will pollute the groundwater beyond cure. This can prove to be disastrous for large populations residing near these three landfill sites which use groundwater. It will also further pollute Yamuna which runs along the course of these three sites.

Pooja Ghosh, a research scholar and co-author of the study, said, "The national Capital produces more than



Toxic compounds, which affect human cells, were found at the Ghazipur site.

ergistic and additive manner to cause toxic effects on organisms such as aquatic species in Yamuna and the human population living alongside the sites."

All the samples were characterized by dark colour, unpleasant odor, alkaline pH, high conductivity and relatively high concentrations of organic matter. Unfortunately, no standard maximum allowable discharge limit for landfill leachate is there

Based on rainfall, age of landfill and waste composition, the sites continuously leak contaminants in the groundwater.

—Pooja Ghosh, research scholar



Methane emissions



Leachate discharge

# Landfills in India

Non-Engineered

No Baseliners

No Leachate

Collection System

No CH<sub>4</sub> capture

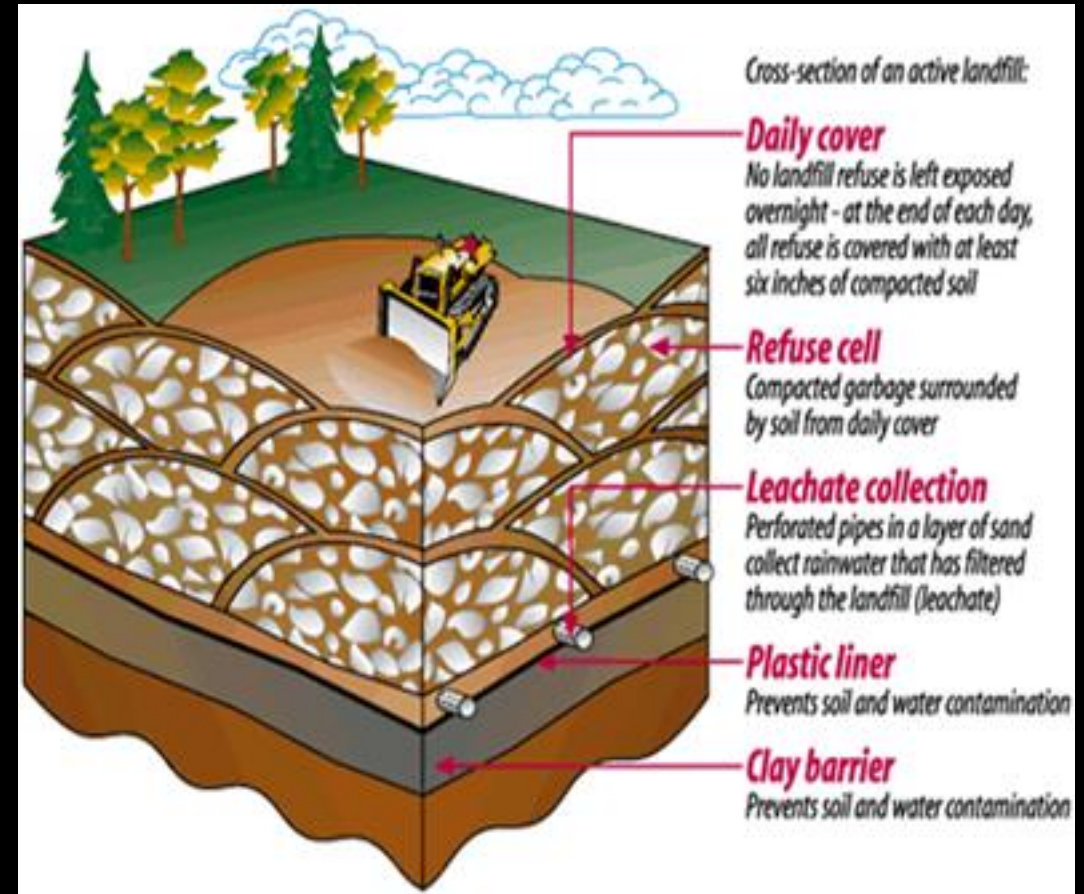
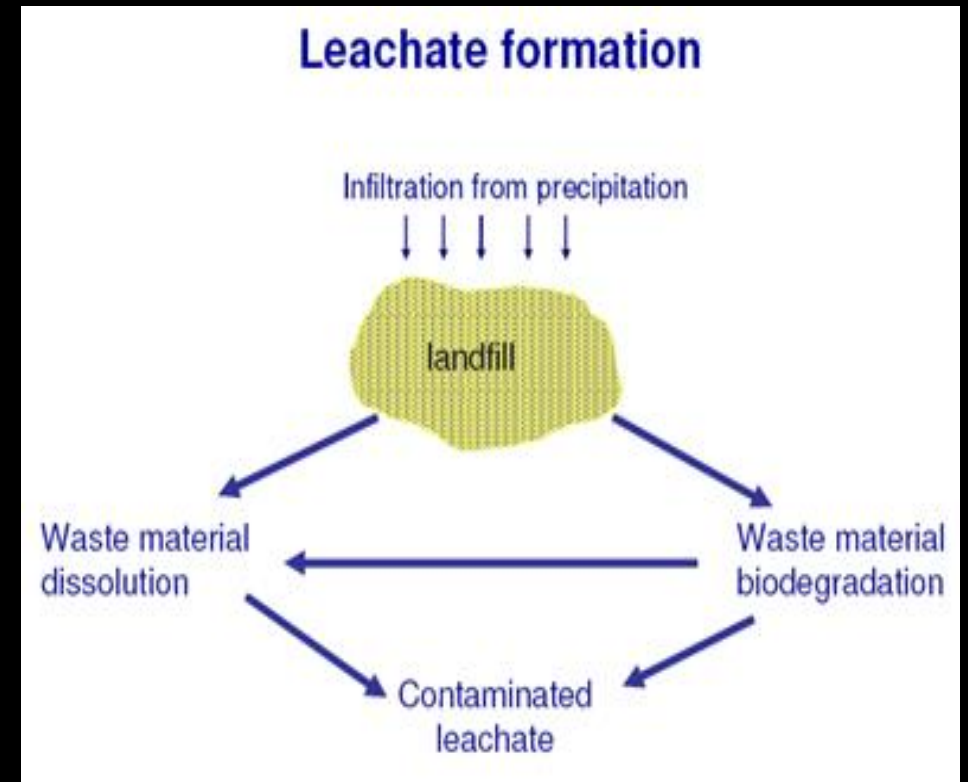


Diagram of an Engineered landfill

# Leachate

## Cause of Concern!

- ∅ Dissolved organic matter
- ∅ Inorganic macro components
- ∅ Heavy metals
- ∅ Xenobiotic organic compounds



**Chemical and  
toxicological  
evaluation of  
leachate from  
municipal solid  
waste landfill sites  
of Delhi, India.**

**#Contaminants  
#CancerRisk  
#Cytotoxicity  
#Genotoxicity**

*Source:* Ghosh P, Gupta A, Thakur IS (2015) **Environmental Science and Pollution Research.** 22:9148-9158.

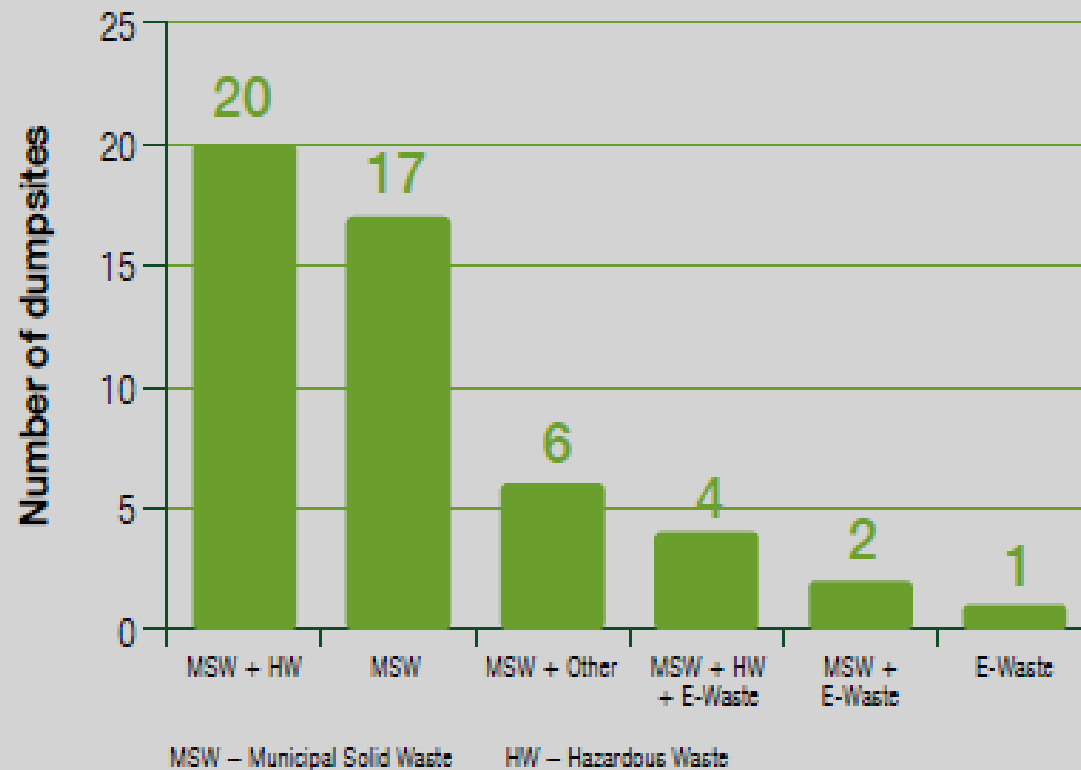


# WORLD'S 50 BIGGEST DUMPSITES



Source: Waste Atlas (2014) [http://wedocs.unep.org/bitstream/handle/20.500.11822/9751/-Waste Atlas Report-2014WasteAtlasReport\\_2014.pdf.pdf?sequence=3&isAllowed=y](http://wedocs.unep.org/bitstream/handle/20.500.11822/9751/-Waste%20Atlas%20Report-2014WasteAtlasReport_2014.pdf.pdf?sequence=3&isAllowed=y)

## Number of dumpsites accepting different combinations of waste types



.....

This figure classifies each of the 50 sites according to the main types of waste it receives: municipal solid waste (MSW), hazardous waste (HW), e-waste and other waste. All sites but one receive municipal solid waste either with or without hazardous waste; e-waste was identified as an important input at seven of the sites.

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# Summary of Impact of MSW Dumping in Unengineered Landfills

Environment and Health	Impact of Indiscriminate MSW Disposal
<b>Air and Climate</b>	Decomposition of organic fraction of MSW leads to the production of methane, a potent GHG and contributing to <b>global warming</b> .
<b>Water</b>	Leachates from waste dump impact <b>groundwater</b> presenting high health risks to consumers of bore water.
<b>Soil</b>	The presence of heavy metals can potentially alter the chemical <b>composition of soil</b> and consequently destroy <b>plant life</b> .
<b>Humans</b>	Inhalation of smoke and fumes produced by open burning of waste, can cause health problems. Toxic materials present in solid waste cause <b>respiratory and dermatological problems, eye infections and low life expectancy</b> . Drinking of groundwater contaminated with leachate may cause serious health issues.

# Challenges in MSW Management

## 1. WASTE COLLECTION

### FLOODS IN GHANA DUE TO PLASTIC BAGS BLOCKING DRAINS

Every year Ghana suffers from seasonal flooding. In Accra, as in many other places, drains blocked by plastics and other wastes are an important factor in this. Due to a lack of organized collection, many people simply dump their solid wastes, some of which gets washed into the drains. Litter on the streets and in the gutters is also widespread, much of it from the indiscriminate disposal of commonly used plastic sachets holding drinking water.

Floods in 2011 incurred loss of life and damaged or destroyed livelihoods and economic value. Fourteen people were killed, 43,000 were affected, and 17,000 lost their homes, with damage to roads, waterways and bridges also reported. In addition 100 incidents of cholera were identified a week after the flooding occurred.<sup>4</sup>



Source: UNEP Global Waste Management Outlook (2015)

[https://www.iswa.org/fileadmin/galleries/Publications/ISWA\\_Reports/GWMO\\_summary\\_web.pdf](https://www.iswa.org/fileadmin/galleries/Publications/ISWA_Reports/GWMO_summary_web.pdf)

## Case: Naples, Italy, 1994-2014

The Naples metropolitan area has had long-running problems with municipal solid waste management. The inability to find a satisfactory permanent solution for waste treatment and disposal has led to periodic 'crises' in which the absence of anywhere to take the waste has meant that waste could not be collected. Left to pile up in the streets, the waste became breeding grounds for vector-borne diseases, representing a public health risk for the population. Emergency solutions have sometimes included new uncontrolled dumpsites near the city, sparking further citizen protests. Such crises made national and international headlines in 1994, 1999, 2003, 2008, 2010 and 2011. The situation has caused substantial friction among the different stakeholder groups and has been further complicated by the active involvement of criminal organizations in waste transport. The new municipal government in 2011 appointed a leading anti-waste protester to head the waste management agency, and waste was thereafter transported to other Italian regions and other EU countries while a sustainable local solution was sought.



Source: UNEP Global Waste Management Outlook (2015)

[https://www.iswa.org/fileadmin/galleries/Publications/ISWA\\_Reports/GWMO\\_summary\\_web.pdf](https://www.iswa.org/fileadmin/galleries/Publications/ISWA_Reports/GWMO_summary_web.pdf)

## Epidemic resulting from uncollected waste blocking drains and creating breeding grounds for disease vectors

### Case: Plague-like epidemic in Surat, India, 1994

In 1994, the city of Surat suffered an outbreak of plague-like disease caused by major flooding as a consequence of uncollected waste blocking the drains. In the preceding years, the city had experienced a growth in population not matched by the infrastructure necessary to provide adequate solid waste management services – services under the responsibility of the municipality. At the time municipal solid waste collection was limited to 40% of the city<sup>5</sup> and the remaining waste was left uncollected and often came to be disposed of in drains and water bodies.

The disease outbreak resulted in 693 cases reported and 56 deaths. Additionally, the country may have suffered as much as USD 2 billion in economic losses,<sup>6</sup> including approximately USD 420 million in lost export earnings (for example, the United Arab Emirates suspended all cargo shipments from India). The disease outbreak occurred just before the Deepavali festival and over 45,000 people cancelled trips to India.<sup>7</sup>



Over the following 18 months the city administration, Surat Municipal Corporation, transformed the city into one of the cleanest cities in the region. The initiatives carried out included monitoring, infrastructure development in slums, engagement of the private sector in waste collection and transportation, capacity building and coordination among municipal employees, awareness raising among the public and the introduction of complaint handling systems.<sup>8</sup> They also created the Littering Detection Squad, an initiative under which people work to maintain the cleanliness of specific areas considered most vulnerable to litter and generate revenue by penalizing residents or shopkeepers who continue littering despite previous warnings.<sup>9</sup> One of the ongoing initiatives, a private sector waste treatment facility, is discussed later in the GWMO (Box 5.12).



## 2. LACK OF AWARENESS & SEGREGATION



# Does urban MSW affect rural areas?

Peri-urban or Intermediately Rural areas are the new targets for dumping solid wastes. For eg. Landfill sites at **Mavallipura and Mandur villages near Bangalore.**

**Mavallipura  
Landfill Site at  
Bangalore, Karnataka, India**



9:20PM 82%

m.timesofindia.com

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## Mandur blocks roads, 200 trash trucks return

TNN | Jun 16, 2014, 05.17AM IST

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BANGALORE: A garbage crisis is staring Bangalore in the face. Residents of Mandur and surrounding villages in Hoskote taluk on Sunday stepped up their protest against dumping garbage in their midst.

Hundreds of protestors gathered near the landfill on Sunday morning and raised slogans against the Karnataka government and the BBMP for not

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**G R O U N D R E A L I T Y**



MAVALLIPURA



BBMP handed over

**46 acres** of land to Ramky Enviro Engineers Ltd.

**12**

Villages around the landfill affected by improper waste processing, leachate contamination

MAVALLIPURA  
LANDFILL  
OPENED IN 2007

Around 700 tonnes  
of waste sent to the  
landfill every day



KSPCB issues closure notice to BBMP and Ramky in July 2012

**10 to 15 per cent** waste yet to be soil capped

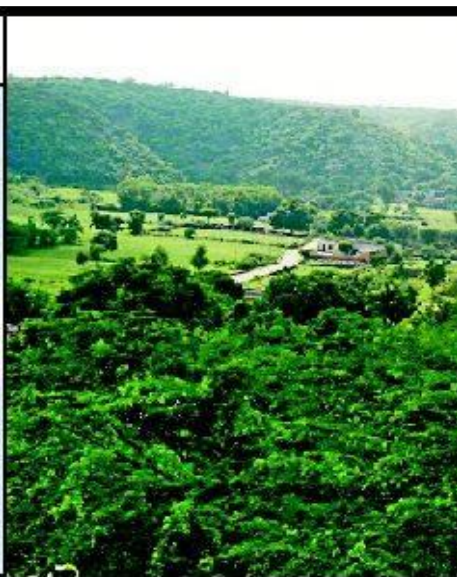
**ACCUMULATED WASTE AT THE LANDFILL IS 12 LAKH TONNES**

# Garbage generated in Gurgaon, Faridabad to be dumped in landfill site in eco-sensitive Aravalis

TNN | Oct 4, 2015, 01:57 AM IST

## THREAT TO FORESTS

- Severe damage to Aravali's forests, particularly along Gurgaon-Faridabad and Gurgaon-Delhi road
- Leakage of leachate from solid waste could pollute ground water
- Bandhwari waste treatment plant, near Mangar, has been shut & ground water in nearby villages is polluted



*Villagers from Gothra Mohbatabad have been opposing any move to either convert a mined pit as landfill or set ... Read More*

**N**EW DELHI: It's official: 92 acres in the Aravalis have been identified as a landfill site for garbage generated in Gurgaon and Faridabad. Since the area falls under the restricted zone where no non-forest activity is allowed, the Haryana government has started the process for exempting the huge land parcel from the legal provision.

For the first time, the Haryana government has officially admitted in an RTI response to a Gurgaon resident, Aseem Takyar, that the site has been identified on the Faridabad-Gurgaon road and falls in the revenue estate of village Gothra Mohbatabad. "This land falls under section - 4&5 of Punjab Land Preservation Act, 1980. The process for exemption of section - 4&5 is in progress," the RTI response said.

What has caused panic among people in the region is the ill-impact of the Bandhwari waste treatment plant, which was set up near Mangar. The plant is shut now and the ground water in some of the nearby villages has been polluted.

# Sustainable Development Goals (SDGs)

These are a collection of **17 global goals** designed to be a “**blueprint to achieve a better and more sustainable future for all**”. The SDGs, set in 2015 by the United Nations General Assembly and intended to be achieved by the year 2030.

**They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.**

**1** NO POVERTY



Jobs in waste collection and recycling

**2** ZERO HUNGER



Reduced food waste, more use of organic waste

**3** GOOD HEALTH AND WELL-BEING



Less disease caused by open dumping & burning

**4** QUALITY EDUCATION



Environmental and health training and awareness

**5** GENDER EQUALITY



Women often bear most of the impact of bad waste mgt

**6** CLEAN WATER AND SANITATION



Better SWM goes hand in hand with better WASH

**7** AFFORDABLE AND CLEAN ENERGY



Bioenergy opportunities from organic waste

**8** DECENT WORK AND ECONOMIC GROWTH



Waste management is the world's largest industry

**9** INDUSTRY, INNOVATION AND INFRASTRUCTURE



Recycling innovation is growing and scalable

**10** REDUCED INEQUALITIES



The poorest are harmed the most by poor waste mgt

**11** SUSTAINABLE CITIES AND COMMUNITIES



Better SWM vital for healthy & resilient communities



SOLID WASTE MANAGEMENT  
a key to delivering

**THE GLOBAL GOALS**  
For Sustainable Development

**12** RESPONSIBLE CONSUMPTION AND PRODUCTION



Need to shift from waste to resource management

**13** CLIMATE ACTION



Reduced methane & CO2 from dumping & burning

**14** LIFE BELOW WATER



Less plastic pollution in the oceans & sea life

**15** LIFE ON LAND



Less pollution on the land, healthier environments

**16** PEACE AND JUSTICE STRONG INSTITUTIONS



Producer responsibility and governance

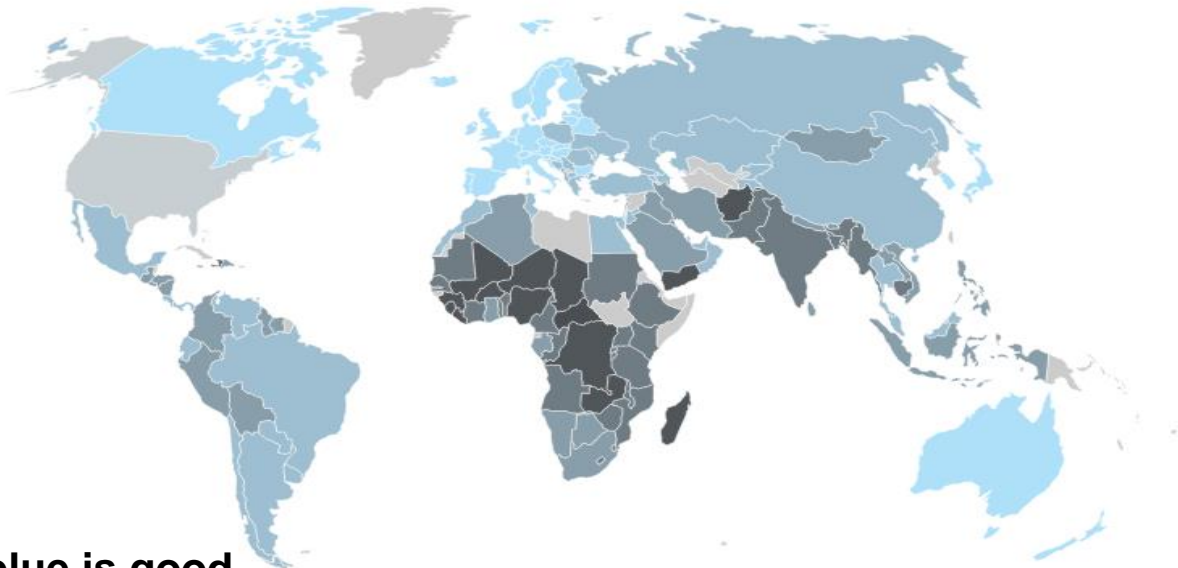
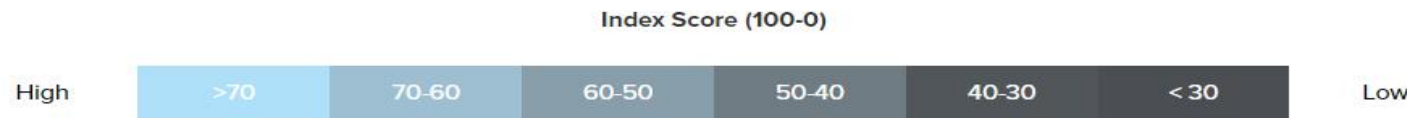
**17** PARTNERSHIPS FOR THE GOALS



Working together: formal & informal, wealthy & poor

# How close are countries to meet the SDGs by 2030?

- To find out, non-profit organization [Bertelsmann Stiftung](#) and the [UN Sustainable Development Solutions Network](#) have created a prototype [index](#) that measures their performance. The SDG Index measures 149 countries, comparing their current progress with a baseline measurement taken in 2015.



Light blue is good

Reference: World Economic Forum

## List of top performers

Rank	Country	Score
1	Sweden	84.5
2	Denmark	83.9
3	Norway	82.3
4	Finland	81.0
5	Switzerland	80.9
6	Germany	80.5
7	Austria	79.1
8	Netherlands	78.9
9	Iceland	78.4
10	United Kingdom	78.1
11	France	77.9
12	Belgium	77.4
13	Canada	76.8
14	Ireland	76.7
15	Czech Republic	76.7
16	Luxembourg	76.7
17	Slovenia	76.6
18	Japan	75.0
19	Singapore	74.6
20	Australia	74.5