Review Article

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Nation Challenges for Solid Waste Management

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Abstract

Solid waste refers to any garbage, refuse, sludge from a waste water treatment plant. It contains organic as well as inorganic matters, which are produced by various activities of the society. Solid waste referred as a non liquid material that no longer has value to the person who is responsible for the generation of the product. In the 21st century, the sustainable management of municipal solid waste (MSW) will get to be distinctly fundamental at all periods of effect from wanting to configuration, to operation, and to decommissioning. Municipal solid waste management is a critical element towards sustainable metropolitan consists of segregation, storage collection, processing, and disposal of solid waste to lower its impact on environment. (Kumar, et al, 2009) [2]. Reutilization of solid waste is not a feasible option in context of solid waste management. (Kasseva & Mbuligwe, 2000) [3]. Rule of SWM should be taken in such a way that ground realities and allow time for suitable processes should be developed. Rag pickers are working for unorganized sectors, thus proper organized sectors for the reuse and recycling of waste needs to be put in place, thus reducing the load on transportation and landfill.

Keywords: Solid Waste; Solid Waste Management; Sustainable; Reutilization.

Introduction

With the increase in population, urbanization and the living standards, results in the increase of solid waste across the nation; About 1.3 billion tones of wastes has been reviewed by the World's Bank in 2011 alone, whereas it has been predicted that the solid waste will be rise up to 2.2 billion tones by the year 2025.

Non- management of solid waste results in significant problems in developing and transitional countries, reasons include for whole this: limited resources and enforcement of relevant regulations especially affecting the quality of waste collection and applications of technologies for safe recycling, treatment and disposal (Chen. etal; 2010) [10].

Anything or material which is of no use and is spread anywhere is called waste and the owner is waste generator (Maria. etal; 2011) [11] World Bank published "What a Waste: Solid Waste Management in Asia in year 1999 (Hoornweg and Thomas 1999) [12] MSW provides a strong social contract between the municipality and community. According to published report its being already predicted that China will produce twice as much solid waste as United States, China will surpass the US as the world's largest waste generator.

According to IPCC (Intergovernmental panel on climate change): MSW may include food waste, garden (yard) and park waste; paper and cardboard; wood; textiles; nappies (disposable diapers); rubber and leather; plastics; metal; glass and other (ash, dirt, dust, soil, electronic waste).

According to PAHO (Pan American Health Organization): Solid or semi-solid waste generated

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in population centers including domestic and commercial wastes, as well as those originated by the small scale industries and institutions (including hospital and clinics); market street sweeping and from public cleansing.

OECD (Organization for economic Co-operation and development): Municipalities collect the waste material and get it treated; waste is covered from households, including bulky waste, waste from commerce and trade, office buildings, institutions and small businesses, yard and garden, street sweepings, content of litter containers and market cleansing.

Waste generation varies from countries as well as regions; Sub Saharan African generates 62 million tons per year of waste, per capita waste generation lies between 0.09 to 3.0 kg per person per day, with an average of 0.65kg/capita/day compared to East Asia and Pacific Region generates 270 million tons of waste per year, it is mainly influenced by waste generation in China, which makes up to 70% of the regional total, per capita waste generation ranges from 0.44 to 4.3 kg per person per day for the region, with an average of 0.95 kg/capita/day (Hoornweg et al 2005) [12].

Similarly in the hilly states of Himachal Pradesh, the same problem of waste management exists. For decades the hilly tourist location has seen an increase in population, developmental activities, and changes in socio-economic scenario and improved standard of living etc. The Increasing industrialization and rising income levels lead to greater use of resources which further leads to the increased MSW generation and more complex composition of MSW than earlier. Thus, waste quantities as well as composition are inextricably linked to the vibrancy of economic activity and resource consumption pattern of the society which generates the waste. Further, the technologies to be adopted for MSW management and processing predominantly depend upon MSW quantity, quality and range of variations.

Urbanization & Solid Waste Generation in India and Entire World

Urbanization

Transformation from traditional rural economies to modern industrial one is known as urbanization and it is in progressive concentration (Davis, 1965) [13]. Annual growth rate of population in India is 3.35%. (Census of India, 2011)

Heap of garbage and waste from all kinds have become common site in urban life which results in threat to public health as well as environment (Supreme Court Committee Report 1999).

Rapid Increase in Volumes and Changing Characteristics of Municipal Solid Waste-A Global Trend

It is being shown that there is correlation between the generations of MSW, Wealth (Gross Domestic Product, GDP per capita) and urbanization. Projections estimate about generation of waste could reach up to 27 billion tons by 2050; Asia will rank third in production of maximum amount of waste. Figure 1 shows the correlation between MSW generation, GDP and Population across the nation and their expected rise in generation of MSW in Asia as estimated by World Bank (ref).

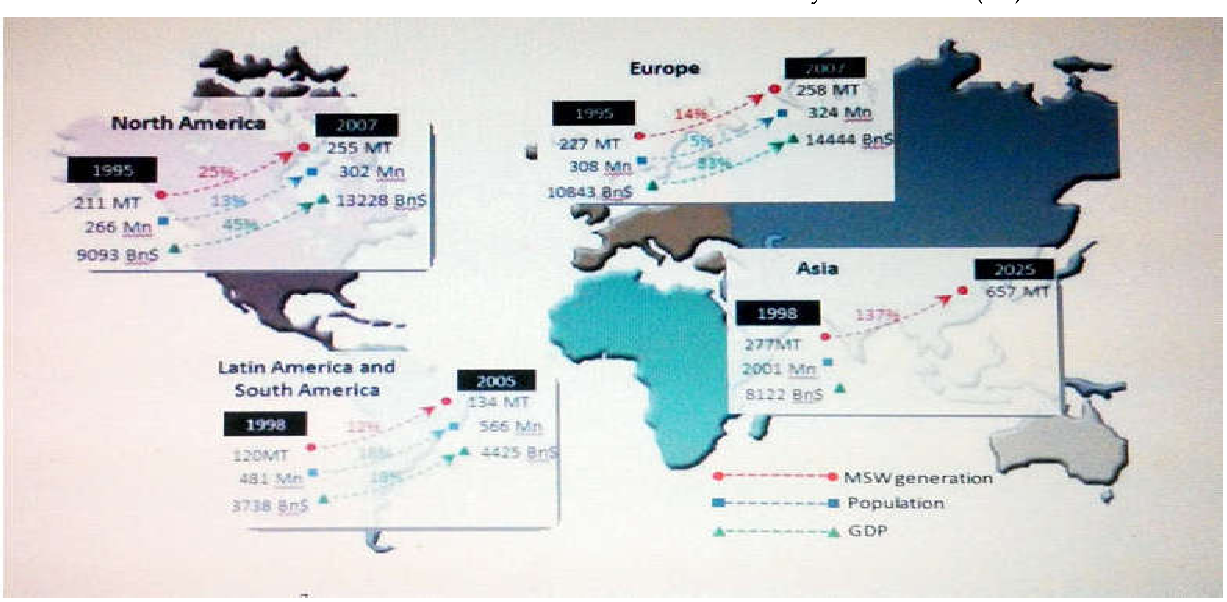


Fig. 1: Correlation between MSW Generation, GDP and Population

Impact of rise in population is more in developing countries compared to developed countries, population of India is 377 million which accounts for 31% of total population (Census of India, 2011a) [14]. An increase in population has been observed from 1961 to 2011, i.e. 18 to 31.2% in urban regions (Census of India, 2011 b) [15].

Solid waste is deliberately linked to urbanization and economic development. With the increase in urbanization , economic wealth also increase, thus result in increasing the living standards and disposable income, more the consumption of goods and services, more will be the amount of waste generation, it had been reported that about 1.3 billion tons of MSW are generated every year or 1.2kg/ capita/day.

Low amount of waste generation is observed in rural areas, waste is a byproduct of consumer based lifestyles that drive much of the world's economies.

Activities Involve in Solid Waste Management

Solid waste management mainly comprise of generation, storage, segregation, collection, transfer, transport, treatment and disposal of solid waste. Waste may generate by household, commercial and institutional activities which is not at all hazardous. There are major eight classifications of solid waste: residential, industrial, commercial, construction, institutional, municipal services, process and agricultural; residential waste is referred as *Municipal solid waste* (Hoornweg et al, 1999) [16].

Segregation

Sorting of waste is generally accomplished by unorganized sector and is practiced by waste producers. Effectiveness of segregation is very low as unorganized sector segregate only valuable discarded constituents from waste stream which results in higher economic return in the recycling market (Kaushal, Varghese & Chabukdhara, 2012) [17].

Segregation as per Solid Waste (Management and Handling) Rules 2000 is now compulsory. Segregation in simple language means separation of waste into dry and wet, so that it is easier to handle it later.

Whether it is collecting the waste through dumpers or we are collecting the waste from the source (door to door collection), it is in the un-segregated form in Himachal Pradesh. Due to this inherent problem of lack of segregation of waste, waste management has become a difficult task in the hilly state. Segregation of waste ensures that the waste is split into organics, plastics, and others giving more room for safe and effective disposal of waste. The plastics and others can either be recycled or sent to cement factories as fuel, while the organics can be composted or used to extract renewable energy.

Without segregation, waste becomes completely useless and void. It is therefore highly recommended that Himachal Pradesh starts to mobilize their municipalities and local authorities to initiate segregation at source drives. Fixing the problem at its root will not only ensure that the waste is segregated; it also throws up a myriad of opportunities for usefulness of waste.

Sundernagar District of Himachal has been the pioneer in implementing door-to-door waste collection and segregation of waste. Having implemented segregation of waste at source, the Sundernagar Municipality stands in good state to supply organics for setting up a biogas plant for extraction of renewable energy.

- *Why Waste Segregation is Important?*

a. If the waste is not separated properly, it all gets mixed up in landfills. The dangers of this is that landfills leak after a period of time, resulting in leachate or toxic soup at the bottom, which can contaminate ground water and release combustible methane gas.

b. Methane is a greenhouse gas, which ultimately leads to climate change, extreme climates and droughts. We can see the impact already in the world.

c. Segregation protects health. When rag pickers put their hands into the waste to clean it up, it results in cuts that further lead to infections, resulting in deterioration of a rag picker's health. Hence, it becomes our responsibility to help these rag pickers by carefully segregating the waste that is generated at our homes.

d. When the waste is not separated properly it leads to less recycling because it is not easy to remove materials for recycling. This means many resources are wasted.

Collection

Waste which is being produced by households is finally transferred into bins which are fabricated from metal mode or from concrete or combination of both. Whereas waste produced by commercial or institutional units are being collected by the municipal authorities. (Kumar et al, 2009) [18].

In the state of Himachal Pradesh no standard system of waste collection is followed. Although the door-to-door collection has been initiated, the absence of segregation of waste puts all waste management practices in difficulty.

We can see standard metal dustbins placed across towns, with no incentive for the citizens to throw their garbage in the bins. The ULBs have placed the big dustbins. Metal bins are placed at different locations without assessing the need, or doing any survey to identify the quantum of waste generation in different waste generating sources.

The citizens are not mobilized or informed of the need to segregate waste separately and to discard it scientifically. The ULB vehicles collect the waste from these large bins on an erratic basis, and most of the waste.

Some people use the dust bins to dispose of their waste but in other cases where waste bins/dumpers are away from their location, they dispose of the waste at un-notified locations 14 keeping in view their convenience. In fact the location of these dust bins have been found to be the dirtiest and stinking places in the town.

Since the people have not been told about the use of these bins and there is no notice/sign board on or near the dust bins indicating the norms for the use of dust bins, they dispose of both biodegradable as well as the non-biodegradable waste in the same bins.

- *Waste Collection System in India*

A. Door to Door Collection: This system is used in narrow streets where a collection truck cannot reach individual houses. The house places the filled containers outside their doors when the waste collectors arrive. Some cities such as Chennai (Madras) and Chandigarh have implemented this in posh localities where influential people reside.

On similar lines, Bangalore City Corporation (BCC) recently introduced door to door collection in some wards and management seems to be satisfactory. Himachal Pradesh should follow suit, and ensure that the pilot project of door-to-door collection initiated at Sundernagar is continued and the awareness spread across the entire state.

B. Curb Side Collection: This method is used in wider streets, where the collection trucks can pass through conveniently. The house owners leave the waste containers at the edge of the pavement. The waste collectors collect the waste from the curb side or empty the containers into the vehicle as it passes through the street at a set time and day and return the containers as practiced in Kanpur (UNCHS, 1994) [19].

C. Block Collection: The collection vehicles arrive at a particular place or a set day and time to collect waste from the households. Households bring their waste containers and empty directly into the vehicle (UNCHS, 1994) [20].

D. Community Bins: Community storage bins are placed at convenient locations, where the community members carry their waste and throw it. (These bins are also called Delhi bins, since it was introduced first time in Delhi).

The phenomenon of recycling by means of repair, reprocessing, and reuse of waste materials is a common practice in India. At the household level recycling is very common. Waste is accessible to waste pickers; they segregate it into saleable materials such as paper, plastics, glasses, metal pieces, textile, etc.

Rag pickers/Kabadis segregate the waste directly from the dumps and bins with no precautions and they are exposed directly to harmful waste. The separated waste is sold to a small waste dealer, from where the waste is transferred to a medium sized dealer or wholesaler. All these activities are not regulated or monitored by any governmental organization. Due to this informal segregation, volume reduction is achieved, while it ignores social, economic, environmental, and health aspects.

Reuse/Recycle

Collection of all waste and finding out which waste can be reused or recycled for making new products, as segregated wastes is dumped at community bins and its optimal recycling is not feasible. Rag pickers often try to sort out and sell recyclable materials like glass, plastics etc. In Pondicherry almost all recyclable waste is being sorted out by rag pickers (Pattnaik & Reddy, 2010) [21].

Transportation

MSW is generally collected via mode of transportation such as bullock carts, hand rickshaws, compactors, trucks, trailers and dumpers. 5-9 tons capacity is used in smaller towns with adequate cover system.

Disposal

Every city, town or village of India adopt unscientific disposal of MSW.

• *Open Dumping*

MSW generated is often disposed on low lying area in routine way which results in violation of sanitary land filling. Unscientific dumping results in flooding and also responsible for surface water contamination due to percolation of leachate (Lo, 1996; Mor, Ravindra, Dahiya & Chandra, 2006) [22].

• *Land Filling*

Land filling might keep to be extensively acknowledged act for India, if metropolitan focuses. In Delhi, Mumbai, Kolkata Also Chennai brings set accessibility about area for waste transfer also designated. Landfill locales need aid running past their limit (Sharholy, Ahmad, Mahmood, & Trivedi, 2008) [23].

Those advancement of new sterile landfills/ expansion for existing landfill are accounted in the. States for example, such that andesine, Delhi, Goa, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Furthermore West Bengal (CPCB, 2013) [24].

A study by United Nation Environment Program shows Green house gases emission from land fill can be reduced by the following ways (UNEP, 2008, 2010) [25]:

1. Waste minimization.
2. If we promote recycling and reuse of waste materials.
3. Reduction in fossil fuels by substituting energy recovered from waste combustion.
4. Energy derived from CH_4 from land fill site that can be used for in situ energy requirement.

Ministry of New and Renewable Energy (MNRE) and Government of India has installed 3 Mega watt capacity plant in order to convert waste to energy project, similarly different plants at different locations with different mega watts have been installed at Hyderabad, Pune, Delhi etc as there is non-availability of requisite quality of MSW along with presence of low calorific matter in MSW has given more chances to support waste to energy projects (MNRE Annual Report, 2014-2015) [26].

Developed countries is adding leachate /liquid/ supplement water in land fill sites to enhance biodegradation and gas recovery (Barlaz, Ham & Schoefer, 1990; Reinhart, McCreanor & Townsend, 2002) [27]. But this technique is not feasible in India, thus energy recovery from land fill remain untapped.

• *Biological Treatment of Organic Waste*

Waste generated by India contains 50% of organic content compared to developed countries which generates 30% of organic waste. Given below are the composting methods:

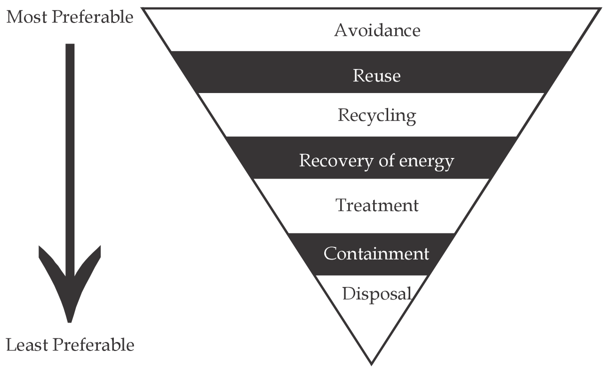
1. *Aerobic Composting:* Process in which there is biological conversion of organic matter existing in MSW in presence of air under humid and warm environment, results in high nutrient value compost. This process is either labor intensive or mechanical, in small towns labor intensive is carried out compared to big towns or cities where power driven composting is given prime importance and is installed (Bhide & Shekdar, 1998) [28].
2. *Vermi –Composting:* Introducing earthworms on semi decomposed waste is done by vermin composting, as we are aware that earthworms consume five times of organic matter per day as compared to their body weight. Biodegradable organic matter is decomposed through microbial enzymatic activity. Largest vermin composting plant is located in Bangalore while smaller plants are there in Hyderabad, Bangalore, Mumbai and Faridabad.
3. *Anaerobic Digestion:* It is also known as Biomethanation process, which is one of the important and sustainable techniques for treating biodegradable part of MSW in subtropical climates. Stabilization occurs by the process which results in the liberation of biogas thus there is conversion of organic matter which can be used as energy. This process contains 50-60% methane and can be used as fuel for power generation. *(Ambulkar & Shekdar, 2004) [29].*
4. *Thermal Treatment:* It can be accomplished by incineration, pyrolysis and plasma arc gasification. Incineration is not possible if the organic constituents of the MSW is high along with moisture content or inert content ranging from 30 to 60% each and calorific value in the range of 800-1100 kcal/kg in MSW (Jalan & Srivastava, 1995; Jaardar, 2000; Kansal, 2002; Sudhir et al,1996) [30].

If waste has low calorific value incineration is not feasible without the help of extra fuel. Whenever there is a burning of hospital waste small incinerators are recommended in India (Sharholy, Ahmad, Mahmood & Trivedi, 2005) [31]. Gasification is also one of the thermal techniques which are used for MSW treatment and results in decrease pollution and increase heat recovery. To burn agro biomass limited gasifiers were installed in India. NERIFIER gasification unit has been installed at Nahar, Rajasthan by NERI for burning of agro wastes, sawmill dust and forest wastes while TERI (Tata Energy Research Institute) gasifiers is installed at New Delhi (Ahsan, 1999; Sharholy et al, 2007) [32].

Comparison of Solid Waste Management Practices by Income Level (Adapted from a what a Waste, 1999)

Activity	Low Income	Middle Income	High Income
Source Reduction	No organized programs, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated into an organized program.	Organized education programs emphasize the three 'R's' — reduce, reuse, and recycle. More producer responsibility & focus on product design.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay. High fraction of inerts and compostable impact collection—overall collection below 50%.	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization. Collection rate varies between 50 to 80%. Transfer stations are slowly incorporated into the SWM system	Collection rate greater than 90%. Compactor trucks and highly mechanized vehicles and transfer stations are common. Waste volume a key consideration. Aging collection workers often a consideration in system design
Recycling	Although most recycling is through the informal sector and waste picking, recycling rates tend to be high both for local markets and for international markets and imports of materials for recycling, including hazardous goods such as e-waste and ship-breaking. Recycling markets are unregulated and include a number of 'middlemen'. Large price fluctuations.	Informal sector still involved; some high technology sorting and processing facilities. Recycling rates are still relatively high. Materials are often imported for recycling. Recycling markets are somewhat more regulated. Material prices fluctuate considerably	Recyclable material collection services and high technology sorting and processing facilities are common and regulated. Increasing attention towards long-term markets. Overall recycling rates higher than low and middle income. Informal recycling still exists (e.g. aluminum can collection.) Extended product responsibility common.
Composting	Rarely undertaken formally even though the waste stream has a high percentage of organic material. Markets for, and awareness of, compost lacking.	Large composting plants are often unsuccessful due to contamination and operating costs (little waste separation); some small-scale composting projects at the community/neighborhood level are more sustainable. Composting eligible for CDM projects but is not widespread. Increasing use of anaerobic digestion.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostable than low- and middle-income countries. More source segregation makes composting easier. Anaerobic digestion increasing in popularity. Odor control critical.
Incineration	Not common, and generally not successful because of high capital, technical, and operation costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties. Air pollution control equipment is not advanced and often by-passed. Little or no stack emissions monitoring. Governments include incineration as a possible waste disposal option but costs prohibitive. Facilities often driven by subsidies from OECD countries on behalf of equipment suppliers.	Prevalent in areas with high land costs and low availability of land (e.g., islands). Most incinerators have some form of environmental controls and some type of energy recovery system. Governments regulate and monitor emissions. About three (or more) times the cost of land filling per tons.
Costs	Collection costs represent 80 to 90% of the municipal solid waste management budget. Waste fees are regulated by some local governments, but the fee collection system is inefficient. Only a small proportion of budget is allocated toward disposal.	Collection costs represent 50% to 80% of the municipal solid waste management budget. Waste fees are regulated by some local and national governments, more innovation in fee collection, e.g. included in electricity or water bills. Expenditures on more mechanized collection fleets and disposal are higher than in low-income countries.	Collection costs can represent less than 10% of the budget. Large budget allocations to intermediate waste treatment facilities. Up front community participation reduces costs and increases options available to waste planners (e.g., recycling and composting).

Municipal solid waste hierarchy ranks in different ways in which we can treat and dispose off MSW in order to attain sustainability or relative environmental benefits. In context of economics waste hierarchy is useful if we convert the waste into energy recovery, recycling, reusing and reducing waste at the minimum. The main goal of waste hierarchy is to reduce the pre land filling and minimization of waste by using simple and low cost technology, moreover by this strategy there is also minimization of odor being produced by solid waste in the area where the waste is present either it's a open dumping or throwing garbage in landfills without covering it. The general hierarchy waste disposal is depicted here under:



Implementation of Municipal Solid Waste Rule 2000

Total 56 ULBs (Urban local bodies) responsible in the state for implementation of MSW rules. There are one Municipal Corporation, 25 Municipal Councils, 23 Nagar Panchayat and 7 Cantonment Boards. Total 16 ULBs have applied for authorization and authorization granted to all 16 ULBs. Only 40 ULBs have reported during the year. Total MSW generation estimated as 276 TPD in 40 ULBs, collected 207 TPD, treated 125 TPD and 150 TPD land filled.

For implementation of Schedule-I, scientifically developed landfill site is not available in the state. There are 56 dumpsites in 56 ULBs. Landfill site identified/approved for 38 ULBs but yet to be developed by 36 ULBs. However, landfill under construction at 02 ULBs (Nalagarh & Baddi). Waste processing facilities have been constructed by 09 ULBs and using by 11 ULBs viz. Shimla (compost) shared by Solan. Nahan (Pit), Una (pit), Santokharh (pit), Hamirpur (compost), Dharamshala (stac), Kangra (pit), Palampur (pit) and Kullu (pit) shared by Bhuntar. Waste processing plant under construction/plan at 07 ULBs (Theog, Talai, Mehatpur, Nadaun, Sujanpur, Mandi & Dalhousie).

Improvement of existing landfill sites are undertaken by 2 ULBs (Naina Devi & Kullu)'. Landfill is under construction in 02 ULBs (Nalagarh & Baddi). Out 40 ULBs, none has complied with the MSW Rules. Presently, 11 ULBs are processing MSW 14 through pit composting, vessel composting & Stack technology. Monitoring not carried out as no ground water sources at the sites. For implementation of Schedule – II, All ULBs are collecting waste wolly/partially; out of which 05 ULBs (Shimla, Rohroo and Cantt. Board of Jatoh, Bakloh & Subathu) covered whole area for collection. House-to-house collection started in few pockets of 03 ULBs (Shimla, Una & Hamirpur).

Segregation is done partially by 39 ULBs and Shimla is segregating 100%. Storage facility is provided partially in all ULBs. Transport facilities comply partially. Presently, out of 56 ULBs, 10 ULBs are processing MSW -Shimla (vessel technology), Solan (Aerobic composting), Una (pit composting), Chamba (pit composting), Kullu (Bio-conversion), Manali-Bhuntar (pit), Kangra/Nagrota (pit), Dharamshala (Aerobic composting), Nahan (pit) & Hairpur (pit). For execution of schedule –III, 40 ULBs have identified/approved landfill sites; out of which 15 ULBs have fenced the landfill site and few of them have installed weigh bridge(3), lighting facilities (8), etc. Waste processing plants installed at Shimla (100 TPD vessel composting), Solan (20 TPD Composting), Nahan (9 TPD not working), Naina Devi (4 battery cell), Una (6 TPD pit), Hamirpur (6-pit Battery Compost), Dharamshala (6 TPD Pit- not working), Kangra (9 TPD Pit), Kullu shared by Bhuntar (240 Bioconversion) & Manali/Bhuntar (240 Pits). There is no waste-to- Energy plant in Himachal Pradesh.

The Way Forward

Smart cities are developing concept in India. Civic bodies have to redraw long term vision in solid waste management and rework their strategies as per changing lifestyles. Garbage management in cities need to be prioritized so that we can process waste and not landfill it (with adequate provisioning in processing and recycling).To do this, households and institutions must segregate their waste at source so that it could be managed as a resource. We need to identify the spare land for dumping garbage, the existing ones are in a critical state. Rag pickers are the persons who start segregating the rags at source sites, later on to recycle it. Compost pits and community participation are the important tools for efficient waste management. E-waste disposal is the prime area of concern which need to adequately contained.

References

1. CPCB. Status report on municipal solid waste management. 2013. Retrieved from http://www.cpcb.nic. in/divisionsofheadoffice/pcp/MSW_Report. pdfhttp://pratham.org/images/paper_on_ ragpickers.pdf.
2. CPCB. "Air Quality Assessment, Emissions

Inventory and Source Apportionment Studies: Mumbai." National Environmental Engineering Research Institute, NEERI. 2010.

3. Hoomweg, D., and L. Thomas. What a Waste: Solid waste management in Asia. Urban and Local Government Working Paper Series No. 1, The World Bank, Washington, DC. 1999.
4. Kumar, Sunil. Effective Waste Management in India. INTECH CROATIA. (2010).
5. Ahmed, S. A., & Ali, M. Partnerships for solid waste management in developing countries: Linking theories to realities. Habitat International, 2004;28:467–479. http://dx.doi.org/10.1016/S0197-3975(03)00044-4.
6. Pappu, A., Saxena, M., & Asolekar, S. R. Solid wastes generation in India and their recycling potential in building materials. Building and Environment, 2007;42:2311–2320.
7. Shekdar, A.V. Municipal solid waste management—The Indian perspective. Journal of Indian Association for Environmental Management, 1999;26:100–108.
8. Kasseva, M.E., & Mbuligwe, S.E. Ramifications of solid waste disposal site relocation in urban areas of developing countries: A case study in Tanzania. Resources, Conservation and Recycling, 2000;28:147–161. http://dx.doi.org/10.1016/S0921-3449(99)00053-1.
9. UNEP (United Nations Environment Programme), 2005 UNEP (United Nations Environment Programme) Solid Waste Management, vol. 1, UNEP (2005).
10. Yuan, H, Wang, L, Su, F & Hu, G. 'urban solid waste management in Chongqing: challenge and opportunities', Waste Management, 2006;26: 1052-1062.
11. Chen, X., Geng, Y., & Fujita, T. An overview of municipal solid waste management in China. Waste Management, 2010;30:716-724.
12. Maria Gaviota Velasco Perez Alonso, Nickolas Themelis. Generation and Disposition of Municipal Solid Waste in Mexico and Potential for Improving Waste Management in Toluca Municipality. Waste-to-Energy Research and Technology Council (WTERT). 2011.
13. Hoornweg, D. and L. Thomas. What a Waste: Solid Waste Management in Asia. East Asia and Pacific Region. Urban and Local Government Working Paper. World Bank. 1999.
14. World Bank. Waste Management in China: Issues and Recommendations, May 2005. www.go.worldbank.org/2H0VMO7ZG0.
15. Census. Provisional population totals, India. 2011a. Retrieved from http://censusindia.gov.in/2011-prov-results/datafiles/india/povpoputotal presentation2011.pdf.
16. Census. Registrar general of India. 2011b. Retrieved from http://censusindia.gov.in/.
17. Hoomweg, D., and L. Thomas. What a Waste: Solid waste management in Asia. Urban and Local Government Working Paper Series No. 1, The World Bank, Washington, DC. 1999.
18. Ahsan, N. Solid waste management plan for Indian megacities. Indian Journal of Environmental Protection, 1999;19:90–95.
19. Ambulkar, A.R., & Shekdar, A.V. Prospects of biomethanation technology in the Indian context: A pragmatic approach. Resources, Conservation and Recycling, 2004;40:111–128. http://dx.doi.org/10.1016/S0921-3449(03)00037-5.
20. Bhide, A.D., & Shekdar, A.V. Solid waste management in Indian urban centers. International Solid Waste Association Times (ISWA), 1998;1:26–28.
21. Kaushal, R. K., Varghese, G. K., & Chabukdhara, M. Municipal solid waste management in India-current state and future challenges: A review. International Journal of Engineering Science and Technology, 2012;4:1473–1489.
22. Ministry of New and Renewable Energy. (2014–2015). Annual report. Government of India. Retrieved from http://mnre. gov.in/mission-and-vision-2/publications/annual-report-2.
23. Shekdar, A.V. Sustainable solid waste management: An integrated approach for Asian countries. Waste Management, 2009;29:1438–1448. http://dx.doi.org/10.1016/j.wasman.2008.08.025.
24. Shekdar, A.V. Municipal solid waste management—The Indian perspective. Journal of Indian Association for Environmental Management, 1999;26:100–108.
25. UNEP. Reports on waste and climate change: Global trends and strategy framework. 2010. Retrieved from http://www.unep.or.jp/ietc/Publications/spc/Waste& Climate Change/Waste & Climate Change.pdf.
26. Sharholy, M., Ahmad, K., Mahmood, G., & Trivedi, R.C. Analysis of municipal solid waste management systems in Delhi—A review. In Proceedings for the second International Congress of Chemistry and Environment, Indore. 2005.p.773–777.
27. Sharholy, M., Ahmad, K., Vaishya, R.C., & Gupta, R. D. Municipal solid waste characteristics and management in Allahabad, India. Waste Management, 27, 490–496. http://dx.doi.org/10.1016/j.wasman.2006.03.001.
28. Kansal, A., Prasad, R. K., & Gupta, S. Delhi municipal solid waste and environment—An appraisal. Indian Journal of Environmental Protection, 1998;18:123–128.
29. Kansal, A. Solid waste management strategies for India. Indian Journal of Environmental Protection, 2002;22:444–448.
30. Kumar, S., Bhattacharyya, J.K., Vaidya, A.N., Chakrabarti, T., Devotta, S., & Akolkar, A.B.

Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: An insight. Waste Management, 2009;29:883–895. http://dx.doi.org/10.1016/j.wasman.2008.04.011.

31. Kumar, S., & Gaikwad, S. A. (2004). Municipal solid waste management in Indian urban centres: An approach for betterment. In K. R. Gupta (Ed.), Urban development debates in the new millennium. New Delhi: I Atlantic & Distributors. 2004.p.100-111.

32. Pattnaik, S., & Reddy, M.V. Assessment of municipal solid waste management in Puducherry (Pondicherry), India. Resources, Conservation and Recycling, 2010;54:512–520. http://dx.doi.org/10.1016/j.resconrec.2009.10.008.

33. Lo, I. M.C. Characteristics and treatment of leachates from domestic landfills. Environment International, 1996;22:433–442. http://dx.doi.org/10.1016/0160-4120(96)00031-1.

34. Barlaz, M.A., Ham, R.K., & Schaefer, D.M. Methane production from municipal refuse: A review of enhancement techniques and microbial dynamics. Critical Reviews in Environmental Science and Technology, 1990;19:557–584. http://dx.doi.org/10.1080/10643389009388384.

35. Jalan, R.K., & Srivastava, V.K. Incineration, land pollution control alternative—Design considerations and its relevance for India. Indian Journal of Environmental Protection, 1995;15:909–913.

36. Siddiqui, F.Z., & Khan, E. Landfill gas recovery and its utilization in India: Current status, potential prospects and policy implications. Journal of Chemical and Pharmaceutical Research, 2011;3: 174–183.