Towards Zero Garbage

Solid Waste Blueprint

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Table of Contents

List of Tables

List of Figures

List of Photos

Abbreviations

BMW	Biomedical waste
C&D	Construction and Demolition
GP	Gram Panchayat
GSS	Gram Swachhata Sabha
IEC	Information, Education and Communication
IHHL	Individual Household Latrine
MDWS	Ministry of Drinking Water and Sanitation
MMR	Mumbai Metropolitan Region
MoEF	Ministry of Environment and Forests
MPCB	Maharashtra Pollution Control Board
MSW	Municipal Solid Waste
NBA	Nirmal Bharat Abhiyan
NGO	Non Government Organizations
PRI	Panchayati Raj Institutions
SLWM	Solid and Liquid Waste Management
TPD	Tons per Day
TSC	Total Sanitation Campaign

Purpose of the blueprint

> To control and reduce environmental and health effects of solid waste through an integrated approach and move towards a clean and healthy society

Management of solid waste is one of the several challenges faced by the society. This challenge is of a larger scale in urban areas. Human activities create waste and our methods of handling, collecting, storing and disposing waste poses a threat to the environment and public health.

It is evident that humans strive for the basic necessities of food, clothing and shelter. As long as economic and population growth takes place, there will be efforts put in to meet the demands of the expanding population. These needs will have to be met by augmenting production endeavors.

As mankind progresses it generates wealth and with wealth comes waste. This trend is observed in developed economies and the urban centres of the developing economies follow suit. The increasing volume of waste spawned by changing consumption patterns presents a formidable challenge. The problem lies in how to deal with such large volumes of waste without affecting the lifestyles of people. Growing waste volumes result in undesirable environmental nuisance to the people and would threaten lifestyles and living environments of our future generations.

Urbanization, industrialization and increase in economic status has increased the volume and altered the contents of waste in Maharashtra. However, the contents of solid waste in the rural and urban areas of the state differ. In urban areas, most of the solid waste is disposed on open ground, some is recycled, some incinerated and some processed into fertilizer. Of late waste to energy technologies have been introduced. Despite new technologies, dealing with large volumes of waste remains a problem.

Recognizing the pressures on society and the associated negative impacts on our natural resources and human health, rapid measures need to be taken. The purpose of this blueprint is to reduce and manage the solid waste generated in rural and urban areas of Maharashtra through an integrated approach towards “zero waste”.

The path towards a “zero waste” society needs a shift in thinking away from treating waste as waste and towards an integrated approach in which material resources are reused, recycled or recovered wherever possible and only disposed of as the option of last resort.

Introduction

Waste is an unavoidable by-product of human activity and needs to be managed efficiently so that it does not create a threat to health and environment. Solid wastes are those organic and inorganic waste materials produced by various activities of the society, which have lost their value to the first user. Solid waste is generated from households, offices, shops, markets, restaurants, public institutions, industrial units, hospitals, construction and demolition sites, agricultural activities, etc. Improperly managed solid waste poses a risk to human health and pollutes the environment, both locally and globally. Uncontrolled dumping and improper handling causes several problems, at times irreversible.

Solid waste is increasing with population expansion, increase in per capita income, standard of living and changing lifestyles. The problem of solid waste is starkly visible in urban areas. Cities and rural centres on the brink of urbanization have population whose personal incomes have increased due to available economic opportunities. This leads to greater spending, consumption and unavoidably “trash".

Thus there is a fundamental basis to huge quantities of waste in urban areas. Prevalence of industries, large use of electronic and electrical equipments, and use of packaged food only add to the waste.

Rural areas use fewer resources. Per capita consumption of water and food, per capita income, and production of goods and services is less and so is waste generation. Remote rural areas lead in the race for environmental conservation by keeping at bay the waste, which has now become a part of urban economy. However, packaged food, bottled water, electronic equipments, as well as industry are infiltrating several rural areas, particularly those on the fringe of urban centres.

Upcoming urban centres and the shift (migration) from rural to urban areas represent the direction of evolution of human civilization. In earlier times, the use of material was such that waste was not generated at all. Use of paper and plastic was less; while the waste generated consisted mostly of wood and metal, utensils were made from mud and clay, packaged food was absent, and the economy was predominantly agricultural –industry was yet to step in. As the civilization has developed into a more advanced one, with a service-at-doorstep character, with specialized equipment and machines, and in general into a more individualistic society, the waste generation graph is on an exponential increase.

Waste management involves more than just collecting trash and dumping it at landfill. Waste management is the collection, transport, treatment, recycling, disposal and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, environment or aesthetics. Waste management is also carried out to recover resources from it[1].

[1] http://en.wikipedia.org/wiki/Waste_management#cite_note-Waste_Management_FAQ-0

Uncontrolled dumping and improper waste handling and management affect the health and amenities of societies in several ways including[2].

- Contaminating groundwater through leaching,
- Contaminating soils,
- Increasing flooding due to clogged drains and sewers,
- Transmitting diseases to residents and waste workers,
- Attracting insects and rodents,
- Affecting natural resources, flora and fauna,
- Through visual and smell impacts.

Sources and Types of waste[3]

Waste can be divided into many different types. The most common method of classification is by their physical, chemical and biological characteristics. One important classification is by their consistency. Solid wastes are waste materials that contain less than 70% water. This class includes such materials as household garbage, some industrial wastes, some mining wastes, and oilfield wastes such as drill cuttings. Liquid wastes are usually wastewaters that contain less than 1% solids. Such wastes may contain high concentrations of dissolved salts and metals. Sludge is a class of waste between liquid and solid. They usually contain between 3% and 25% solids, while the rest of the material is water dissolved materials.

Solid waste is mostly referred to as the waste generated from households and the entire focus of management is diverted to this waste which is visibly strewn around on the streets, gutters, around community bins. But there are other types of waste as well that require attention and management as much as the domestic waste.

Solid waste includes domestic and commercial waste which is classified as municipal solid waste (MSW), industrial and/ or hazardous waste, hospital waste *i.e.* biomedical waste, construction and demolition (C&D) waste, e-waste and waste from rural areas. MSW and industrial waste are the leading causes of surface and ground water pollution. C&D waste is also a serious threat to the environment as no hard and fast methods are being followed for its appropriate disposal and it is dumped in the river beds. Solid waste comprises wastes from households, shops, commercial establishments, hotels, schools and other institutions. Solid Waste can be categorized into five broad groups as

- **Biodegradable waste** – Food and kitchen waste, green waste (vegetables, flowers, fruits, leaves)
- **Recyclable waste** - Paper, glass, bottles, cans, metals, certain plastics, etc
- **Inert waste** - construction and demolition waste, debris, dirt, etc
- **Composite waste** - Waste clothing, tetra packs, waste plastic like toys
- **Domestic hazardous waste**- (also called "household hazardous waste") & toxic waste: Medication, paints, chemicals, light bulbs, fluorescent tubes, spray cans,

[2] Solid waste management- Delhi Urban Environment & Infrastructure Improvement Project
[3] http://www.umich.edu/~gs265/society/wastedisposal.htm

fertilizer and pesticide containers, batteries, shoe polish, hair dyes, chemicals in cosmetics, etc.

- **Hazardous waste** - Old medicines, paints, chemicals, bulbs, tube lights, spray cans, fertilizer and pesticide containers, batteries, shoe polish, etc. Wastes from industries and treatment plants. Categories of hazardous waste are given in Annexure I- Categories of hazardous waste.
- **Bio-medical waste** - Any waste, which is generated during the diagnosis, treatment or immunization of human beings or animal or in research activities pertaining thereto or in the production or testing of biological. Hospital waste such as cloth soiled with blood and other body fluids, syringes, anatomical waste, swabs, bandages, cultures, chemicals from hospitals used for cleaning, etc. The types of biomedical waste are tabulated (Table 2) below.
- **Agricultural waste-** Any waste from farms, poultry farms, dairies.
- **E-waste** - E-waste is a collective term used for end of life electronics and electrical equipment. The bulk of the e-waste in India comes from computers, laptops, mobile phone and related devices, television sets, washing machines, refrigerators, DVD players, fax machines, etc as well as fluorescent tubes which contain mercury. This waste contains significant quantities of hazardous waste including lead, mercury and cadmium.

Table 1-Sources and types of solid waste

Source	Types of Solid waste
Residential Households	Food wastes, plastics, paper, rags, metal, wood, glass, ash, cardboard, special waste (consumer electronics, batteries, oil, tyres, chemicals, paints) and household hazardous wastes
Industrial Light and heavy manufacturing industries, chemical plants, fabrication units, mineral extraction & processing, power plants, etc	Packaging, food waste, hazardous waste, ashes, special waste, etc
Commercial Hotels, restaurants, shops, markets, beauty parlors, etc	Paper, cardboard, plastics, wood, food wastes, glass, metals, (consumer electronics, batteries, oil, tyres, chemicals, paints), special wastes, hazardous wastes.
Institutional Schools, hospitals, government offices, prison	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Construction and demolition New construction sites, road repair, renovation and demolition activities	Rubble, bricks, tiles, concrete, steel, dirt, etc
Municipal services Street cleaning, Gardens and parks, Beaches, other recreational areas, Waste water treatment plants, slaughter houses,	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge, carcasses.
Agricultural Farms, Orchards, Dairies, Poultries	Agricultural residue, hazardous waste (pesticide)

Table 2 -Type of Biomedical waste[4]

Type of waste	Includes
Human Anatomical Waste	Human body parts, tissues and organs
Animal Waste	Animal body parts, carcasses, excreta, bleeding parts and wastes generated at veterinary hospitals
Microbiology and Biotechnology Waste	Wastes from laboratory cultures, live or attenuated vaccines, human and animal cell culture used in research, wastes from biological toxins
Waste Sharps	Needles, syringes, blades, scalpels
Discarded Medicines	
Soiled Waste	Cloth containing blood stains, blood coated cotton balls, soiled plasters
Solid Waste	Waste generated from disposable items like tubing and catheters
Liquid Waste	Waste generated from laboratory housekeeping activities
Incineration Waste	Ash generated from incineration of biomedical waste
Chemical Waste	Chemicals used for disinfection.

It is termed as MSW as large volumes of wastes are generated in the urban centres. MSW management rules are applicable only to the municipal areas. The waste composition in rural centres is more or less same as that generated in urban centres but the volume is substantially less.

Methods of waste disposal

There are different methods of disposing wastes, the two most commonly used methods are given below.

Landfill: This is the most common the most cost effective method of disposal and it involves burying the waste. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits. A properly-designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. However unscientific and poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, generation of liquid leachate and attraction of animals[5], birds, rodents and fleas creating nuisance and unhygienic conditions. Under European Union policy, land filling is seen as the last resort and should only be used when all the other options have been exhausted, i.e., only material that cannot be prevented, re-used, recycled or otherwise treated should be land filled[6]. Hazardous waste such as chemicals, batteries should not be disposed off into a landfill. Ideally a landfill should be lined and should have a cover, gas recovery system, leachate collection system, a place to treat leachate after it is collected and a ground water monitoring mechanism.

[4] National Guidelines on Hospital Waste Management based upon the Biomedical Waste (Management & Handling) Rules, 1998
[5] - http://en.wikipedia.org/wiki/Waste_management#cite_note-Waste_Management_FAQ-0
[6] http://scp.eionet.europa.eu/themes/waste

This is the most commonly used method in Australia as it is a large country with a low density of population.

Incineration: It involves combustion of waste material and is the second most common method for disposal which can greatly reduce the incoming solid waste[7]. It is more expensive but a safer method of disposal than landfill. However, incinerator ash may contain hazardous materials including heavy metals and persistent organic compounds such as dioxins[8], which may have serious environmental consequences in the area immediately around the incinerator.

This method is common in countries like Japan, where land is scarce as these facilities do not require as much area as landfills[9].

Other than landfill and incineration, the following methods are also used to dispose waste

Plasma gasification: A gasifier vessel utilizes proprietary plasma torches operating at +10,000°F (the surface temperature of the Sun) in order to create a gasification zone of up to 3,000°F to convert solid or liquid wastes into a syngas. When municipal solid waste is subjected to this intense heat within the vessel, the waste's molecular bonds break down into elemental components. The process results in elemental destruction of waste and hazardous materials. Plasma gasification offers states new opportunities for waste disposal, and more importantly for renewable power generation in an environmentally sustainable manner[10].

Waste injection technique: Pumping the waste into deep wells is yet another method of disposal. However, earthquakes and explosions have resulted from this technique. This method is used in USA, but there is a strong opposition for its use[11].

Apart from the two common and two quite uncommon processes of disposal, Recycle and Reuse is by far the best way of waste disposal. It reduces the quantity of waste, reduces harm to environment, and also reduces the pressure on natural resources to manufacture new products.

[7] Municipal solid waste management in India: From waste disposal to recovery of resources
[8] http://www.umich.edu/~gs265/society/wastedisposal.htm
[9] http://en.wikipedia.org/wiki/Waste_management#cite_note-Waste_Management_FAQ-0
[10] http://en.wikipedia.org/wiki/Waste_management#cite_note-Waste_Management_FAQ-0
[11] http://www.umich.edu/~gs265/society/wastedisposal.htm

Legal and Institutional Framework

The responsibility for solid waste management lies with the respective Civic Bodies consisting of Municipal Corporations, Municipalities, Cantonment Boards, Nagar Panchayats, Gram Panchayat, etc. It is a complex task and requires cooperation between several stakeholders in the public and private sector.

The Municipal Solid Waste (Management and Handling) Rules, 2000, issued by the Ministry of Environment and Forests (MoEF), Government of India, under the Environment (Protection) Act, 1986, prescribe the manner in which the civic bodies have to undertake collection, segregation, storage, transportation, processing and disposal of MSW generated within their jurisdiction under their respective governing legislation. Municipal solid waste management is an obligatory function of the civic bodies.

The expense towards waste management is usually met by way of property taxes collected from the residents. A few local bodies levy administrative charges if anyone is found dumping garbage indiscriminately in places other than those specified, one such being the Surat municipality in Gujarat, which suffered an outbreak of plague in 1994. Civic bodies have the responsibility to enforce Municipal Solid Waste (Management & Handling) Rules, 2000, under which a wide spectrum of functions are to be undertaken. The major functions include[12]:

- Prohibiting littering of streets
- Organizing house to house waste collection
- Conducting awareness programs to disseminate information to public
- Providing adequate community storage facilities
- Use of color code bins and promotion of waste segregation
- Transport of wastes in covered vehicles
- Processing of wastes by adopting an appropriate combination of composting, anaerobic digestion, pelletization, etc.
- Up gradation of existing dump sites and disposal of inert wastes in sanitary landfills

As per the Municipal Solid Waste (Management & Handling) Rules, citizens are responsible for

- Segregation of wastes at source
- Avoid littering of streets
- Delivery of wastes in accordance with the delivery system notified by the respective Civic body.

There are separate legislations addressing issues related to management and handling of Bio-Medical and Hazardous wastes. Maharashtra Pollution Control Board (MPCB) has a range of regulatory functions in the state of which those related to wastes and solid waste

[12] International Symposium on the Technology and Management of the Treatment & Reuse of the Municipal Solid Waste, Shanghai, China, 2002: Perspectives of solid waste management in India: Kurian Joseph

are enlisted below. These various enactments and rules are under the Environment (Protection) Act, 1986.

- Bio-Medical Waste (Management & Handling) Rules, 1998
- Hazardous Material (Management, Handling and Trans boundary Movement) Rules, 2007
- Municipal Solid Waste (Management & Handling) Rules, 2000
- Plastic (Manufacture, Usage & Waste Management) Rules, 2009
- Batteries (Management & Handling) Rules, 2001
- E Waste (Management & Handling) Rules, 2011

MPCB facilitates the implementation of MSW rules. The board provides technical and financial assistance in all cities to set up municipal solid waste collection, transport, and treatment and disposal facilities as well as augment existing infrastructure[13]. A public interest litigation in the Supreme Court, addressing the dismal situation of SWM in India, a situation in which both collection and disposal systems were woefully inadequate posing multifarious dangers to human health and the natural environment, led to the framing of the Municipal Solid Waste (Management and Handling) Rules, 2000, under the Environment Protection Act, 1986[14].

Solid waste management in rural areas comes under the purview of the Ministry of Drinking Water and Sanitation (MDWS), under Nirmal Bharat Abhiyan (NBA) – Total Sanitation Campaign (TSC)[15]. Integrated approach towards solid and liquid waste management (SLWM) is envisioned in TSC. Ten percent funds are earmarked for SLWM. The MoEF has also been trying to enhance the budget share for solid waste management[16].

[13] Achievements of MPCB 2006-07: http://www.3rkh.net/3rkh/files/20062007Achievements%20of%20Maharashtra%20Pollution%20Control%20Board.pdf

[14] Economic and Political Weekly June 3, 2006; Public, Private and Voluntary Agencies in Solid Waste Management - A Study in Chennai City: pp 1

[15] http://tsc.gov.in/TSC/NBA/AboutNBA.aspx

[16] United Nations Development Program (UNDP), "Greening Rural Development in India", Volume I, 2012 http://moef.nic.in/assets/Greening%20RD%20Report.pdf

Overview of Solid Waste in Asia and India

This section deals with the status of the waste generated in Asian countries and a comparison among Asian countries. Similarly status in India and a comparison of the metropolitan cites has also been discussed in brief.

During the flourishing of civilizations from 300 to 1000 BC, solid waste was paced in large pits with a layer of soil cover[17]. This practice continues today though with technological modifications such as lining of the pits (landfills), leachate collection, etc. Management of urban solid waste is the most neglected areas of urban development in India. Landfill sites and garbage dumps are overflowing in most cities attracting rodents and flies[18].

Asia[19]

- The urban areas of Asia spend about US$25 billion on solid waste management per year; this figure will increase to at least US$50 billion in 2025. Today's daily waste generation rate is about 760,000 tonnes. By 2025, this rate will be increased to about 1.8 million tonnes per day.
- Total waste management costs in low income countries are usually more than 80 percent for collection costs. Lower cost land filling is usually a more practical waste disposal option than incineration.
- Indonesia and the Philippines as well as parts of China and India are the Asian countries facing the greatest waste management challenge, based on projected waste generation rates and relative affluence to deal with the problem.
- The waste components requiring priority attention in Asia are organics and paper.

Comparison of waste management practices in low, middle and high income countries of the Asia-Pacific region is placed as *Annexure I*.

India[20]

Management of MSW continues to remain one of the most neglected areas of urban developments in India. In spite of heavy expenditure by the civic bodies, the present level of service in many urban areas is so low that there is a threat to public health in particular and the environmental quality in general (Supreme Court Committee Report, 1999). Municipal agencies spend about 5-25% of their budget on MSW management. Community storage system is usually practiced in India. Individuals deposit their waste in bins located at street

[17] Current Science, Vol. 95, No.6: Municipal solid waste disposal in Pune city – An analysis of air and groundwater pollution: 25 September 2008
[18] http://india-reports.in/earth-solutions/urban-solid-waste-management-in-india/; Sub Ref: Bio Energy News Vol'1 No.1, 1996
[19] Urban Development Sector Unit East Asia and Pacific Region : What a Waste: Solid Waste Management in Asia, May 1999
[20] Eleventh Five Year Plan, 2007-2012, Volume III- Agriculture, Rural Development, Industry, Services, and Physical Infrastructure, pp 403

corners and at specific intervals. Households also tend to throw wastes in the roadside gutters to be removed by the street sweepers. This problem is more acute in slums, low and middle income group areas. At places of storage arrangements, waste tends to be strewn around partly due to indiscipline and partly due to scavenging by rag pickers and stray animals. Due to the absence of adequate storage capacity for the refuse generated and poor discipline among the generators, the wastes are continually dumped on the road (Boyar et al, 1996). In some areas, NGOs are involved in making arrangements for waste collection from households, leading to improvement in local street cleanliness (Shekdar, 1999)[21].

Reuse and recycling waste has always been practiced in India, as in most developing countries of the world. Among the first items to be collected by waste pickers were rags, bones and paper, which used to form raw material for reprocessing industry. Industrialization and urbanization led to a greater generation of waste. The advent of plastic and use of sophisticated items provided a further boost to the recycling industry[22]. Recycling in India has developed into a profitable industry [Macqueen 1987]. Waste needs little capital and is labor intensive. Many people are taking up this occupation in the developing world for various reasons (including higher economic returns)[23]. Segregation of waste (at source), is not well organized in comparison to the amount and quality of waste generated.

- It is estimated that 1,15,000 metric tons of municipal solid waste is generated in the country daily.
- The daily per capita solid waste generated in small, medium and large towns in India is around 0.1 kg, 0.3-0.4 kg and 0.6 kg, respectively, with the recyclable content varying from 13 to 20%.
- Per capita waste generation in cities varies between 0.2– 0.6 kg per day and it is increasing by 1.3% per annum. With the growth of urban population, the increase in solid waste is estimated at 5%.
- The solid waste generated by million plus cities varies from 1200 metric tons per day (TPD) in cities like Ahmedabad and Pune to a maximum of 5000–5500 metric TPD in cities like Delhi and Mumbai.
- Collection efficiency of solid waste ranges between 70% and 90% in metro cities, whereas in smaller cities it is below 50%.
- Out of total waste generated in the million plus cities, hardly 30% is treated before disposal.
- Most of the municipal solid waste generated in India is being disposed unscientifically[24].
- The biodegradable fraction is high in the wastes.

[21] International Symposium on the Technology and Management of the Treatment & Reuse of the Municipal Solid Waste, Shanghai ,China, 2002: Perspectives of solid waste management in India: Kurian Joseph

[22] Economic and Political Weekly, October 7, 2000: Formalizing livelihood – Case of waste pickers in Pune:pp 1

[23] Economic and Political Weekly, December 13, 2003: Waste and Waste-Pickers: pp 1

[24] Current Science, Vol. 95, No.6: Municipal solid waste disposal in Pune city – An analysis of air and groundwater pollution:25 September 2008; Sub ref: Down To Earth, 15 March 2007: Pandora's garbage can: Yadav Kushal Pal S: pp. 20–21.

Overview of Solid Waste Management in Maharashtra

This section explores the current scenario, details of type and quantity of wastes in and the prevailing practice of waste management in Maharashtra. Maharashtra has 535 towns and 43,663 villages[25]. Out of the 535 towns, 256 are statutory towns *i.e.* have a municipal body, cantonment board or a notified area committee. However solid waste problems are more concentrated in the urban areas than rural areas. Rapid population growth, illegal settlements where no garbage collection services are provided, decreasing open spaces and increasing opposition from populations living nearby landfill sites, has made waste management a tougher problem to deal with in urban areas. In fact the growth in MSW in many urban centers has outpaced population growth. Population of Mumbai grew from around 8.2 million in 1981 to 12.3 million in 1991, registering a growth of around 49%. On the other hand, MSW generated in the city increased from 3200 tonnes per day to 5355 tonnes per day in the same period registering a growth of around 67%.

There are various issues such as collection of mixed waste, lack of use of sanitary landfills, dumping of waste in open grounds, socio-economic problems, *etc.* Improper disposal of large quantities of solid waste has caused severe land degradation. The waste statistics in Maharashtra are presented in the box below[26] [27].

- Over 20,500 TPD of MSW is generated.
- 1.8 million tons per year of hazardous waste is generated.
- Maharashtra has largest share of bio-medical waste (BMW), ~ 43.5 TPD *i.e.* 60% of the total BMW produced in India.
- 20,270 tons per annum of waste from electrical and electronic equipment is generated.
- 10-20% of MSW comprises C &D waste.
- Per capita waste generation is ~0.4-0.5 kg per day

Rural solid waste

The quantity of waste generated is increasing in rural areas as a result of increased population, consumerism and commercial activities. It is estimated that 15,000 to 18,000 million liters of gray water and 0.3 to 0.4 million metric ton of solid waste are generated each day in rural areas[28].

[25] Census of India, 2011

[26] Maharashtra State Development Report (2005)

[27] State of Environment Report, Maharashtra, 2006-07

[28] Government of India, Ministry of Drinking Water and Sanitation, and UNICEF: "Solid and Liquid Waste Management in rural areas – A Technical Note", 2008
http://www.mdws.gov.in/sites/upload_files/ddws/files/pdfs/SLWM_2.pdf

Municipal Solid waste (MSW)

MSW is collected by the respective civic bodies and disposed off to designated disposal sites (landfill sites) which are usually located in low lying areas on the outskirts of the city. The overall solid waste composition includes 2.63% paper, 0.96% textiles, 0.33% leather, 1.31% plastics, 1.95% glass, 62.28% ashes and fines (dust) and 32% compostable matter (CPCB 2000)[29].

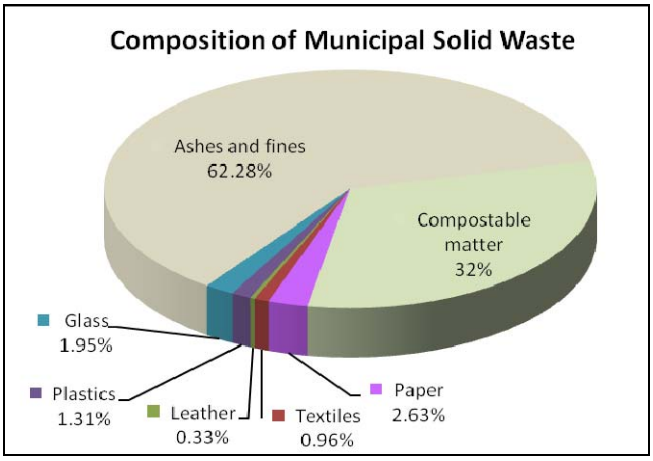

Figure 1- Composition of MSW

MSW is characterized as dry and wet waste. The wastes generated in Maharashtra are characterized with a relatively higher moisture content and lower calorific value. Characteristics of waste generated in four major cities in the state are provided in the table below[30].

Table 3 - Characteristics of waste generated in cities in Maharashtra

City	Compostable	Recyclable	C/N Ratio*	HCV** (Kcal/kg)	Moisture (%)
Greater Mumbai	62.44	16.66	39.04	1786	54
Pune	62.44	16.66	35.54	2531	63
Nagpur	47.41	15.53	26.37	2632	41
Nashik	39.52	25.11	37.62	2762	62

C/N ratio: Carbon to nitrogen ratio; HCV: Heat Calorific Value of MSW

In Maharashtra, over 20,500 TPD of MSW is generated of which 50% is generated in three cities alone *viz.* Mumbai, Thane and Pune (2011-12). Mumbai alone generates about 6500 TPD followed by Pune (1750 TPD) and Thane (1200 TPD)[31].

[29] State of Environment Report, Maharashtra, 2005-06
[30] State of Environment Report, Maharashtra, 2006-07
[31] MPCB Annual Report 2011-12

Waste collection is through community bin system, wherein bins are placed at various locations along roadsides / streets in residential, business and commercial areas. Solid waste generated is transferred into the nearest bin. In many cities in Maharashtra house-to-house collection of waste has been started. In this system residents are encouraged to segregate the biodegradable waste from the rest of the waste.

Biomedical waste (BMW)[32]

The state accounts for the highest generation of BMW in the country, which is 43.5 TPD[33]. Mumbai contributes 23.26% of the total BMW load. Pune contributes 19.58% and Nagpur is close third with 17.33% contribution. MPCB states that out of the 43.5 TPD BMW generated, 38.2 TPD (88%) is treated. Pune and Nagpur have only incineration facility but no arrangement for ash disposal. The hospitals find that cost for treatment and disposal is too high.

> Of the total biomedical waste generated in India, 60% is generated in Maharashtra alone.

Hazardous waste

With rapid development in agriculture, industry and hospitals the consumption of significant amounts of toxic chemicals has increased and so has the production of hazardous waste. Hazardous waste is a byproduct of industrial and agricultural processes. Large quantities of hazardous waste is generated from chemical, petrochemical, paper and pulp, leather, textiles, auto and equipment repair shops, electroplating shops, factories, etc. Hazardous waste also includes used batteries, motor oil, compact fluorescent bulbs, fluorescent tube lights, etc.

Table 4: Region wise hazardous waste generation (MPCB, 2012)[34]

Region	Hazardous waste ('000 tons)	Region	Hazardous waste ('000 tons)
Amravati	6.948	Navi Mumbai	141.855
Kolhapur	59.41	Pune	151.099
Chandrapur	85.244	Thane	157.992
Nagpur	88.115	Raigad	255.131
Nasik	100.617	Kalyan	260.936
Aurangabad	132.269	Mumbai	365.671
		TOTAL	**1805.292**

[32] The figures represent BMW generated from health care centres authorized by MPCB. Actual BMW generated may be much greater than the figure that MPCB declares.
[33] Status of Biomedical Waste Management in the State of Maharashtra, MPCB: http://mpcb.gov.in/images/pdf/Status_BMW_MahJune2011.pdf
[34] http://mpcb.gov.in/hazardous/pdf/HW_Inventary2012/ExecutiveSummary2012.pdf

In a number of cities and towns, small scale industries just dump hazardous waste on any open ground in their vicinity. In households hazardous waste from the households gets mixed with the MSW. Management of Industrial Solid Waste is not the responsibility of local bodies. Industries generating solid waste have to manage such waste by themselves and are required to seek authorizations from Maharashtra Pollution Control Board.

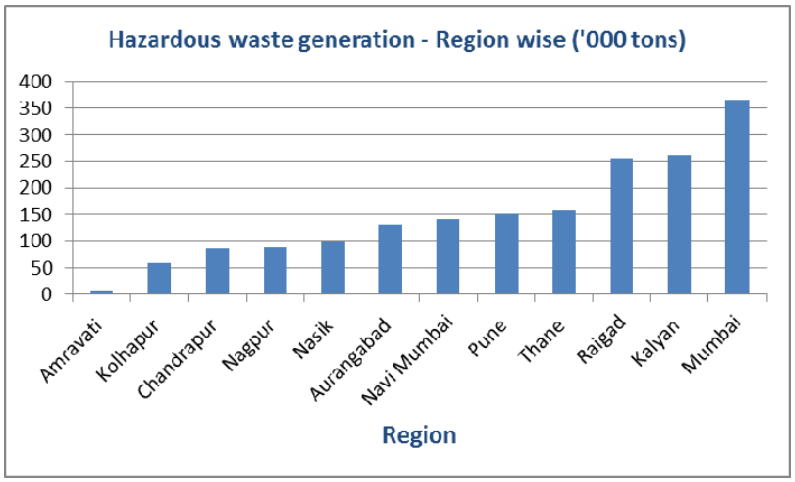

Figure 2- Region wise hazardous waste generation

Total hazardous waste generation for Maharashtra State is 18,05,292.66 MT/Annum of which about 29% is fit for landfill, 57% is recyclable and balance 14% is fit for incineration.

Of the total hazardous waste generated in India, 50% is generated in Maharashtra alone.

E-waste

Ten states generate 70% of the total e-waste generated in India *viz.* Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab.

In India, among the ten states, Maharashtra ranks first in e-waste generation.

The total e-waste generation in Maharashtra accounts for 20,270.6 tons per year**.** Navi Mumbai contributes 646.48 tons, Greater Mumbai 11017.06 tons, Pune 2584.21 tons and Pimpri-Chinchwad 1032.37 tons[35]. Mumbai Metropolitan Region (MMR) generates 35000 tons e-waste a year[36]. Among top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur. In 2015, MMR will generate 50000 tons e-waste a year.

[35] http://mpcb.gov.in/images/pdf/ewastereport1.pdf
[36] http://mpcb.gov.in/images/pdf/ewastereport2.pdf

Maharashtra Pollution Control Board has already given authorization to companies interested in tapping the potential of e-waste. Three e-waste collection centres[37], eight e-waste dismantlers[38], and a single e-waste recycler[39] have been authorized.

Construction and Demolition (C&D) waste

C&D waste includes cement and concrete, bricks, plaster, steel (from RCC, door/window frames, roofing support, railings of staircase etc.), rubble, stone (marble, granite, sand stone), timber/wood (especially demolition of old buildings and excavation). It also includes conduits, pipes, electrical fixtures laminations etc. The C&D waste is dumped in the rivers or nullahs and is not disposed properly. Moreover people just dump C&D waste just outside their shops/establishments on roads or footpaths creating nuisance and obstruction to traffic. This waste is not quantified.

The MSW Rules clearly stipulate waste generated by demolition and construction activities to be a type of municipal solid waste. The C&D wastes in Pune are currently included in the MSW management rules. However, there have been guidelines introduced for C&D waste management in the city of Mumbai.

Plastic

Plastic production crosses the 150 million tonnes per year globally. In India approximately 8 Million tonnes plastic products are consumed every year (2008). Plastic waste generation in four major cities of Maharashtra is as follows. It is a part of Municipal Solid Waste.

Table 5-Plastic waste generated in Major cities in Maharashtra[40]

City	Mumbai	Pune	Nagpur	Nasik
Tons per day	421	104	45	20

Annual aggregate waste generation in Maharashtra

MSW	(20500 TPD X 365)	=	7.5 MT per year
Hazardous waste		=	1.8 MT per year
Biomedical waste	(31.5 TPD X 365)	=	11500 tons per year
E-waste		=	20270 tons per year
TOTAL		**=**	**9.33 MT per year**

[37] http://mpcb.gov.in/ewaste/pdf/E-WasteCollectionCenter31122012.pdf
[38] http://mpcb.gov.in/ewaste/pdf/E-wasteRegistreddismantlersCtoO31122012.pdf
[39] http://mpcb.gov.in/ewaste/pdf/E-wasteRegistredrecyclers31122012.pdf
[40] Plastic Waste management, Central Pollution Control Board: http://cpcb.nic.in/divisionsofheadoffice/pcp/management_plasticwaste.pdf

Present Waste Management Practices in Maharashtra

Urban centres

Waste generated at households is generally collected in small containers (often plastic buckets) in the household until there is sufficient quantity to dispose it into community bins. Though waste segregation is mandatory as per the Municipal Solid Waste (Management & Handling) Rules, it is seldom practiced.

Community storage system is usually practiced in the state. Individuals deposit their waste in bins located at street corners and at specific intervals. These are huge metal containers. Of late in many cities house to house collection has started. It is observed that in spite of community bins, householders tend to throw waste on the footpaths, road sides or open drains (nullahs), rivers and lakes. This problem is acute in slums and low income group areas. This waste that is strewn around is cleared by the street sweeping staff of the municipal bodies. People also tend to empty their individual waste containers just outside the community bin and not into it. This results in waste being scattered around the storage area. Rag pickers also when scavenging through the waste scatter it around the community storage bins. Thus even though community bins are conveniently located, waste is often scattered partly due to indiscipline of people, scavenging by rag-pickers and stray animals. This poses a health hazards to those communities living in the vicinity. The waste from storage bins is collected by the civic bodies and dumped at designated sites. When there is too much of waste scattered the civic workers simply burn it as it becomes difficult to gather all the strewn waste and put it in the community storage, thereby polluting the air.

Photo 1- Community Storage Bins: Waste scattered around the storage area (Pune City)

In some cities, door to door collection of waste is facilitated by Non Government Organizations (NGOs) through the rag pickers. The waste is collected and segregated by these rag pickers on the road side. The degradable waste is dumped in the community storage bins or collected in trucks (depending on the facility available), whereas the rag pickers benefit by selling the recyclable waste, in addition to a fixed minuscule amount paid

by the households. For door to door waste collection different types of vehicles are used such as trucks, push carts or cycle carts. In smaller towns tractor trailers are used.

Commercial sector like shops, offices, hotels etc all use the community waste bins and their wastes are also collected along with the household wastes. In some cities Municipal Authorities collect waste from the premises of commercial complexes and hotels.

Waste from the vegetable markets is also collected by the street sweepers. A vegetable market produces large quantities of waste and the collection, transportation and disposal of this waste is a major problem. This waste lies rotting in the market place, posing environmental and public health hazards.

An informal system of recycling already exists in the state, especially in the urban areas. Several urban dwellers make their living by collecting waste and recycling it. In fact every readily marketable waste such as newspapers, papers, cardboard, boxes, plastic, glass, tin cans, etc. are recycled by the households themselves or rag pickers.

Figure 3 - Informal Sector of waste recycling

The waste that usually reaches the community bins comprises broken glass pieces which cannot be physically scavenged by the rag pickers, scraps of soiled paper, household hazardous waste, used toiletries, organic waste, etc which contains very little recyclable waste. Recently in several towns and cities, efforts are being taken to promote waste segregation and composting at individual and multi-family dwellings.

Lately waste processing plants have also been set up to deal with the waste menace. But these plants need waste with a certain calorific value to operate efficiently.

In the urban centres waste is being disposed of in designated site on the outskirts or in low lying areas. New disposal sites are identified only when the existing ones are completely saturated. The waste is simply dumped at these sites and is rarely compacted by using bulldozers, except in Mumbai. However in Mumbai too, they are used only for leveling of the deposited waste. The incoming vehicles are not weighed and no specific plan is followed when dumping the waste. Soil cover is provided only at the time of closure of the site.

Landfills are not scientifically constructed; they are just open dumping sites, without a fence and without any provision for leachate collection and gas control. Even at the disposal site the waste is burnt to reduce the volumes and for easy rag-picking.

Rural centers

Panchayati Raj Institutions (PRIs) are required to put in place mechanisms for garbage collection and disposal and for preventing water logging[41].

Swachhata Diwas

Each Gram Panchayat (GP) earmarks a particular day of the month to be named as '*Swachhata Diwas'* (Sanitation Day) with the following objectives:

- Recording the achievements made in number of toilets constructed in previous month, works undertaken under Information, Education and Communication (IEC), HRD and Solid and Liquid Waste Management.
- Identifying individuals demanding sanitation facility and identifying other works that could be undertaken under TSC.
- Projecting Month Plan for construction of Individual Household Latrine (IHHL), School and *Anganwadi* toilets and sanitary complexes in the GP, IEC events, trainings undertaken, *etc*.
- Identifying slip back cases under IHHL and working out strategy for addressing the issue of making the community open defecation free as a whole.
- Verifying expenditure made on various activities in the previous month including disbursement of incentive amount, construction and other works and activities.
- Carrying out any other work as may be identified under the program.

Gram Swachhata Sabha[42]

A Gram Sabha is convened by the Secretary, Gram Panchayat as 'Gram Swachhata Sabha' (GSS) every six months to undertake mandatory review of progress made under various Month Plans and proceedings of Swachhata Diwas that were held in the GP.

[41] Government of India, Ministry of Drinking Water and Sanitation, Total Sanitation Campaign – Guidelines 2011: http://www.mdws.gov.in/sites/upload_files/ddws/files/pdf/TSC%20GUIDELINES%20-%20JULY%202011_0.pdf

[42] Government of India, Ministry of Drinking Water and Sanitation, Total Sanitation Campaign – Guidelines 2011

Projections 2025

Current total waste generation in Maharashtra is around 9.3 million tons annually, out of which municipal solid waste is 7.5 million tons.

According to the global review of solid waste management report by the World Bank – What a Waste – the current solid waste generation per capita in South Asia Region is 0.45 kg per day. Government of Maharashtra quotes the waste generation rates in Maharashtra to be in the range of 0.14 kg/capita/day to 0.63 kg/capita/day. Average waste generation is quoted as 0.35 kg/capita/day (2005)[43].

With rapid urbanization in the state, and considering the fact that Maharashtra is one of the leading urbanizing states in India[44], we consider the World Bank estimate to be correct at 0.45 kg/capita/day.

Table 6: Projection for solid waste generation in Maharashtra in 2025[45]

	Kg/capita/ day	Population	Urban percentage	Total waste generation (TPD)
2012	0.45	112372972	45%	22755 (actual 20500)
2025	0.77	136000000	55%	57600

It is quite clear that the predictions hint a tripling of the total solid waste generation in the state. The systems in place to treat the waste are under huge pressure to carry out their roles. Large cities and urban agglomerations generate large amounts of waste that is sent to landfill. A strategy needs to be evolved which makes people aware of the hazards of waste, makes people cognizant of waste in their surroundings, gets hundred percent waste segregation done, recycles and reuses all the potential waste, generates compost and energy from the potential waste and eradicates the landfill from the face of the earth.

[43] Ministry of Environment, GoM: http://envis.maharashtra.gov.in/envis_data/files/MSW_.pdf
[44] Maharashtra State Development Report, Planning Commission of India
[45] What a Waste, A Global Review of Solid Waste Management, World Bank

Solid Waste Mismanagement

Waste generation is scaling up with huge proportions, and effective waste management has become the need of time. Moreover, waste generated at one point is collected and transported to long distances and then dumped on open spaces adding to the environment and economic costs. These open spaces are usually located on the outskirts. Dumping waste on land is a rudimentary way to deal with solid waste and it only adds to the expenditure on waste management and further burdens municipal services. Groundwater pollution is a major concern. Methane and carbon dioxide gases formed due to microbial reaction can lead to fires.

The most casual yet striking thing about waste is that we throw it and forget about it. Waste weakens our sense of connect with environment. We consider the environment as a dumping ground. Producing unnecessary waste is not valuing the resources and not using them sustainably. Inefficient use of resources generates more waste than useful products.

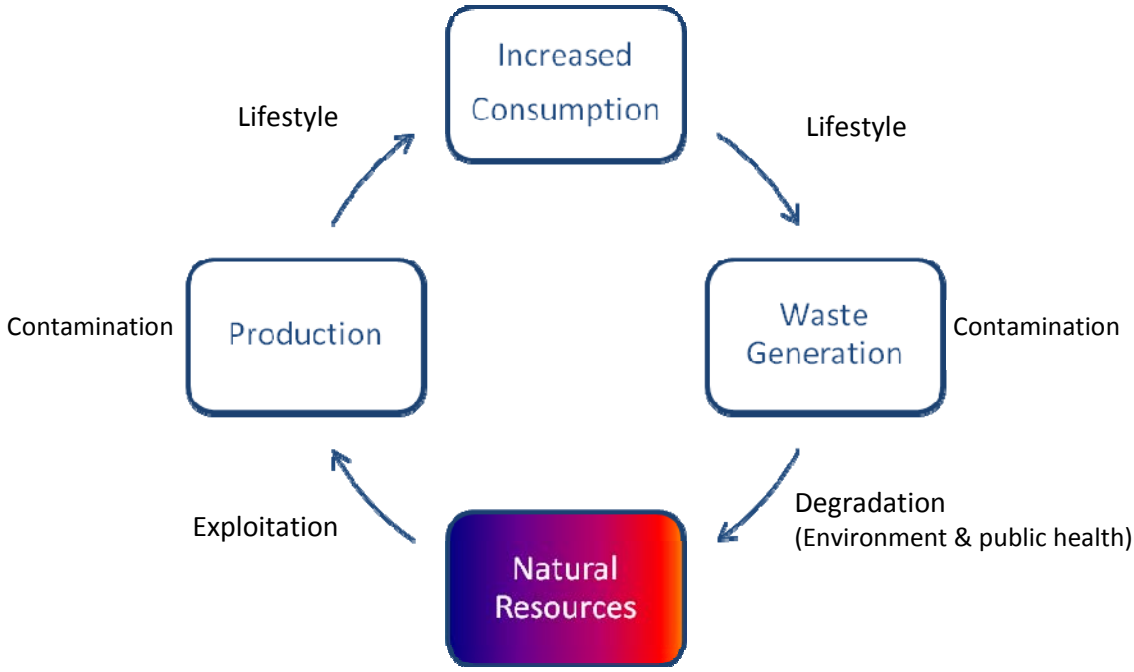

Figure 4 – Connect between Environment and Society

Per capita increase in waste

Waste generation is influenced by various demographic and economic factors including employment, personal income, value of recyclable materials, cost of disposal services, etc. Our lifestyle and consumption patterns, decides the quantum of waste generated in our lifetime. The richer you get, the more you can afford to waste. As cities grow economically, growth in business activities and consumption patterns drive up solid waste quantities.

In today's consumerist society per capita waste generation is growing faster than population and will further increase with the rise in personal incomes.

The content of the waste we produce has also altered over the years and dealing with the varying types of waste is a serious issue with no segregation and technology for treatment of such kinds of waste. Also with technological progress, we expect additions in the waste baskets in terms of items and their variety.

Lack of implementation

The legal framework of our country is adequate to address the solid waste management problem. The problem lies in implementation. Open dumping is practiced at large even though it does not meet the norms of disposal specified in the MSW Rules. Cities like Mumbai situated on the sea coast dump their waste in creeks[46].

Mismanagement of waste disposal deprives the society of good quality organic manure and biogas and increases the cost of recycling.

Photo 2 - Waste dumping along the coast in Mumbai

Apathy

Waste management is not on the priority list of governments and politicians. Waste needs to be brought into the forefront. Political will, public awareness and participation are essential for successful implementation of waste management strategies.

Moreover "solid waste" comes under the purview of the health department but the management of waste should be upgraded to separate departments.

[46] Proceedings of the International Conference on Sustainable Solid Waste Management, 5 - 7 September 2007, Chennai: National Solid Waste Association of India, Mumbai: Present Scenario of Municipal Solid Waste (MSW) Dumping Grounds in India: A. K. Sahu

Lack of public awareness

People are neither aware of the health hazards associated with waste nor aware of the benefits associated with segregating waste. So waste is casually strewn along road sides or in water bodies. Moreover, waste is not considered as a resource when actually one can get good quality manure from organic waste. Awareness on the benefit of segregating waste makes recycling easier and reduces the volume of waste that ends up in a landfill. Lack of segregation is a major problem in most cities across Maharashtra. In Pune city, barring a few, all wards segregate less than 40% of waste. It can be said that only a third of generated waste is segregated into wet and dry waste.

Waste is not an issue to be tackled by municipal bodies alone but it requires involvement of all stakeholders at all levels of waste generation and management. Understanding of collective ownership of waste is extremely important to gear up for efficient waste management.

Inaccurate quantification

The most prominent and basic problem is precise quantification of waste generated. There are no precise estimates of wastes generated in rural areas and during festivals. To cite an example - Pune city generates around 1500 tpd of waste, but during Ganpati festival the waste quantity more than doubles, increasing the burden and eventually collapsing the waste management system.

Moreover the C&D waste or any type of waste (industrial, municipal, medical) disposed in vacant plots or water bodies goes unaccounted for.

Lack of infrastructure

Our existing infrastructure is grossly insufficient to handle the large quantities of waste generated, which is evident from the overflowing community garbage bins. Moreover most of the urban centres lack facilities to treat hazardous and medical wastes. In rural areas there is no mechanism for treatment of medical and industrial wastes. It is often observed that such wastes are disposed into the rivers or water bodies.

Environment and public health degradation

The problem of solid waste management in the context of environment is closely related to air and water pollution and soil contamination. Pollution of air, water and soil pose a serious health hazard and social/economic burden on the residents and the civic bodies. Open air burning of waste causes air pollution due to the rising smoke and dust. Moreover burning wastes also releases hazardous and toxic substances into the air and the ashy residue left behind needs further treatment and disposal. Decomposing organic waste in landfills generates methane, a harmful green house gas.

Contamination of water by untreated medical waste can have devastating effects. When municipal solid waste, chemical and pharmaceutical waste is disposed on unlined landfills or pits, the leachate can contaminate ground or surface water.

Waste management is of crucial concern to public health. Main problem connected to public health is poor waste management system. Solid waste is often dumped on open land where it rots and stinks and attracts rodents and flies, causing public health problems. Disease ridden carriers pose a major problem. The waste that collects such as polythene bags nurtures mosquitoes which spread malaria and dengue fever. . Rats that thrive on the waste are principal carriers of bubonic and pneumonic plague.

The people living in the vicinity of the landfill sites have a serious threat to their lives as waste is often burnt at the open dump sites to reduce the volume and also by rag pickers. This causes air pollution which in turn causes respiratory disorders and eye infections. Leachate from untreated waste disposed on open land that is not properly lined, contaminates ground water or surface water threatening people who live in the vicinity and use this water for drinking, bathing and cooking and also damage local fauna and flora.

Waste when thrown in nullahs, it clogs drainages and causes dirty water to overflow in the monsoon resulting in insanitary environment thereby spreading diseases.

The civic workers sweeping the streets and collecting wastes as well as the informal workers (waste pickers) are also exposed to health hazards as the general population, but the amount of exposure and risks are high. Since the formal and informal workers come directly in contact with the waste they are prone to skin diseases, respiratory, gastrointestinal problems. It has often been observed that children also work as waste collectors or accompany their parents for the same work and are more prone to diseases. Accidents due to poorly disposed wastes like surgical needles, glass materials etc. is also a health hazard.

The health hazards with industrial waste are much more, both for the formal and informal work force. Most of the waste is toxic, flammable, and reactive, which can harm people who inhale, touch or are in close proximity to such waste. The workers are not aware of this fact and when dealing with such waste with bare hands poses a serious threat.

Vision

The waste problem in Maharashtra is large and growing. Waste has spread in the environment and it is going to be a challenge to clean it all. Water and soil which is already contaminated due to poor management cannot be undone. We cannot afford to contaminate our natural resources and degrade public health and environment further. Public awareness, political will and involvement of stakeholders is of utmost importance to have an integrated approach.

The first and foremost step is to no longer regard waste as inevitable. It should not be looked at as someone else's problem and each one should strive to minimize the amount of solid waste being by adopting and identifying innovative technologies.

Towards zero waste for a progressive, clean and healthy Maharashtra

Waste Management Strategy for progressive, clean and healthy Maharashtra

Treating waste as a resource is the first step towards efficient and sustainable waste management. The following principles should be followed to deal with waste:

- Minimize waste generation
- Segregate waste at source
- Maximize waste reuse and recycling
- Decentralize waste management
- Promote waste processing technologies
- Promote safe disposal of waste

Minimize waste generation

This is the most preferred method for managing solid waste. Before taking measures to manage and treat waste effectively and then dispose it, there is a need to tackle the problem at the root *i.e.* manage the generation of waste. Waste reduction programs reduce the cost and environmental problems associated with collection, processing and disposal. The primary waste reduction goal is to reduce per capita waste generation. Currently around 0.45 kg/capita/day of waste is being generated.

Programs should be promoted that reduce waste at the point of purchase. This not only saves money but avoids cost to local authorities of dealing with it. It is necessary to reduce waste throughout the supply chain by changing the way products are designed, manufactured and used. In the waste management hierarchy, minimizing waste is the most productive way of waste management.

Reduce waste generation to 0.25 kg/capita/day by the year 2025

Segregate waste at source

Waste segregation reduces the volume of waste and enables different kinds of materials to be handled appropriately. Separating hazardous waste from general wastes reduces the amount that must be treated. Segregation at source brings the highest efficiency in waste management and significantly reduces the volume of waste that ends up otherwise in the landfill.

Improper segregation does not recognize the hidden potential in solid waste which could be tapped through recycling or by processing it for energy generation or use as fertilizer. Segregation at the processing plant site is very tedious and time consuming. Moreover the health of rag pickers is threatened as they pick up the waste that can be recycled with bare

hands. Proper segregation at source (offices, markets, shops, households,) will reduce the burden on local government bodies. The process of centralized segregation is tedious and harmful to waste workers as well as rag pickers who make their living from the recycled waste they collect. It is easier to segregate small volumes of waste rather than larger volumes when dumped in the landfills or in the waste bins.

> Waste segregation at source will ease the process chain of waste management by reducing the operation time.

Figure 5 - Waste Management Strategy at a glance

Maximize waste reuse and recycling

Reuse not only prevents waste but also helps to save resources. Reuse requires less labor, less energy and fewer resources compared to recycling, disposal or the manufacture of new products from raw materials. It also helps by reducing the quantum of waste entering the landfill.

Collecting, sorting and recycling of disposed materials provide income to several people. Recycling is predominantly in the informal sector with rag pickers being at the lowest level scavenging through the waste despite the associated risks. This informal sector comprises rag pickers, middle man, waste dealers and small scale recyclers. Recycling prevents waste from entering the landfills where it pollutes ground water and also out of incinerators that can pollute air. Recycling creates green jobs however if this sector is formalized and got into the mainstream industry. A lot of safety precautionary measures are needed in the manual processes involved in waste recycling. Working in unhealthy conditions and getting directly exposed to toxic substances can pose lethal threats to working personnel[47].

[47] http://envis.maharashtra.gov.in/envis_data/files/Etreatment%20&%20disposal.html

The business potential of waste reuse and recycle is largely underestimated. Waste recycling can be opened up in the private sector where incentives can be readily and rapidly tapped by it. Making buy-back or acceptance of used electronic products *mandatory* may bring initially reluctance but would introduce efficiency in waste recycling chain. Directives and guidelines should be issued to companies to accept used products that arrive at the doorstep.

Materials such as glass, steel, plastic and aluminium can be recycled an infinite number of times and reprocessed using a fraction of the amount of energy that is needed to create a new product. It should be pointed out that if glass is put in landfill it will take about 4,000 years to break down[48].

Decentralize waste management

The system is place today is a centralized one in which waste generated at one place is collected and transported to be disposed in another place. Solid waste should b treated as locally as possible. Localized waste management programs are more effective as communities realize the importance of being responsible for the waste they produce. In decentralized systems the organic waste management can be micro managed at source *i.e.* within the dwellings or businesses.

> A shift from centralized to decentralized waste management system of waste will be highly efficient. Increasing local self government share of funds for waste management will increase accountability.

Promote waste processing technologies

Waste to Energy

Power generation potential from waste is as follows[1]:

Total waste quantity: W tons
Net Calorific Value: NCV k-cal/kg.
Energy recovery potential (kWh) = NCV x W x 1000/860 = 1.16 x NCV x W
Power generation potential (kW) = 1.16 x NCV x W/ 24 = 0.048 x NCV x W
Conversion Efficiency = 25%
Net power generation potential (kW) = 0.012 x NCV x W
If NCV = 1200 k-cal/kg., then
Net power generation potential (kW) = 14.4 x W

[48] http://www.earthtimes.org/encyclopaedia/environmental-issues/waste/

Considering 50% of waste as treatable[49], the net power generation potential from waste in Maharashtra is 288 MW (considering 20000 tons of daily waste generation).

Net power generation potential from waste in Maharashtra is 288 MW

Waste to compost

The solid waste from households and hotels can be converted into compost within the premises and can be used as manure for gardens. In the rural areas the agriculture waste from farm produce is used on the farm itself. Composting will reduce the quantum of organic waste considerably.

Promote safe disposal of waste

This is the last step in the ladder of waste management process. Even though waste minimization and recycling are practiced there still remains some amount of waste that cannot be processed and needs to be disposed in an environmentally sound manner. Rather than dumping waste on land, the site of waste disposal should be scientifically and technologically sound such that it does not pollute the surroundings. The landfill should be well operated and maintained.

Disposal of any type of waste onto a landfill does not solve the problem; it just shifts the problem of waste from one place to another. Piling up of waste in blotches at different sites is just replaced by piling up of waste in total at some other location.

The ultimate achievement would be no landfill

The process of waste management started with landfill. When one landfill got filled we simply shifted to another, thereby rendering huge land mass useless and groundwater polluted. When the health of people living in areas surrounding landfill deteriorated due to consumption of polluted water or breathing the polluted air, alternative strategies were looked upon.

Recycling, reuse and conversion to compost and waste proved to be profitable, since they used waste not just as waste but as a resource. Application of these 'alternative' strategies is prevalent at some places, to some extent.

These alternative strategies should be at the forefront of waste management. The methods of treatment of waste must be restricted to (a) Conversion and (b) Recycle and Reuse. Landfills must be eradicated in the course of time. This will provide clean and healthy living conditions to the people living in the area surrounding the landfill. Unnecessary management of unwanted, unusable and inert matter will vanish from the purview of the local body, which will directly benefit the society. Political will to completely shut off landfills

49 http://envis.maharashtra.gov.in/envis_data/files/MSW_.pdf

will greatly enhance the face of a region, and state as a whole. Eradication of landfill will serve as a solution as well as a catalyst to the waste management problem.

Raise Awareness

It is important for every household, every business, and every institution (school, college, temple, religious places, hotels, etc) to take care of the organic waste and to segregate waste. Public awareness is the key to successful waste management. Awareness about waste management should be applied at the individual level. A critical component in any waste management program is public awareness and participation in addition to proper legislation, technical support and funding.

Raising awareness at the government and political level about the need of proper waste management is also essential. A separate department for solid waste management and handling needs to be established which would be run by qualified staff like environmental engineers and environmental scientists.

> Confluence of conscious effort from the public representatives, the administration and the community, combined with managing waste at the lowest level of public representation will tackle waste problem most effectively.

Awareness among waste workers

Waste workers should be made aware about the health hazards associated with waste handling. Waste management rules devised by the Central Government also prompt local governments to alert waste workers about the potential hazards and provide them with personal protective equipment like gloves, masks, boots, etc.

Conclusion

Since prehistoric times, human activities have generated materials that were discarded because they were of low value or no longer of any use. These discarded materials were considered as waste. However, in the early days since populations were small and vast tracts of land were easily available disposing this waste was never an issue. Moreover, the waste composition was such that it used to easily degrade in the environment without polluting it.

As human population grew and they began to settle in communities the accumulation of waste became synonymous with the way of living. Since then production has increased dramatically and so has consumption, which can be attributed to industrialization and increasing population. Rapid economic growth, increase in per capita income, rise in community living standard has accelerated the solid waste generation as well as the complexity and variety of waste.

To deal with the increasing quantities and changing characteristics of waste, we will have to move from the traditional practices of waste management of a centralized collection system to a decentralized system. In the decentralized approach that we propose local authorities will be empowered economically and technically. These authorities will formulate policies on solid waste management according to the sources and types of waste being generated and establish waste management system at a local level catering to suit the needs of smaller community groups and also offer income generating opportunities. In our approach, we will involve stakeholders at every level of the system, protect public health and prevent contamination of environment.

Through our waste management strategy for zero waste we will move towards a progressive, clean and healthy Maharashtra.

Case Study

Khat Prakalp, Nasik

Photo 3- Mechanical Waste Segregation and Processing plant (Waste to Compost)

- Waste gets segregated with the use of (i) more than 100 mm; (ii) less than 100 mm; (iii) 10 mm; (iv) 5mm segregation filters.
- Leachate – wells in the area adjoining the waste plant have contaminated waters due to leachate percolation.
- Capacity up gradation from 300 ton/day to 500 ton/day (TPD) is underway.
- 50 kW biogas plant is slated to be used to power the biogas plant itself.
- The incinerator for disposal of dead animals installed at the waste treatment site operates on diesel. It is planned to operate the incinerator on both diesel and biogas.
- Main problem in operation of the project is choking.
  The waste absorbs moisture quite naturally and easily; it frequently chokes the waste segregators, especially the smaller 5mm ones.
- The process of waste segregation takes 25-35 days – for one bulk of waste to go from the raw dump to the end produced compost (khat).
- The waste treatment facility falls short of workers. The plant when set up used to manage waste intake of 100-125 tons per day with 70 workers. Today the waste intake has increased to 370 tons per day yet the number of workers has unfortunately remained the same. This has resulted in accumulation of waste on site.
- The workers are provided with gloves, boots and masks for protection and to avoid direct contact with waste. In addition they are paid Rs.1000/employee/month for health care since they work in a potentially unhealthy environment. A health van visits the plant every week to check the health of the employees.

Photo 4 – Incinerator for disposal of dead animals

Photo 5- Piling up of waste at the waste treatment site

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Annexure

Comparison of Waste Management Practices in Low, Middle and High Income Countries of the Asia-Pacific region[1]

High Income countries - Australia, Japan, Hong Kong, China, Republic of Korea and Singapore
Low Income countries - Indonesia, Malaysia and Thailand
Middle Income countries - Bangladesh, India, Vietnam and Myanmar

Activity	Low Income	Middle Income	High Income
Source reduction	No organized rogrammes, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated in to any organized programme.	Organized education programmes are beginning to emphasize source reduction and reuse of materials.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization.	Collection rate greater than 90%. Compactor trucks and highly machined vehicles are common.
Recycling	Most recycling is through the informal sector and waste picking. Mainly localized markets and imports of materials for recycling.	Informal sector still involved some high technology sorting and processing facilities. Materials are often imported for recycling.	Recyclable material collection services and high technology sorting and processing facilities. Increasing attention towards long-term markets.
Composting	Rarely undertaken formally even though the waste stream has a high percentage of organic material.	Large composting plants are generally unsuccessful; some small scale composting projects are more sustainable.	Becoming more popular at both backyard and large scale facilities. Waste stream has a smaller portion of compostables than low and middle-income countries.
Incineration	Not common or successful because of high capital and operation costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties; not as common as high-income countries.	Prevalent in areas with high land costs. Most incinerators have some form of environmental controls and some type of energy recovery system.
Landfilling	Low-technology sites, usually open dumping of wastes.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills with a combination of liners, leak detection, leachate collection system, and gas collection & treatment systems.
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 very inefficient.	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.	Collection costs can represent less than 10 % of the budget. Large budget allocations to intermediate waste treatment facilities. Upfront community participation reduces costs and increases options available to waste planners (e.g. recycling & composting).

[1] http://www.unescap.org/esd/environment/soe/2000/documents/CH08.PDF

Categories of Hazardous Wastes

Waste Categories	Type of wastes	Regulatory Quantities
Waste Category No. 4	Mercury, Arsenic, Thallium and Cadmium bearing wastes.	5 kg per year the sum of the specified substance calculated as pure metal.
Waste Category No. 5	Non-halogenated hydrocarbons including solvent.	200 kg per year calculated as non-halogenated hydrocarbons.
Waste Category No. 6	Halogenated hydro-carbon including solvents	50 kilograms per year calculated as halogenated hydrocarbons.
Waste Category No. 7	Wastes from paints, pigments, glue, varnish and printing ink.	250 kg per year calculated as oil or oil emulsions.
Waste Category No.8	Wastes from Dyes and Dye intermediate containing inorganic chemical compounds.	200 kg per year calculated as inorganic chemicals.
Waste Category No. 9	Wastes from Dyes and Dye intermediate containing organic chemical compounds.	50 kg per year calculated as organic chemicals.
Waste Category No. 10	Waste oil and oil emulsions.	1000 kg per year calculated as oil and oil emulsions.
Waste Category No. 11	Tarry wastes from refining and tar residues from distillation or prolytic treatment.	200 kg per year calculated as tar
Waste Category No. 12	Sludge arising from treatment of waste waters containing heavy metals, toxic organics, oils emulsions and spend chemical and incineration ash.	Irrespective of any quantity.
Waste Category No. 13	Phenols.	5 kg per year calculated as phenols.
Waste Category No. 14	Asbestos.	200 kg per year calculated asbestos.
Waste Category No. 15	Wastes from manufacturing of pesticides and herbicides and residues from pesticides and, herbicides formulation units.	5 kg per year calculated as pesticides and their intermediate products.
Waste Category No. 16	Acid/Alkaline/Slurry	200 kg per year calculated as Acids/Alkalis.
Wastes Category No.17	Off-specification and discarded products.	Irrespective of any quantity.
Wastes Category No.18	Discarded containers and Containers liners of hazardous and toxic wastes.	Irrespective of any quantity.