RESEARCH REVIEW JOURNALS
Volume-03
Issue-03
March-2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com[UGC Listed Journal]

A Review of Environmental Impact of Solid Waste Management in India

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ARTICLE DETAILS

Article History
Published Online: 30March2018

Keywords
Environmental Impact, solid waste management, India, Municipal solid waste, developing countries, challenges

ABSTRACT

One of the world's major areas of concern is municipal solid waste(MSW). MSW. In developing countries such as India, urbanization and population growth are rapidly increasing municipal solid waste. Waste composition varies with various factors, such as living standards, climate conditions, socio-economic factors, etc. This paper presents India's current scenario in terms of quantity, quality and management of municipal solid waste. Urbanization contributes to increased generation of municipal solid waste (MSW) and unscientific management of MSW degrades the urban environment and poses a risk to health. In addition to an extensive review of MSW generation, its characterisation as well as the collection and treatment options in India, an effort is made in this paper to evaluate the major parameters of MSWM. MSWM's current status is also reported in the Indian states and major cities. The essential requirements for the optimal use are discussed, as well as the challenges and the unusual role of rag-pickers, of public private partnership opportunities. The study concludes that it is important for developing countries such as India to set up decentralized solid waste processing plants in metropolitan towns and for developing the formal recycling industry.

1. INTRODUCTION

India is rapidly moving from a country based on agriculture to a country that focuses on industrial and services. Currently, approximately 31,2 percent live in urban areas. In 7,935 towns, more than 377 million urban residents live. India is a vast country divided into 29 States and 7 UTs. The population is more than 10 million, 53 cities more than one million, and 415 cities more than 100,000 and more have a population — Greater Mumbai, Delhi and Kolkata are 3 mega-cities. The towns with a population of more than 10 million are mostly State capitals, Union territories and other commercial / industrial centres. The geographic and climatic regions of India are different (tropical wetland, dry tropical, subtropical humid climate and mountainous) and have a wider four-season pattern (winter, summer, rain and autumn). No concrete steps were taken until now, however, to analyze patterns of regional and geographical waste generation in these urban villages and the study carried out by the CPCB (New Delhi); the NEERI Institute of Environmental Research (Nagpur); the CPCB (Central Institute of the Plastics Motor Engineering), Nagpur; Critical to sustainable metropolitan development, Municipal Solid Waste Management (MSWM) encompasses segregation, storage, collection, relocation, transporting, processing and disposal of solid waste, to minimize its negative impact on the environment. Innumerable distresses are spread by unmanaged MSW. The Solid Waste Management (SWM) is one of the main innovative areas of research in the developing countries and has led stakeholders to respond to it. The important reasons for paying attention to mswm as more areas are needed to cater for waste are high population growth rates, rapidly varying waste characterisation and production patterns, increasing urbanization and industrialisation in developing countries. Several studies suggest that the reusal of solid waste is a viable, socially, economically and environmentally desirable option for the MSWM. One important problem in the urban area of India is the virtually non-separation of MSW and construction and demolition (C&D), plastical wastes, commercial and industrial waste and e-waste. Every year approximately 12 million tons of inert waste are created from street sweeping and C&D waste in India and it accounts for approximately a third of all MSW at springs. Multi-urban solid waste (MSWR) rules are applicable in India, and implementation of MSWR is an important concern for local urban bodies (ULBs). The quality and the quantity of MSW produced by a specific community vary depending on socio-economic status, cultural habits, urban structure, population and business activity etc. On the basis of the composition and quantity generated by MSW it can be planned , designed and operated the municipal solid waste management system. In general Indian MSW is more indigenous than Western countries such as the USA, Canada and so on. The quantity of waste paper in India is much less, since people take even the quantity of waste away to be used as fuel as well as packed by hawkers on the road. The content of plastics, rubber and leather is less than that of paper and not more than 1% except in metropolitan cities.

2. URBANIZATION AND SOLID WASTE GENERATION IN INDIA

1. Urbanization

Compared with developed countries, the consequences of an emerging population in urban centers are more apparent in developing countries. There were 377 million urban in India, representing 31 percent of the entire population. Global history shows that if the urban population of a country reaches more than 25% (as is the case in this case), the pace of urbanization is increasing. The population in urban areas grew between 1961 and 2011 respectively from 18 to 31,2 percent.

Table 1. Per capita waste generation rate

Population size	Waste generation* (kg/capita/day)	Waste generation** (kg/capita/day)
>2000000	0.43	0.55
1000000–2000000	0.39	0.46
500000–1000000	0.38	0.48
100000–500000	0.39	0.46
<100000	0.36	-

Table 2. Statistics of MSW generated in different states in India

S. No.	States	Municipal Solid Waste (TPD) 2000	Municipal Solid Waste (TPD) (2009–2011)	Collected (TPD) (2009–2011)	Treated (TPD) (2009–2011)	Growth (%)
1	Andhra Pradesh	4376	11500	10655	3656	163
2	Assam	285	1146	807	73	302
3	Delhi	4000	7384	6796	1927	85
4	Gujarat	NA	7379	6744	873	-
5	Karnataka	3278	6500	2100	2100	98
6	Kerala	1298	8338	1739	4	542
7	Madhya Pradesh	2684	4500	2700	975	68
8	Maharashtra	9099	19204	19204	2080	111
9	Manipur	40	113	93	3	182
10	Meghalaya	35	285	238	100	713
11	Orissa	655	2239	1837	33	242
12	Punjab	1266	2794	NA	Nil	121
13	Puducherry	69	380	NA	Nil	451
14	Rajasthan	1966	5037	NA	Nil	156
15	Tamil Nadu	5403	12504	11626	603	131
16	Tripura	33	360	246	40	991
17	Uttar Pradesh	5960	11585	10563	Nil	94
18	West Bengal	4621	12557	5054	607	172

2. Generation and collection

Special reasons for MSW's acute problem are fast urbanization and uncontrolled population growth in India. Table 1 shows the per capita population size of waste generation and growth over the course of a decade. It is expected that India's population would reach approximately 1,823 million by 2051 and approx. 300 million tons per annum from MSW, which would require about 1,450 km2 of land to be systematically disposed of, if ULBs continue to rely on MSW management landfill route in India (Indian solid waste management position paper, 2009). But these projections are conservative, retaining an annual increase of 1.33 percent in the production of MSW per capita. Thus, there could be many plugs with an annual growth of 5% in the per-capita waste waste disposal sector. For landfill piles at a height of 20 meters, the area required from 2031 to 2050 would be 43,000 hectares. These projections are based on waste generation of 0.45 kg / capita per day. In India, different reports give different values and estimates because of a lack of access to primary information on waste generation per capita, insufficient information on waste characteristics, and effect of informal sectors. The land requirement is therefore difficult to evaluate and appropriate treatment / disposal techniques are chosen.

3. Composition and characteristics of Indian municipal solid waste

Following major categories of waste are generally found in MSW of India:

• Biodegradable Waste: Food and kitchen waste, green waste (vegetables, flowers, leaves, fruits) and paper.

• Recyclable Material: Paper, glass, bottles, cans, metals, certain plastics, etc.

• Inert Waste Matter: C&D, dirt, debris.

• Composite waste: Waste clothing, Tetra packs, waste plastics such as toys.

• Domestic Hazardous Waste (also called "household hazardous waste") and toxic waste:

Waste medicine, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, and shoe polish. MSW in India has approximate 40–60% compostable, 30–50% inert waste and 10% to 30% recyclable. Analysis carried out by NEERI reveals that in totality Indian waste consists of Nitrogen content (0.64 ± 0.8) %, Phosphorus (0.67 ± 0.15)%, Potassium (0.68 ± 0.15)%, and C/N ration (26 ± 5) %. Change in the physical and chemical composition of Indian MSW.

3. REGULATORY FRAMEWORK FOR MSWM IN INDIA

The Municipal Solid Waste Rules 2000 stipulated that all Local Administrative Organizations (LAB) must take steps in order to better MSWM in India. In the sense of the collection, storage, segregation, transportation, processing and disposal of MSW each LAB is to provide infrastructure and services. The urban development departments of each state government have responsibility in accordance with MSWM Rule 2000 for the implementation of the regulations in metropolitan towns. The district magistrate or deputy commissioner of the districts concerned shall be responsible for enforcing the laws within their geographical limits. The state pollution control boards monitor compliance with air, water and noise pollution standards. They must also track compliance with the requirements of compost quality and incineration as set out in the regulations. All aspects of MSWM from the collection are set aside under MSWM Rule 2000.

Collection of Solid Waste: In order for MSWM to be able to collect properly, MSW is recommended by the MSW Museum at the household level using approaches like door-to - door collection or collection of community bins. By minimizing the cost of transport in complacency with environmental restrictions, the optimum schedule for collection should be created. MSW collection arrangements are to be arranged separately from slums and business areas. Disposal of waste must be promoted at source. Separate horticultural waste collection and disposal of waste should be promoted, along with general MSW. Asnani pointed out that there is a lack of knowledge and an inadequate manpower to collect doors to doors are the key problems with collection of MSW.

Secondary Storage and Transport of Waste: In accordance with MSW-Rule 2000, secondary storage for the total generated MSW should be supplied by the municipal authorities. MSW should be transferred from secondary storage at regular intervals to the disposal site. In order to avoid atmospheric exposure and spills, MSW should be covered during transport. Before overflowing waste should be transported from community bins.Asnani noted that MSW has few transport vehicles in most municipalities.

Waste Treatment: Prior to recovery and recycling, MSW collected should be separated. In conformity with rule MSW 2000, compost and anaerobic digestion, or other suitable biological processes for the stabilization of waste, shall be treated with biodegradable waste. It may also be suggested that waste incineration be composed with or without energy recovery. The lack of technical and financial knowledge in India leads to improper treatment of MSW.

4. MSW IN METRO CITES

The disposal of solid waste in metropolitan towns is one of the most demanding issues. The production of enormous quantities of solid waste gives them serious problems with pollution. The number of solid waste generation, with an increase in population and urbanization in India, is also increasing in various cities. Over the course of the year 2004–2005, CPCB carried out the survey through NEERI, with an estimated 39 031 tons of MSW per day generated in 59 cities / cities (35 metro-cities and 24 national capitals). In 2010-11, 59 cities reported generating 50,592 tons of MSW per days from the Central Institute of Plastics Engineering and Technology (CIPET) at CPCB. These findings show that MSW generation in metro cities / state capitals grew by 77,1% from 2005 to 2011. It was found that about 48134 MT/ day waste was created from class-I cities according to reports by the SPCBs / PCC (2009-12) and CPCB. According to studies by Tata Energy Research Institute, more solid waste is produced by higher income groups than medium and lower income groups. In New Delhi, for example, less than 1 third of solid waste comes from lower income groups than from their higher income components. A wetweight analysis of MSW by generation and collection point from Metro Cities / Class I cities shows large organic fraction (40%–60%) ash and earth (30-40%), paper (3%-6%), plastic , glass and metals (less than 1%). The C / N ratio ranges from 20 to 30 and the heat value ranges from 800 to 1000 kcal / kg. The analysis of waste collected from waste disposal sites shows that waste parameters are viz. In the moderate range were found pH, moisture content, organic matter, organic carbon and NPK. The MDW produced from residential areas is also reported to include a predominant part of material that is degradable compared to non-degradable waste. Cities of metro / class I have a well-defined MSW collection, movement and disposal / composting system. Cities are divided into different MSW collection wards, since they can be handled conveniently. The collection system for community bin collections is the primary procedure for collecting waste. In this system, residents deposit their waste at specific intervals in the nearest community basins in the street corners. MSW is collected from source by waste collectors and then transferred in the other leading practice to the community bin. MSW is being moved to the sanitary deck. At waste collection and disposal points, Rag pickers can be seen. Rag pickers are therefore very important component of current MSWMs for collecting resalable / recyclable waste from the MSW. Most municipalities are not properly disposing and processing MSW, and thus much of the municipal solid waste produced remains unattended and grows in heaps in poorly maintained collection centres.

As waste is also dumped continuously on the road, because of the lack of adequate storage capacity for waste generated and poor discipline among generators. MSW is uncovered along the roadside causing health risks and harms to the environment. Many local authorities involved waste collection and transportation organizations (NGOs) that resulted in improving local road cleanliness Different types of vehicles are used in the process of transporting waste. These vary from bullock carts to compactors, regular lorries, tractors and trailers, dumper placers and tippers. Before it is sent to final disposal site, the MSW collected is transferred to transfer stations. In only a few metropolitan cities, however, there are transfer stations. As the population and urbanization grow,

municipalities face financial crashes and are no longer able to meet demands. The limited revenues earmarked for the municipalities make them powerless to ensure that waste is collected, processed, handled and properly disposed of at great cost. In the MSWM of those cities, studies show many shortcomings. These deficiencies include incorrect waste collection, a wide range of waste volumes and therefore inadequate storage facilities , inadequate routing and vehicle maintenance. It leads to waste being dumped at the bottom of the city's outskirts. Open dumping of trash facilitates the cultivation of fly, mosquito, cacao, rats and other disease vectors. In these cities there are no or less sanitary land-fills. Compost plants have been established and commissioned by private agencies in metropolitan cities such as Bangalore , Hyderabad, Ahmedabad, and Kolkata (total of 13 cities). The installation of the plants has a capacity of 40-700 tons / day. However, plants are underutilized for a variety of reasons, mainly due to the poor compost quality which leads to a decrease of end-use demand.

5. SOLID WASTE MANAGEMENT PRACTICES AND CHALLENGES IN INDIA

MSWM is operated by MSWR in India. Most ULBs, however, do not have suitable MSWR implementing and implementing action plans. Sadly, no town in India can claim 100% separation of wastes at a housing unit and only 70% collection on average, while the rest of the 30% is once again mixed and lost in urban areas. Only 12.45 per cent waste is processed and residue disposed of in open dumps from the total waste collected. Existing and future land disposal requirements for MSW, population growth and the generation of MSW. Effective, solid residue management system is a key feature of environment friendliness, cost-efficiency and acceptability for the local community. Critical examination of important parameters of MSWM practice with respect to Indian Scenario is delineated below:

1. Segregation

At the household or the community base, there is no organized and scientifically planned separation of MSW. Waste collection, often carried out by an unorganized industry and seldom used by waste producers. Separation and triage occurs under very hazardous and dangerous conditions and segregation performance is fairly low, since unorganized industries only segregate useful waste streams from valuable components which can provide them with relatively higher recycling market economic returns. Due to the improper handling of separated components, the transport and disposal again mixed up on a number of occasions. Failure to segregate deprives experimental waste disposal.

2. Collection

Home waste is generally passed on to communal bins made of metal, concrete or in combination with both. The waste produced by homes. Sweeping streets also find their way to community bins. These community waste tanks are also used by other key commercial sectors in the area around disposal tanks and household waste, with the exception of the fact the municipal authorities paying some sums to transfer waste to a waste disposal site in some commercial complexes or industrial units.

3. Reuse/recycle

This involves tasks such as gathering materials from waste, which could be recycled and used profitably for the production of new goods. When waste is dumped at community dumps, it can not be optimally recycled. However, recyclable items, such as plastics , glass, etc., are usually sorted out and taken and sold. Almost all recyclable materials are processed in Pondicherry by rag-pickers and consumed by recycling in the material system.

4. Transportation

Transportation modes for MSWMs in India include bullock carts, hand-hubs, compactors, trucks, tractors, trailers and dumpers. Trucks of 5 to 9 tonnes, without a proper decking system, are used in smaller towns. The transport by these compacters of MSW is based on stationary compactors, Mobile Compactors / Closed Tempos, and Tarpaulin covered vehicles with around 65, 15 and 20 per cent waste. In the workshop run by ULBs, vehicles used for waste transport are usually kept up. However, most workshops can only repair small amounts. No wonder that the overall collection, transport, and disposal efficiency of these vehicles is dramatically reduced in the event of a collapse. In a metropolitan area , for example, only few transfer stations can be found. Bombay. Bombay.

5. Disposal

MSW has been taken over by nearly every city, city or village in India. The current availability of MSWM practices and technology for 59 cities has been indicated. Of these cities, 40 showed an increase in waste generation, seven showed a decrease and for six cities it was more or less the same. Although the population of these cities increased over the decade, no significant reason for a reduction and equal quantity in waste generation was identified by the author. The probable explanation for reducing the waste generated could, however, be the fact that the designated dumping site could not be reached and was lost on the highways, in the suburbs of towns, along the rivers, along the drain, in green areas, etc.

6. PUBLIC–PRIVATE PARTNERSHIP IN MSWM IN INDIA

The introduction of the PPP mode usually takes place at ground level when either public or private entities can not fulfill their respective stakeholder goals and expectations individually. It seems that MSWM is suitable for Indian PPP mode as ULBs alone can not perform the task assigned under the MSWR. Appropriate MSWM services to Indian Cities are required at a sum of USD 5 billion per year, and this level of funding can only be achieved by means of PPP in order to address MSWM challenges. The PPP mode is still in its infancy in India and MSWM hasn't succeeded. However, many firms take the MSWM challenge as an opportunity, and around 40 projects in MSWM in India are in PPP mode for different sectors (community bin segregation, collection, transport and energy waste). Some of the Indian firms involved in MSWM include Zen Global Finance Ltd (RDF), ESSEL Infra, Enkem Engineers Ltd, Future Fuel Engineers, (Indian), Pvt (biomethanation in cooperation with the Entec Group, Astria). Global Environmental Engineers Ltd (biodegestion with ECOTEC, Finland) (biodivision with the collaborations of PAQUES Pvt., Netherland), Hanzer Biotech (MSWM), Thermax Ltd (in-cutting plants in co-operation, ACWA, UK, Danskrodzone, Denmark and Thermal Process,

US), Excel Industries (composting), EDL Power (India) Ltd (Sanitary landfills). The EISU, UK, Nellemen, Neilsen and Rauscvenberger from Denmark, Lunde, TBW and BTA from Germany, and Entec, Astria, Hitachi Zosen, Japan, etc, are some others of the international companies working on the Indian Market for MSWM. Fast implementation, quality facilities, risk sharing, cost reduction and revenue generation are all criteria for effective collaboration. Power sharing, loss of ULBs' control, increase in costs, irresponsibility, political risks and competitiveness are major threats on the other hand. The public and private sectors will make a significant commitment to addressing the complications related to MSWM. The efficiency of ULBs in the handling of SWM can only be improved thanks to the cooperation of both sectors. The interaction between different PPP components viz. It should be assessed sociological, economic and management aspects. Partnership efficiency, well-defined relations, and clear role-distinction, accountability and adoption are essential to PPP work for MSWM due auxiliary dynamics of different stakeholders.

7. MSW PRESENT SCENARIO AND FUTURE DIRECTIONS

Metro / large cities have solid waste management which differs from the small cities and villages around them. Waste collection and segregation can be carried out in metro / large cities at different zoning locations in socio-economic, commercial-home, industrial etc. waste collected cumulatively may be diverted and disposed, as necessary to provide an affordable option, because less manpower and other services are needed (UN Environment Programme, 2009). In order to ensure safe, environmentally sound waste disposal, the integrated municipal solid waste management must be done. For better MSWM, in developing countries such as India, where 71% of the population lives in small towns and villages between towns and their surrounding towns. Villages generate very few waste, which in individual villages are both difficult and financially unsustainable to deal with. In addition, much of the waste generated by villages can be biologically degraded. Therefore, the amount of waste that is disposable is further reduced. The integrated MSWM approach, which is designed specifically for these scenarios, is therefore advisable. Overall , the main reasons for the shortcomings in MSWM are the lack of community participation, the lack of technological skills and lack of financial capital. Kumar and Pandit also noted that the above-mentioned factors represent key challenges to be addressed by the Indian government in order to improve its waste management system.

8. CONCLUSION

Municipal solid waste generated depends on population climate, urban growth, socio-economic criteria, etc. In India, the overall practices of MSWM are currently insufficient. It should also be noted that efforts are being made to improve MSWM in major cities, but MSWs in medium- and small-scale cities are not taken due care of. The present rules are very stringent (MSWM rules, 2000). In the implementation of the policy, many deficiencies are identified. Mainly due to the absence of preparation, financial constraints, lack of good strategy and leadership, non-compliance with MSWM is induced. For developing countries such as India with 71 percent, effective waste management policies should be enforced in these areas for small towns and villages. To explore the feasibility of integrated waste management by clustering small towns and their surrounding villages into a better MSWM, optimization studies are to be carried out.

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