Status And Challenges of Municipal Solid Waste Management In India

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Abstract- *India is one of the fastest growing economies in the world today. Increasing prosperity and standard of living of millions of people leads to increase in consumption of energy and consumer goods. Concurrently, this growth likely put a strain on the environment and on the availability of natural resources. Already, India has 16.8% of the world's population and only 2.2% of the world's total land area. In India, as in other developing countries, solid waste management and sanitation are the least prioritized public services. These services are necessary for preventing the spread of diseases, promoting general well being, and improving the standard of living. However, due to lack of knowledge about the linkages of waste management to public health and environmental protection, unwillingness on the part of the local officials to take necessary action, and due to lack of funds for implementing and maintaining best practices, waste management has not received the attention as it requires. This paper provides an overview of waste generation, collection, disposal for India as a whole and some possible suggestions to overcome the problems associated with municipal solid Waste management.*

Keywords- Solid Waste Management (SWM), Municipal Solid Waste (MSW), Generation, Collection, Disposal

I. INTRODUCTION

Indian municipalities have overall responsibility for solid waste management (SWM) in their cities. However, most of them are currently unable to fulfill their duty to ensure environmentally sound and sustainable ways of dealing with waste generation, collection, transport, treatment, and disposal. The failure of municipal solid waste management can result in serious health problems and environmental degradation. Because of deficient collection services, uncollected waste-often also mixed with human and animal excreta-is dumped indiscriminately in the streets and in drains, thereby contributing to flooding, breeding of insect and rodent vectors, and spreading of diseases. Furthermore, even the collected waste is disposed of in uncontrolled dumpsites or burned openly, thus contributing to severe environmental impacts including pollution of water resources and air. The problem of SWM in India, when combined with rapid urbanization and unplanned development, is expected to be of such magnitude that significant reasons exist to initiate immediate action for improvement of this appalling situation.

A. Some Facts about Municipal Solid Waste Management in India

The total Indian urban population amounts to approximately 285 million. There are 4,378 cities and towns in India. Of those cities, according to the 2001 census, 423 are considered class I, meaning that the population exceeds 100,000. The class I cities alone contribute to more than 72 percent of the total municipal solid waste (MSW) generated in urban areas. Class I cities include 7 mega cities (which have a population of more than 4 million), 28 metro cities (which have a population of more than 1 million), and 388 other towns (which have a population of more than 100,000). The population growth rate in urban India is high. The percentage of the total population living in urban areas shows a continuous increase. For 2015, a value of 32.2 percent is predicted although there are no comprehensive data on waste generation rates, collection coverage, storage, transport, and disposal volumes and practices, the Central Public Health and Environmental Engineering Organization (CPHEEO) estimated a per capita waste generation in Indian cities and towns in the range of 0.2 to 0.6 kilograms per day.

A World Bank publication [11] estimated that in 2000 urban India produces approximately 100,000 metric tons of MSW daily or approximately 35 million metric tons of MSW annually. Comparing 1996 with 2005 shows how the physical composition of MSW can change over time along with the changing lifestyle and economic growth of the country. Although the typical urban growth rate has been determined at around 2.5 percent annually, the growth of waste generation is outpacing the urban population growth in Indian cities [15]. Therefore, urban population growth as well as increasing per capita waste generation will continue to amplify the waste problem. To prevent future problems, India must take immediate steps to control waste generation, to enhance recycling recovery and reuse, and to ensure better collection and sustainable disposal. According to the Central Pollution Control Board (CPCB), average collection coverage

ranges from 50 to 90 percent. Furthermore, of all collected waste, 94 percent is disposed of in an unacceptable manner without any consideration of state-of-the art engineering principles. Hence, there is severe degradation of groundwater and surface water through leachate, as well as degradation of air through uncontrolled burning of waste.

In India, as in other developing countries, solid waste management and sanitation are the least prioritized public services. These services are necessary for preventing the spread of diseases, promoting general well being, and improving the standard of living. However, due to lack of knowledge about the linkages of waste management to public health and environmental protection, unwillingness on the part of the local officials to take necessary action, and a lack of funds for implementing and maintaining best practices like wealth from waste, waste management has not received the attention. At the time of independence (1947), cities and towns in India generated an estimated 6 million tones of solid waste, while in 1997; this has grown to, 48 million tones. In India, more than 25% of the municipal solid waste is not collected at all. 70% of the Indian cities lack adequate capacity to transport it and there are very few sanitary landfills to dispose the MSW. Even the existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and groundwater.

Until recently, environment was not a big issue in a country like India and solid waste management was definitely not the prime concern of environmentalists and the governments. It is only in very recent times, the realization has dawn since it is unequivocally proved that the management of municipal solid wastes are very closely linked to public health and hence GDP [10].The Indian policy makers realized the importance of environmental management when the pathetic state of municipal waste services was highlighted mostly by the NGO sector and independent research groups highlighting its environmental/ ecological problems. This changed the outlook of Indian policy makers, politicians, public and private sectors and the general public at large towards Municipal Solid Wastes; right from its generation point down to its management.

India has achieved multifaceted socio-economic progress during the last 63 years of its independence and emerged as the tenth industrialized nation in the world, and is completely self-sufficient in food grains. India's population, as on March1991 stood at 1065.07 million (July 2004 est.) [23], making it the second most populous country of the world after China. Assuming an annual growth rate of 1.3%, the estimated figures for 2021 AD are 1296.8 million (Eduard.V.et al., 1993). The current per capita GDP figure is Rs. 3197.21 and is projected to increase to Rs. 11599.7 by 2021 (unpublished data, TERI). The quantum of waste generated in the country is increasing day-by-day on account of its increasing population and increased GDP; correspondingly the civic services have not been expanding proportionately and hence are under tremendous pressure.

The most common types of waste treatment and final disposal are materials recycling, composting, incineration and land filling 24]. Nowadays refuse no longer is simply considered as waste, but rather something that must be recovered or re-used as a potential resource [25]. Efficient planning for municipal solid waste management system requires accounting for the complete set of environmental effects and costs associated with the entire life cycle of MSW [8]. For such a system to be truly effective it needs to be environmentally compatible, economically viable, socially acceptable and sustainable [20].

II. MSW GENERATION IN INDIA

The amount of waste generated in a country is directly proportional to economic growth and consumption levels. Since the GDP is low the low-income countries generally consume fewer goods and hence generate less waste than developed countries. It is also observed that low-income countries also generally use less recyclable materials, especially in packaging. In the mid-nineties, the average waste generated in urban areas in India was estimated to be approximately 0.46 kg/person/day [15, 27]. The Ministry of New and Renewable Energy (MNRE), formerly known as the Ministry of Non conventional Energy Sources, estimated that approximately 42 million tons of MSW are generated in the urban areas of India annually (Ministry of New and Renewable Energy, Govt. of India). Urban waste generation in India tends to be lower compared to other developing countries and approximately one-third to half that of developed countries [1]. In low-GDP countries, MSW generation rates range from 0.4-0.9 kg/person/day, while in high-income countries it's approximately 1.1-5.0 kg/person/day.

A. Future MSW Generation in India

Waste generation in India is expected to increase rapidly since more people are migrating to urban areas and as income levels are increasing, consumption levels are likely to raise, hence the rates of waste generation. This has significant impacts on the amount of land that is and will be needed for disposal, economic costs of collecting and transporting the waste, and the environmental consequences of increased MSW generation levels.

It is estimated that the amount of waste generated in India will increase at a per capita rate of approximately 1-1.33% annually [15]. A World Bank publication reports that the waste generation rate in urban areas of India will be approximately 0.7 g/person/day by 2025, which is roughly four to six times higher than it was in 1999 27]. There has been a significant increase in MSW (municipal solid waste) generation in India in the last few decades. This is largely attributed to the rapid population growth and economic development in the country. Solid waste management has become a major environmental issue in India in general and urban centers in particular. The per capita of MSW generated daily, in India ranges from about 100 g/person/day in small towns to 500 g/person/day in large towns/cities. Though, there is no national level data for MSW generation, collection and disposal, and increase in solid waste generation, over the years, can be studied for a few urban centers. For example, the population of Mumbai grew from around 8.2 million in 1981to 12.3 million in 1991, registering a growth of around 49%. On the other hand, MSW generated in the city increased from 3 200 tons per day to 5 355 tons per day in the same period registering a growth of around 67% [5]. This clearly indicates that the growth in MSW in our urban centers has outpaced the population growth in recent years. This trend can be ascribed to our changing lifestyles (traditional to throw away culture), food habits, and change in living standards.

MSW in cities is collected by respective municipalities/local governments and transported to designated disposal sites, which are normally low lying areas on the outskirts of the city. The limited revenues earmarked for the municipalities make them ill-equipped to provide for high costs involved in the collection, storage, treatment, and proper disposal of MSW. As a result, a substantial part of the MSW generated remains unattended and grows in the heaps at poorly maintained collection centers. The choice of a disposal site also is more a matter of convenience i.e. what is available than what is suitable. The average collection efficiency for MSW in Indian cities is about 72.5% and around 70% of the cities lack adequate waste transport capacities [23].

The unscientific and in-sanitary methods adopted for the disposal of solid wastes is, therefore, a serious health concern in India. The poorly maintained landfill sites are prone for groundwater contamination because of leachate production. Open dumping of garbage facilitates the breeding for disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests [5].The municipalities/local governments in India therefore face the challenge of reinforcing their available infrastructure for efficient MSW management and ensuring the scientific disposal of MSW by generating enough revenues either from the generators or by identifying activities that generate resources from waste management.

B. Waste Generation and the Associated Problems in India

In India, the amount of waste generated per capita is estimated to increase at a rate of 1%–1.33% annually [28]. The rising quantities of municipal solid waste from 1997 to 2047 under the BAU scenario assuming the daily per capita waste generation in 1995 is 0.456 kg [9] and the per capita increase in waste generation is 1.33%.

The calculated value of daily per capita waste generation in 1997 was 0.468 kg. The total waste quantity generated in 2047 would be approximately above 260 million tones—more than five times than the present volume of solid waste generation. This increase will have significant impacts in terms of the land required for disposing this waste as well as on methane emissions.

C. Land Requirement

The burden that the increase in solid waste generation would impose is evident from the fact that the cumulative requirement of land (base year 1997), for disposal of MSW, would amount to around 1400 km^2 by 2047.The estimates under the BAU scenario are made considering the average collection efficiency of waste at 72.5% [21]. Diversion of land for waste disposal would be physically impossible since areas with the largest concentration of solid waste would also be the areas with serious scarcity of vacant land. The implication, therefore, is that if the current methods of solid waste disposal persist, the waste would have to be carried over long distances, which would require the creation of a great deal of transport facilities and infrastructure. This would involve enormous additional finances.

D. Methane Emissions

Indiscriminate land filling leads to deterioration of water quality in neighborhood areas of landfill sites due to contamination by leachates from the landfills. This has adverse health impacts on people living nearby, causes offensive odors, and the people living nearby live in the constant fear of explosion of methane gas that can accumulate at the landfill sites. Landfill gas, which is 50%–60% methane, contributes significantly to global warming. It is estimated that in1997, the landfills released about 7 million tones of methane into the atmosphere, which would increase to 39 million tons by 2047 under BAU scenario Emissions have been calculated using Bingemer and Crutzen's(1987) approach, which assumes that 50% of the carbon emissions in the landfills is transformed into methane.

E. MSW Collection in India

In the absence of modernization and atomization of waste management services and its various components like collection, transportation and disposal continue to be labor-intensive activities in India. About 80% of the total budget of all municipal corporations/local governments is accounted for by the salaries of sanitation workers engaged in road sweeping and related activities. A survey of 159 cities conducted by the National Institute of Urban Affairs [21] in 1989 revealed that the waste collection efficiency in these cities varied from 66% to 77% and the national average was a poor 72.5%, as compared to the developed countries where the waste collection is almost complete except for the most rural areas. Waste collection efficiency is a function of two major factors; manpower availability and transport capacity. Less than 10% of the 157 cities surveyed in 1989 had more than 2800 workers: million populations which is an accepted benchmark of optimum workforce requirement, by most of the municipal corporations in India.

Man power shortfall calculations are based on benchmark of 2800 workers/one million population and transport volume shortfall calculations are based on the figure of 320 m^3 transport capacity requirement for one million population. [3].

The Solid Waste Manual published in 2000 by the Ministry of Urban Development [19] states that, "In India, the system of primary collection of waste is practically non-existent …thus streets are generally treated as receptacles of waste". Most cities lack primary collection systems. MSW is often left on the streets or in community bins that are overflowing. House-to-house collection of MSW is carried out in only some locations in large cities in India. A large portion of the waste is collected by street sweeping, which is not done on a daily basis in many areas.

Compared to developed nations, where the majority of the waste is collected, most low-income countries have collection efficiencies ranging from 30-60% [15]. However, the collection efficiency in India ranges from 50-90%. A survey of the Indian cities in 1989 revealed that the average collection efficiency was 72.5%. However, given the results of the survey, as shown below, the national average must have been considerably lower than 72.5% [10].

A study conducted by the National Institute of Urban Affairs of India in 1989 found that collection efficiencies in Indian cities were low due to two main factors: availability of labor and transportation facilities [21]. Using a benchmark of 2,800 workers/million population for an optimum manpower requirement, the survey found that less than 10% of the cities surveyed met this requirement, and that over 77% of the cities had a shortfall of at least 46% with regard to transportation, another survey used a benchmark of 320 m^3/million population for community waste bin in Mumbai transport volume. This survey concluded that 95% of the cities had a shortfall ranging from 22-53%, and that 5% of the cities had a shortfall of over 68%. A more recent study in 2006 found that 70% of urban areas in India lack proper transportation facilities to transfer MSW to disposal or dumping sites[18].

F. MSW Disposal in India

In most cities and towns in India, MSW is disposed in open dumps in an unregulated and unscientific manner in low-lying areas on the outskirts of the cities. Most dumps lack systems for leachate collection, landfill gas collection or monitoring, nor do they use inert materials to cover the waste [1, 19]. This results in groundwater contamination from leachate, surface water contamination from runoff and lack of covering, air pollution caused by fires, toxic gases, and odor, and public health problems due to mosquitoes and scavenging animals [19]. Apparently, India is not the only country lacking of proper waste management systems. Open dumping is commonly practiced in developing countries. It is estimated that in low-income countries, less than 25% of wastes are sent to regulated landfills [6].

G. Waste Transportation Services

In India, the local governments are entrusted with the Municipal solid waste management. Transportation of waste is carried out by the municipalities/municipal corporations employing vehicles including open trucks, tractor-trailers, tipper trucks, dumper trucks and animal drawn carts (mostly in small towns and rural areas). The recent trend in big cities/municipal corporations and towns is however, towards using container-carriers and dumper-placers, wherein the containers of the vehicles are themselves the community bins. The volume of the waste to be transported is generally expressed in the terms of cubic meter per million of population. Studies made on the basis of waste density, waste generated etc. indicate that on an average 320 m^3 of transportation capacity is required for daily transportation of waste generated by population of one million. The compilation and analysis of the data of 44 Indian cities in 1996 by bhoyar et al, 1996, indicates that 70% of these 44cities do not have the 320 m^3/million transport capacity. This percentage might best ill higher as the vehicular fleet of most of the cities is several years old and is off the road for a large proportion of the year for want of repairs.

MSW Management is the major problem being faced by municipalities because it involves a huge expenditure and receives scant attention [2]. It is not only a technical problem but it also is strongly influenced by political, legal, socio-cultural, environmental and economic factors, as well as available resources. Moreover, these factors have interrelationships that are usually complex in waste management systems [17]. Many cities in developing Asian countries face serious problems in managing their solid waste. The annual waste generation increases in proportion to the rise in population and urbanization, and issues related to disposal have become challenging as more land is needed for the final disposal of these solid wastes [12].MSW is normally disposed of in an open dump in many Indian cities and towns, which is not the proper way of disposal because such crude dumps pose many environmental hazards causing ecological imbalances with respect to land, water and air pollution [13].Increasing population levels, rapid economic growth and rise in community living standards will accelerate the future MSW generation rate within Indian cities. The present annual quantity of solid waste generated in Indian cities has increased from 6 million tons in 1947 to 48 million tons in 1997 with an annual growth rate of 4.25%, and it is expected to increase to 300 million tons by 2047[5].Improper management of MSW constitutes a growing concern for cities in developing countries. Proper management requires the construction and installation of essential facilities and machinery, based on a suitable management plan. More than 90% of MSW in India is directly disposed of on the land in an unsatisfactory manner. The problem is already acute in cities and towns as the disposal facilities have not been able to keep pace with the quantum of wastes being generated. It is common to find large heaps of garbage lying in a disorganized manner at every nook and corner in the cities [14].

The MSW management in India is handled primarily by the Local governments/City Municipal Corporations as a service. The main activities include MSW collection, storage, transportation and disposal. In general, the quantity and quality of MSW generated in the metropolis are generally governed by the parameters such as population, standards of living socioeconomic conditions, commercial and industrial activities, food habits, cultural traditions and climatic conditions. The problem of MSW disposal does not entirely depend upon the efficiency of Municipal corporations. It also depends on the adaptation of suitable technologies to provide environment friendly scientific options for processing MSW that would enable generation of useful products through recycling processes and minimize the quantity of landfill disposable fraction. One such method is composting of MSW in some parts of the country. However, this itself is not a solution by itself which should be comprehensive. The efforts to mechanization were also not successful because of the very low yield of methane from mixed garbage as well as disposal problem of digester residue.

One important aspect to be taken note of in this connection is that most of the recyclable materials like papers, plastics, glass, metals are picked up by the rag pickers, thus making MSW unattractive for commercial exploitation in view of recycling. Indian garbage is known for its high moisture, soil and silt and putrifiables than the developed nations.

Rapid urbanization has led to over-stressing of urban infrastructure services including Municipal Solid Waste Management because of poor resources and inadequacies of the existing systems. Therefore, augmenting, operating & maintaining solid waste management system in a sustainable manner by urban local bodies would require huge capital investment, introduction of latest technologies which are cost effective, Public-Private Partnerships (PPP) in waste management and introduction of appropriate waste management practices in order to prevent urban waste from causing environmental pollution and health hazards.

Per capita waste generation varies between 0.2 Kg to 0.6 Kg per day in cities with population ranging from 0.1 million to 5.0 million. An assessment on MSW revealed i) the increase in per capita waste generation is about 1.3% per year, ii) growth of urban population is between 3% and 3.5% per annum. Basing on these two variables, the yearly increase in the overall quantity of solid waste in the cities is about 5%. Waste collection efficiency ranges from 50% to 90%. Urban Local Bodies (ULB's) spend between Rs.500/- to Rs.1500/- per ton on solid waste management, of which 60% to 70% is spent on collection alone, 20% to 30% on transportation and less than 5% on treatment and disposal which is very essential to prevent environmental pollution. In India, majority of the ULB's resort to crude dumping of MSW as the only way of management technique without adopting scientific and hygienic approach of sanitary land filling.

Problem of urban waste management is notable in India not only because of large quantities involved, but also its spatial spread across 5161 cities and towns and enormity and variety of problems involved in setting up and managing systems for collection, transportation and disposal of waste.

III. CONCLUSION

Most of the MSW in India is dumped on land in an uncontrolled manner. Such inadequate disposal practices lead to problems that will impair human and animal health and

result in economic, environmental and biological losses. Comparing the biological, chemical and thermal treatment options in the Indian scenario, perhaps the biological processing options get the priority. Composting and vermin composting are successful and quite popular now in India instead of incineration. But, it is slow process and requires a large space. An open dump or an uncontrolled waste disposal area should be rehabilitated. It is advisable to move from open dumping to sanitary landfilling in a phased manner. Landfilling should be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. The current regulations (MSWM rules, 2000) are very stringent. Norms have been developed to ensure a proper MSWM system. Unfortunately, clearly there is a large gap between policy and implementation. The producer responsibility is to avoid having products on the market that cannot be handled effectively and environmentally correctly when they become waste products. A new survey should be carried out on the generation and characterization of MSW in India. Since the MSW is heterogeneous in nature, a large number of samples have to be collected and analyzed to obtain statistically reliable results. Finally, this study concludes that the lack of resources such as financing, infrastructure, suitable planning and data, and leadership, are the main barriers in Municipal Solid Waste Management.

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