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Scenario of Present and Future of Solid Waste Generation in Metro Cities of India

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Abstract
Rapid industrialization, urbanization, population growth and migration from the country side are resulted in Solid Waste generation, which is commonly considered as an Urban Issue. It is highly related with Economic growth, degree of industrialization and consumption pattern and lavish lifestyle of city dwellers. Solid Waste generation and management is a burning issue all over the world and the planners and policy formulators are finding it extremely difficult to handle this problem mainly because of slapdash and unchecked urbanization. Solid Waste contributes 3% of total Green House Gases Emission Globally, which are culprit for Global Warming and Climate Change. Huge amount of Solid Waste generation and their improper management worsen the air quality in the urban areas which results in health problems. When the urbanization expands, the amount of municipal solid waste increases rapidly even faster than the rate of urbanization, one of the most important by-products of an urban lifestyle, is growing even faster than the rate of urbanization. Ten years ago there were 2.9 billion urban residents who generated about 0.64 kg of Municipal solid wastes per person per day (0.68 billion tons per year). Hence, today these amounts have increased to about 3 billion residents generating 1.2 kg per person per day (1.3 billion tons per year). By 2025 this will likely increase to 4.3 billion urban residents generating about 1.42 kg/capita/day of municipal solid waste (2.2 billion tons per year). The main aim of this paper is to quantify the present generation of Solid Waste and project the generation in future by projecting population growth in Metro Cities and find out the causative factors for the same. In the present study, an attempt has been made to provide a comprehensive review of the present infrastructure available, the future requirements to manage Municipal solid wastes and the Organizations and agencies involved in it. The main aim of this paper is to quantify the present generation of Solid Waste and project the generation in future by projecting population growth in Metro Cities and find out the causative factors for the same.
Keywords: Solid Waste, Urbanization, Population, Green House Gases (GHGs)

Introduction

Solid waste is generally an urban issue. Today, more than 50 percent of the population of the World lives in the cities and the rate of urbanization is increasing quickly. Solid Waste generation is the by-product of the Urbanization. It is highly related with Economic growth, degree of industrialization and consumption pattern. With the increase of urban population of the cities and towns all other activities associated with population also increases resulting in more and more generation of Municipal Solid Waste. And in the absence of technology and efficient and effective methods of disposing refuse worsen the quality of Air of the urban centers which have detrimental impacts on human health. The most common problems associated with improper management of solid waste include disease transmission, odor, nuisance, atmospheric, land & water pollution, fire hazards, aesthetical nuisance and economic losses (Yeny and Yulinah, 2012).

More or less every human activity creates some kind of waste. As countries develop economically, socially, and technologically waste generation also increases. Both developed and developing countries face the problems associated with solid waste generation and its management. Rapid urbanization directs to the densification and an increase of large amounts of solid waste within a concentrated area.

Global population rose to 6.9 billion in 2010 and the majority of people live in developing countries. A major challenge is how to manage the ever-increasing waste generated, especially in developing countries already lacking a sufficient public service infrastructure to manage municipal waste, and where poverty and unplanned settlements lead to unmanaged waste (World Bank, 2012).

Globally, we live in “throw-away” societies in which we consume packaged products that often do not last past a single use or even a year, and we discard as waste what we no longer want. This wasteful lifestyle seriously impacts the environment, public health, and produces social and economic problems. Waste disposal can have serious environmental impacts: landfills consume land space, and cause air, water and soil pollution - including the emission of greenhouse gases, while incineration results in emissions of dangerous air pollutants. Our consumptive and often wasteful behavior needs to be examined, and changed, so that we can live more sustainably (World Bank, 2012).

Solid waste generation is the common basis for activity data to estimate emissions from solid waste

disposal, biological treatment, and incineration and open burning of waste. Solid waste generation rates and composition vary from country to country depending on the economic situation, industrial structure, waste management regulations and life style.

The availability and quality of data on solid waste generation as well as subsequent treatment also vary significantly from country to country. Statistics on waste generation and treatment have been improved substantially in many countries during the last decade, but at present only a small number of countries have comprehensive waste data covering all waste types and treatment techniques. Solid waste is generated from households, offices, shops, markets, restaurants, public institutions, industrial installations, water works and sewage facilities, construction and demolition sites, and agricultural activities (Hoornweg and Thomas, 1999).

Solid waste management practices include: collection, recycling, solid waste disposal on land, biological and other treatments as well as incineration and open burning of waste.

A new, far-reaching report on the state of municipal solid waste around the world predicts a sharp rise in the amount of garbage generated by urban residents between now and 2025. The report estimates the amount of municipal solid waste (MSW) will rise from the current 1.3 billion tons/year to 2.2 billion tons/year, with much of the increase coming in rapidly growing cities in developing countries (World Bank, 2012).

Globally, waste volumes are increasing quickly even faster than the rate of urbanization. World Bank report shows that the amount of municipal solid waste is growing fastest in China (which surpassed the US as the world's largest waste generator in 2004), other parts of East Asia, and part of Eastern Europe and the Middle East. In the last two decades the amount of waste generated in China is very high due to increased number of population and economic growth. For instance the waste generation in China is parallel to its economic growth, i.e. from 1979-1995 the average annual rate of increase in its solid waste had been 9% slightly below the average annual growth of its economy 10% (Zang, 1998).

There is a direct correlation between the per capita level of income in cities and the amount of waste per capita that is generated. In general, as a country urbanizes and populations become wealthier, the consumption of inorganic materials (e.g. plastics, paper, glass, aluminum) increases, while the relative organic fraction decreases (UNEP, 2001).

As the world hurtles toward its urban future, the amount of municipal solid waste (MSW), one of the most important by-products of an urban lifestyle, is growing even faster than the rate of urbanization. Ten years ago there were 2.9 billion urban residents who generated about 0.64 kg of MSW per person per day (0.68 billion tons per year). This world report estimates that today these amounts have increased to about 3 billion residents generating 1.2kg per person per day (1.3 billion tons per year). By 2025 this will likely increase to 4.3 billion urban residents generating about 1.42 kg/capita/day of municipal solid waste (2.2 billion tons per year) (World Bank, 2012)..

Waste generation in sub-Saharan Africa is approximately 62 million tons per year. Per capita waste generation is generally low in this region, but spans a wide range, from 0.09 to 3.0 kg per person per day, with an average of 0.65 kg/capita/day (ibid)

The annual waste generation in East Asia and the Pacific Region is approximately 270 million tones per year. This quantity is mainly influenced by waste generation in China, which makes up 70% of the regional total. Per capita waste generation ranges from 0.44 to 4.3 kg per person per day for the region, with an average of 0.95 kg/capita/day (Hoornweg *et al*, 2005).

In Eastern and Central Asia, the waste generated per year is at least 93 million tons. Eight countries in this region have no available data on waste generation in the literature. The per capita waste generation ranges from 0.29 to 2.1 kg per person per day, with an average of 1.1 kg/capita/day (World Bank, 2012).

Latin America and the Caribbean has the most comprehensive and consistent data (e.g. PAHO's Regional Evaluation of Solid Waste Management, 2005). The total amount of waste generated per year in this region is 160 million tons, with per capita values ranging from 0.1 to 14 kg/capita/day, and an average of 1.1 kg/capita/day (ibid).

In the Middle East and North Africa, solid waste generation is 63 million tons per year. Per capita waste generation is 0.16 to 5.7 kg per person per day, and has an average of 1.1 kg/capita/day. The OECD (Organizations for Economic Co-operation and Development) countries generate 572 million tones of solid waste per year. The per capita values range from 1.1 to 3.7 kg per person per day with an average of 2.2 kg/capita/day (ibid).

In South Asia, approximately 70 million tons of waste is generated per year, with per capita values ranging from 0.12 to 5.1 kg per person per day and an average of 0.45 kg/capita/day.

Uruguay has the distinction of generating the least MSW that is 0.11kg/capita/day while Trinidad and Tobago generates 14.40 kg/capita/day, which is the highest in the world. And surprisingly both the countries lie in Latin America and the Caribbean Region (ibid).

India, one of the fastest growing economies in the world, faces a challenge of MSW Management. To address the issue, the Indian Government enacted MSW (Handling and Management) Rules in the year 2000

with a view to improve the present scenario. All Urban Local Bodies (ULBs) were supposed to have MSW management systems by end of year 2003. Being engrossed in their day-to-day activities and due to typical nature of Indian MSW, no single ULBs could achieve the targets. The Courts of Law in India are now issuing summons to ULBs for non compliance with the law of the land (ibid).

Urban India generates about 1.0 lakh MT/day of Municipal Solid Waste and it requires more than 1500 Acres of land/year for land fill. This is a very imposing land demand, in a land- scarce India. Despite the fact that the urban local bodies utilize major part of its staff and resources for collection and disposal of MSW, nearly half of MSW generated remains unattended in many cities. Out of the funds spent on MSW management, ULBs typically spend about 65% funds on collection, 30% on transportation and a mere 5% on waste disposal. There is thus an urgent need to address the problem with a more scientific approach than the commonly adopted; crude dumping of MSW. Proper management of MSW can play significant role in national progress. Not many Municipalities have been able to take desired steps in this direction. Generally in India, MSW is disposed of in low-lying areas without taking proper precautions or operational controls. Therefore, municipal solid waste management (MSWM) is one of the major environmental problems of Indian megacities.

SWM involves activities associated with generation, storage and collection, transfer and transport, treatment and disposal of solid wastes. But, in most Indian cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. Poor collection and inadequate transportation causes the accumulation of MSW at every nook and corner.

Objectives

- To find out the present generation and composition of Solid Waste in different Metro Cities of India
- To project the future generation of Solid Waste with increasing population and urbanization

Study Area

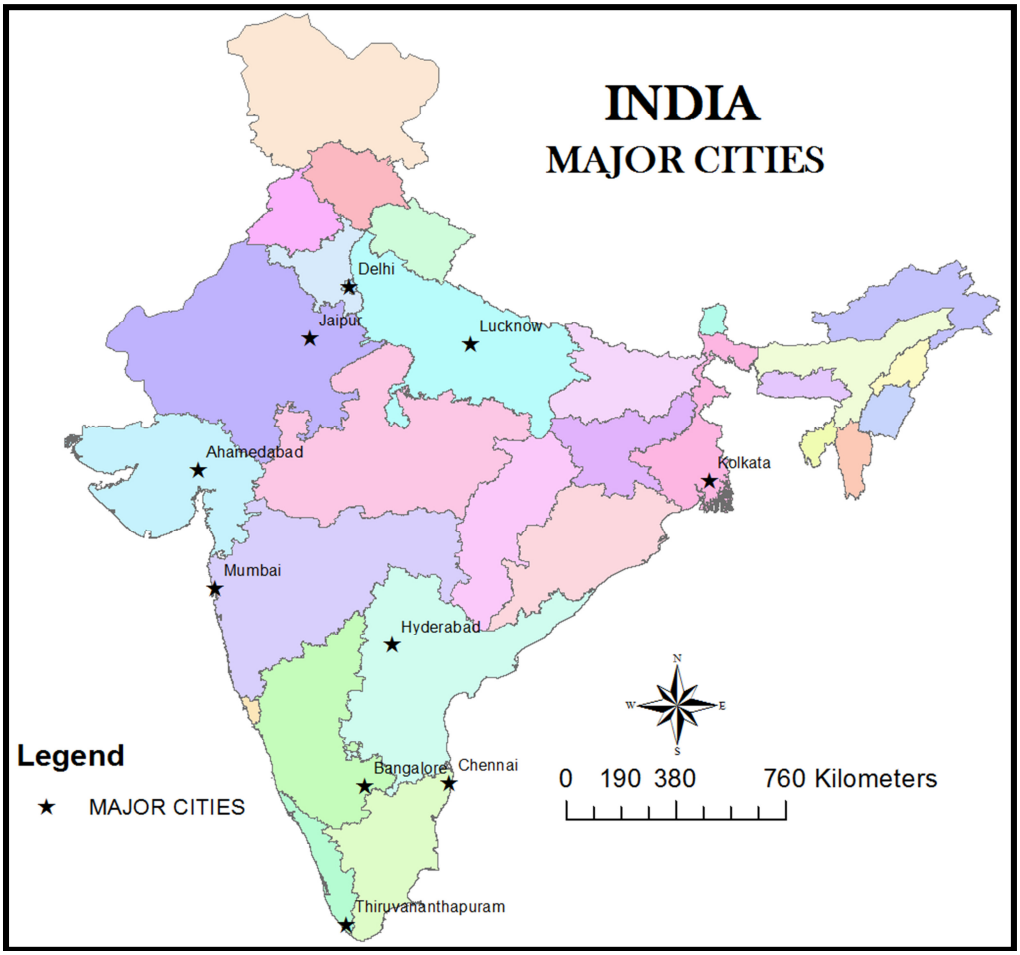


Figure 1: Map of Indian Metro Cities

Data Base and Methodology

Secondary data was used for this study. Secondary data was gathered from published reports of the city

administration and Central Pollution Control Board (CPCB). To analyze the data and project the population growth and Solid Waste Generation simple statistical techniques like percentage, mean, probabilistic model and geometric methods were used.

Results and Discussions

A positive correlation tends to exist between a population's income and the amount of solid wastes generated. Rich individuals or affluent class consume more than lower-income or poor ones, resulting in a higher waste generation rate for the former. The processes of rapid population growth and urbanization translate into a greater volume of wastes generated. Globalization (interaction and integration of different people from different parts of the world) can promote economic growth, a desirable outcome. However, this economic growth –in addition to population increase and urbanization– will seriously strain municipal resources to deal with a extraordinarily huge amount of solid wastes generation.

Higher incomes and economic growth also tend to have an impact on the composition of wastes.

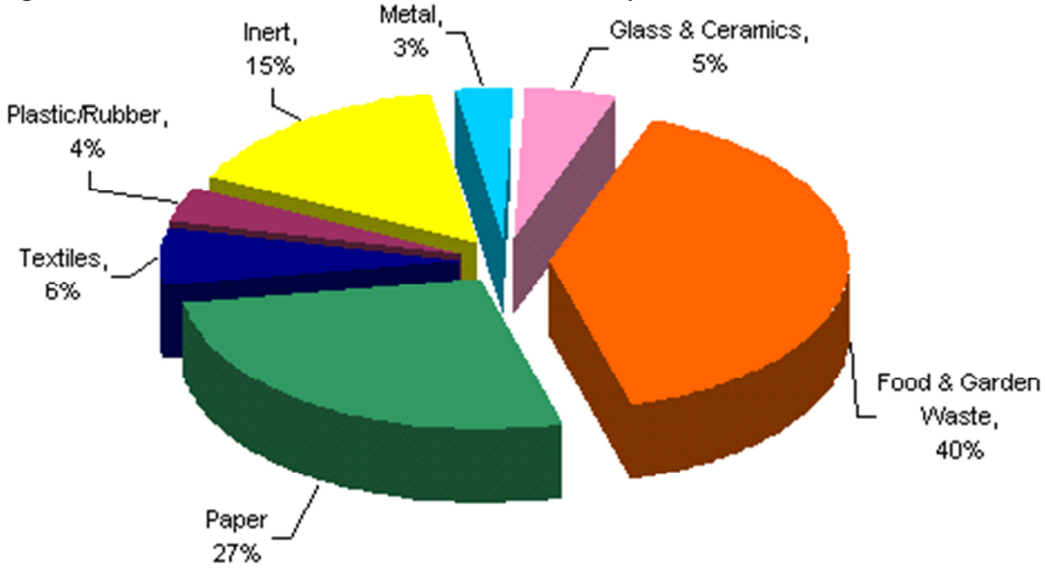
Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials –metals, plastics, glass, textiles, and so on– in the waste stream. Higher generation of wastes and a changing composition with changing of income level have a profound impact on waste management practices. It also points out and stress upon the policy changes that developing countries need to make.

More wastes being generated and with a higher content of inorganic materials could have a significant impact on human health and the environment. If those additional wastes resulting from population and economic growth are not collected, treated and disposed of properly, health and environment in cities will further deteriorate undoubtedly.

Composition of MSW in a Typical Indian City

Due to population Explosion, lavish lifestyles and changing dietary habits, not only the quantity of waste generation increases but the quality as well as composition of the waste also changes. It means that as country gets richer, the organic share decreases whereas the paper and plastic increases. The general composition of solid waste being generated from the cities of India is 40% Food and Garden waste, 5% glass and Ceramics, 3% Metal, 15% inert, 4% Plastic/ Rubber, 6% Textile, 27% Paper.

Total Organic Fraction - 40%, Combustible Fraction - 37%, Recyclables - 8%, Inert - 15%



Source: CPHEEO Manual on MSW, 2005

Type of litter we generate and approximate time it takes to degenerate.

Type of litter	Approximate time to degenerate
Organic waste (Vegetable and fruit peels, foodstuff)	A week or two.
Paper	10-30 days
Cotton cloth	2-5 months
Wood	10-15 years
Woolen items	1 year
Tin, aluminum, and other	100-500 years
Metal items such as cans	One million years?
Plastic bags	Undetermined
Glass bottles	Undetermined

Source: http://edugreen.teri.res.

Characterization of Solid Waste in the Cities of India

Characterization of waste is necessary to know changing trends in composition of waste. Based on composition/ characterization of waste, appropriate selection of waste processing technologies could be selected.
Waste characterization in 10 cities is depicted below:

Table 1: Municipal Solid Waste Generation in Metro cities (2005)

S.No.	City	Urban Population	Generation Rate (kg/capita/day)	Total MSW Generated (kg/day)	Total Waste (Tons/day)
1	Ahmedabad	3,520,085	0.37	1,302,431	1,302
2	Banglore	4,301,326	0.39	1,677,517	1,678
3	Chennai	4,343,645	0.62	2,693,060	2,693
4	Delhi	10,306,452	0.57	5,874,678	5,875
5	Greater Mumbai	11,978,450	0.45	5,390,303	5,390
6	Hyderabad	3,843,585	0.57	2,190,843	2,191
7	Kanpur	2,551,337	0.43	1,097,075	1,097
8	Kolkata	4,572,876	0.58	2,652,268	2,652
9	Pune	2,538,473	0.46	1,167,698	1,168
10	Surat	2,433,835	0.41	997,872	998

Source- Central pollution Control Board (CPCB) (2005)

Projection of solid waste generation in cities of India

For per capita rate of generation (kg/c/d) , the following formula is used
Y=0.0913Ln(X) + 0.3568, Where X is frequency factor

$$X = \frac{PlanningYear}{PlanningYear + 1}$$

Table 2

No	Year	Planning year	Frequency factor(X)	Rate of generation (Y)
1.	2004	0	--	
2.	2005	1	0.5	0.2923
3.	2006	2	0.667	0.319
4.	2007	3	0.75	0.33
5.	2008	4	0.8	0.336
6.	2009	5	0.833	0.34
7.	2010	6	0.857	0.342
8.	2011	7	0.875	0.3446
9.	2012	8	0.888	0.346
10.	2013	9	0.9	0.347
11.	2014	10	0.909091	0.3481
12.	2015	11	0.923077	0.3488
13.	2016	12	0.923077	0.349
14.	2017	13	0.928571	0.35
15.	2018	14	0.93333	0.3505
16.	2019	15	0.9375	0.3509
17.	2020	16	0.94117647	0.3512

Table 3: Municipal Solid Waste Composition in Metro cities (2005)

S.No.	City	Urban Population	Organic (%)	Total Recyclable (%)	Paper (%)	Plastic (%)	Glass (%)	Metal (%)	Other (%)
1	Ahmedabad	3,520,085	41	12	-	-	-	-	48
2	Banglore	4,301,326	52	22	-	-	-	-	26
3	Chennai	4,343,645	41	16	-	-	-	-	42
4	Delhi	10,306,452	54	16	-	-	-	-	30
5	Greater Mumbai	11,978,450	62	17	-	-	-	-	21
6	Hyderabad	3,843,585	54	22	-	-	-	-	24
7	Kanpur	2,551,337	48	12	-	-	-	-	41
8	Kolkata	4,572,876	51	11	-	-	-	-	38
9	Pune	2,538,473	62	17	-	-	-	-	21
10	Surat	2,433,835	57	11	-	-	-	-	32

Source- CPCB 2005

Concluding Remarks

Time is running out. Politicians, planners, policy makers, executives, academicians and researchers specifically politicians have to think about the so called plague of Solid Waste Management genuinely otherwise it will be proved suicidal.

Active participation and awareness of the Public is utmost important in effective and fruitful Municipal Solid Waste Management without which it is not only impossible but next to impossible also. Public at large do not segregate the waste at source which is the demand of the hour to sort out this "Urban Menace".

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