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RESEARCH ARTICLE OPEN ACCESS

MSW Characterisation of Bhopal City of Madhya Pradesh India

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Abstract
The total No. of local bodies is 407 (98 municipal corporation and 309 Nagar panchayat) in Madhya Pradesh. Out of it 16 is Municipal Corporation. Presently most of the local bodies do not have scientific land fill site. Most urban area plagued by acute problems related to solid waste. Due to lack of serious efforts by town/city authorities, garbage and its management has become a tenacious problems and this notwithstanding the fact that the largest part of municipal expenditure is allocated to it. It is not uncommon to find 30-50% of staff and resources being utilized by urban local bodies for these operations Despite this there has been a progressive decline in the standard of services with respect to collection and disposal of municipal solid waste. In many local bodies half of solid waste generated remains unattended giving rise to insanitary conditions especially in densely. Populated slums which in turn results in an increase in morbidity especially due to microbial and parasitic infections and infestations is all regiments of population with the urban slum dweller and the waste handlers being the worst effected.
Refuse characteristics depend on a number of factors such as food habits, cultural traditions, socio-economic and climatic conditions. Refuse characteristics vary not only from city to city but even within the same city itself and also seasonally. Quality of refuse should be assessed taking into account seasonal variation, zonal characteristics, etc. Sampling points should betruly representative of the given occupation sub-group.

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I. COMPOSITION OF MUNICIPAL SOLID WASTE GENERATED IN BHOPAL,

Generation quantities are estimated to increase 886.5 metric tones per day in year 2021 from569 metric tons in 2011 in Bhopal (Henry, 2006). BMC is planning and implementing various solutions for proper waste disposal in Bhopal city. Since the last three years, the Corporation has established door to door collection scheme in which about 6000 rag pickers and 300 rickshaw pullers are engaged for waste collection. Out of the 4.5 lacks households in Bhopal, waste is collected from at least 2.5 lacks households daily. This waste is either unloaded in the nearby dustbins or at the collection centre from where the municipal vehicles lift the garbage and dumps it at the Bhanpura dumpsite which is situated at Vidisha road of the city. Moreover, the habits of people throwing garbage here and there, leads to even more pollution in the city and an increased problem of management of garbage (CPCB, 2000: Goel, 2008). More than three decade old and about 90% filled to its capacity, this site is now inside municipal limits Thus, there is a need for various technological options to cap the dumpsite scientifically and create a scientific landfill outside the municipal limits. For proper engaging these huge amount of municipal waste in Bhopal whole Bhopal city is divided in 18 municipal zonal offices for proper collection, transportation and disposal of these solid waste. BMC has identified and allotted a 60 acre land in Adampur for developing scientific landfill by using these waste to resolve the problems municipal solid waste in Bhopal city (GOI 2003 NEERI, 2005). QUALITATIVE AND QUANTITATIVE ANALYSIS OF MSW OF BHOPAL ISSN: 2410-8790 Pandey et al Current Science Perspectives 2(3) (2016) 52-56 iscientic.arg www.bosaljourmals/csp/ 54 editorcsp@bosaljournals.com There are many categories of MSW such as food waste, rubbish, commercial waste, industrial waste, institutional waste, street sweeping waste, construction and demolition waste, sanitation waste, worship waste. MSW contains recyclables (pipe. plastic, polythene, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines, and electronics

waste), compostable organic matter (fruit and vegetable peels, food waste) and soiled waste (blood stained cotton, sanitary napkins, disposable syringes (Nagayama, 2010). Characterization of the municipal waste shows that Bhopal has the highest proportion of mixed residue as organic material mixed with soil, mud, sand and other inert materials to the extent of 60%. This material has an organic content measured as volatile solids of approximately 20% and demonstrates the high inert or inorganic content of the waste. In these waste 21% carbonic material, 50% ash and dust, 9% paper and 13% plastic are broad composition of the garbage. The inert material is mostly dust, sand, sediments and sol, and is a large fraction of Indian MSW due to the largely unpaved areas. The chemical characteristics of MSW of Bhopal (BMC, 2014). The quantity of MSW generated depends on a number of factors such as food habits, high standard of living, degree of commercial activities, education back ground of population, religious value of place, seasonal and climate patterns. Data on quantity variation and generation are useful in planning for collection, treatment and disposal systems. Due to increasing the urbanization and changing life styles of people of Bhopal, solid waste generates more than it used to generate earlier.

Table Characteristics of Solid Waste in Bhopal (Mehta & Associates)

S. N	Test	Site-I Arera Coloney (Resi/Com)	Site-II Old City	Site-III Bairagar
	Physical			
1	Compostable Material	28%	63%	72%
2	Paper	2.9%	16%	6%
3	Plastics	2.9%	10%	6%
4	Glass & Ceramics	2.4%	1.2%	Nil
5	Earth, Stones, Bricks	30%	10%	7%
6	Moisture Content	25%	46%	58%
7	Volatile Substance	36%	44%	53%
8	Non Volatile Substance	64%	56%	47%
	Chemical			
9	Carbon Content	26%	27%	29%
10	Total Nitrogen	0.8%	0.65%	0.7%
11	PH	6.0%	6.2	6.4%
12	Potassium	0.41%	0.48%	0.68%
13	Phosphorus	0.7%	0.65%	0.45%
14	HCV in Kcal/kg	1252	1024	821
15	C/N ration	32.5	41.5%	41.4

Quantification & characterization of MSW in the State :-

Quantification of MSW is done on the basis of the information supplied by the local bodies. The quantity is given by the local bodies on the basis of the actual collection as per the facilities available with them. It is estimated that the actual collection is not more than 60% of the total waste generation. The region-wise status of waste generation and its composition as organic and inorganic is depicted in table

Municipal Solid Waste Generation:-

			Quantity of MSW (MT/day)		
S.No	Region	No of local bodies	Organic	Inorganic	Total
1	Rewa	32	174.00	114.90	288.90
2	Ujjain	57	334.70	220.60	555.30
3	Gwalior	33	299.38	345.57	644.95
4	Sagar	50	180.23	273.67	453.90
5	Satna	11	69.80	42.80	112.60
6	Dhar	17	79.20	21.80	101.00
7	Indore	31	400.75	267.16	667.91
8	Bhopal	39	200.50	548.12	748.62

9	Jabalpur	43	438.55	191.35	629.90
10	Guna	29	111.50	74.50	186
	Total	342	2288.61	2172.47	4461.08

Table General Characteristics of Municipal Solid Waste in Bhopal

S. N	Fraction of MSW	Site-I Arera Colony (Resi/Com)	Site-II Old Bhopal (Resi)	Site-III Bairagar
Physical				
1	Compostable Material	28%	63%	72%
2	Paper	2.9%	16%	6%
3	Plastics	2.9%	10%	6%
4	Glass & Ceramics	2.4%	1.2%	Nil
5	Earth, Stones, Bricks	30%	10%	7%
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7	C/N ration	32.5	41.5%	41.4

(Source: Integrated Urban Development in Madhya Pradesh, Bhopal ADB)

Table Solid Waste Generation from Year 2008-2023 in different zone of Bhopal City

Ward Number	Name of The Ward	Population 2018	Waste Generation (MT/day) 2018	Population 2023	Waste Generation (MT/day) 2023
1	Mahatma Gandhi	59669	19.86	66467	23.25
2	C.T.O.	32808	10.92	36691	12.83
3	Hemu Kalani	27924	9.29	30522	10.68
4	Sadhu waswani	41850	13.93	46.64	16.11
5	Koh-E-Fiza	29394	9.78	32222	10.27
6	Noor Mahal	27235	9.06	29757	10.41
7	Malipura	23006	7.66	25165	8.80
8	Bagh munis hussin	30469	10.14	33936	11.87
9	Idgah Hills	39345	13.09	42947	15.02
10	Babu Jagivan	21894	7.29	22649	7.92
11	Gufa Mandir	61330	20.41	66874	23.39
12	Geetanjali	34862	11.60	38065	13.31
13	Shahjanabad	32229	10.73	34372	12.02
14	Congress nagar	31986	10.64	34953	12.23
15	Motilal Nehru	35058	11.67	38185	13.36
16	J.P. Nagar	24141	8.03	26676	9.33
17	Ibrahim Ganj	38688	12.88	42235	14.77
18	Ram mandir	20890	6.95	22857	7.99
19	Mangala Wara	20588	6.85	22535	7.88
20	Lal Bahadur Shastri	20836	6.93	22473	7.86
21	Mahavir	21394	7.12	23406	8.19
22	Jain Mandir	17497	5.82	19160	6.70
23	Moti Masajid	28637	9.53	30773	10.76
24	Islam Pura	18069	6.01	19011	6.65

25	Bhojpura	28055	9.34	30665	10.73
26	Rani Kamlapati	24721	8.23	27086	9.47
27	Vivekanad	35111	11.68	38769	13.56
28	Ambedkar	39403	13.11	43003	15.04
29	Tulsi Nagar	42255	14.06	46040	16.10
30	Pansheel Nagar	25785	8.57	28145	9.84
31	Maulana Azad	63135	21.02	69935	24.46
32	Shivaji Nagar	30761	10.24	33949	11.87
33	T.T. Nagar	19258	6.41	21122	7.79
34	Jawahar Lal Nehru	20938	6.97	22912	8.07
35	Pt Madan Mohan	43550	14.49	47748	16.70
36	R.N. Tagore	32670	10.87	36117	12.63
37	Jajangirabad	29039	9.66	31721	11.10
38	Berkhedi	27282	9.08	29547	10.33
39	Chandabad	30273	10.08	33075	11.57
40	Kapda Mill	43561	14.50	47643	16.66
41	Bagh umro dulah	49245	16.39	53723	18.79
42	Aish Bagh	59036	19.65	64405	22.53
43	Maharani Lax, bai	23117	7.69	24853	8.69
44	Zinci	17200	5.59	17600	5.88
45	Maida Mill	30357	10.10	33161	11.60
46	Neta Subchandra	42120	14.02	46082	16.12
47	Maharana Pratap	26058	8.67	28491	9.97
48	Ravishankar Ngr.	33632	11.19	36740	12.85
49	Dr. Rajendra Prasad	50600	16.84	55861	19.54
50	Indra Gandhi	40498	13.48	44202	15.46
51	Sahpura	39774	13.24	43425	18.19
52	Asha Niketan	70626	23.50	77053	26.95
53	Barkatullh	65114	21.67	72762	25.45
54	Berkheda pathani	59524	19.81	6646	23.25
55	Saket shakti Nagar	23994	7.99	26221	9.17
56	Sasturba Nagar	31875	10.61	34846	12.19
57	Anna Nagar	20072	6.68	21964	7.68
58	Berkheda (BHEL)	22285	7.42	24351	8.52
59	Govindpura	3772	7.91	25975	9.09
60	Piplani	45969	15.30	520584	18.22
61	Gautam Budh	21354	7.11	23348	8.17
62	Sonagiri	65821	21.91	72893	25.50
63	Indrapuri	5725	25.20	82593	28.89
64	Guru Nanak	63120	21.01	68835	24.08
65	Rajeev Nagar	68225	22.71	73883	26.89
66	Babhi Bagh	117221	39.01	129124	45.16

Solid waste Generation Status in the state
Solid waste treated would be 6431 TPD instead of 6461 TPD
There is change in data on different ODF categories for Swachh Survekshan 2020 (For the year 19-20) as declared by Govt. of India on March'20

ODF : 20 Cities
ODF+ : 234 Cities
ODF++ : 108 Cities

Waste-to-Energy Plants:
There is change in the Status of operation for Bhopal and Indore city.

Table Status of WTE Plant In MP

Sl. No.	Plant Location	Status of operation	Power generation (MW)
1	1. Bhopal	**In the Process of Termination**	23 Mw
	2. Gwalior	Under Construction	11 MW
	3. Indore	**Terminated**	20 MW
	4. Jabalpur	Operational	11.5 MW
	5. Rewa	Under Construction	2x6 MW

Disposal of Solid Waste.

There is change in the status of Landfill site identified, landfill constructed and Landfill under construction. Please find the updated list below:

Table Status of Landfill sites

Activities	No of Cities/Towns	Names of ULBs
Landfill sites identified	51	
Landfill constructed	07	1.Gwalior 2.Indore 3.Jabalpur 4.Katni 5.Rewa 6.Sagar 7.Ujjain
Landfill under construction	01	1.Bhopal
Landfill Site		1.Gwalior 2.Indore
Operational		3.Jabalpur 4.Katni 5.Ujjain

Status of MSW Rules 2016 in Madhya Pradesh

Urban Administration and Development Department (UADD) has been at the forefront of complying with Solid Waste Management Rules – 2016. GoI has also recognized the efforts of Madhya Pradesh and awarded the State as the best State in Solid Waste Management in 2019. commitment and dedication towards achieving a clean and dirt-free State succeeded in bringing the State to **3rdRank** in Swacch Survekshan 2020. State has been working earnestly towards complying with the orders of Hon'ble NGT. In March'20, we started a 'planning exercise' to implement the Order dated 25th Feb 2020. However, due to Covid-19 and rising cases in Madhya Pradesh, the entire government machinery – all the departments including Urban Development & Housing had been at the fore front of managing the Covid situation well across all the Urban Local Bodies (ULBs) of MP.

PROGRESS REPORT OF MUNICIPAL SOLID WASTE MANAGEMENT RULES, 2016

1. The policy followed by the State Government for the management of the solid waste generated in the State.

2. The cluster-based Integrated Solid Waste Management model adopted by the State is working in **06 clusters**– that are in various stages of implementation. This covers a total of 94 ULBs. Out of 07 clusters, 04 clusters are waste to compost

(Sagar, Katni, Chhatarpur and Singrauli) and 02 Clusters are waste to energy (Jabalpur and Rewa).

3. Indore Cluster and Bhopal Cluster has been terminated because of delay in signing of the PPA. Indore and Bhopal have been sanctioned as standalone Projects and State is planning to implement solid waste management through 'Decentralized Solid Waste Management Model' (Standalone Mode) in remaining 7-7ULBs of Bhopal Cluster and Indore Cluster each. Bhopal and Indore have also signed and MOU with NVVN (NTPC Vidyut Vyapar Nigam Ltd) for setting up of 400 and 500 MTD capacity "Municipal Solid Waste to Torrefied Charcoal Pellets Plant"

4. In various feasible options with the sector experts and is rethinking to adopt the mixed approach of cluster based ISWM model with decentralized SWM projects. The mixed approach will help the State to ensure. effective implementation of SWM Rules,2016 across all the ULBs. '**Decentralized Solid Waste Management Model**' with processing facilities at ULB Level is already working in Ujjain City which has Waste to Compost Facility for processing 190 TPD of waste.

a) Each ULB will set up facilities for end to end management of municipal solid waste such as:

i. Material Recovery Facilities

ii. Plastic to Fuel

iii. Bio-methanation

iv. Compost Facility

v. C&D Waste Management Processing Facility

vi. Transfer Stations

vii. Landfill site

b) Nearby towns to be linked to District Head Quarters.

c) ULBs to be made responsible for Collection and Transportation (C&T) of Municipal Solid Waste.

d) Processing & Disposal (P&D) to be done by Private Player

e) ULBs to recycle / process 75% of their waste.

Mechanism for processing Construction and Demolition (C&D) Waste

The State has prepared a policy for Construction and Demolition Waste Processing Facilities. The State is ensuring all the ULBs in the State have the required infrastructure to manage C&D Waste from collection to disposal. The waste hierarchy for C&D Waste can be similar to the waste hierarchy of Solid Waste (Solid Waste Management Rules, 2016 – Rule 3). The waste hierarchy is prioritized and managed in the following order – reduction, reuse, recycling, recovery and disposal, with reduction and reuse being the most preferred option and disposal at the landfill being the least.

1. 333 ULBs have "C&D Waste Helpline" in place

2. 332 ULBs have notified user charges for services and fines for open dumping of C&D waste

3. 338 ULBs have dedicated vehicles for collection and transportation of C&D waste

4. 318 ULBs have dedicated areas earmarked to keep C&D waste in the city

The State plans to set up C&D Waste Processing Plants in big cities (>10 lakh of population) that generate huge amount of C&D waste and cluster-based approach to cover small ULBs. Currently, Indore and Ujjain Municipal Corporations has C&D Processing plant on PPP basis with capacity of 100 TPD each. Jabalpur and Rewa have functional C&D waste processing plant of capacity 50 TPD each. A 100 TPD plant in Bhopal Municipal .

- For smaller ULBs, the State intends to reuse the C&D waste for leveling of low-lying areas and road construction activities.

Status of GPS-enabled Solid Waste Collection Vans / Vehicles

As per the mandate, all towns / cities with more than 1 lakh of population are required to have GPS fitted in their garbage collection and transportation vehicles. In Madhya Pradesh, there are 34 towns with more than 1 lakh population. There are 3,399 vehicles with ICT based monitoring for collection and transportation of municipal waste.

In total, there are 5,200 vehicles that are being deployed for collection and transportation of municipal waste and are monitored through various ICT based monitoring mechanisms.

Initiatives on 3R – Reduce, Reuse and Recycle

The State aims to move toward 3R (Reduce-Reuse recycle).

A.- 332 ULBs have taken different measures to reduce generation of Dry/Wet Waste

B- Over 200 ULBs have claimed that they have reduced their municipal waste by an average of ~10%

C- 277 ULBs have taken a 1,700+ initiatives in total (and around 6 initiatives per ULB as average) to reduce municipal waste

D- Some of the initiatives taken by the ULBs on 3R principles are: ban on single-use plastic, home composting, bartan banks, cloth banks, extensive IEC activities (such as rallies, meetings, workshops, campaigns) and involvement of SHGs and RWAs, converting leaves into disposables, distribution of cloth-bags, "neki ki diwar", etc.

Number of Home Composting Units

The State has been actively promoting home composting in order to move towards Waste Reduction at source, The number of households practicing home composing have increased from 2,14,518 households to 2,60,252. This excludes households falling under RWA and are qualified as Bulk Waste Generators).

Number of Material Recovery Facilities

As per the latest State MIS, 256 ULBs have 275 Material Recovery Facilities (MRF) facilities that are operational.

A- **Processing of Dry Waste**

As per the latest State MIS, 256 ULBsare processing dry waste through functional facilities.

B- **Processing of Wet Waste**

As per the latest State MIS, 354 ULBsare processing wet waste.

C- **Processing of Plastic Waste**

As per the latest State MIS, 256 ULBsprocess their plastic waste.

D- **Processing of Domestic Hazardous Waste**

The 316 ULBs have started collecting domestic hazardous waste. The processing and disposal of domestic hazardous waste is being done through installation of incinerators by ULBs and / or by having tie ups with agencies that process domestic hazardous waste. 263 ULBs have started processing domestic hazardous waste (Sanitary Napkins, Pads).

Informal waste collectors been integrated in solid waste management system

As per the latest MIS for the month of December - 2019, 279 ULBs have integrated 4,217 waste pickers in solid waste management system. They have been provided source of livelihood through this integration.

Status of Model Cities and Towns in the State in the first phase which can be replicatedlater for other cities and towns of the State.

The Model cities have been working towards end to end implementation of solid waste management as per the SWM Rules 2016 and have set up facilities and infrastructure to meet the needs of the city.

a) INDORE-The population of Indore is above 25 Lakhs and it has been declared asthe cleanest city of India for four years in a row i.e. 2017 to 2020. The State has identified Indore as the model city for cities having the population of above 5 lakhs. As per recently declared results by MoHUA for 'Garbage Free City Star Rating Protocol', Indore has been awarded 5-Star Rating and is among the 6 other cities that are declared as 5 Star Cities in India. This is the second time in a row that Indore has been awarded 5-Star for its achievements in Sanitation, hygiene and Solid Waste Management. Last year Indore was the first and only city in India to receive 5 Star City.

b) KHARGONE-The population of Khargone is between 1 to 10 Lakhs and it has beendeclared as the 5th cleanest city in India in the 1-10 lakh population category in Swachh Survekshan 2020. The State has identified Khargone as the model city for cities having the population between 1 to 10 Lakhs. Khargone has been awarded 3-Star Rating under Garbage Free City Star Rating Protocol. Khargone has retained its 3-Star Rating for the second time in a row.

c) SHAHGANJ-Shahganj has been declared as the 20thcleanest city in less than 1 Lakhpopulation category of Swachh Survekshan 2020. The State has identified Shahganj as the model city for cities having the population below 1 Lakhs. Shahganj has been awarded 1-Star Rating under Garbage Free City Star Rating Protocol.

The State has identified the following 27 cities/town in different population categories to make them fully compliant to environmental norms.

Characteristics of Municipal Solid Waste in India Urban Centres

National Environmental Engineering Research Institute (NEERI) has carried out extensive studieson characterization of solid waste from 43 cities during 1970-1994. The average characteristics have been presented in Table1 and Table 2 . The paper content generally vares between

2.9 to 6.5% and increases with the increase in population. The plastics, rubber and leather contents are lower than the paper content, and do not exceed 1% except in metropolitan cities. The metal content is also low, viz. less than 1%. The low values are essentially due to the large scale recycling of these constituents. During a study in Bombay (1993-94), samples were collected both at the source as well as disposal sites to ascertain the extent of recycling. The paper is recycled on a priority basis while the plastics and glass are recycled to a lesser extent. The biodegradable fraction is quite high, essentially due to the habit of using fresh vegetables in India. The high biodegradable fractions also warrants frequent collection and removal of solid waste from the collection points. The ash and fine earth content of Indian municipal solid waste is high due to the practice of inclusion of the street sweepings, drain silt, and construction and demolition debris in municipal solid waste. The proportion of ash and fine earth reduces with increase in population due to improvements in the road surfaces. Percentage of inert material increases with the increase in population may be due to fast than construction and demolition waste find its way into the municipal solid waste disposal stream. High ash and earth content increases the densities of municipal solid waste which are between 350 and 550 kg/m^3 in Indian cities.

The chemical characteristics indicate that the organic content of the samples on a dry weight basis ranges between 20 to 40%. The nitrogen, phosphorus and potassium content of the municipal solid waste ranges between 0.5 to 07%, 0.5 to 0.8% and 0.5 to 0.8% respectiverly. The calorific value ranges between 800-1000 kcal/kg. Knowledge of the chemical characteristics is essential in selecting and designing the waste processing and disposal facilities.

Ragpickers are observed to be more active in bagger cities. They prefer to remove paper, plastics, rags and packaging and such other material, which is light and also have a high calorific value. The remaining waste hence tends to have a higher inert content and a lower calorific value.

The demolition activity is observed to increase with populations leading to increased inert content and reduced organic content in MSW.

Table 1 Physical Characteristics of Municipal Solid Wastes in Indian Cities

Population Range (in Million)	**Number of Cities Surveyed**	**Paper**	**Rubber, Leather and synthetics**	**Glass**	**Metals**	**Total compostable matter**	**Inert**
0.1 to 0.5	12	2.91	0.78	0.56	0.33	44.57	43.59
0.5 to 1.0	15	2.95	0.73	0.35	0.32	40.04	48.38
1.0 to 2.0	9	4.71	0.71	0.46	0.49	38.95	44.73
2.0 to 5.0	3	3.18	0.48	0.48	0.59	56.67	49.07
>5	4	6.43	0.28	0.94	0.80	30.84	53.90

All values in table 1 are in percent, and are calculated on net weight basis

Source : Background material for Manual on SWM, NEERI, 1996

Table 2 Chemical Characteristics of Municipal Solid Wastes in Indian Cities

Population range (in millions)	**No. of Cities surveyed**	**Moisture %**	**Organic Matter %**	**Nitrogen as total Nitrogen %**	**Phosphorous as P_2O_5 %**	**Potassium as K_2O %**	**C/N Ratio**	**Calorific value* in kcal/kg**
0.1 to 0.5	**12**	**25.81**	**37.09**	**0.71**	**0.63**	**0.83**	**30.94**	**1009.89**
0.5 to 1.0	**15**	**19.52**	**25.14**	**0.66**	**0.56**	**0.69**	**21.13**	**900.61**
1.0 to 2.0	**9**	**26.98**	**26.89**	**0.64**	**0.82**	**0.72**	**23.68**	**980.05**
2.0 to 5.0	**3**	**21.03**	**25.60**	**0.56**	**0.69**	**0.78**	**22.45**	**907.18**
>5.0	**4**	**38.72**	**39.07**	**0.56**	**0.52**	**0.52**	**30.11**	**800.70**

All values, except moisture, are on dry weight basis.

***Calorific value on dry weigh basis**

Source : Background material for manual on SWM, NEERI, 1996.

Per Capita Quantity of Municipal Solid waste in India Urban Centres

The quantity of waste from various cities was accurately measured by NEERI. On the basis of quantity transported per trip and the number of trips made per day the daily quantity was determined. The quantity of waste produced is lesser than that in developed countries and is normally observed to vary between 0.2-0.6 kg/capita/day. Value upto 0.6kg/capita/day are observed in metropolitan cities (Table 3). The total waste generation in urban areas in the country is estimated to be around 38 million tones per annum.

Forecasting waste quantities in the future is as difficult as it is in predicting changes of waste composition. The factors promoting change in waste composition are equally relevant to changes in waste generation. An additional point, worthy of note, is the change of density of the waste generation. An additional point, worthy of note, is the change of density of the waste as the waste moves through the management system, from the source of generation to the point of ultimate disposal. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste density. As a general rule, the lower the level of economic development, the greater the change between generation and disposal. Increases in density of 100% are common in developing countries, which mean that the volume of wastes decreases by half.

Table : Quantity of Municipal Solid Waste in Indian Urban Centres

Populations Range (in million)	**Number of Urban Centres (sampled)**	**Total Population (in million)**	**Average per capita value (kg/capita/day)**	**Quantity (tones/day)**
<0.1	**328**	**68.300**	**0.21**	**14343.00**
0.1 to 0.5	**255**	**56.914**	**0.21**	**11952.00**
0.5 to 1.0	**31**	**21.729**	**0.25**	**5432.00**
1.0 to 2.0	**14**	**17.184**	**0.27**	**4640.00**
2.0 to 5.0	**6**	**20.597**	**0.35**	**7209.00**
>5.0	**3**	**26.306**	**0.50**	**13153.00**

*** 0.6 kg/capita/day generation of MSW observed in metro cities**
Source : Background material for manual on SWM. NEERI 1996

Estimation of Future Per Capita Waste Quantity

For purposes of project identification, where an indication of service level must be estimated and data from the project preparation state have not yet been developed, the following municipal refuse generation rates are suggested.

Residential refuse : 0.3 to 0.6 kg/cap/day
Commercial refuse : 0.1 to 0.2 kg/cap/day
Street sweepings : 0.05 to 0.2 kg/cap/day
Institutional refuse : 0.05 to 0.2 kg/cap/day

If industrial solid waste is included in municipal refuse for collection and/or disposal purposes, from 0.1 to 1.0 kg/cap/day may be added at the appropriate step where the municipality must estimate service delivery requirements. These generation rates are subject to considerable site-specific factors and are required be supported by field data.

II. CONCLUSION

The composition and characteristics of municipal solid wastes vary throughout the world. Even in the same country it changes from place to place as it depends on number of factors such as social customs, standard of living, geographical location, climate etc. MSW is heterogeneous in nature and consists of a number of different materials derived from various types of activities. Even then it is worthwhile to make some general observation to obtain some useful conclusions. 1. The major constituents are paper and putrescible organic matter 2. Metal, glass, ceramics, plastics, textiles, dirt and wood ae generally present although not always so, the relative proportions depending on local factors 3. The average proportion of constituents reaching a disposal site (S) for a particular urban area changes in long term although there may be significant seasonal variations within a year. For these reasons an analysis of the composition of solid waste, for rich and poor countries alike, is expressed in terms of a limited number of constituents. It is useful in illustrating the variations from one uroan center to another and from country to country.

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