International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 7, July - 2014

Municipal Solid Waste Collection and Disposal in Bengaluru City –A Review

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***Abstract*--Be**ngaluru city has identified many disposal sites for the scientific disposal of municipal solid waste generated in its jurisdiction. On an average, 5000tons of municipal solid waste is generated per day. Since source segregation is not done by the people, not strictly made mandatory by the authorities, and no proper logistics arrangement for the separate collection of different kinds of municipal solid waste, mixed waste is reaching the processing/landfill sites, thereby seriously affecting the efficiency of processing plants, and about 23.5lakh tons of mixed solid waste indiscriminately dumped at supposedly called processing and landfill sites, leading to the early closure of many landfill/processing plants. This paper reviews the present collection system in connection with the status of the waste processing/landfill site and also reviews and concise the research papers findings on the effect of the existing processing /landfill sites on the environmental attributes.

Keywords— Bengaluru, Disposal sites, Municipal solid waste, Review, Waste collection.

I. INTRODUCTION

Municipal solid waste management is one among the obligatory responsibilities of the city corporations as per the Municipal Corporation Act, 1976 [1]. The Solid Waste Management rules, 2000 by the Supreme Court of India mandates scientific handling of municipal solid waste from generation to final disposal [2]. The definition of municipal solid waste differs to each state based on the Municipal Solid Waste State Policy. The municipal solid waste management in Bengaluru comprises of managing the solid waste generated from residential houses except the human excreta, solid waste generated from commercial establishments, parks, playgrounds, institutions, religious places, slaughter houses, medical facilities, public litter bins, from bulk generators such as hotels, restaurants, markets and apartments, maintaining cleanliness of the streets (also includes vegetation removal along roadside) and storm water drains (areas where Under Ground Drainage still not provided), animal carcasses management, maintaining cleanliness in bus shelters, burial grounds, and open space in front of Corporation offices [3]. On an average Bengaluru generates 5000Tons of Municipal Solid waste, from all the sources mentioned in the previous paragraph. The different kinds of waste generated from the above sources is categorized as bio-degradable organic waste, non-biodegradable organic waste (slow degradable), recyclable dry waste, non-recyclable dry waste (rejects), household bio-medical waste, household hazardous waste, commercial hazardous waste, dust and silt from street sweepings, silt and clogged materials from drain cleanings, leaf litter and garden trimmings from parks and streets, and animal carcasses.

The objectives of the present study are

1) To review the waste collection system adopted for different kinds of municipal solid waste, and
2) To review the status of waste disposal site.

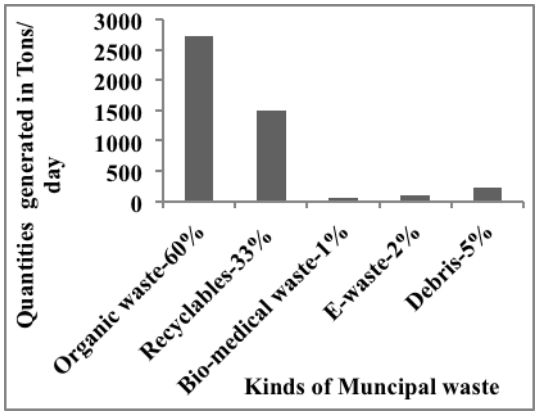
II. MATERIALS AND METHODS

To objectives of the present study are achieved by visiting some of the wards to know about the waste collection system, field visits to the disposal sites /recycling centers to review the status. The published and unpublished research work on environmental impact studies pertaining to these disposal sites were reviewed. Also, insight into the prevailing scenario was obtained by conducting structured and semi-structured interviews/discussions with the solid waste experts, and waste managers.

III. LITERATURE REVIEW

Bengaluru city generates around 5000tons of municipal solid waste. The break up for different categories of municipal waste as projected by the Bengaluru Corporation is depicted in *Fig.1*.

Fig.1: Quantities of Municipal solid waste generation in Bengaluru



The various sources generating organic waste can be broadly categorized into bulk waste generators and individual generators. Individual generators include all individual houses, and bulk waste generators include marriage halls, markets, hotels and restaurants, hostels, apartments, bus stands, railway stations, airports and temples. The Karnataka state pollution control board has issued circular mandating big educational institutions/big campuses to manage the waste inside their premises and has also directed to establish landfill site in the campus with a design period of 5-10years [5]. The Bengaluru Corporation has issued circular mandating bulk waste generators (units producing more than 100kg wet waste per day) to manage the organic waste inside the premises, wherever space constraint does not exist. Otherwise, can handover the organic waste on payment basis to the corporation waste collectors or make their own arrangements to manage wet waste [6]. In view of the above mandates and voluntary initiatives, some of the hotels are diverting their waste to biogas plants established by private parties outskirts the city, a 5 TPD biogas pilot plant is established by the corporation to manage market waste, a 5 TPD biogas plant is established by a private-government initiative at Yelahanka zone to manage bulk organic waste from hotels, many resident welfare associations have established decentralized composting plants, many apartments have decentralized composting plants and many individual house owners are practicing household waste management using daily dump earthen pot /manthans and many educational institutions have established decentralized composting plants. The overall effort in diverting the organic waste from reaching the landfill site accounts to just 25-30 TPD. The rest of the waste is reaching waste processing center/landfill sites located outskirts the city.

Dry waste comprises the recyclable and non-recyclables dry waste, household and commercial hazardous waste, biomedical waste. Bangalore Corporation has established 15 dry waste collection centers with the objective of collecting the dry waste (both recyclables and non-recyclables) where secondary segregation is done and rejects are sent to the landfill sites. Also, there are around 150 informal dry waste collection centers collecting only recyclables having high economic returns. The collective effort by both formal and informal recycling centers is able to divert about 200tons of recyclables reaching the landfill site. Since, there does not exist any separate collection vehicle as well as separate collection schedule and segregation of waste at source is not strictly adhered to by the waste generators, mixed waste consisting of both organic and recyclables, reach landfill/processing centers. In Bengaluru there are about 30 lakh households, waste collection efficiency projected by the authority is about 80% i.e., from 24lakh households waste is collected everyday. Lets say, out of 24 lakh households, some 80% of the households handover the organic waste in plastic covers, then it results in about 1,92,000 plastic covers reaching the disposal site along with organic waste; affecting the efficiency of both compost plant and the recycling activity.

The dry waste also consists of household hazardous wastes such as toilet cleaners, paint box, tube-lights, CFL bulbs, mosquito coils, cosmetics, razor blade, expired medicines and medicine bottles etc. and commercial hazardous waste such as cosmetics from beauty parlors and hair salons, expired medicines from medical facilities. Since these kinds of hazardous waste are collected along with the dry waste, poses danger to the waste recyclers. Since for the collection of municipal hazardous waste, a separate collection system does not exist they reach municipal landfill sites as rejects along with non-recyclable dry waste. The non-recyclable dry waste consists of styro foam, rags, thermo coal, soiled paper, already recycled materials etc.

Municipal bio-medical waste comprises of diapers and sanitary napkins from residences, hostels, big shopping malls etc. there did not exist and does not exist any management system to handle the same. As per the directions from the Corporation in 2012-13, it has to be wrapped in newspaper and should be handed over to the bio-medical waste collector who in turn manages it by incineration. In the present system of waste collection, only in some apartments, hostels and big shopping malls, it is handed over to the bio-medical waste collector. Since bio-medical waste collection is on payment basis, no such agreement exists between the Corporation and the bio-medical waste collector, absolutely there does not exist any control over this in the bio-medical waste collection from individual houses. It reaches the waste processing/landfill sites along with other wastes, obviously contaminating all the other types of wastes.

The street cleanings and small storm water drain cleanings are a part of municipal solid waste management for Bengaluru Corporation. Presently, the waste obtained during such cleanings are mixed with the other kind of waste and sent to landfill/processing centers. The research findings by the Central Pollution Control Board in 2006, indicate, the presence of heavy metals in the roadside waste samples of Bengaluru. The concentration of Pb was in the range of 245-506mg/l, Ni- 49 to 120mg/l, Cd- 4 to 17.81mg/l, Cu- 14-544mg/l, Zn 341-648mg.l, Mn- 21-152mg.l, and Fe- 1967 to 22888mg/l [7]; since this gets mixed up with the organic waste, the heavy metal concentration in the final compost will be high. To ensure the heavy metals concentration within limits, the street sweepings and drain cleanings should not be mixed with the organic waste. The collected waste reaches the waste processing centers/landfill sites, the details of the disposal sites in Bengaluru presently receiving municipal solid waste are detailed in *Table. I.*

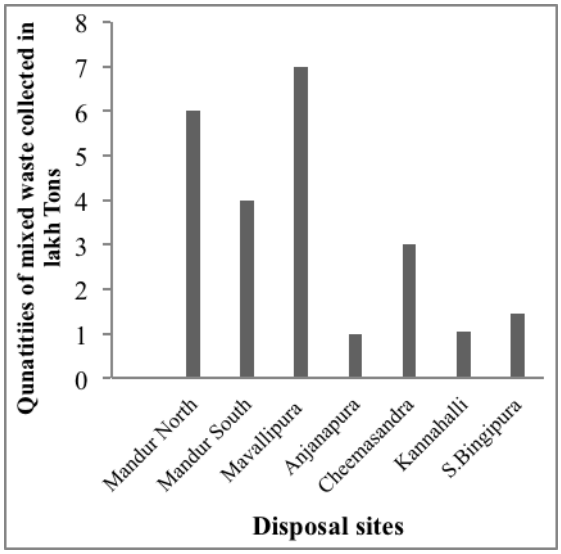
TABLE 1: WASTE PROCESSING/LANDFILL SITES IN BENGALURU

Waste Processing/ Landfill sites	Area in Acres	Capacity of waste received in Tons/ Day	Waste management methodology followed at present	
			Processing methodology	*Land-filling*
Mandur North	95	750	Mixed waste dumped	BBMP
Mandur South	135	1500	1500 tons of Mixed waste dumped	Nil
Mavallipura	100	Nil	Closed	Closed
Anjanapura	5	Nil	Mixed waste dumped	Closed
Cheemasandra	10	Nil	Mixed waste dumped	Closed
Kannahalli	25	Nil	Mixed waste is dumped	Closed
S.Bingipura	20	600	Mixed waste dumped and covered with soil	BBMP
Doddaballapura	90.7	300	Mixed waste converted to compost by aerobic Composting; biomethanation using leachate	Land Filling Not Practiced
KCDC – *Haralakunte*	15.1	300	Mixed waste converted to compost by aerobic Composting; Vermi composting	Land Filling Not Practiced

The waste processing and landfill sites are filled with mixed waste since source segregation is not practiced as well as due to the non-existence of the Separate - collection system.

Many sites identified for waste disposal is closed since people from the surrounding areas started agitating due to bad odors, polluted ground waters, mosquito menace and due to the increase of health effects. The data on the quantities of mixed solid waste accumulated over the years in the Municipal solid waste disposal sites of Bengaluru are depicted in *Fig.2*.

Fig.2: Mixed solid waste accumulated over the years at disposal sites in Bengaluru.



Many researchers have studied the characteristics of leachate and the quality of ground water near the dumpsites of Bengaluru, which are concised and presented in *Table. 2* and *Table. 3* respectively. From the data, it is evident that the leachate quality is not conforming to the standards of MoEF, hence necessitates the need for efficient leachate treatment plant, which is non-existent in the dumpsites of Bengaluru

TABLE 2: LEACHATE CHARACTERISTICS OF DUMPSITES OF BENGALURU.

Parameters (mg/l)	MoEF, 2000 Norms [2]	Prathiba, et al., 2009-10 pre-monsoon [9]	Prathiba, et al., 2009-10 post-monsoon [9]	B.P. Naveen, et al., 2013 [10]	G.Venkata - ramaiah, et al., 2014 [11]
T0C.	-	30.72-31.5	23.85-29.1	29	30.3
pH	5.5-9	7.27-8.355	7.37-8.675	7.6	11.5
TDS	2100	6183-12364	4874-9392	1935	9700
EC	-	9988-19876	8210-14467	3870	18700
Cl	100	1700-3900	1300-3150	7800	882.5
BOD	30	730-1780	560-1240	1500	-
COD	250	1467-3600	1147-2933	10400	-
TKN	100	244-420	208-294	-	-
AN	50	165-375	120-263	-	-
F	2	0.2-0.55	0.1-0.35	-	-
Zn	5	0.961-3.319	0.585-2.935	3	-
Ni	3	0.263-3.720	0.116-2.050	1.339	-
Cu	3	0.104-4.777	0.069-2.468	0.151	-
Pb	0.1	0.191-0.408	0.133-0.362	0.3	-
Cr	2	0.076-1.512	0.057-0.970	0.021	-
Cd	2	0.144-0.198	0.090-0.160	0.035	-
BOD/ COD	0.12	0.41-0.5	0.33-0.53	-	-
SO_4^{2-}	-	264-309	233-250	4	198.4
HCO_3^{2-}	-	2135-4270	1647-2623	-	-
NO_3	-	31-78	21-60	-	297

PO_4	-	2.007-3.865	1.243-2.446	-	2.15
Ca^{2+}	-	380-1010	340-708	400	510
Mg^{2+}	-	195-482	157-343	2916	770
Na	-	1066-1545	807-1260	3710	300
K	-	268-718	207-534	1672	-
Fe	-	11.896-91.22	8.735-56.42	11.16	1.7
Turbi-dity	-	-	-	100	27.08
TH	-	-	-	13000	1280
TA	-	-	-	11200	1050

EC-µmhos/cm; Turbidity-NTU; TKN-Kjeldhal N2
AN-Ammoniacal N2; TA-Total alkalinity;
TH-Total hardness: TDS-Total Dissolved Solids

TABLE-3: GROUND WATER/SURFACE WATER QUALITY NEAR DUMPSITES OF BENGALURU

Parameters (mg/l)	Lakshmikantha,H 2006 [12]	.Venkataramaiah,G et al., 2014 [11]	Naveen, B.P., et al., 2013[10]	Dept.of Mines & Geology, 2013 [13]	Sruthi Subbanna, et al., 2010 [14]
Ca	100-300	132-223	0	224	<75
TH	100-1300	205-368	1500	980	<250
Mg	30-180	73-145	364.5	105	<40
HCO_3^{2-}	200-400	-	-	408	<320
SO_4^{2-}	50-300	-	10	117	<60
Cl	200-800	-	250	308	<110
NO_3	25-120	-		260	<45
K	5-25	-	1078	3	<15
pH	7.5-8.5	7.6-8.8	8.1	7.06	6.5-7.0
Na	40-110	-	1676	50	<45
F	0.1-0.2	0.4-0.6		0.289	0.3
EC	-	533-917	2500	2200	-
Turbidity	-	1-1.7	440		-
TDS	-	320-641.9	1250	1300	<500
TA	-	217-255	2000	-	-
DO	-	0.3-2.6	2.7	-	-
BOD	-	0.4-3.1	105	-	<32
Fe	-	0.01-0.04	0.16	0.079	<0.46
MPN/ 100ml	-	-	-		23-1600

IV. CONCLUSION

- The increased rate of waste generation in Bengaluru is an indicator of the increasing economy level of the people.
- Municipal organic waste can be a reliable source of organic manure, if proper scientific management is adopted.
- Logistics arrangement should be made for separate collection of different kinds of solid waste especially, household hazardous waste and municipal biomedical waste, from generation to final disposal.
- All possible scientific methods of decentralizing the bulk waste should be attempted, thereby diverting much of the solid waste reaching the landfills.
- There is a requirement to establish more dry waste collection centers for enhancing the recycling efficiency.
- The waste collected from drain cleaning and street sweeping should not be mixed with organic waste to maintain the quality of the organic manure.
- The BOD to COD ratio of the leachate indicates that the landfills are medium to old aged between i.e.,5-10 years old.
- The concentration of most of the physic—chemical parameters in leachate sample exceeds the normative standards of MoEF, hence necessitates site specific effluent treatment plants.
- The higher concentration of Mg is an indicator of presence of algal growth.
- The ground water quality indicates that the parameters such as Ca, TH, Mg and NO_3, TDS, MPN are all exceeding in comparison with the BIS 10500-1991, drinking water standards, which may be due to the seepage of leachate into underground source.

We can conclude that unscientific waste management scenario persists in Bengaluru, which is evident from the quality of ground water in nearby water sources and by looking to the data on the mixed waste accumulated in the dumpsites. The reasons for this pathetic condition are many, but the collection system plays a major role in deciding the fate of the disposal sites. Therefore, good logistics management, for the collection of waste, is the need of the hour. Also, the mixed solid wastes at the disposal sites have to be cleared by either Bio-mining or Waste to Energy technologies and the sites should be recovered for future usages.

V. REFERENCES

[1] Karnataka Municipal Corporations Act, 1976 available at http://dpal.kar.nic.in/pdf_files/14%20of%201977%20(E). pdf.
[2] Ministry of Environment and Forests (MoEF), Solid Waste (management and handling) Rules, 2000, Government of India. http://www.tidco.com/india_policies/environment_policies/municipal_solid_wastes.asp.
[3] BBMP, Request For Proposal, available at, http://218.248.45.169/download/engineering/tender1.pdf.
[4] BBMP, Solid Waste Details, available at http://218.248.45.169/download/health/swm.pdf.
[5] http://kspcb.kar.nic.in/big%20campuses.pdf.
[6] http://218.248.45.169/download/engineering/SWM%20PublicNotifn (Bulk%20Genr). pdf.
[7] Central Pollution Control Board, MoEF, Characterization of MSW compost and its application in agriculture, Control of Pollution Series: CUPS/59/2005-06.
[8] BBMP, Evaluation of Technology for processing existing waste at seven landfill sites of BBMP, Bangalore, 2013, available at http://218.248.45.169/download/swm/eoi.pdf.
[9] Prathiba D'Souza, Somashekhar, R.K., Assessment of Stabilization, Temporal variation and leachate contamination potential of municipal solid waste dumpsites in Bangalore, Intl. Journal of Environmental Protection, Vol.3, Iss1, pp28-35, 2013.
[10] Naveen, B.P.,Sharma, A.K., Shivapullaiah, P.V., Sitharam, T.G., and Ashwath Narayana, M.S., Characteristics of the leachate from MSW landfill, Bangalore, Geosynthetics India, 2013.
[11] Venkataramaiah, G., Krishnaiah, S., Maya Naik, Shankara, Leachate characterization and Assessment of ground water pollution near MSW landfill dumpsite of Mavallipura, Bangalore, Intl. Journal of Engineering Research and applications, ISSN 2248:9622, Vol.4, Issue 1(version 2), pp 267-271, 2014.
[12] Lakshmikantha, H., Report on waste dumpsites around Bangalore, Waste Management & Research, 26(6): 640-50, 2006.

[13] Department of Mines & Geology, Ground water quality data for the borewell -Id 010308, Mandur Village, 25/5/2013.
[14] Sruthi Subbanna, Bhargavi, S. Rao., and Mallesh, K.R., Bangalore's Toxic Legacy-Investigating Mavallipura's Illegal landfills, Environmental Support Group, July, 2010.