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MUNICIPAL SOLID WASTE GENERATION, PROCESS AND PRESENT ASSOCIATE PROBLEMS IN THE URBAN CENTERS OF GADA DISTRICT, KARNATAKA

Dr.L.T.Nayak
Associate Professor & Research Guide
Karnatak Science College, Dharwad
Email: nayaklt68@gmail.com

Mr.B.R.Jarakunti
Assistant Professor
Dept. of Geography
KLE Society's HK Arts College and HSK Science Institute, Hubballi
Email: gbrjarakunti87@gmail.com

ABSTRACT

*Rapid growth of urbanization, standard of living and per capita income lead to high rate of municipal solid waste generation, and unscientific handling of MSW degrades the urban environment and causes health hazards. In recent times E-waste and plastic waste also contributing remarkably to waste stream due to utilization of electric and other items. In this paper an attempt is made to examine major parameters of **MSWM** like trends of population, solid waste per capita generation, growth and associate problems of urban centers in Gadag district, in addition to this its process, management and present problems and characteristics of MSWM are also examined. The present study is based on secondary data gathered from Urban Development Authority (UDA), city municipal council, town municipal councils and town panchayats of the urban local bodies of the respective urban centers. The urban population has increased from 2, 97,957 in 1991 to 3, 79,309 in 2011, at the same time the generation of solid waste has also increased to 14,972 kg per day in 2011 from 10,674 kg. per day in 1991. During 1991, the average per capita waste generation was 35.82 grams per person/day, whereas in 2011 it has increased to 39.47 grams. It is noticed that the solid waste generation is growing with the rapid growth of urban population. In fact, the study area per capita generation of waste is significantly lower than the India's average i.e., 400g per capita.*

Key Words: *Solid waste, Management, MSW, Per capita, urbanization, biodegradable, population, MSWM.*

INTRODUCTION

The term solid waste is used to determine the non-liquid waste materials which are generating from the domestic, trade and commerce, industries, public services and agricultural activities. It is a combination of different heterogeneous waste materials in India, and also known as garbage, refuse, rubbish or trash. India is a land of rural society where more than 67 per cent of people residing and directly or indirectly depends on agriculture sector. But this agrarian society is gradually shifting towards industrial and services-oriented society. More than 377 million people are living in 7,935 towns/cities which account 31.2 per cent of India's total population (World Bank, 2018). India has significant progressed social, economic and environmental areas but urban solid waste management systems have remained relatively unchanged. The urban centers are the main generator of urban solid waste. The Indian urban centers main sources for major urban components namely organic matter 51 per cent, recyclables 17.5 per cent and rest of 31 per cent is in active waste. Economic development, urbanization and improved living standard in cities enhance the quantity and complexity of solid waste (Gidde M. R, Todkar, V.V and

Kokate K.K.2008 & S.Rathi, 2007). Most of the urban centers growths in India are unplanned and over population thee net result is enormous generation of solid waste. The objectives of solid waste management are to control, collect, process, utilize and dispose of solid wastes in such an economical way which protects health of human being and natural environment and the objectives of those served by the system. In this regard, in 1989, the U.S. Environmental Protection Agency (U.S. EPA) adopted hierarchy of waste management practices (Henry & Heinke, 2008). The elements of hierarchy are: Source reduction, recycling of materials, Combustion, Land filling, In India, initially there has not been much awareness about solid waste management and its hierarchy. However, since last few years, the scenario of solid waste management has been changing continuously.

STUDY AREA

Gadag District is located in the Northern part of the state of Karnataka, India. The district was formed in 1997, when it was split from the Dharwad district. The district lies between 14˚ 57' to 15˚ 52' North Latitudes and 75˚ 05' to 75˚ 56' East Longitudes. The total area of the district is 4656 square kilometers. Gadag district is surrounded by Bagalkot district on North Koppal district on East, Bellary district on South, Haveri district on Southeast, the Dharwad district on West, and Belagavi district on the Northwest. Gadag district has nine urban centers namely, Gadag – Betageri (district head quarter), Gajedragarh, Lakshmeshwar, Mundargi, Mulgund, Naregal, Naragund, Ron and Shirahatti. In the Northern side the Malaprabha river forming the natural boundary between Gadag and Bagalkot districts about 25 kilometers. In Southern side of the district, river Tungabhadra forms the boundary between Gadag and Bellary districts about 20 kilometers. The two rivers bounded the region and flows from West to East direction. According to 2011 census Gadag district consists of 9 towns and 337 villages with a population of 10,65,235 of which 3,79,309 (35.63%) are Urban and 6,85,267 (64.37%) are Rural. The total area of urban centers is 360.45 square kilometer and population density of the area under study is 1052, sex ratio 967 and a lite racy rate is 65.64 percent

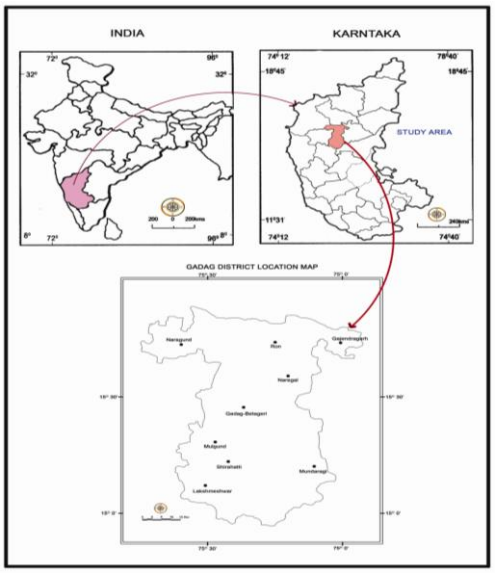

Fig.1

OBJECTIVES

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The main objectives of the present investigation are:

1. To examine the trends of population, municipal solid waste per capita generation and growth and associate problems of urban centers in Gadag District
2. To study the various factors influencing the generation of solid waste, process and different facets of waste management.
3. To evaluate the physical and chemical characteristics of urban solid waste.

HYPOTHESIS

To find out the meaningful conclusion in the present study the fallowing hypotheses have been formulated.

1. There exist a positive correlation between growth of urbanization, industrialization and generation of solid waste.
2. The largest areas of urban centers carry highest solid waste generation and vice versa to the smallest areas.

DATA BASE AND METHODOLOGY

The present investigation is base on secondary data collected from collected by visiting the office of Urban Development Authority (UDA), city municipal council, town municipal councils and town panchayats of the urban local bodies of the study area. The temporal variation has been observed for two points of time i.e., **1991 and 2011.** Results have been shown with the help of charts and diagrams to give the precise picture of the theme.

Factors responsible for enhancement of municipal solid waste (MSW) generation: Growth of urbanization and per capita income, industrial development and growth of slums directly lead to high rate of municipal waste generation in the study area. Besides nowadays electronic industries (E- waste) and plastic waste also remarkably contributing to total waste stream owing to huge utilization of electric and plastic items. It is evident that big towns namely Gadag Betgeri and Lxmeshwar generate large quantity of industrial, commercial, construction and demolition Waste like medicine, e-waste, paints, chemicals, and light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, and shoe polish and the like. Whereas small towns such as Mulagund, Naregal, Mundargi and others generate usually generate household waste like Food waste, paper, cardboard, plastics, wood, glass, metals, electronic items and agricultural wastes.

POPULATION AND SOLID WASTE GENERATION

The consequences of rapid growth of population in urban centers are more noticeable in big towns as compare to the small towns. During 1991, the study area has 2, 97,957 urban population, but in 2011 it is increased to 3, 79,309 (Fig.2). Similarly the urban solid waste has also increased many folds. The data collected from the respective urban centers municipal corporation and town panchayats reveals that the generation of solid waste in urban local bodies was 10674 in 2011 and in 2011 it increased to 14,972 kg per day (Table.2 and Fig.3). The city corporation and town panchyats are able to left 13,172 kg ever day leaving 1800 kg left behind which creates unhealthy condition of the towns/ cities. The solid waste generation efficiency of the urban centers in the study area unevenly and varied owing to degree of urbanization, industrial development and commercialization. The population of Gadag Betgeri town was1, 34,051 in 1991 and 1,72,612 in 2011 which counts for 45 per cent and 45.5 percent respectively. All most all the small towns of the study area registered small

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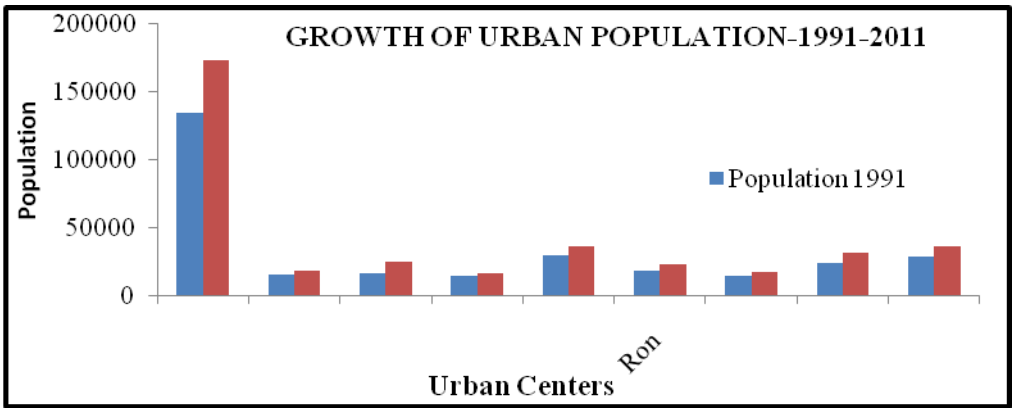
proportion of urban population which results to very low efficiency of waste generation. The average growth percentage of solid waste generation is 40.26. The Gadag-Betageri center generators the highest quantity of waste i.e., 4920 Kg/day in 1991 and in 2011 it increased to7970 Kg/day, growth percentage of solid generation during the study periods i.e., 1991and 2011.This center shows about 62 per cent of growth in waste generation in the study area. Therefore the hypothesis viz., "The big urban centers generate large quantity of solid waste and smallest urban centers generates small amount of waste owing to less urbanization and industrial development.



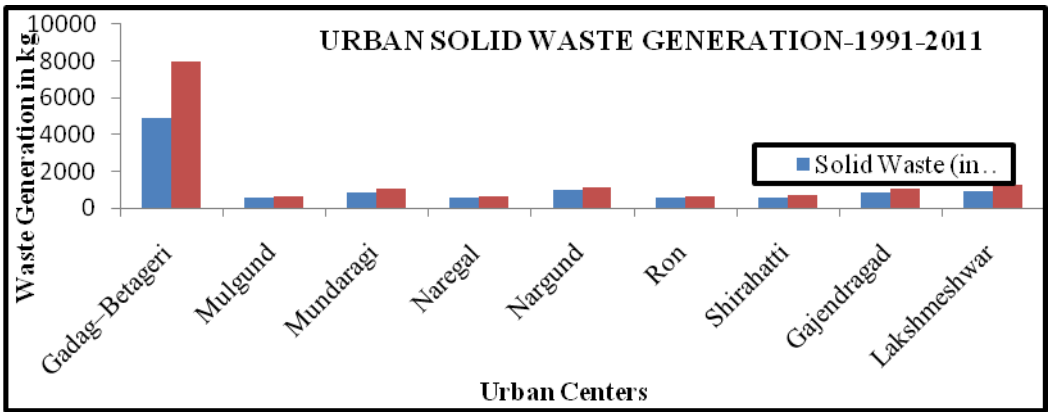


Fig. 2

Table.1: Urban population and Growth of Solid Waste Generation (1991-2011)

SL. No	Urban Centers	Total Population		Solid Waste (in Kg)		Growth of USW
		1991	2011	1991	2011	%
1	Gadag–Betageri	134051	172612	4920	7970	62.00
2	Mulgund	15760	18763	540	630	16.66
3	Mundaragi	16542	24919	850	1070	25.85
4	Naregal	14592	16690	550	609	10.72
5	Nargund	29944	36291	960	1140	18.75
6	Ron	19116	23311	544	620	13.97
7	Shirahatti	14984	17610	580	668	15.17
8	Gajendragad	24184	32359	840	1018	21.19
9	Lakshmeshwar	28784	36754	890	1247	40.11
Total		**297957**	**379309**	**10674**	**14972**	**40.26**

Source: Authors compiled the data collected from CMC, TP and TMC.

Fig.3

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PER CAPITA PER DAY AND ANNUM GENERATION OF SOLID WASTE

The table.2 reveals that per capita solid waste in the urban centers of Gadag district. Per capita waste generation varies between 35 and 40 kg per capita per day depending upon Size of population, standard of living, industrial development growth etc. As per the municipal data municipal solid waste generation in the year 1991 was about 10,674 kg. per day**.** The same has increased to 14,972 kg in 2011 with a growth of 40.22 per cent. During 1991, the average per capita was 35.82 grams per person/day. But in 2011 it has increased to 39.47 grams per person/day. It is noticed that the solid waste generation is growing with the rapid growth of urban population. Gadag-Betageri (36.70 gr. p/day) and Mundaragi (51.38gr. p/day), Naregal (37.69 gr. p/day) and Shirahatti (38.70 gr. p/day) centers generated urban waste above the study area average in 1991 and remaining centers registered below the study area average per capita solid waste whereas in 2011 Gadag-Betageri (46.17gr. p/day) generate highest amount of waste as compare to other centers and Mundaragi (42.93gr. p/day) center is the second largest waste produced center next to Gadag-Betageri. It should be noted that the agricultural waste was more produced in the Mundargi center as it has yet agrarian characters. Remaining seven centers of the district waste generation was below the study region average.

Table.2: Per Capita Solid Waste of Urban Centers in Gadag District (1991-2011)

Sl. No	Urban Centers	1991		2011	
		Solid Waste (in Kg)	P / SW (in grams)	Solid Waste (in Kg)	P / SW (in grams)
1	Gadag–Betageri	4920	36.70	7970	46.17
2	Mulgund	540	34.26	630	33.57
3	Mundaragi	850	51.38	1070	42.93
4	Naregal	550	37.69	609	36.48
5	Nargund	960	32.05	1140	31.41
6	Ron	544	28.45	620	26.59
7	Shirahatti	580	38.70	668	37.93
8	Gajendragad	840	34.73	1018	31.45
9	Lakshmeshwar	890	30.91	1247	33.92
10	**Total**	**10674**	**35.82**	**14972**	**39.47**

Source: CMC, TMC and TP of Gadag

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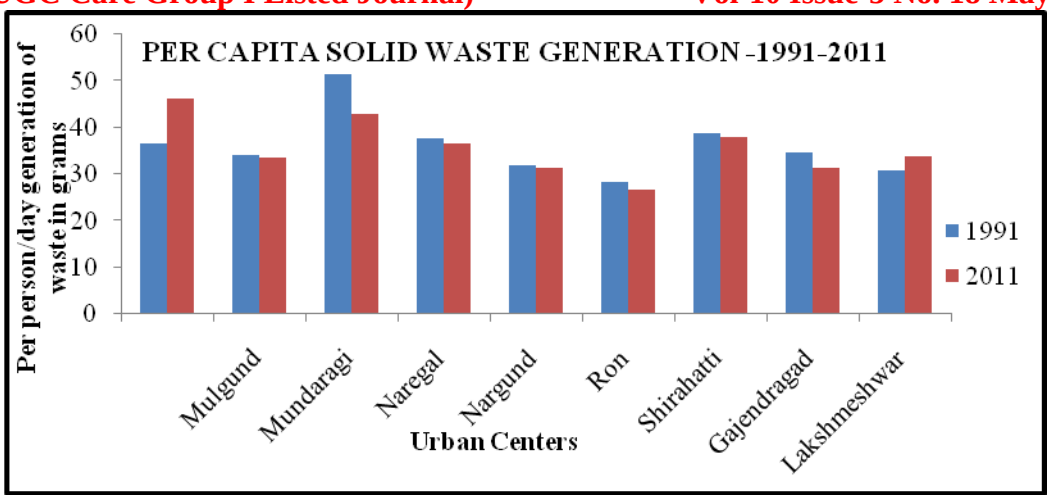

Fig.4

PROCESS AND MANAGEMENT OF SOLID WASTE

Government of India has initiated Municipal Waste Management Rule (2000) and accordingly it is responsibility of the municipal to prevent the littering of solid waste in urban area and local bodies have to arrange door to door collection of waste through one of the methods: 1.Community bin collection 2.Door to Door collection 3.Schedule by using bell ringing of musical vehicles. It is believed that the integration of these methods can increase the collection efficiency. In the study area many local bodies along with certain NGOs having expertise in this sector of Solid Waste Management have initiated efficient waste collection. Garbage is cleaned once in every six, seven days in the area.

The Gadag-Betageri city municipal council occupies the center stage but civil issues and problems which are faced by the inhabitants are continued to remain. In the city the management of the garbage has became a perennial and it is very intense in the core areas i.e. CBT, Central Bustand, Tangakoot, Janata colony, Panchakshari Nagar, Mahaveer Colony and Rahmat Nagar at CBT, Settlement area, Kurahatti Pete, Railway colony, KHDC colony, Hamalara Colony at Betageri. In order to rest of the urban local bodies of the Gadag district including Gadag-Betageri the garbage spilled on the roads during shifting time even after the trucks lifted by corporation or town municipal councils. The people who travel between city centers and their own places complain that they have to face the waste falling on them. The sucking vehicles leave foul smell too much on the way to dump sites of the outside the city centers. Heaps of un cleared waste can be seen scattered in the places i.e. CBT, Central Bustand, Railway stations and colony, settlement area, vegetable and mutton market areas, market yards, hospitals, temples and residential areas. It is important notice that it is a hazardous to the human health of the urban dwellers and can be lead to the spread of many diseases, lack of sufficient number o public toilets and latrines are cause to problems of waste deposition and sanitation in the entire towns / cities. Generally the town/city population and its waste are accelerating the urban centers waste management which is not yet improved. In the present study there are 20 beats in the urban centers, each beat comprised sanitary inspector. Among all nine urban centers there are 25 sanitary macadam and about 450 sweepers are engaging in the work.

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Table.5 reveals 141.97 acre of land is reserved for dumping the solid waste. Out of which 85 acre reserved by Gadag Betageri center. It can be pointed out that small urban centers reserved very small land for dumping the waste as their per capita generation of waste is also very less. As per the directions of the Supreme Court, there should be at least one sweeper for every 1000 persons in the town/cities. Though the study area crossed 3 lakhs population as per 2011 and the number of sweepers are inadequate. The numbers of waste pickers and other related workers have not been increased. It is very difficult to clean the city with existing workers. The sweepers and pickers are irregular and they are attending too late to their jobs otherwise they leave too early from their working places. The instruments which provided for the sweeping and cleaning are fully traditional and not up to date. The study area adopted the following methods of management to collect, segregate, dispose, recycle/ reuse, transportation

Table.3: Solid Waste Management of Urban Centers in Gadag District (2011)

Sl. No	Urban Centers	Total Solid Wate (in Kg)	Un Segregated Waste (in Kg)	Segregated Waste (in Kg)	Disposal Workers	Disposal Vehicles	land fill Area (in Acres)
1	Gadag–Betageri	7970	5470	2500	260	120	85.00
2	Mulgund	630	480	150	20	8	5.30
3	Mundaragi	1070	710	360	35	13	7.27
4	Naregal	609	464	145	15	7	5.00
5	Nargund	1140	790	350	33	15	8.50
6	Ron	620	440	180	20	9	6.20
7	Shirahatti	668	508	160	17	6	5.60
8	Gajendragad	1018	678	340	36	12	8.90
9	Lakshmeshwar	1247	857	390	40	17	10.20
10	**Total**	**14972**	**10397**	**4575**	**476**	**207**	**141.97**

Source: CMC, TMC and TP of Gadag District.

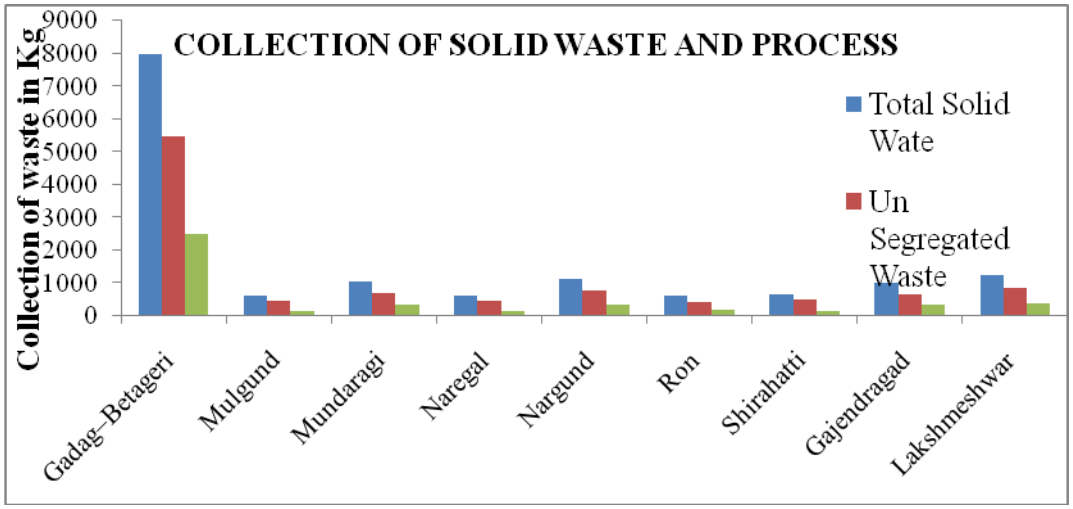

Fig.5

Segregation: The study area badly experienced the unorganized and unscientifically planned segregation of MSW either at household level or at community bin. Sorting of waste is

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mostly accomplished by unorganized sector and seldom practiced by waste producers. Segregation and sorting takes places under very unsafe and hazardous conditions. On a number of occasions, due to improper handling the segregated constituents got mixed up again during transportation and disposal Lack of segregation deprive proper scientific disposal of waste (Singhal & Pandey, 2000).

Collection: Waste produced by houses is usually transferred into communal bins that are fabricated from metal, made from concrete or in combination of both. Street sweepings also find its way to community bins. These community waste bins are also used by other essential commercial sectors in the vicinity of disposal bins along with household waste except where some commercial complexes or industrial units engage municipal authorities for transfer of their waste to disposal site by paying some amount (Kumar et al., 2009).

Reuse/Recycle: This entails activities like collecting those materials from the waste, which could be gainfully retrieved and utilized for making new products. Since un segregated waste is dumped at community bins, its optimal recycling is not possible. However, rag-pickers usually sorted out and took and sell recyclable material like plastics, glass, etc. In Pondicherry, almost all recyclable material is sorted out by rag-pickers and absorbed in material stream through recycling (Patnaik & Reddy, 2010).

Transportation: Modes of transportation for MSWM practiced in India are: bullock carts, hand rickshaws, compactors, trucks, tractor, trailers, and dumpers. In smaller towns trucks having 5–9 ton capacity are used without adequate cover system. Stationary compactors, mobile compactors/closed tempos, and tarpaulin- covered vehicles are used in the transportation of MSW and about 65, 15, and 20% of waste is transported through these compacters, respectively. The maintenance of vehicles used in for transportation of waste is usually done in workshop run by ULBs but most of these workshops can do minor repairs only. No wonder, in the event of breakdown of these vehicles, the overall collection, transportation, and disposal efficiency reduces drastically. Only few transfer stations can be found in some metropolitan e.g. Mumbai (Joseph, 2002).

Disposal: In India, almost every city, town, or village adopted unscientific disposal of MSW. The existing practice and technology availability for MSWM for 59 cities have been indicated in Figure 4 (Kumar et al., 2009). Among these cities, 40 cities have shown increase in waste generation, 7 cities shows reduction, and it was more or less same for 6 cities. Though there was an increase in population during the decade for these cities, no significant reason was indicated by author for reduction as well as equal amount in waste generation for these cities. However, the possible reason for reduction could be that the waste generated could not reach the designated dumping site and was lost in the cities peripherals, outskirts, along the road, low lying area, along the drain, green areas, etc. Data reveal that uncontrolled open dumping is a common feature in almost all cities (Kumar et al., 2009).

PHYSICAL CHARACTERISTICS OF SOLID WASTE

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The four major characteristics are applicable to solid waste management are weight, density, physical and chemical properties. The following categories of waste are generally found in the study area

1. Recyclable such as glass, metal, paper, leather, rubber etc.
2. Compostable materials such as vegetable or fruit waste, kitchen waste, dray grass, mutton, fish waste, dry leaves etc., ranging between 31% and 56%.
3. Inherit materials i.e. construction, demolition, road dust, as etc. which ranging between 40% to 56%.

Table-4: The Physical and Chemical Characteristics of Solid Waste in Urban Centers

SL. No	Physical Characteristics of Solid Waste		Chemical Characteristics of Solid Waste	
	Item	**(%)**	**Item**	**(%)**
1	Paper	5.34	Moisture content	25.05
2	Plastics	1.15	Organic matter	22.21
3	Metals	0.22	Carbon	12.55
4	Glass	0.27	Nitrogen	0.61
5	Ash and fine Curth	35.63	Phosphorus	0.71
6	Compostable Matter	41.22	Potassium	0.73
7	Other	16.17	C/N	20.73
8			Others	17.41
9	**Total**	**100.00**	**Total**	**100.00**

Source: City Corporation.

The table 4 depicts the physical and chemical characteristics of solid waste generated by the urban centers in the study area. The materials like Compostable matter (41.22%), Ash and fine curth (35.63%), other particulates (16.17) and paper (5.34%) contained major part in physical structure. In addition to this, the chemical structure reveals that Moisture content (25.05%), Organic matter (22.21%), C/N (20.73%) and others (17.41%) are consumed above stated percentage.

PRESENT ASSOCIATE PROBLEMS

Unscientific and improper management of solid waste in the study area leads to emerge several problems in the study area. The study area has not systematic and properly adopted and follow the MSWM rules. Local Municipal authorities handling the process and management of waste with inadequate waste collecting labours and other related workers, as per the directions of the Supreme Court, there should be at least one sweeper for every 1000 persons (excluding other workers) in the town/cities but study areas having one sweeper for every 2500 persons. These sweepers and waster pickers are irregular, and they are attending too late and leave too early from their working places. The instruments provided for sweeping and cleaning workers are fully traditional and not updated. Biodegradable wastes from the residential areas (kitchen and garden waste) and from the market wastes (vegetable, mutton and fish) are simply being dumped without changing them into compost (manure). The waste picking points and vehicles engaged in cleaning, transporting and dumping the garbage are insufficient (at present 12 wastes picking points and 207 vehicles).Similarly

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There are 2 solid waste (Garbage) dumping sites, at outskirts of the Gadag-Betageri center and 1 each in the remaining centers which are also inadequate.

There are plenty of technologies available for generating energy and other useful substances from the MSW eco friendly, but 60%- 90% of MSW generated in cities and towns are directly disposed off on or into land in an unsatisfactory manner. Therefore, the management of MSW generated in study area has been found inadequate and challenging. The method of segregation system followed in the study area is unscientific. It is noticed that Out of 14972 collection, only 4575 Kg (45 ton) waste is segregated and remaining 10,397 (103 ton) is directly thrown into dumping sites without segregation or treatment It is observed that more than 75 per cent of diseases come from foul smell, mosquitoes, rats, flies etc., which breading under waste dumped on either side of the roads or gutters in the town/city. The poor people and the people whose the standard of living condition is very low level are engaged in cleaning and shifting the waste collection, rag pickers as well as people residing in garbage dumping stations (Janata colony and Settlement areas in Gadag-Betageri).

The uncontrolled and incomplete combustion of solid waste materials are resulting in release of undesirable pollutants comprising particulate matter, sulphur dioxide etc., several hydrocarbons from burning fires and plastic emit dioxin etc. Most of threaten diseases spread due to the various effluents which caused by the unhygienic disposal and discharges of urban waste. Among them the water born diseases affect the human beings due to biological agents like houseflies which transit bacteria, viruses, and viral hepatitis, typhoid, dysentery, cholera and worm infestations. Such diseases affected the person who's living in Janata colony, settlement area, Rahamat nagar, railway colony as well as very narrow and congested areas of the all urban centers in the study area.

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