Chapter 4

Urban Solid Waste: An Overview

SWM is an urban centric issue which is addressed by both developed and developing countries. Solid waste generation is found to be influenced by factors like production and trade, private consumption, socio-economic factors like income of the household, population, size of the households, level of industrialization, GDP and climate and soft factors such as environmental awareness, legislation or waste management measures etc. (Peter Beigl et al 2003). High income individuals consume more than low income ones, which results in a higher waste generation rate for the former. High income countries generate more than twice the weight of waste percapita when compared with the low-income countries. Generally, the greater the economic prosperity and higher the percentage of urban population, the greater will be the amount of solid waste generation (World Bank, 1999). This chapter outlines the various sources and types of urban solid wastes, a cross country comparison of urban solid waste generation and solid waste in Kerala. In general, the sources of urban waste or Municipal Solid Waste (MSW) are (i) domestic waste (ii) market and commercial waste (iii) street sweeping (iv) industrial waste (v) hospital waste (vi) demolition and building waste and (vii) sewage sludge. (Singdha Chakrabarti, 2005).

4.1 Source and types of urban solid wastes

The table: 4.1 shows the source and types of urban solid wastes

Table:4.1 Source and types of solid wastes

Source	Typical waste generation	Types of Solid Waste
Residential	Single and Multi family dwellings.	Food wastes, paper, cardboard, plastics, leather, yard wastes, wood, glass, metals, ash, special wastes (bulky items, consumer electronics, batteries, tyers) and household hazardous wastes.
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping wastes, packaging food wastes, construction and demolition materials, hazardous wastes, ashes and special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings**.**	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Institutional	Schools, hospitals, prisons, government offices.	-do-
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings.	Wood, steel, concrete, dirt.etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and waste water plants.	Street sweepings landscape and tree trimmings, general wastes fro parks, beaches and other public places, sludge.
Process	Heavy and light manufacturing refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, office specification products, slag.
Agriculture	Crops, orchads, vineyards, dairies, farms.	Spoiled food wastes, agriculture wastes, hazardous wastes (pesticides.etc.)

Source: Hoornweg (1999**)**

The given table helps us to understand the different types of solid waste that is generated in an urban area by various sectors. It shows the various sources and types of solid waste generated in an urban area.

Developing countries have solid waste problems different than those found in fully industrialized countries as the waste generation rates and the composition of their waste is different than that of developed nations. The waste generated tends to go up as income increases. First World cities have higher waste generation rates than Third World cities. In the U.S., cities can have waste generation rates of over 1.2 Kg / person / day, while the residents of some African cities generate less than 200 gr. / person / day. A positive relationship also tends to exist between income and waste generation rates within each city, in Mexico City, for example, low-income households generate 2.6 Kg. a day, middle-income households produce 2.7 Kg. a day, and upper-income households, 3.7 Kg. a day (Salazar J,1995).

Cointreau (1982), Blight and Mbande (1996), Arlosoroff (1982), have noted several common differences in the composition of solid waste in developing nations: Waste density 2-3 times greater than industrialized nations; Moisture content 2-3 times greater than industrialized nations; Large amount of organic waste ; Large quantities of dust and dirt; Smaller particle size on average than in industrialized nations.

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4.2 Waste generation per capita in countries- cross-country comparison of solid waste generation

Urbanisation and rapid economic development in developing countries has resulted in increased solid waste generation. The urban solid waste management situation in India too is quite alarming with around 17% of the world's population and an urban population of around 27% of the country's total population. It is estimated that the country generates about 30 million tones

of urban solid waste annually (GOI 1998) and is expected to increase 300 million tones per annum by 2047(CPCB 2000). The per capita generation of waste in India ranges between 0.1 kg and 0.6 kg per day with an average of 0.33 kg (Bhide 1990).There exists a large difference between urban and rural levels of waste generation and also between larger and smaller urban areas and this shows the presence of economic extremes within the Indian society(WHO 1991). The larger cities have greater waste generation due to greater economic activity, prosperity and the culture of consumerism among the residents. Indians in general reuse and recycle extensively within the household and their lifestyle results in a greater conservation of resources which is confirmed by earlier studies (UN 1997). Also the use of packed goods in India is still modest but an increasing trend is noticed in cities in Kerala at present. A comparison of urban municipal solid waste generation per capita figures for low income, middle income and high income countries is given below. Table: 4.2 and figure: 4.1 show the per capita urban municipal solid waste generation in low income countries.

Table: 4.2 Low income countries

No.	Country	UMSW Generation (kg/capital/day)
1	Sri Lanka	0.89
2	China	0.79
3	Lao PDR	0.69
4	Mongolia	0.60
5	Vietnam	0.55
6	Nepal	0.50
7	Bangladesh	0.49
8	Myanmar	0.45
	Average	0.64

Source: World Bank (1997a)

The average urban per capita solid waste generation in low income countries is 0.64kg. Sri Lanka has the highest per capita generation while Myanmar has the lowest with 0.45kg. The following figure represents the data given in the table.

Figure: 4.1 Low income countries

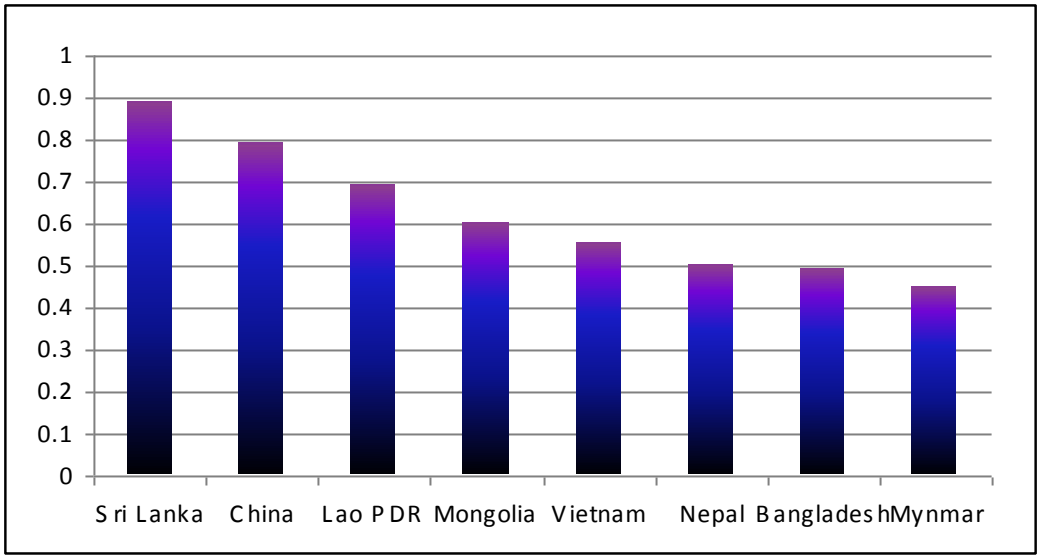


Table: 4.3 and figure: 4.2 show the per capita urban municipal solid waste generation in middle income countries.

Table: 4.3 Middle income countries

No.	Country	UMSW Generation kg/capital/day)
1	Thailand	1.10
2	Malaysia	0.81
3	Indonesia	0.76
4	Philippines	0.52
	Average	0.73

Source: World Bank (1997a)

The average urban per capita solid waste generation in middle income countries is 0.73kg. Thailand has the highest per capita generation and Philippines have the lowest with 0.52kg. The following figure represents the data given in the table.

Figure: 4.2 Middle income countries.

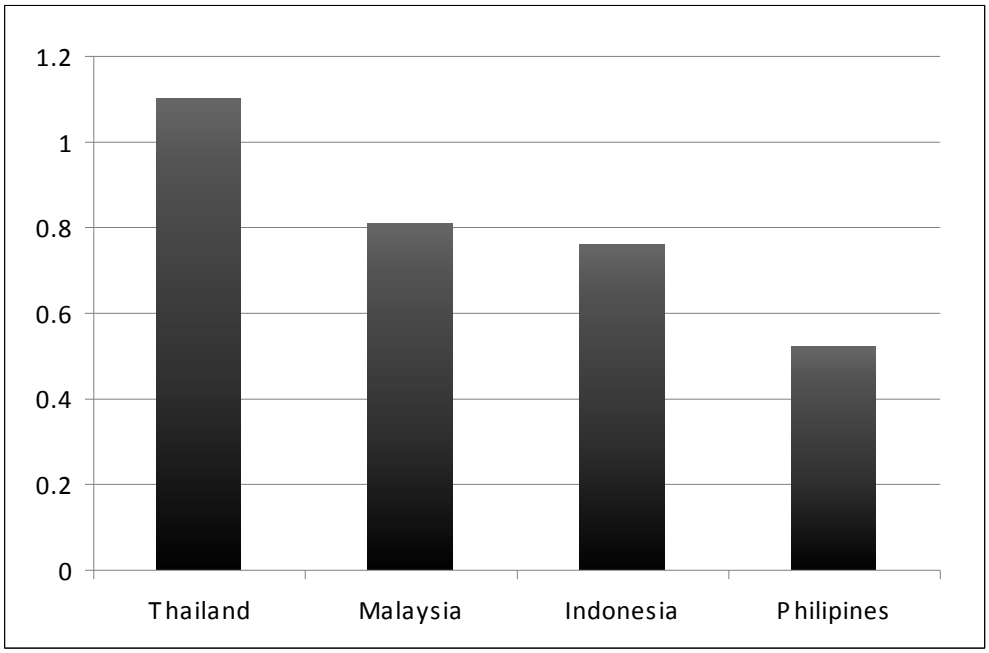


Table: 4.4 and figure: 4.3 show the per capita urban municipal solid waste generation in high income countries.

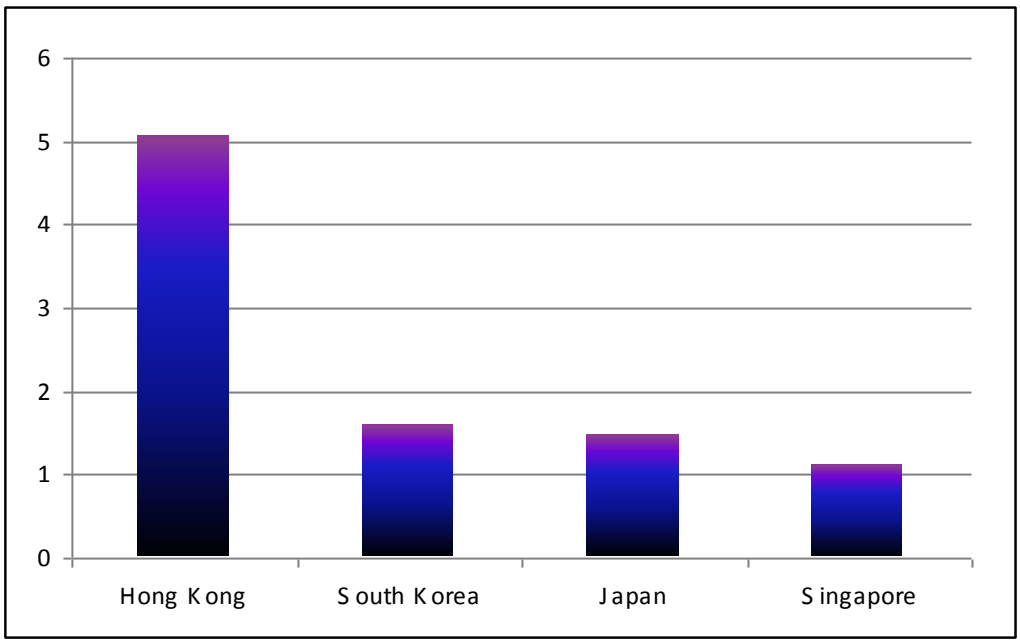
Table: 4.4 High income countries

No.	Country	UMSW Generation kg/capital/day)
1	Hong Kong	5.07
2	South Korea	1.59
3	Japan	1.47
4	Singapore	1.10
	Average	1.64

Source: World Bank (1997a)

Among the high income countries HongKong has the highest urban per capita solid waste generation at 5.07kg while Singapore has the lowest with 1.10kg. The average urban per capita solid waste generation in high income countries is 1.64kg. The following figure represents the data given in the table.

Figure: 4.3 High income countries



4.3 Waste generation per capita in Indian cities

The quantity and characteristics of the waste generated in an urban area depends generally on the size of its population, area, level of economic activities and the culture of the residents (K.N. Nair et al 2004). Per capita waste generation ranges between 0.2kg and 0.6 kg per day in the Indian cities which will work out to about 1.15 lakh MT of waste per day and 42million MT annually. The average per capita waste generation will increase as the city expands (Asnani 2006). The table: 4.5 and figure: 4.4 show the relation between waste generation per capita and population range in Indian cities. The average density of Indian MSW at the point of collection varies from 400 to 600kg/m^3 .At the landfill site, the density is much higher because of compaction and putrefaction.. The density of dumped refuse can increase two folds in about six

months due to putrefaction and self-compaction of biodegradable organic matter. The average density of waste at the landfill site can be assumed to be approximately 1 tonne/m^3 (Sivapullaiah, 1977).

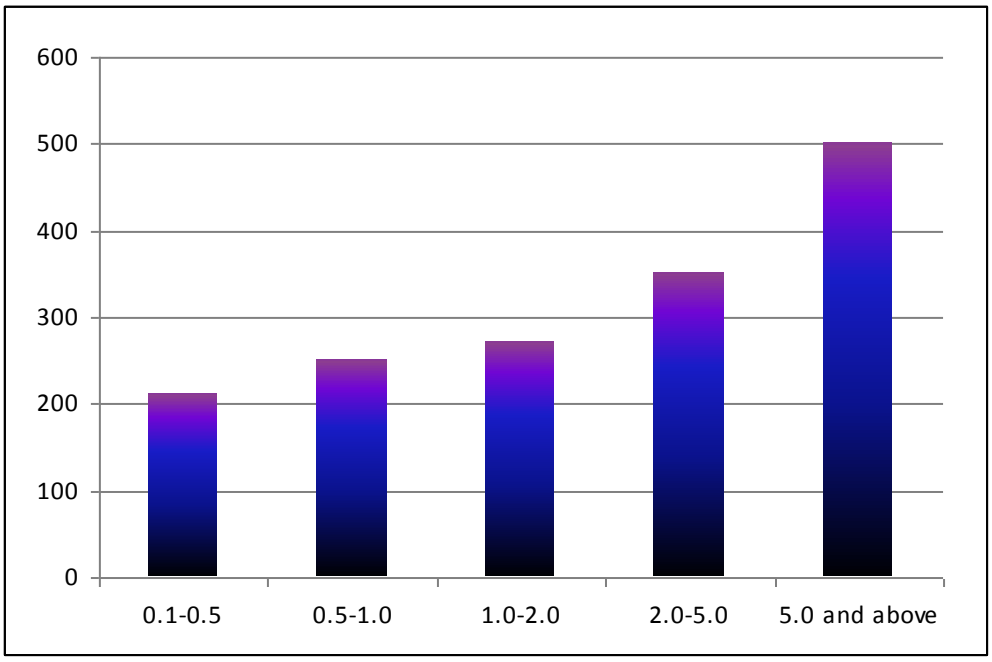
Table: 4.5 Waste generation per capita

Population Range (in million)	Average per capita waste generation gm/capita/day
0.1 -0.5	210
0.5-1.0	250
1.0-2.0	270
2.0-5.0	350
5.0 and above	500

Source: NEERI (1995)

It is clear from the table as the population of the city increases, the waste generation also increases. The following figure represents the data given in the table.

Figure: 4.4 Waste generation per capita



4.4 Solid waste generation and solid waste generation rates

Table: 4.6 shows the solid waste generation and solid waste generation rates of city/state capitals in India with more than one million population. Figure: 4.5 and figure: 4.6 represent the data given in the table.

Table: 4.6 Solid waste generation rates

City/state capitals with more than one million population	Waste quantity generated (MT/day)	Waste Generation rate (kg/c/d)
Kohima	12.48	0.12
Nashik	200	0.19
Lucknow	474.59	0.21
Guwahati	166.25	0.21
Gandhinagar	43.62	0.225
Jabalpur	216.19	0.23
Ranchi	208.27	0.246
Nagpur	503.85	0.25
Dehradun	131	0.29
Raipur	184.27	0.3
Indore	556.51	0.35
Bhubaneshwar	234.46	0.36
Patna	510.94	0.37
Ahmedabad	1302	0.37
Faridabad	448.01	0.38
Dhanbad	77.12	0.387
Bangalore	1669	0.39
Bhopal	574.07	0.4
Agarthala	77.36	0.4
Asansol	206.65	0.425
Daman	15.2	0.43
Meerut	490	0.46
Agra	653.57	0.49
Allahabad	509.24	0.51
Ludhiana	734.37	0.53
Jamshedpur	387.98	0.59
Vishakhapatanam	600	0.62

Note: MT/d: metric tones per day; kg/c/d; kilograms per capita per day.

Source: Akolkar (2005).

Figure:4.5 Solid waste generation

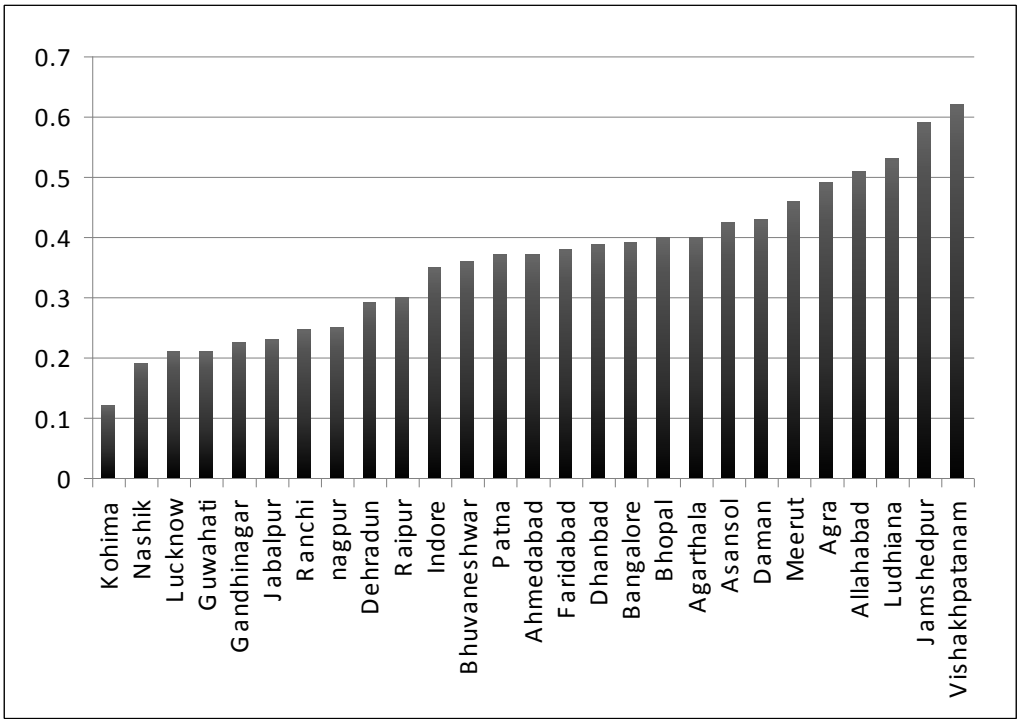
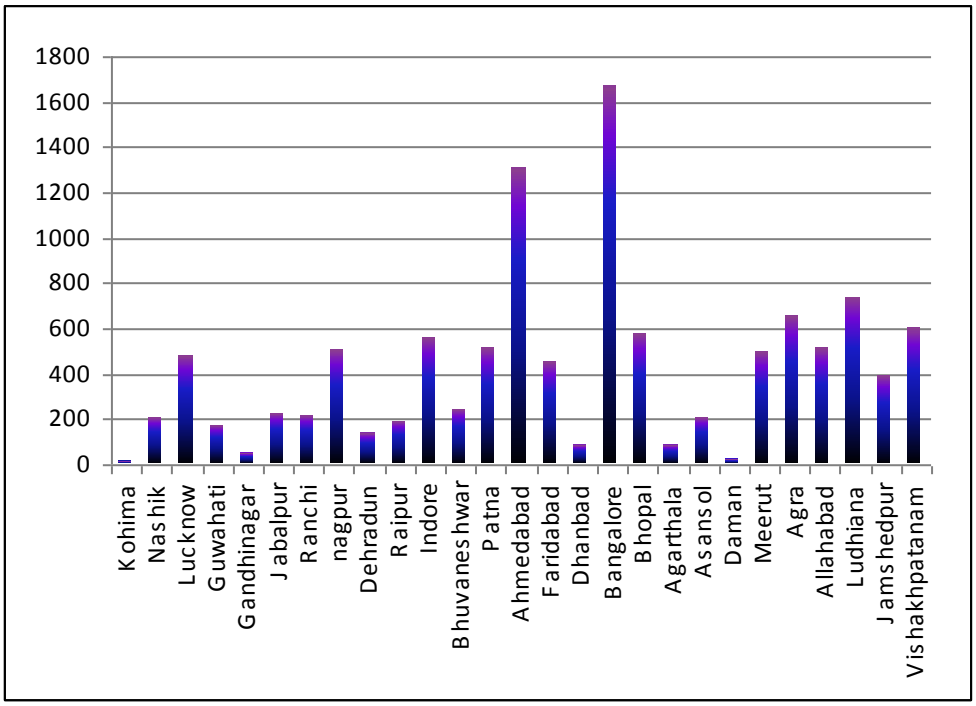


Figure: 4.6 Solid waste generation rates



4.5 Status of solid waste generation in Kerala

The pattern of solid waste generation in Kerala is similar to the pattern of urban solid waste generation in India. The data on the MSW generation maintained by the Urban Local Bodies (ULB) is based on the number of trips made by the waste transportation vehicles or approximation on other basis (Ajayakumar Verma, 2008). Generally, there is no practice of weighing the MSW at any stage, giving the available data little authenticity (SEUF, 2006). It is estimated that about 2500 tones of solid waste is generated per day in the state of which only about 50% is collected for disposal (Economic review,2004). The main issues associated with MSW in Kerala are: inefficient, inadequate and ad hoc primary collection of system, which results in the dumping of solid wastes into water bodies, road side.etc; lack of proper road cleaning; inefficient waste transportation in open trucks; lack of proper technical expertise in SWM ; lack of proper financial base for the urban local bodies as they depend too much on government grants; absence of engineered landfills and crude waste dumping in open dumps resulting in ground water contamination and breeding of mosquitoes, flies, rodents and pests and lack of proper private sector participation in the MSW system (SEUF,2006,economic review 2004). The Clean Kerala Mission was set up in 2003 to find a lasting solution to the problem of SWM. The main objective of the programme was to strengthen the managerial capacity and responsibility of the community and local governments in planning, implementation and maintenance of SWM facilities. The table 4.7 shows the various sources of waste generators in Kerala.

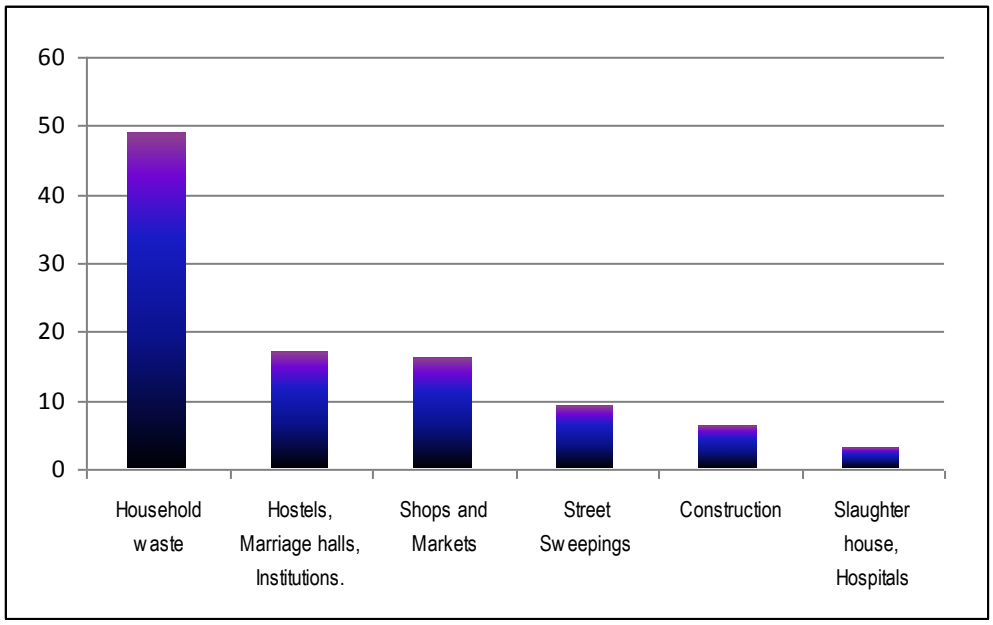
Table: 4.7 Solid waste generation

Sl. No	Source	% to total
1	Household Waste	49
2	Hostels, Marriage halls, Institutions	17
3	Shops and Markets	16
4	Street Sweepings	9
5	Construction	6
6	Slaughter house, Hospitals	3

Source: Malinya Mukta Keralam-Action Plan (2007).

The maximum amount of solid waste comes from domestic waste followed by Hotels, marriage halls and institutions and other contributors followed by shops and markets etc. The following figure represents the data given in the table.

Figure: 4.7 Solid waste generation



The per day percapita generation of solid waste is a better measure than the total waste generated in an area (Muraleedharan.S 2009). The city of Kozhikode with 458gms of solid waste has the highest per day percapita generation of solid waste in Kerala, followed by Cochin with 419gms and Kannur with 313gms. At the same time, in the case of solid waste density (solid waste per sq km), the town of Ponnani and Cochin with a measure of 2.63 is at the top. Kozhikode stands at the third position. Alappuzha town has a solid waste density of 0.86 (Integrated solid Waste Management, Govt of Kerala 2007).

4.6 Composition of MSW in Kerala

The composition of waste in terms of its physical characteristics will give a clear idea regarding the consumption pattern and waste disposal in an

area. It is also important for reduction, reuse and recycling of waste. Higher incomes and economic growth will also affect the composition of wastes. Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials –metals, plastics, glass, and textiles. etc. in the waste stream. Large amount of wastes with a higher content of inorganic materials could have a significant impact on human health and the environment. Developed countries, such as the US and Japan have rates of waste generation larger than other countries. European countries generate between 70% and 80% of those of the US (Fields, 1995). Developing countries have solid waste management problems different from those found in fully industrialized countries as the very composition of their waste is different from that of developed nations.

Various studies have shown that the municipal solid waste in Kerala contains a high biodegradable content. The following table: 4.8 shows the physical composition of solid waste in Kerala and the chemical composition of MSW is given in the appendix.

Table: 4.8 Composition of solid waste

Sl. No	Component	% to total
1	Biodegradable	71-83
2	Paper	3.5-5
3	Plastic, rubber, glass, metal	5-9
4	Inerts, earth, domestic hazardous	4.9-11.5

Source: Malinya Mukta Keralam-Action Plan (2007).

The bio degradable component of the solid waste stream is considerably high. It is followed by plastic, rubber, glass and metal. The important urban solid waste management approaches will be discussed in the next chapter.

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