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Municipal Solid Waste Generation in Yusmarg: A Health Resort of Kashmir Valley

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ABSTRACT

The increasing municipal solid waste (MSW) generation along with the high fraction of organic and other types of wastes is the current scenario in many tourist resorts of Kashmir valley in India. As a response to this problem, we carried out a study on the municipal solid waste (MSW) generation between May 2010 and 2011 in Yusmarg area, of the valley. The purpose of this study was to evaluate the quantity, composition and sources of wastes generated to recommend appropriate management practices. The study was based on three sites with marked differences in their physical and biotic features. The pattern of generation of municipal solid wastes (MSW) during the study showed a marked seasonal variation. The maximum average net weight of wastes was observed at site 2 (7.86 Kg/day), while as minimum was observed at site 3 (2.55 Kg/day). Among the constituents of wastes the net weight (%) was dominated by Food wastes (41.23%) followed by cardboard (15.28%), glass (11.16%) and rubber & Leather (0.17%) at all sites. Further analysis showed that the maximum Total Net Weight (46.25 Kg/Day) was contributed by recyclable wastes followed by (33.33 Kg/Day) compostable wastes, 2.57 Kg/Day by combustible wastes and 0.7 Kg/Day by inert materials. These insights into generated waste and management practice in Yusmarg health resort allow making suggestions for improved collection and disposal methods. A primary conclusion is that the biodegradable waste is a major fraction having suitable properties for recycling.

Introduction

Most of the cities and health resorts in the world are experiencing unplanned urban growth and heavy pressure of population. The net result is an enormous production of solid wastes. The quantity of generated solid waste mainly depends on population, economic growth, and the efficiency of the reuse and recycling system. In 1947, cities and towns in India generated an estimated 6 million tons of solid waste which rose to 48 million tons in 1997 (NEERI 1999).Rapid population growth and expanding urbanization have caused a drastic increase of the municipal solidwaste generation and the variety of the waste composition(Nguyen et al. 2011). Municipal solid waste(MSW) consists of all types of solid waste generated by households and commercial establishments, and collected usually by local government bodies (Bhada-Tata and Hoornweg 2011). The majority of substances composing MSW in developing countries include paper, kitchen waste, plastics, metals, textiles, rubber, and glass. According to Visvanathan et al. (2004) the solid waste composition in most Asian countries is highly biodegradable, mainly composed of an organic fraction with high moisture content. Food waste, plastic/foam, paper, rubber/leather, wood/grass, metal, glass and textiles are the common MSW components. The productions of the solid wastes in the mountainous regions have serious cascading effects on the lower valley. Often production of solid waste is the most serious threat to the fragile ecology of the mountainous environments(Jain 1994). Besides this, seasonal tourist inflow adds significantly to the demands on resource base and contributes considerably to the generation of municipal solid wastes (MSW). Khajuria et al. (2008) evaluated that, ecological impacts such as land degradation, water and air pollution are related to improper management of municipal solid wastes (MSW).

Municipal solid waste management (MSWM) encompasses planning, engineering, organization, administration, financial and legal aspects of activities associated with generation, storage, collection, transfer and transport, processing and disposal of municipal solid wastes in an environmentally compatible manner adopting principles of economy, aesthetics, energy and conservation (Tchobanoglous et al. 1993). In this regard situation in India is grim as more than 25% of the municipal solid waste (MSW) is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose-off the waste (NEERI 1999). In the last few decades, the amount of waste generated per capita has recorded an annual increase at a rate of 1%to 1.33% (Shekdar 1999).If this rate of increase continues, India will probably see a rise in waste generation from less than 40,000 tons per year to over 125,000 tons by 2030 (Srishti 2000). If an adequate MSWM strategy is not in place, human and environmental health would be jeopardized. It has been generally observed that less attention is being given towards the increasing soil pollution and proper management of solid waste in Jammu and Kashmir by the pollution control board. So, the current study was undertaken as an initiative in this direction.

Materials and Methods

Location and site description

Yusmarg health resort situated at 33°49 '42"N latitude and 74° 39' 59"E longitudes, 2712 m above sea level (a.s.l) 47 Km from Srinagar city and 13 Km from Chrar-i-Sharief town is a set of meadows surrounded by pine trees, grassy pastures and snow-

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capped mountains full of pine trees. Situated amidst Sang-i-Safed valleydrained by mighty Doodh Ganga River, it is reputed for having some unique spring flowers and highest mountain peaks in PirPanjal range like Tatakoti 4725 m (a.s.l), Romesh Thong 5000 m (a.s.l) and Sunset Peak 4746 m (a.s.l). It has the potential to be the gateway of some potentially valuable tourist destinations in its South, West and East includingDodpathri, Nilnag, Bargah and Tosaimaidan. In order to assess the generation of municipal solid wastes (MSW) three sites viz., Yusmarg Main Market (Site 1), JK TDC Huts (Site 2) and Near Doodh Ganga (Site 3) as shown in fig. 1 were selected in this area.

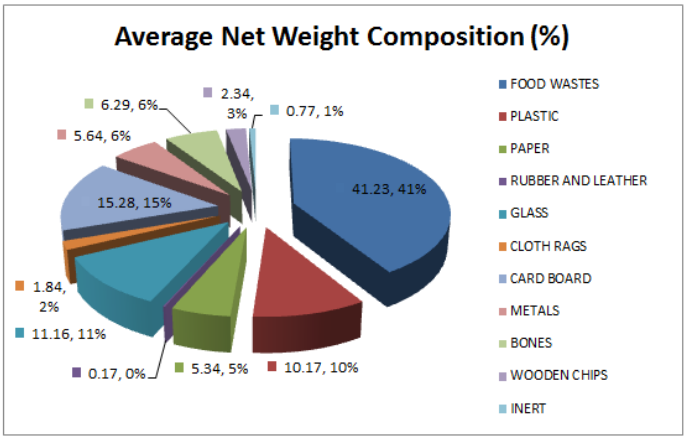

Fig 2. Average Net Weight composition (%) of Municipal solid waste (MSW) generation

Yusmarg Main Market (Site 1)

This site situated at 33° 49' 46.98"Nlatitude and 74° 39' 54.62"E longitudes is the main commercial hub with some shops, restaurants and hotels which remains active seasonally with least activities taking place in winter season and most taking place in the summer seasons. The wastes generated in this site are disposed in an open meadow by means of traditional burning.

JK TDC Huts (Site 2)

This site situated at 33° 49' 48.4"N latitude and 74° 39' 42.42"E longitudesis located inside the fenced area mostly occupied by government huts, restaurants and a paramilitary base camp. This is the only site where tourists (local, national as well as foreign) spent lot of time and hence experiences a maximum tourist pressure.

Near Doodh Ganga (Site 3)

This site situated at33° 50' 17.8"N latitude and 74° 39' 35.0"E longitudesislocated near Doodh Ganga River with a few temporary restaurants (locally called as Dabas). SampleCollectiontechnique for municipal solid waste (MSW) generation For the collection of samples houses, shops, hotels and dustbins established in the area by Yusmarg Development Authority (YDA) at the three sites were selected for the present study.During each sampling wastes produced during whole day were collected in polythene bags of 5kg capacity provided to each house-hold, shopkeepers and hotel owners. Wastes were also collected from dustbins after 24 hours and weighed on spot as per the methods of Gaxiola et al. (1995);Rampal et al. (2002) and Benitez et al. (2003).Samples of the generated wastes were collected from all sampling areas once a day at a fixed time for eight consecutive days and in all months mentioned tables. This was done because seasons may affect the composition, quantity, and peak days of the solid waste production (World Health Organization 1996; Thanh et al. 2010). To investigate the generation of municipal solid wastes (MSW) the samples collected were manually sorted andsegregated into compostable, recyclable, combustible (fuel) and inert categories. In addition, given the origin of the waste (mainly untreated waste from food), vegetable, food stuff peelings, paper, grasses and leaves were considered as biodegradable waste.

Laboratory analysis

For each type of waste, triplicate samples were analysed for moisture content, net weight composition (%)and net weight (Kg) or dried weight (Kg). The moisture content of the samples was determined following the standard procedure and formula (Aarne et al. 1994). It was determined after drying the waste material at 105°C for 24 h (and at a temperature of 70 to 75°C in case of combustible material) and expressed as a percentage of total weight. The formulas used for the measurement of above mentioned parameters are:

$$\text{Net weight composition (\%)} = \frac{\text{Weight of constituent of solid waste}}{\text{Total weight of constituents}} \times 100$$

$$\text{Moisture content} = \frac{(W_w - W_d)}{W_w} \times 100$$

$$\text{Net weight (Kg)} = W_w - \frac{(\text{Moisture content} \times W_w)}{100}$$

Results and discussion

The present research is an attempt to assess the composition and generation of municipal solid waste (MSW) in Yusmarg: a health resort of Kashmir Valley. The research analysis of data as presented in tables 1 to 3 revealed that at site 1, the total net weight of solid wastes was highest in May 2010 (9.88Kg/day), followed by June 2010 (7.09 Kg/day) and lowest in December 2010 (3.75 Kg/day). At site 2 the total net weight of municipal solid wastes (MSW) was recorded maximum (16.39 Kg/day) in May 2010, followed by 7.7 Kg/day in May 2011 and 6.9 Kg/day in June 2010 while as minimum 3.63 Kg/day was recorded in December 2010. At site 3 the total net weight was again recorded highest (3.84 Kg/day) in May 2010, followed by 3.07 Kg/day in May 2011 and lowest 0.45 Kg/day in December 2010. This increased generation of municipal solid waste (MSW) in spring and summer months (May and June)at all the three sites was due to the heavy influx of local, national and foreign tourists. However the lowest generation of municipal solid waste (MSW) in winter months (November and December) was due to severe cold which restricted the tourist inflow to the area. It has been observed that seasonal tourist inflow adds significantly to the demands on resource base and contributes considerably to the amount of wastes generated (Jain 1994). Rampal et al. (2002) also reported in their study conducted in residential areas of Jammu city that generation of solid wastes is maximum in summer and minimum in winter months. Among the constituents of solid wastes the total net weight was highest (20.41 Kg/day) for food wastes at site 2, followed by 10.45 Kg/day at site 1 and lowest 4.45 Kg/day at site 3. This highest percentage of food waste generation can be attributed to the preference of tourists to carry cooked rice, vegetables, fresh fruits and non-vegetable items to be consumed there. These activities have been reported to contribute significantly to the production of biodegradable wastes (Patil et al. 1985). Of the consonance, Siddiqui et al. (2011) did report that food wastes contribute about 37% of solid wastes in Moradabad city. The overall moisture content (%) of the waste samples collected ranged from a maximum of 55.99 % to0.0 %. This large amount of moisture in the refuse is mainly contributed by cooked waste material from hotels, restaurants and household kitchen waste.

Table 1. Estimation of Municipal solid waste (MSW) generation at site 1

Material (Wastes)	May (2010)				June (2010)				November (2010)				December (2010)				May (2011)				TNW Kg/D	ANW Kg/D
	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %		
Food Wastes	4.48	43.21	2.54	25.71	4.43	47.11	2.34	33	3.97	56.81	1.72	34.96	3.72	55.18	1.66	44.27	5.11	56.99	2.19	32.44	10.45	2.09
Plastic	0.63	3.1	0.61	6.17	0.78	2.19	0.76	10.72	0.42	3.71	0.4	8.13	0.43	3.15	0.41	10.93	0.73	3.92	0.27	4	2.45	0.49
Paper	0.41	12.13	0.36	3.64	0.12	16.12	0.1	1.41	0.41	19.72	0.33	6.71	0.41	21.72	0.32	8.53	0.11	25.17	0.08	1.19	1.19	0.24
Rubber& Leather	0	0	0	0	0.01	0	0.01	0.14	0.04	0	0.04	0.81	0.03	0	0.03	0.8	0.01	0	0.01	0.15	0.09	0.02
Glass	0.9	2.1	0.88	8.91	0.92	1.21	0.9	12.69	0.72	3.21	0.69	14.02	0.11	3.1	0.1	2.67	0.2	2.1	0.19	2.81	2.76	0.55
Cloth Rags	0.32	8.1	0.29	2.93	0.21	3.9	0.2	2.82	0.09	4.91	0.09	1.83	0.21	6.71	0.19	5.07	0.05	4.9	0.04	0.59	0.81	0.16
Cardboard	2.42	19.71	1.94	19.63	2.21	15.29	1.87	26.38	1.27	21.71	0.99	20.12	0.16	22.91	0.12	3.2	3.07	18.11	2.51	37.19	7.76	1.49
Metals	0.92	1.93	0.89	9	0.32	0.19	0.32	4.51	0.41	2.12	0.4	8.13	0.33	3.15	0.31	8.27	0.39	1.12	0.38	5.63	2.3	0.46
Bones	1.3	18.11	1.06	10.73	0.63	10.73	0.56	7.9	0.15	13.71	0.13	2.64	0.46	15.31	0.45	12	0.53	13.71	0.45	6.67	2.65	0.53
Wooden Chips	1.38	4.4	1.31	13.26	0.04	25.1	0.03	0.42	0.11	29.19	0.07	1.42	0.13	35.21	0.08	2.13	0.81	21.71	0.63	9.33	2.12	0.42
Inert Materials	0	0	0	0	0	0	0	0	0.06	0.01	0.06	1.22	0.09	0.02	0.08	2.13	0	0	0	0	0.14	0.03
Total	12.76		9.88	100	9.67		7.09	100	7.65		4.92	100	6.08		3.75	100	11.01		6.75	100	32.72	6.48

TNW=total net weight, ANW=average net weight, Q= quantity, Kg/D= kilogram/day, MC=moisture content, NW= net weight

Table 2. Estimation of Municipal solid waste (MSW) generation at site 2

Material (Wastes)	May (2010)				June (2010)				November (2010)				December (2010)				May (2011)				TNW Kg/D	ANW Kg/D
	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %		
Food Wastes	11.73	55.21	7.25	36.48	8.32	51.01	4.05	59.13	6.52	51.61	3.16	63.84	4.01	53.11	1.88	51.65	8.44	51.71	4.07	52.86	20.41	4.08
Plastic	2.38	2.9	2.3	15.48	0.36	2.81	0.35	5.07	0.1	2.11	0.1	2.02	0.36	4.1	0.35	9.62	0.89	.91	0.86	11.17	3.96	0.79
Paper	1.23	15.71	1.04	7.23	0.25	12.11	0.23	3.33	0.2	13.11	0.17	3.34	0.05	8.9	0.04	1.1	0.89	10.9	0.79	10.26	2.27	0.45
Rubber& Leather	0.08	0	0.08	0.55	0	0	0	0	0.003	0	0.03	0.06	0	0	0	0	0	0	0	0	0.11	0.02
Glass	2.6	1.91	2.55	17.72	0.62	3.11	0.6	8.7	0.33	1.11	0.32	6.46	0.87	11.11	0.77	21.15	0.2	0.91	0.19	2.47	4.43	0.87
Cloth Rags	0.22	5.62	0.21	0.15	0.11	4.1	0.1	1.45	0	0	0	0	0.12	8.2	0.1	3.02	0.33	0.22	0.33	4.29	0.74	0.12
Cardboard	1.27	16.11	1.06	7.37	0.63	10.75	0.56	8.12	1	19.11	0.8	16.16	0.39	12.71	0.34	9.34	0.55	12.11	0.48	6.23	3.24	0.65
Metals	0.49	1.97	0.48	3.33	0.14	1.51	0.13	1.88	0.07	2.1	0.06	1.21	0.07	3.19	0.06	1.65	0.22	2.74	0.2	2.6	0.93	0.19
39.576Bones	1.47	12.17	1.29	8.96	0.62	14.07	0.53	7.68	0.25	11.11	0.22	4.44	0.11	16.11	0.09	2.47	0.71	18.71	0.57	7.4	2.7	0.54
Wooden Chips	0.07	15.11	0.06	0.42	0	0	0	0	0.01	18.11	0.01	0.2	0	0	0	0	0.17	10.71	0.15	1.95	0.22	0.04
Inert Materials	0.07	1.2	0.07	0.49	0.32	0	0.32	4.64	0.11	1.1	0.11	2.22	0	0	0	0	0.07	0.005	0.06	0.78	0.56	0.11
Total	21.61		16.39	100	11.37		6.9	100	8.59		4.95	100	5.98		3.63	100	12.47		7.7	100	39.57	7.86

TNW=total net weight, ANW=average net weight, Q= quantity, Kg/D= kilogram/day, MC=moisture content, NW= net weight

Table 3 . Estimation of Municipal solid waste (MSW) generation at site 3

Material (Wastes)	May (2010)				June (2010)				November (2010)				December (2010)				May (2011)				TNW Kg/D	ANW Kg/D
	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %	Q(Kg/D)	MC (%)	NW (Kg/D)	NW %		
Food Wastes	2.82	51.55	1.37	35.68	1.1	53.61	0.51	24.88	2.42	49.11	1.23	36.18	0.45	47.11	0.23	51.11	2.11	47.32	1.11	36.16	4.45	0.89
Plastic	0.63	3.3	0.61	15.89	0.32	1.07	0.31	15.12	0.41	1.92	0.4	11.76	0.07	4.7	0.06	13.33	0.4	1.12	0.39	12.7	1.77	0.35
Paper	0.1	12.11	0.09	2.34	0.09	17.3	0.08	3.9	0.09	9	0.08	2.35	0.09	26.21	0.06	13.33	0.25	19.7	0.2	6.51	0.51	0.1
Rubber& Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glass	0.13	1.1	0.13	3.39	0.36	0.91	0.35	17.07	1.01	0.92	1	29.41	0.01	3.1	0.09	20	0	0	0	0	1.57	0.31
Cloth Rags	0.09	4.23	0.07	1.82	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.41	0.11	3.58	0.18	0.04
Cardboard	1.02	18.11	0.84	21.88	0.5	19.31	0.4	19.51	0.34	10.71	0.3	8.82	0.02	28.7	0.01	2.22	0.99	28.12	0.71	23.13	2.26	0.45
Metals	0.42	2.3	0.41	10.68	0.24	1.1	0.23	11.22	0.15	1.77	0.14	4.12	0	0	0	0	0.4	3.3	0.38	12.38	1.16	0.23
Bones	0.25	13.17	0.22	5.73	0.12	13.17	0.1	4.88	0.29	16.1	0.25	7.35	0	0	0	0	0.22	18.11	0.17	5.54	0.74	0.15
Wooden Chips	0.02	13.6	0.1	2.6	0.1	21.71	0.07	3.41	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0.03
Inert Materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	5.45		3.84	100	2.83		2.05	100	4.71		3.4	100	0.73		0.45	100	4.57		3.07	100	2.55	

TNW=total net weight, ANW=average net weight, Q= quantity, Kg/D= kilogram/day, MC=moisture content, NW= net weight

Table 4. Category wise Net weight (Kg/Day) of Municipal Solid waste (MSW) generation at different sites

Category	**Material (wastes)**	**NW (Kg/D)**																		**T NW Kg/D**	**TNW %**	**ANW Kg/D**
		Site 1						**Site 2**						**Site 3**								
		May 2010	**June 2010**	**Nov 2010**	**Dec 2010**	**May 2011**	**T NW Kg/D**	**May 2010**	**June 2010**	**Nov 2010**	**Dec 2010**	**May 2011**	**T NW Kg/D**	**May 2010**	**June 2010**	**Nov 2010**	**Dec 2010**	**May 2011**	**T NW Kg/D**			
Recyclable	Metals, Paper, Plastic, Cardboard, Rubber & Leather, Cloth Rags, Glass and Bones	6.03	4.72	3.067	1.93	3.93	19.68	9.01	2.5	1.67	1.76	3.42	18.36	2.37	1.5	2.17	0.22	1.96	8.22	46.25	55.82	3.08
Compostable	Food wastes	2.54	2.34	1.72	1.66	2.19	10.45	5.25	4.08	3.16	1.88	4.07	18.44	1.37	0.5	1.23	0.23	1.11	4.44	33.33	40.22	2.22
Combustible (Fuel)	Wooden Chips	1.31	0.03	0.07	0.08	0.63	2.12	0.06	0	0.004	0	0.15	0.25	0.1	0.1	0	0	0	0.2	2.57	3.11	0.17
Inert Materials	Ash	0	0	0.06	0.08	0	0.14	0.07	0.32	0.11	0	0.06	0.56	0	0	0	0	0	0	0.7	0.85	0.01

The results are similar to that reported by Sivapalan et al. (2002) and Thitame et al. (2010) from the study of Kuala Lumpur and Sangamner city waste. Waste composition survey by BCSIR (1998) found that the moisture contents in residential and commercial wastes are 50% and 54%, respectively, and in mixed waste is around 59%.

The total average net generation of solid waste constituents was highest (7.86 Kg/day) at site 2 followed by site 1(6.48 Kg/day) and by site 3(2.55 Kg/day), the same could be due to the maximum tourist related activities like recreational, consumption of food etc. at site1 and site 2 as compared to site 3. The total net weight of paper was highest (2.27 Kg/day) at site 2, followed by 1.19 Kg/day at site 1 and 0.51 Kg/day at site 3. The food and other materials carried by people in paper wrappings, leads to the production of paper wastes. Cardboard contribute the maximum share of 7.76 Kg/day at site 1 and minimum share of 2.26 Kg/day at site 3. The reason for the production of such amounts of cardboard wastes on daily basis at site 1 was the commercial activities taking place here. Ling et al. (1991); Jain (1994) and Patil et al. (1998)also reported in their studies that commercial activities contribute more to the production of cardboard as a constituent of solid waste. The total net weight of glass was observed highest 4.43 Kg/day at site 2, followed by 2.76 Kg/day at site 1 and 1.57 Kg/day at site 3. The higher quantity of glass may be attributed to the presence of paramilitary force base camp and tourist inflow in the area. According to Kuniyal et al. (1998) there is a positive correlation between the tourist activities and production of glass as a constituent of municipal solid wastes (MSW). Contribution of wood to the total generation of municipal solid wastes (MSW) was 2.12 Kg/day, 0.22 Kg/day and 0.17 Kg/day at site 1, site 2 and site 3 respectively. As plastic has become an important and unavoidable component of solid wastes. Generation of plastic as solid waste was maximum 3.96 Kg/day at site 2, followed by 2.45 Kg/day at site 1 and 1.77 Kg/day at site 3. Presence of plastic in the solid waste could be attributed to the excessive use of plastic items like tea cups, plates, spoons, water bottles, juice bottles, soft-drink bottles and polythene bags by the tourists. The average net weight composition of constituents of solid wastes generated at different sites was dominated by food wastes 41.23% followed by cardboard 15.28%, glass 11.16% and rubber & leather 0.17% (Fig.2). The reason could be the preference of people to enjoy food consuming activity at the tourist destination. Ahmad and Bhat (2007) also observed that food wastes and cardboard are the major constituents of solid wastes in Srinagar. Category wise net weight (%) of different solid waste constituents asshown in Table 4 depict that on an average recyclable materials dominated with the production of 55.82%, followed by compostable wastes with 40.22%, combustible wastes with 2.57% and inert materials with 0.85%. The results are in consonance with the findings of Yousuf and Rehman (2007) while monitoring quantity and characteristics of municipal solid waste in Dhaka City.

Conclusion

The study showed that the current scenario of municipal solid wastes in Yusmarg health resort of Kashmir valley is due to open dumping practice that is being followed by the residents, tourists, shopkeepers, and hoteliers for MSW disposal. Reliable estimates of solid waste generation along with estimation of their physical and chemical characteristics are very important for designing appropriate waste treatment, management and disposal strategy.

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