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Assessment of Sustainable Municipal Solid Waste Management options with reference to Seasonal variations in Zone-B, Town-II Peshawar, Pakistan

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Abstract

This study was conducted for the Municipal Solid Wastes (MSW) produced in the urban area of district Peshawar. The objective of this study was to assess the seasonal wise characterization, composition and generation of MSW for 3R's (Reuse, Recovery, Recycling) potential. For this purpose, composite samples of MSW were collected for two seasons' summer and winter from main dumping site using quartering method. These samples were analyzed for characterization, moisture contents, mass, volume, density and percent composition. Per capita generation rate was also determined by conducting household field survey. The main bulk of the MSW generated in Zone-B Town-II, Peshawar comprised of organic waste. Percentage composition of MSW for both summer and winter season has no significant change of organic matter. It was concluded that ~50% of MSW in both seasons can be used for making composting, ~30 % for recycling and ~20% as Refused Derived Fuel (RDF) for energy recovery.

Keywords: *Municipal Solid Waste, Composition, Generation Rate, Recycling, Seasonal Variation.*

Introduction

In developing countries, Municipal Solid Waste Management (MSWM) is an alarming challenge facing by municipal authority especially in urban areas (Al-Khatib et al, 2010). Countries like Pakistan (Adila et al., 2008), and India (Das et al., 2002; Sharholy et al., 2007) practices primary and secondary collection and open dumping (90%) of the collected waste and reflects as MSWM. Nearly 60% of generated waste is collected in urban areas of Pakistan and India and the rest of waste remains in drains, streets, roadsides, railway tracts and other related regions (JICA, 2005).

Developing countries are now in critical circumstances regarding inappropriate collection of MSW (Shimura et al., 2001) and causing water contamination of water, soil and air and key impacts on human health (Batool and Ch, 2009). Proper MSWM in Pakistan needs reliable information, trained administration, skilled labor, strict regulations, and financial assistance (KOICA – World Bank, 2007).

Percentage composition of MSW regarding seasonal variation in Pakistan in both summer and winter season has no noteworthy change of organic matter (Iqbal et al, 2010). The composition of the MSW mainly comprised of organic waste and ranges from 14% to 51% (OECD, 2008).

Effective, economic and safe disposal of municipal solid waste is high on the agenda of developed and of developing countries (Beukerering et al., 1999). The problem of uncontrolled solid waste generation and improper disposal is easily handled by Recycling, reuse and recover (3R) technology (Cheng et al.,2002; Qureshi, 2000; Ludwig et al., 2012). Recovery, Reuse, Recycling uses much less energy compared to other methods of waste treatment and disposal and saves natural resources (Gaines and Stodolsky, 1993; Stodolsky and Mintz, 1993; Vencatasawmy et al., 2000; Van Beukering and Bouman, 2001).

Currently in Pakistan MSWs is not carried out in a sufficient and proper manner due to which the environmental and sanitary conditions have become more serious year by year, and therefore the people are suffering from living such conditions. The importance and scope of the problems regarding solid waste management is very wide and involves the consideration of all the aspects relating to solid waste management i.e. storage, collection, transportation and disposal.

The proper implementation of MSWs management plan is a challenge for developing nations of the world. Sustainable MSWs involves storage, collection, transfer, processing and disposal of municipal solid wastes which are environmentally compatible, adopting principles of recovery, reuse and recycling. In Pakistan the proper mechanisms of recovery and recycling on countryside large scale does not exist. Due to rapid increase in urbanization and industrialization the life style of people's also changed as a result municipal solid waste generated has increased many folds.

The aim behind this study was to identify the sustainable option for MSW management. This was accomplishing by assessing generation rate, physical composition and characterization of MSW in Zone B Town-II of Peshawar with special consideration on seasonal variation during two (summer, winter) seasons.

Materials and Methods

Mapping and zoning of concerned area 34° 0'46.19"N, 71°36'24.70"E to 34° 0'39.62"N, 71°34'51.00"E (Fig.1) selected for study to assess the quantity of MSW generation per day and determining waste composition and characteristics. For this purpose main dumping site inspection and waste composition survey was done in summer and winter season.

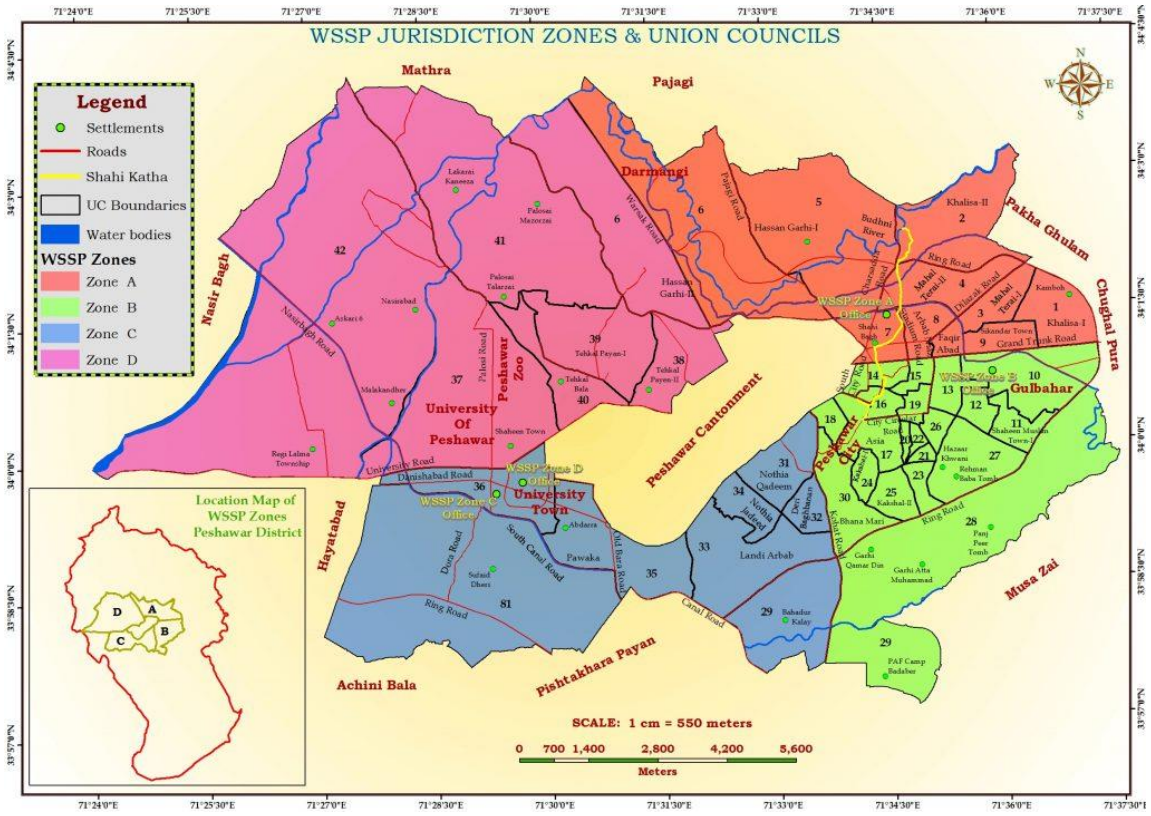


Fig: 1. Map of study area Zone B Town-II, Peshawar Urban

Sample Collection

Grab composite quartering sample of municipal solid waste was collected from main MSW dumping site located on southern end of Ring Road Peshawar. The sample was thoroughly mixed, and reduced to 1.0 kg by quartering of quarter method (Kumar et al., 2009).

Generation Rate

Generation rate of MSW was determined by conducting various field surveys in both seasons at household level. From household per-capita MSW generation rate was determined by using spring balance (Kumar et al., 2009).

Characterization of MSW

Characterization of MSW sample was done by separation of putresible (food waste) and non-putresible (non-food waste) through physical investigation and sorting.

Physical analysis of MSW

i. Moisture contents

To determine the moisture contents of individual components, each component was fresh weighted by using digital balance then dried in oven at 100 C for 3 hours. After that the dried weight of MSW sample component subtracted from the fresh weight.

ii. Mass

Mass of individual components of composite MSW sample was determined by using digital balance. The mass of individual components come in gram unit that was converted into kg by using following equation (see equation.1).

$$\text{Mass (KG)} = \frac{\text{mass in gram}}{1000} \quad \text{.....Equation.1}$$

iii. Volume

Volume of MSW components was determined by using water displacement method in graduated cylinder of 1litre volume capacity.

iv. Density

Density of all individual components was determined by dividing the mass of individual components to volume of that component. (See Equation.2)

$$\text{Density} = \frac{\text{mass of individual component (kg)}}{\text{Individual Volume (Liter)}} \quad \text{.....Equation.2}$$

v. Contents Percentage

Percentage of individual components was determined by multiply the ratio of fresh mass of individual component to whole mass of fresh MSW sample (see equation.3).

$$\text{\% age by mass} = \frac{\text{mass of individual component}}{\text{Whole mass of fresh sample}} \times 100 \quad \text{.....Equation. 3}$$

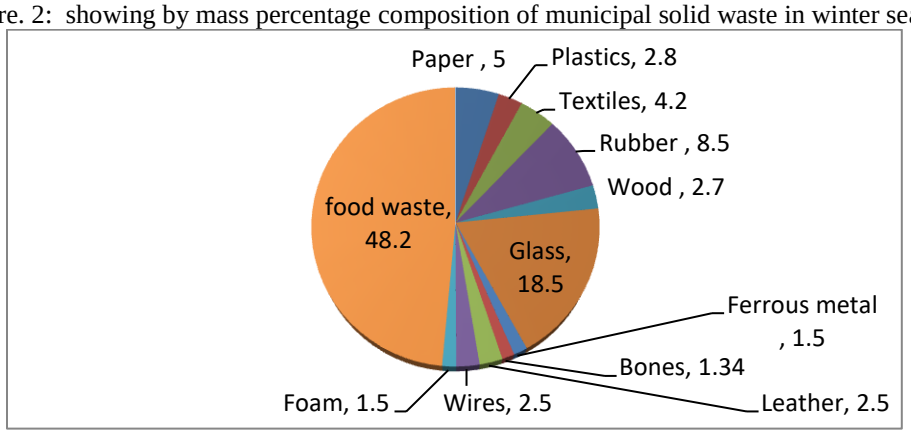
Results and Discussion

Average per capita MSW generation rate was found in range of 0.2-0.5 kg. According to district Government estimate the population of Zone B Town-II in district Peshawar is 0.8 million. The daily generation rate of MSW is in the range of 160-400 ton. Characterization and physical components analysis reveal that in winter season ~48% of MSW comprised of organic matter. The organic matter mainly consists of food waste and animals residues. Beside from this ~5% of MSW comprise of waste paper, 2.8% plastics, 4.2% textiles, 8.5% rubber, 2.7% wood, 18.5% glass, 1.5% metals, 1.3% bones, 2.5% leathers, 2.5% wires and 1.5% different types of foams pieces by weight (table 1).

Table 1: Physical characterization and composition analysis of 1kg MSW sample in Winter Season

S.No	Components	Fresh mass (kg)	Dry mass (kg)	Moisture (kg)	Volume (L)	Density (kg/m3)	% by mass
1	Paper	0.051	0.043	0.008	0.1	400	5
2	Plastics	0.028	0.027	0.001	0.15	186.67	2.8
3	Textiles	0.042	0.038	0.004	0.2	210	4.2
4	Rubber	0.085	0.083	0.002	0.1	850	8.5
5	Wood	0.027	0.026	0.001	0.05	540	2.7
6	Glass	0.185	0.184	0.001	0.15	1233.33	18.5
7	Metals	0.021	0.017	0.0009	0.04	375	1.5
8	Bones	0.013	0.007	0.006	0.04	325	1.34
9	Leather	0.025	0.017	0.008	0.05	500	2.5
10	Wires	0.025	0.024	0.001	0.02	1250	2.5
11	Foam	0.013	0.012	0.0009	0.2	65	1.5
12	Food waste	0.482	0.089	0.343	0.365	12197	48.2
	Total	0.997	0.567	0.3768	1.465	18132	99.24

Figure. 2: showing by mass percentage composition of municipal solid waste in winter season.

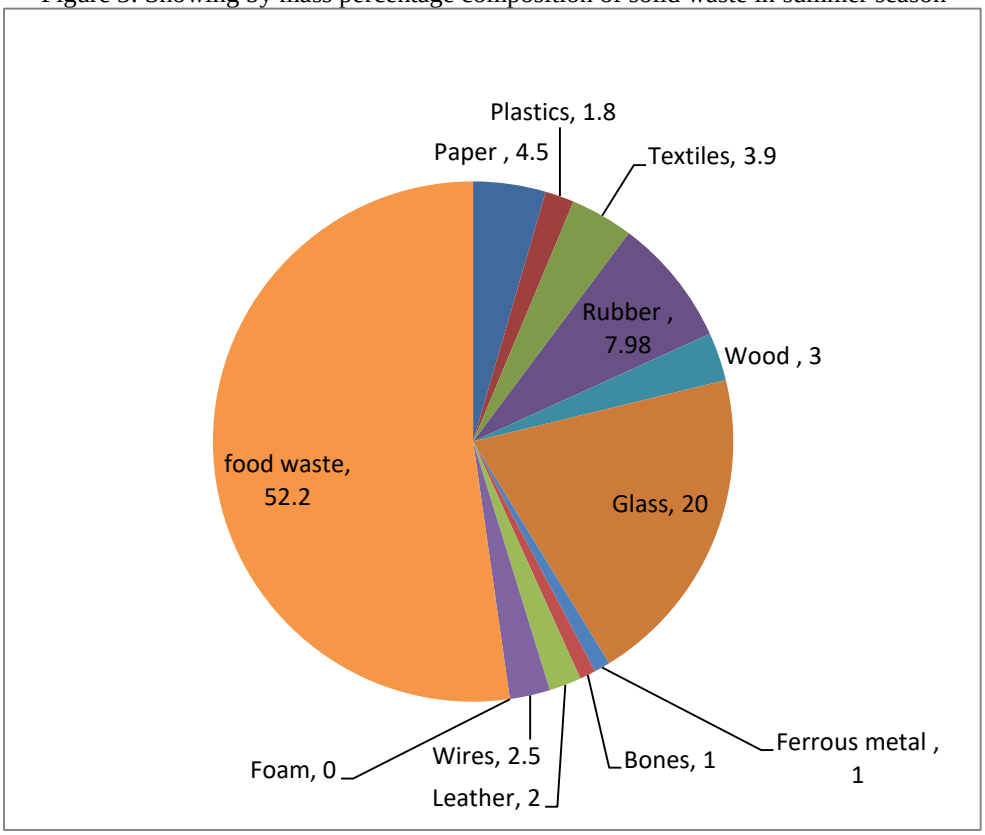


In summer season a large portion of MSW > 50% was composed of organic portion (Table.2). Waste paper occupied 4.5%, plastic 1.8%, textile 3.9%, rubber 7.98%, wood 3%, glass 20 %, metals 1%, bones 1%, leather 2% and wires 2.5% of MSW by weight. Comparative analysis of MSW produced in both seasons shows not significant difference in the composition. In which the metallic and paper waste having great recycling potential after efficient recovery. The organic portion of MSW is easily convertible into composting which is the best cost effective option. Components like textile, plastics and rubber having large calorific values, which can be used as, refused derived fuel (RDF).

Table 2: Physical characterization and composition analysis of 1kg MSW sample in Summer Season

S.No	Components	Fresh mass (kg)	Dry mass (kg)	Moisture (kg)	Volume (L)	Density (kg/m3)	% by mass
1	Paper	0.055	0.046	0.009	0.09	376	4.5
2	Plastics	0.03	0.03	0.00	0.12	166.66	1.8
3	Textiles	0.035	0	0.035	0.3	198.25	3.9
4	Rubber	0.065	0.063	0.002	0.11	770.5	7.98
5	Wood	0.02	0.02	0.00	0.04	554	3
6	Glass	0.05	0.05	0.00	0.15	1350.4	20
7	Metallic's	0.2	0.2	0.00	0.03	391	1
8	Bones	0.01	0.007	0.003	0.02	343	1
9	Leather	0.01	0.01	0.00	0.03	550	2
10	Wires	0.01	0.01	0.00	0.01	1160.5	2.5
11	Foam	0.00	0.00	0.00	0.00	0.00	0.00
12	food waste	0.52	0.089	0.431	0.365	15123	52.2
	Total	1.005	0.525	0	1.265	20983.31	99.88

Figure 3: Showing by mass percentage composition of solid waste in summer season



Conclusion

It was finally concluded that in the urban area of Town-II, Peshawar, a large amount of MSW generates. The main contents of MSW produced are food wastes, paper, cardboard, wood, plastics and metallic's. There was not significant change observed in the organics bulk of MSW in both summer and winter seasons. The current MSW management practices include open dumping and land filling. Therefore, it was recommended to adopt 3R's technology as a sustainable MSW management option. According to physical component analysis, characterization and quantity of MSW produced shows great potential towards reuse, recovery and recycling. Results shows that ~50 % of the waste can be easily composted which could help to enrich soil. For this purpose establishment of composting facility is necessary. While out of the remaining MSW ~30 % can go for recycling and ~20 % for using as refused derived fuel as an energy recovery option.

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