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Survey of Waste Collection and its Energy Generation Potential in Nawanshehr, Pakistan

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Abstract: The present study highlights the current status of solid waste collection and disposal practices in Nawanshehr, Abbottabad Pakistan along with its possible management. It involved the surveys of different places such as general stores, tailor shops, cotton processing etc, during the month of July to October 2010. It is estimated that an average 7-8 t of Municipal Solid Waste (MSW) is generated daily of which 2-3 t is collected by the local administration and dumped at "Salhad" solid waste dumping site. This waste can be efficiently used to produce electricity and biogas. Total 3000 t of MSW annually formed which is use to produce 1.9×10^6 kWh_e amount of electricity. Major proportion of the generated MSW goes to open drains of the town and taken away to the Mandrocha Katha by the water flow, worsening the facilities of drinking water quality of this natural water stream, it is further ended into Daurr River. It is recommended that organic waste may be employed for many beneficial uses. With the collaboration of industrialists, a small scale fertilizer factory may be established. This will fulfill the fertilizer demands of local farmers to increase crop productivity.

Key words: Solid waste management, disposal, scavengers, electricity, collection point, plastic

INTRODUCTION

Solid Waste Management (SWM) involves the functions of collection, transfer resource recovery, recycling and treatment. Basic idea of SWM is to provide safety to public health, promote environmental quality and help in economic productivity. Achieving these goals is only possible when the local authorities in collaboration with both public and private sectors practice sustainable SWM. The amount of Solid Waste (SW) generated in the developing countries is much less than the industrialized countries but SWM still remain inadequate.

Most of the local authorities in developing countries spend over 30% of their budgets on refuse collection and disposal but can only collect at most 50-70% of Municipal Solid Waste (MSW) (MDC, 1993). Most of the authorities in Pakistan do not meet the SW disposal standards because of lack of sanitary landfills. At present, the majority of the solid waste is being dumped in the open, lacking environmental pollution control and monitoring.

Furedy (1997) defines waste as residual materials that are considered to be of no use and must eventually be disposed off typically by dumping or incineration. An observational study on Healthcare Waste Management (HCWM) was performed in Pakistan, which showed that almost all of the hospitals did not have practice of HCWM on their priority. Segregation, handling, storage, transportation and disposal of waste were below WHO and Pakistan bio-safety standards (Kumar *et al*., 2010).

A study done by Faiqa and Khan (2008) investigated the practices of hospital solid waste management at Ayub Medical Complex, Abbottabad Pakistan. Field visits were conducted to collect information about the different aspects of infectious medical waste management and its final disposal. It was observed that infectious and non-infectious wastes were mixed and openly dumped without proper handling. The results indicate that the waste generation rate was approximately 464.7 kg day^{-1}, which includes approximately 37.4 kg day^{-1} or 8% of the infectious medical waste and 427.3 kg day^{-1} or 92% of non-infectious waste. Approximately 20-30% of the infectious solid waste is incinerated at the hospital and rest of 10% is openly dumped.

Solid waste management involves waste recovery (at the source, through final disposal) and public education to encourage the population to develop attitudes and practices, which are sensitive to waste issues such as source separation or waste minimization. Waste recovery represents the removal of waste for some type of reuse, recycling or composting (Al-Sayyid, 1993).

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Research on urban solid waste management in developing countries in general and in particular Africa, have been developed from two main concerns: from a public health perspective (normally referred to as public management approach) and from a contribution to sustainable development approach (including reuse, recycling and composting). Solid waste accumulating in densely populated urban areas posed epidemiological health hazards, which local authorities sought to control by providing effective collection, transport and safe disposal services (Baud, 2000).

In an overview of municipal solid waste in the developing world, it is worthwhile to note that the amount of solid waste generated in many cities in the developing world, has been increasing rapidly over the years, mainly as a result of increases in population and urbanization amongst other factors. Rapid population growth in developing countries has direct implications for human living patterns, leading to a greater concentration of people mostly organized in the form of urban centers. In urban Asia alone, 760,000 t of waste is produced daily (Hoornweg, 1999).

In developing countries, the approach to managing waste has mainly focused on getting rid of the trash, with very little or no attention paid to waste minimization or recovery efforts (Poerbo, 1991; Cointreau, 1994).

MATERIALS AND METHODS

Observational study was conducted in the Nawanshehr region of Abbottabad city. This included waste generation in commercial area and household.

This study focused on individuals and different enterprises involved in solid waste generation at different levels. Collection of observation included the solid waste collection, transportation and disposal facilities during the months of July and October 2010. During the survey, 120 shops were visited, this included 40 general stores, 12 vegetable shops, 05 tailor shops etc. (Table 1).

House hold data was collected by random sampling. Two hundred houses were visited for the survey. Objective of this survey was to collect information from the residents about the composition, volume and weight of waste generated at house hold level and the willingness of solid waste management. Nawanshehr has wide diversity in the status of people, the selected area for the survey comprised of families of all financial status and un-bias data was collected from communities of all different status from upper to middle and poor class. Most of the houses had an average of 6-10 family members and few of them were willing to pay for proper waste management from Rs. 10-50 per month.

Table 1: Details of commercial area in Nawanshehr

Types	Estimated number of shops
General stores	160
Vegetable shops	48
Tailor shops	20
Carpenter shops	20
Chicken shops	30
Butcher shops	05
Medical clinics	10
Cotton filling	03
Tandoor shops	20
Sweet and bakers shops	08
Scavenging shops	13
Kabab shops	05
Pakora shops	10
Barber shops	18
Sanitary/hardware store	08
Fruit shops	25
Total shops	403

Scavenging shops: The scavengers or "Kabaria" are playing very important role in the solid waste management throughout the country. In Nawanshehr, there are more than 10 scavenger shops located in various hamlets. The shop owners collect/purchase various kinds of wastes from collection points or even from houses and sale out to various factories for recycling.

RESULTS AND DISCUSSION

Solid waste management people willingness: Among the surveyed shops and households, people had different opinions. About 47% of shopkeepers (Fig. 1) and 42% of the resident (Fig. 2) were voluntarily willing to escort any efforts for the betterment of their surroundings and were ready to pay for proper waste management services however, 53% of shopkeeper and 58% of resident were in the view that the solid waste management is the sole responsibility of the Tehsil Municipal Authority (TMA) and other government bodies and they were not willing to pay for the services in return of any efforts towards better solid waste management.

Most of the houses cook their food thrice a day. Both organic and inorganic waste was generated. Different practices of waste disposal employed were shown in Fig. 3, among which TMA sweeper collects the waste 44 and 28% was disposed at identified collection points.

It is desirable that organizations should concentrate on scavenger shops to manage solid. On the first shop type of solid waste received was mostly paper, bottles, cans, metals, plastic etc. They purchased metal and then sold it to the re-rolling mills. In the second shop solid waste type was paper, bottles, cans, metals, plastic, shoes etc. Plastic and bottles were recycled. Glass was sent to the glass factory for re-use. The third shop collected paper, bottles, cans, metals, plastic, silver, medical waste

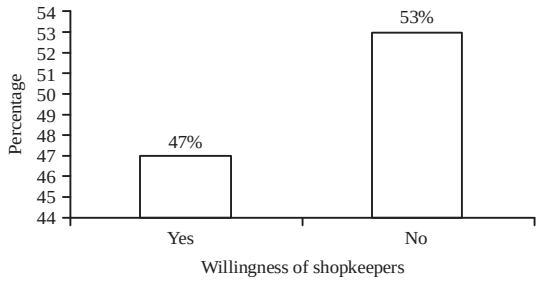

Fig. 1: Willingness of the shopkeepers wants to contribute for solid waste management

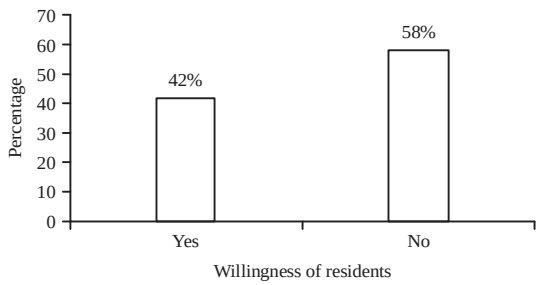

Fig. 2: Willingness of the residents want to contribute for solid waste management in nawanshehr

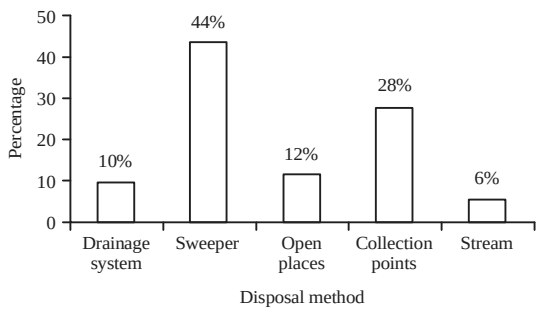

Fig. 3: Solid waste disposal practices among the residents of nawanshehr

etc. (Table 2). Children were involved in collection of the waste. The scavengers purchase different waste at low price and sell it to market on a little higher price (Table 3) which compensates their labor.

Electricity generation potential from municipal solid waste: Nawanshehr discards annually 3000 t of MSW. The 18 different collection points were selected (Table 4) to calculate the amount of solid waste generated and to calculate amount of different type of waste in percentage.

Total weight of each waste type is calculated (Table 5) which is use to calculate the electricity generation potential of this waste by using the formula (Khan and Abu-Gharah, 1991). The low heating value of MSW is assumed to be 11.4 MJ kg^{-1}. A mass-burn

Table 2: Details of various kinds of solid wastes collected by scavengers

Shop name	Type of waste	Willingness for SWM
Scavenging shop 1	Paper, bottles, cans, metals, plastic	Yes
Scavenging shop 2	Paper, bottles, cans, metals, plastic, shoes	Yes
Scavenging shop 3	Miscellaneous	No

Table 3: Details of costs of various kinds of solid wastes collected by scavengers

Type of waste	Purchase price ($ kg^{-1})	Selling price ($ kg^{-1})
Paper	0.06-0.07	0.08-0.09
Rubber	0.02	0.02-0.03
Plastic	0.12	0.15-0.18
Glass	0.02	0.03-0.04
Bones	0.03	0.04-0.05
Silver	1.00	1.05
Steel	0.30	0.40

Table 4: Names of different collection points

1	Jamia Madni Masjid
2	Nawanshehr post office
3	Maira Mandrochh Chungi
4	Jharian road
5	Bani Chowk
6	Naya Mohallah
7	Sabaa Colony
8	Women medical college
9	Dhudial Mohallah Qazian
10	Dhudial collection point
11	Do Masjidein, Musazai
12	Ehtesham Colony
13	Orush Colony
14	Murree Road
15	Stadium Road
16	Jhaarian Link Road
17	Awami Road near service station
18	Malik bazar

waste-to-energy facility can convert those wastes to electricity at a net efficiency of about 20% (typical MSW has moisture content of around 20%) (Masters, 2004). At 20% efficiency, to produce 1 kWh_e of electricity requires 5 kWh_t of heat input to boiler (the subscript t and e refer to thermal and electrical forms of energy). Using the conversion 1 kWh_t of heat equals 3.6 MJ gives:

$$\text{Heat input} = \left(\frac{5\,kWh_t}{1\,kWhe}\right)\times 3.6\,{}^{MJ}\!/_{kWh_t} = 18\,{}^{MJ}\!/_{kWh_{te}}$$

$$= \frac{3\times 10^2\ {}^{tonnes}\!/_{yr}\times 1000\,{}^{kg}\!/_{tonnes}\times 11.4\,{}^{Mj}\!/_{kg}}{18\,{}^{Mj}\!/_{kWh_e}}$$

$$= 1.9\times 10^6\ {}^{kWh_e}\!/_{year}$$

The total amount of electricity generated from this waste would be 1.9×10^6 kWh_e in a year.

Table 5: Types of waste present at collection points (by weight)

Point	Total weight (kg)	Tetra pack (kg)	Paper (kg)	Kitchen waste (kg)	Medical waste (kg)	Construction waste (kg)	Plastic (kg)	Poultry waste (kg)
1	10	0.1	0.1	8.8	-	-	1.0	-
2	10	0.3	0.2	8.2	-	-	1.3	-
3	10	-	0.4	6.6	-	-	-	4
4	10	1.0	0.2	7.6	-	-	1.2	-
5	10	0.5	0.5	5.0	-	3.0	1.0	
6	10	-	1.0	5.0	-	1.7	2.3	-
7	10	-	1.2	6.0	-	-	2.8	-
8	10	0.5	0.5	8.8	-	-	0.2	-
9	10	1.2	0.6	6.8	-	-	1.4	-
10	10	2.0	-	6.0	2	-	-	-
11	10	1.0	0.8	6.0	-	-	2.2	-
12	10	0.8	0.4	8.0	-	-	0.8	-
13	10	1.0	0.5	7.0	-	-	1.5	-
14	10	0.8	0.7	7.3	-	-	1.2	-
15	10	0.6	0.9	7.7	-	3	2.8	-
16	10	1.4	0.6	6.4	-	-	2.4	-
17	10	2.0	-	6.0	-	-	2.0	-
18	10	0.75	0.75	9.0	-	-	1.5	-
Total	180	13.95	9.35	117.4	2	7.7	25.6	4
Percentage of age	100	7.75	5.19	65.20	1.10	4.20	13.8	2.20

Table 6: Estimated high heating value (HHV) of MSW

Sites	Paper (%)	Metals (%)	Glass (%)	Food (%)	*PLR (%)	HHV (MJ kg^{-1})
Nawanshehr	5.19	-	18	65.2	13.8	9.62

*PLR: Plastic leather rubber

In Table 6 by using following equation, high heat value was calculated based on the weight percentages of paper, food fractions, plastic, leather and rubber:

$$\text{HHV (kJ kg}^{-1}) = 53.5(F+3.6\ CP)+372\ PLR$$

CONCLUSION

The SWM in Nawanshehr is not satisfactory. There is a strong need to create awareness at community and municipality levels about the solid waste segregation, collection and composting. The literacy rate of Nawanshehr town is above 95%, the community is very much concerned about the plight of waste dumping sites spread across the streets. Inorganic waste is mostly collected by scavengers and there is no existing practice of processing organic waste of various types, for composting or digestion to produce quality fertilizers for use in gardening and agriculture. It has been observed that animal manure is also dumped at the various dumping points. A better way of solid waste collection is to collect it from the doorstep of the houses. This involves reformation in the existing system of SW collection. A private entrepreneur is suggested which facilitate the SW collection, provision of SW collection bags to the residents and on-site training of anaerobic digestion of organic waste after it is segregated from the rest of waste. It has been observed that the number of sanitary worker is not sufficient. One worker should be deployed in every street with a wheel barrow.

Another important factor is the frequency of SW collection. It is necessary to collect waste on daily basis. It has been observed that due to lack of man power and community participation, in certain areas waste is collected after few days which creates a nuisance and is a risk of spreading diseases in the area. It is suggested that the number of collection points should be raised to at least 36, currently there are 18 points. It is suggested that service charges at house hold levels should be fixed with the willingness of the community. The operational and management costs of the SWM would be generated from these resources and the budget provided by the government.

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