Review of Arts and Humanities
March 2014, Vol. 3, No. 1, pp. 127-143
ISSN: 2334-2927 (Print), 2334-2935 (Online)

Published by American Research Institute for Policy Development

An Analytical Study oif Effect of Family Income and Size on Per Capita Household Solid Waste Generation in Developing Countries

Dr. Priya Grover[1] and Pavitra Singh[2]

Abstract

The rate of generation of household solid waste in the developing countries is increasing with an increase of population, technological development, and the changes in the life styles of the people which is posing a great environmental and public health problem. As family size and income are the most significant factors affecting the quantity of solid waste from household consumption, a study on the relationship among these is vital in the decision making on waste management strategies. Therefore, a study was conducted in Dehradun city to find out the correlation among residential solid waste generation, family size and income. This study covered 100 houses with different socioeconomic levels such as income level and family size. There were six components of solid waste; food waste, paper, polyethylene, plastic, glass and metal which were evaluated in this study. Based on monthly income, generation of food, paper, plastic and glass waste showed non-significant positive correlation while non-significant negative correlation was found with polyethylene waste. Further, residential waste generation such as food, paper, plastic and metal showed significant positive correlation with family size whereas generation of glass and polyethylene waste showed non-significant positive correlation with family size.

Keywords: Family size, Food waste, Income level, Plastics, Solid waste

1. Introduction

Solid wastes are the materials which arise from various human and animal activities and discarded as useless or unwanted (Rana, 2007).

[1] Assistant Professor(Senior Scale), College of Management & Economic Studies, University of Petroleum & Energy Studies, Dehradun, India. Email:pgrover@ddn.upes.ac.in, Contact no. 91-9897214320

[2] Research Assistant, College of Management & Economic Studies, University of Petroleum & Energy Studies, Dehradun, India. E-mail: pavitra@ddn.upes.ac.in, Contact No.:9634938211

Solid waste generation is an inevitable consequence of production and consumption activities in any economy (Eugenia et al., 2002). UNEP (2005) also reported that fast expansion of urban, agricultural and industrial activities spurred by rapid population growth has produced a huge amount of solid waste that pollutes the environment and destroy resources. Globally the per capita amounts of municipal solid waste generated on a daily basis vary significantly (WRI, 1996). Globalization can promote economic growth, a desirable outcome. However, this economic growth in addition to population increase and urbanization will seriously strain municipal resources to deal with booming amounts of wastes (Medina, 2002).

Solid waste generation depends on the economy of the people and level of income of the family or individual. Previous studies have shown that for every Indian, an increase in income by Rs. 1000 results in an increase of solid waste generation by one kilogram per month. It is a common observation that with an increase of economic growth the waste generation grows in an equal manner. Economic growth and waste generation have not been decoupled in both developing and industrialized world (Visvanathan & Trankler, 2006). Medina (2002) also reported that a positive correlation tends to exist between a community's income and the amount of solid waste generated. Wealthier individuals consume more than lower-income ones, which result in a higher waste generation rate for the former. Income and household size are the most significant factors affecting the quantity of solid wastes from household consumption (Richardson & Havlicek, 1974). Visvanathan & Trankler (2003) reported that in a family with rich socioeconomic condition, daily waste generation rates were generally higher than the lower socioeconomic families.

Solid waste disposal is one of the major issues in Manmunai North (MN) area of Batticaloa. NECCDEP (2008) reported that about 60 to 80 tons solid waste are generated per day in MN area and from this only 40 to 45 tonnes are collected for disposal. Enormous amounts of solid wastes are generated from various sources such as household, markets, commercial establishments and institutions including schools, hospitals and government offices in the MN area of Batticaloa. However, this study only deals with household sector in order to find out correlation between solid waste generation and socioeconomic factors such as income level and family size.

The principal hypothesis of this study is that residential waste generation increases with increasing family size and income.

Waste is unwanted or useless materials and it is directly linked to human development, both technologically and socially. Rapid population growth, urbanization and industrial growth have led to severe waste management problem in the cities of developing countries like India. The annual waste generation has been observed to increase in proportion to the rise in population and urbanization and issues related to disposal have become challenging as more land is needed for ultimate disposal of these solid wastes.

There has been a significant increase in the generation of municipal solid waste in India over the last few decades. The increase in the population and rapid income growth in India has changed the lifestyle of urban residents, thus changing the composition of the garbage generated. The characteristics of MSW Collected from any area depends on a number of factors Such as food habits, cultural traditions of inhabitants, lifestyles climate, etc; The income group of the society directly affects not only waste quantity but at the same time the quality of the waste.

2. Review of Literature

Rapid urbanization and unplanned township has created the major problem of solid waste collection, segregation and engineered waste management practices. The problem of waste management arises also due to the unsustainable consumption system typically developed countries. The migration of people from rural area to urban township leaded to create problems of disposal of waste and proper collection.

Pollution from Household Hazardous Waste (HHW)constitutes an acute problem. However, society economic growth and industrialization are considered as prototypes of modernization and economic progress. The so-called development has been established in the massive extraction of natural resources and an accelerated exploitation of the ecosystem. (Otoniel et al. 2008)

Bernache (2003) reported the household waste composition of Guadalajara metro areas of Mexico. According to him the majority of household waste comes from kitchen in the form of peelings, bones, seeds and other byproduct of food preparation processes starting from fresh products and raw ingredients. In terms of contribution of other waste the contribution was less than 15 % of the total waste production. According to Gupta et al. (1998) the waste composition depends on a wide range of factors such as habitats, culture tradition, lifestyle, climate and income etc.

Ojeda-Benitez et al. (2003) investigated the household waste composition and its characterization in a Mexican city. According to their findings the potentially recyclable organic component was the major component of household waste (57 %) followed by non-recyclable inorganic components (25.5 %), recyclable inorganic part (5 %), potentially recyclable inorganic part (4%). Nair and Sridhar (2005) reported the urban waste composition of Thiruvananthapuran, Kottayam and Palakkad town of Kerala. In all town wastes the biodegradable (organic waste) was the major component (of the total waste weight) of household waste ranging from 50. 5 % to 75.1% in different sampling locations. Other waste components like paper, glass scraps, textile, plastic and polythene, and metals were in the ranges of 8.7 – 25.64 %, 1.73 – 2.4 %, 0.67 – 2.6 %, 6.35 – 7.60 % and 1.12 – 2.2 %, respectively.

Similarly report by Municipal Corporation of Delhi (MCD, 2004) suggested the difference between income group of the society in terms of quantity and quality of waste generated. The overall sample analysis suggested that food waste as major component of household waste in all the three socioeconomic groups of the society which was about 58.4 – 76. 6 % of the total waste component. Other waste includes recyclable 15.7 % in low income group, 21.2 5 in middle income group and 23.1 % in high income group.

According to indiastat report (indiastate.com, 2009) the waste generated in Indian cities have high component of biodegradable items and that can be utilized effectively for compost preparations. But majority of such waste is either dumped in landfill sites or consumed by scavenges. In India 40 – 60 % of the total waste is of compostable

nature while the percentage of recyclable items is very low as these are picked up by the rag pickers from the houses (indiastat.com, 2009).

According to a report by TERI (2002) the biodegradable is the major proportion of municipal waste (38.6 %) followed by inert materials ((stones, bricks, ashes, etc. 34.7 %), non-biodegradable (leather, rubber, bones, and synthetic material, 13.9 %), plastic (6 %), paper (5.6 %) and glass and crockery (1.0 %).

The relative percentage of organic waste in municipal solid waste is generally increasing with the decreasing socio-economic status; so rural households generate more organic waste than urban households.

Sujauddin (2008) investigated the household waste characterization and management in Chittagong, Bangladesh. They reported waste generation rate in the ranges of 0.25 kg/capita/day to 1.3 kg/capita/day. According to them household waste was comprised of nine categories of waste with vegetable/food waste being the largest composition (62 %). The high income group and low income group showed great variations in terms of total waste generation and quality of the waste. In high income and low income group the component of vegetable/food waste was 47 % and 66 %, respectively of the total waste generated per day.

Thus literature of review clearly suggests that waste generation per capita in the country varied according to the population, region, geography, culture and climate.

3 Materials and Methods

3.1 Study Site

Dehradun, Capital of Uttaranchal state in India is also known as Doon valley and is situated at the foothills of Shivalik ranges in India. Dehradun city has an area of 67 Sq. Km. Dehradun is the administrative centre and the interim capital of the new state of Uttarakhand. Dehradun is situated at the Himalayan foothills in the fertile Doon Valley.

The Doon Valley has the Himalayas to its north, the Shivalik range to its south, the sacred river Ganga to its east and the river Yamuna to its west. The city of Dehradun is surrounded by river Song on the east, river Tons on the west, Himalaya ranges on the north and Sal forests in the south. Fig 1. The population of Dehradun is 4.48 lakhs as per Census, 2001. During 1981 to 1991 about 39.7 % increase in total population has been recorded. This could be due to migration of people from other areas due to formation of Dehradun as State's capital. The climate of this part is generally temperate and it varies greatly from tropical to severe cold depending upon the altitude of the area.The area receives an average annual rainfall of 2073.3 mm.

Most of the annual rainfall in the district is received during the months from June to September, July and August being rainiest. The winter months are colder with the maximum and minimum temperatures touching 23.4°C and 5.2° C respectively.

The Dehradun city is divided in several subzone and colonies. The city is divided into 45 wards. A total of 11 different colonies namely *Nala Pani, D. L. Road, Rishi Nagar, Adhoiwala, Karanpur, Kewal Vihar, Dharampur, Vijay Nagar, M.D.D.A colony, Sumanpuri* and *Vikas Lok* were selected to study the composition and characterization of solid waste; mainly generated from households. Fig 2.As per the Census 2001 the population of theses colonies varies from 7677 (Vikas Lok) – Adhoiwala (17028) (Table 1). The details of population and existing secondary storage facilities in these colonies are described in Table 2. The main secondary waste collection system is comprised of open, masonry, concrete and metallic containers. Fig. 3 In majority of sampling stations the masonry and concrete device has been for secondary waste deposits.

1. Population and total area of colonies selected for present study

S. No	Location	Pop as per census 2001	Area (Km^2)
1.	Nala Pani	11389	5.38
2.	D.L. Road	9178	0.33
3.	Rishi Nagar	8686	4.30
4.	Karanpur	8022	0.90
5.	Adhoiwala	17028	2.43
6.	Kewel Vihar	8403	0.98
7.	Dharampur	9913	0.39
8.	Vijay Nagar	8244	1.68
9.	M.D.D.A Colony	18023	4.41
10.	Sumanpuri	8118	0.40
11.	Vikas lok	7670	0.24

2. Secondary waste deposit system in colonies selected for present study

3.

Ward No.	Ward Name	Secondary Storage				
		Open	Masonry	Concrete	Metallic	Total
1.	Nala pani	4	Nil	4	7	14
2.	D.L. Road	3	1	Nil	4	8
3.	Rishi Nagar	2	Nil	2	Nil	4
4.	Karanpur	Nil	Nil	4	2	6
5.	Adhoiwala	4	2	1	1	8
6.	Keval Vihar	Nil	Nil	Nil	3	3
7.	Dharampur	2	4	2	Nil	8
8.	Vijay Colony	Nil	Nil	Nil	3	3
9.	M.D.D.A	4	Nil	Nil	12	16
10.	Sumanpuri	2	Nil	Nil	2	4
11.	Vikas lock	2	Nil	Nil	1	3

3.2 Sampling Methodology and data Collections

To carry out the survey, a total of 145 houses were selected randomly from 11 different colonies of the city. For waste collection houses were selected randomly from different location of the colony. Care was taken to cover almost all localities of a colony for waste collection program. In first step houses were marked for household waste generation data collections.

A detailed questioner was prepared to collect basic data about number of residents in per household, total income of the household, waste management options, disposal options, segregation facilities, waste recycling options etc.

After selecting houses for sampling, a large sized polythene bag of 5 kg was provided to each house who agreed to participate in the study. Residents of house were instructed to put their all garbage in the polythene bags provided by the researcher. The polythene bags were collected from houses and brought to the laboratory and each polythene bag was weighted individually in order to measure the total weight of household generated during that particular duration. After weighing waste was screened out using hand sorting method to separate the different fractions of the waste and each fraction was then weighted separately in order to get the data of waste fraction in each household's garbage. The obtained data were expressed in percentage of the total waste.

In initial screening houses were also separated in three socioeconomic groups: low income group, middle income group and high income group. The houses were identified in terms of socioeconomic status of the house and major criterion includes: annual income of household, building structure, locality of colony, availability of modern transportation and other luxury facilities in houses etc. A total of 35 houses for low income group, 67 for middle income group and 42 for high income groupwere selected for study of household waste generation in different socio-economic groups of the city.

The household waste diving into following main categories:

- Vegetable waste – Peeling waste, discarded vegetables, food waste, discarded food, seeds etc
- Paper – paper scrapes, packing papers, discarded papers from students bags etc.
- Plastic – plastic articles, polythene and other items made of primarily plastic
- Glass – scrape of glass, bottles, glass containers, broken kitchen articles made of glass and ceramics etc.
- Cardboards – non-recyclable paper, cardboards, cartons, etc.
- Others – metallic items, can, jars of metal, dirt and other inert material

3.3 Statistical Analysis

An analysis of variance was calculated in order to find out significant difference regarding the generation of the household waste among different household and different income group. Data were subjected for descriptive statistical analysis for production a range of statistical parameters like median, standard deviation, range and variance and Stem-and-Leaf Plots. SPSS® statistical package (Window Version 13.0) was used for data analysis. All statements reported in this study are at the $p< 0.05$ levels. Relationship between numbers of dwelling per household and total waste generation was calculated using simple correlation matrix.

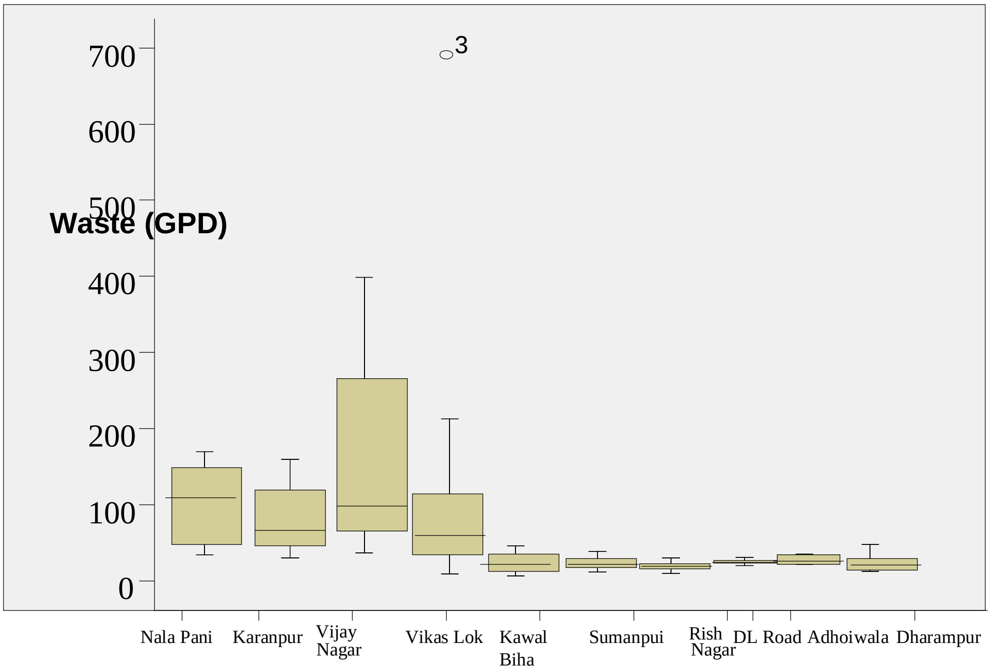
3. Per capita household waste generation in different localities of Dehardun city

S. No	Colony Name	Per Capita / Day (g)
1.	Nala Pani	101.34
2.	Karanpur	80.72
3.	Vijay Nagar	115.76
4.	Vikas lock	75.78
5.	Kawal Vihar	22.54
6.	Sumanpuri	23.29
7.	Rishi Nagar	19.63
8.	D.L. Road	24.62
9.	Dharampur	24.63
10.	M.D.D.A	18.53
11.	Adhoiwala	29.78

On the basis of average household waste generation data, the total household waste generation in that colony was also calculated. The quantity of household waste generated from Nala pani colony (1.5MT) followed by Vijay Nagar (1.241 MT), Karanpur (0.842 MT), Vikas lok (0.756 MT), Adhoiwala (0.659 MT), M.D.D.A colony (0.434 MT), Dharampur (0.317 MT), D.L. Road (0.294 MT), Sumanpuri = Kewal Vihar (0.246 MT) and Rishi Nagar (0.222 MT).

4. Human population and total household waste generation in different colonies in Dehardun city

Colony	Census 2001	Current population *	MT/Day	Annual waste generation (MT)
Nala Pani	11389	14805.7	1.500	547.6495
D. L. Road	9178	11931.4	0.294	107.2191
Rishi Nagar	8686	11291.8	0.222	80.90518
Adhoiwala	17028	22136.4	0.659	240.616
Karanpur	8022	10428.6	0.842	307.2558
Kewal Vihar	8403	10923.9	0.246	89.87202
Dharampur	9913	12886.9	0.317	115.8526
Vijay Nagar	8244	10717.2	1.241	452.8274
M.D.D. A colony	18023	23429.9	0.434	158.467
Sumanpuri	8118	10553.4	0.246	89.71287
Vikas lok	7670	9971	0.756	275.7949



5. Waste generation g/day in different colony

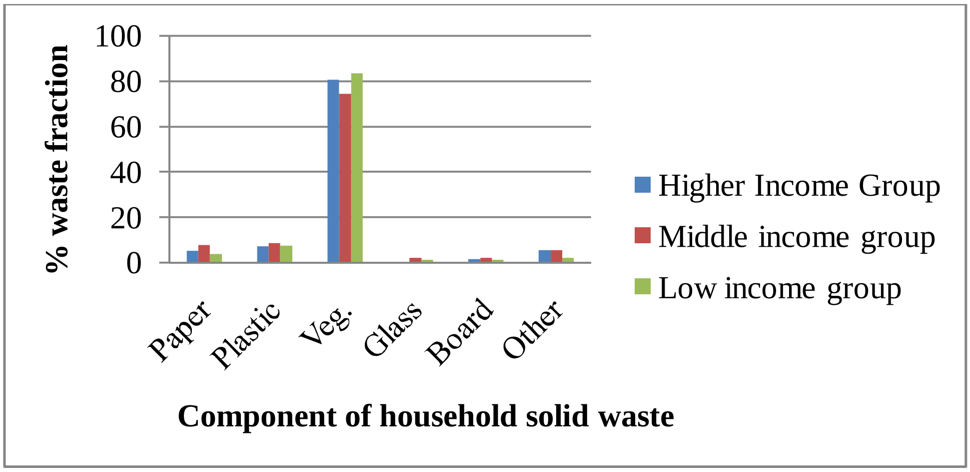
4.5 Waste Generation in Different Socio- Economic Group

Some colonies were classified on the basis of income of individual household. In higher income group, middle income group and lower income group 3, 5, and 3 colonies were selected to study the household waste generation and its characterization. Statistically, there was no significant difference among all the three socioeconomic groups for total waste production rate (waste in g/capita/month) (ANOVA, $F = 0.122$, $p = 0.887$). Per capita waste generation varied from 1.20 ± 0.93 kg/pc/month to 1.69 ± 1.54 kg /pc /month. The maximum waste generation was 1.69 ± 1.54 kg /pc /month in higher income group followed 1.49 ± 1.16 kg /pc /month by middle income group and 1.20 ± 0.93 kg /pc /month in lower income group.

Income wise group of society also showed great variations in terms of waste composition and characterization. The composition of waste collected from different sector of the society is described in Table 26. In all income groups the vegetable waste component (74.5 – 80.7 % of the total volume/weight) was dominant followed by polythene and plastics, and papers. In higher group the overall composition was: vegetable and food waste (80.7 %), paper and scrape (5.17 %), plastic and polythene (7.13 %), glass scrape (0.10 %), non-recyclable paper and cardboards (1.38 %), and miscellaneous items (5.47 %). In middle income group the composition of the waste was: vegetable and food waste (74.5 %), paper and scrape (7.97 %), plastic and polythene (8.69 %), glass scrape (0.89 %), non-recyclable paper and cardboards (2.22 %), and miscellaneous items (5.68 %). The low income group of the society showed slight variations for waste composition and household waste showed composition: vegetable and food waste (83.54 %), paper and scrape (3.96 %), plastic and polythene (7.66 %), glass scrape (1.03 %), non-recyclable paper and cardboards (1.42 %), and miscellaneous items (2.36 %).

6. Component of Household solid waste

S. No	Socio- Economic Group	Type of Waste%					
		Paper	Plastic	Veg.	Glass	Board	Other
1.	Higher income group	5.17	7.13	80.7	0.10	1.38	5.47
2.	Middle income Group	7.97	8.69	74.5	0.89	2.22	5.68
3.	Lower income group	3.96	7.66	83.54	1.03	1.42	2.36



7.The ranges of each waste fraction in household garbage described for high income group, (Total Houses = 42 and Total population = 185)

Items	Mean	Range	SD
Paper	12.75	0 – 195.6	19.0
Plastic	17.59	0 – 143.8	31.16
Vegetable	245.34	18.7 – 886	458.86
Glass	0.267	0 – 101.3	1.036
Board	3.41	0 – 147.6	19.17
Other	14.80	0 – 390	60.90

Statistical analysis clearly suggests a high range of standard deviation (SD) for different fraction of the waste in high income group in the city. For, example vegetable waste ranges form 0 – 886 g/pc/day. The ranges of different component of waste in high income group varied from 0 to 886 and SD for different waste fractions was 1.036 – 458.86.

8.The ranges of each waste fraction in household garbage described for middle income group, (Total Houses = 67 and Total population = 285)

Items	**Mean**	**Range**	**SD**
Paper	20.06	0 – 195.60	33.10
Plastic	21.88	0 – 143.80	29.63
Vegetable	186.34	0 – 886.70	238.69
Glass	2.39	0 – 101.30	13.60
Board	4.72	0 – 147.60	22.06
Other	12.67	0 – 390	53.32

In middle income group the major fraction of the waste, i.e. vegetable/kitchen waste varied from 0 to 886.7 g/pc/day while miscellaneous items also have major component in household waste from middle income group (12.62 ± 53.32).

9. The ranges of each waste fraction in household garbage described for low-income group, (Total Houses = 35 and Total population = 160)

Items	Mean	Range	SD
Paper	8.13	0 – 49.60	12.41
Plastic	15.71	0 – 125	25.29
Vegetable	171.27	0 – 831.30	204.67
Glass	2.11	0 – 73.90	12.49
Board	2.9	0 – 33.70	8.62
Other	4.84	0 – 80.20	14.23

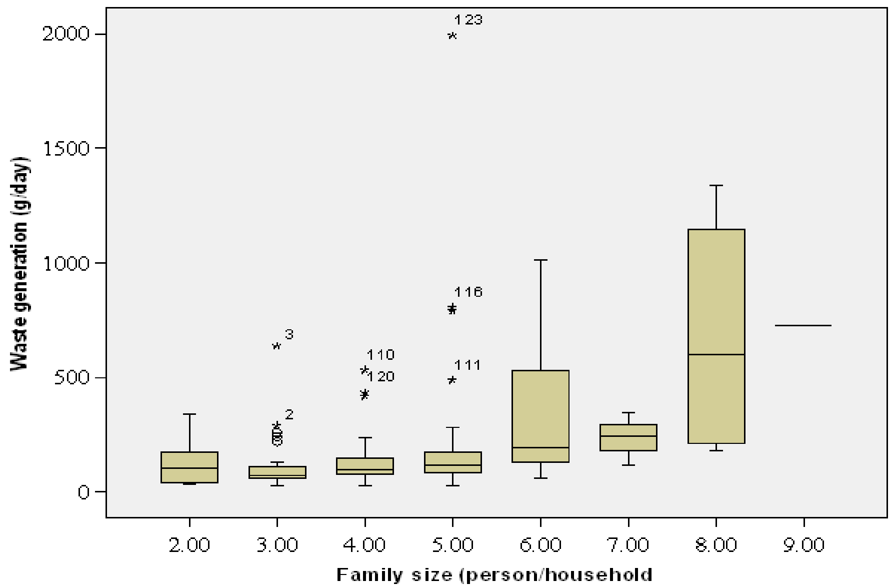
The low income group waste composition also varied from 0 to 831.3 g/pc/day. The major proportion was of vegetable waste 0 – 831.3 g/pc/day.

10 Table showing significant relationships between household waste generations and characterisations. (Number of person per house hold and waste generation ratio was also calculated for this study)

Persons / household	**Range**		**Mean**	**SD**	**Variance**	**95% confidence interval for mean**	
	Min	**Max**				**Lower bound**	**Upper bound**
2	33.90	339.50	129.1571	118.75	14102.5	19.32	238.98
4	25.50	532.40	136.97	118.00	13924.57	93.68	180.25
5	30.00	1993.00	240.74	381.67	145676.6	98.22	383.26
6	60.40	1014.60	342.93	314.49	98908.7	195.74	490.11
7	118.80	346.60	236.133	114.055	13008.57	-47.19	519.46
8	179.50	1340.40	680.825	564.189	318309.7	-216.92	1578.5

The majority of household have 5 to 6 persons/household. There was great variation in the quantity of waste generation in different family size in the city. The maximum average quantity of waste was 680.25 ± 564.19 g/pc/day in household with 8 family members followed by 342.9 ± 314.49 g/pc/day in household with 6 family members, 240.74 ± 381.67 g/pc/day in household with 5 family members, 236.13 ± 114.05 g/pc/day in household with 7 family members, 136.97 ± 118.0 g/pc/day in household with 4 family members and 129.16 ± 118.75 g/pc/day in household with 2 family members. The total waste generation in per family size category was high in household with 5 family members, i.e. 30 – 1993.0 g/day. On the other hand the difference between household with family size of 2 and 7 did not show significant variations in terms of the maximum value of total waste generation per day, i.e. 339.5 and 346.6 g/day, respectively.

11. Table showing family size and total waste generation per day



As described inFigure, the family size with 2, 5 and 6 showed great fluctuations in terms of total quantity of waste generated per day.

12. Table showing relationship between number of family members in per household and total waste generation pc/day

Conclusions

As the economy grows and the population becomes more urbanized, the substantial increase in use of paper and paper packaging is probably the most obvious change. The composition of municipal solid waste varies according to the cultural habits and economic status of the residents, urban structure, density of population, extent of commercial activity and climate. Information and data on physical components of the waste stream are important in the selection and operation of equipment and facilities, in assessing the feasibility of energy and resource recovery and in the design of a final disposal facility. Also, the physical component of household waste is always important for adaptation of further management practices. The high organic content indicates the necessity for frequent collection and removal, as well as having a good prospect of organic waste recycling through composting.

There are wide variations in magnitude of household management problems between cities with similar income levels. A well-managed city with medium or low income may be significantly different from a similar city with poor urban household management. Food, paper, plastic, metal and glass waste generation increases with an increasing income level whereas polyethylene waste generation decreases with increasing income level. Further, residential waste generation increases with increasing family size.Waste stream analysis, material balance and lifecycle assessment may be helpful in sustainable landfill management. Sustainable landfill management may not be possible in absence of complete understanding and required capacity enhancement along with financial support. Efforts should also be made to break the linkage of prosperityto waste generation.

Bibliography

Benjamin, B. & A. Mansoor. 2004. Sampling household waste at source. Journal of Waste Management and Research 22(3): 142-148.

Beukering, P. V. & M. Sehker. 1999 . Analyzing Urban Solid Waste in Developing Countries. A Perspective in Bangalore, Working Paper No 24, India. pp 46-67.

Duminda, K. & K. Prasansa. 2005. The problem of solid waste: A case study of the Maharagama local authority. Journal of National Science Foundation 33(1**):** 51-53.

Eugenia, C. B., N. Georgina & L. Ramil. 2002. Solid Waste Segregation and Recycling in Metro Manila: Household Attitudes and Behaviour. Resources, Environment and Economics Center for Studies, Philippines. pp 45-67.

Medina, M. 2002. Globalization, Development and Municipal Solid Waste Management in Third World Cities. Institute of Advance Studies, Mexico. pp 1-23.

National Research Institute. 2003. Municipal Solid Waste Management in Sri Lanka. Country Report, National Research Institute, Sri Lanka. pp 35-47.

North East Coastal Community Development Project. 2008. Preparation of Initial Environmental Examination Report and Detail Design for the Proposed Composting Plant and to the Improvement of Existing Dumping Site at Thirupperunthurai in Batticaloa District. NECCDEP. pp 1-5.

Rana, S.V.S. 2007. Environmental Pollution. Narosa Publishing House, New Delhi. pp. 81-84.

Richardson, R.A. & J. Havlicek. 1974. An analysis of seasonal household waste generation. Southern Journal of Agricultural Economics. 06(02): 143-153.

United Nations Environment Programme. 2005. Selection, Design and Implementation of Economic Instruments in the Solid Waste Management Sector in Kenya. United Nations Environment Programme, Nairobi. pp 157-163.

Visvanathan, C. 2006. Solid Waste Management in Asian Perspectives. Asian Institute of Technology, Bangkok pp 1-7.

Visvanathan, C. & J. Trankler. 2003. Municipal Solid Waste Management in Asia: A Comparative Analysis. Proceedings of Workshop on Sustainable Landfill Management, 3-5 December, 2003, Chennai. pp 3-15.

Visvanathan, C. & J. Trankler. 2006. Municipal Solid Waste Management in India : A Comparative Analysis. Asian Institute of Technology, Bangkok. pp 1-11.