Landscape Architecture and Regional Planning
2017; 2(3): 72-77
http://www.sciencepublishinggroup.com/j/larp
doi: 10.11648/j.larp.20170203.11

Waste Composition for Solid Waste Management and Its Characteristic Analysis, a Case Study

Won-Guk Kim, Nam-Chol O*, Hyo-Song Pak

Faculty of Global Environmental Science, Kim Il Sung University, Pyongyang, Democratic People's Republic of Korea

Email address:
ryongnam26@yahoo.com (Nam-Chol O)
*Corresponding author

To cite this article:
Won-Guk Kim, Nam-Chol O, Hyo-Song Pak. Waste Composition for Solid Waste Management and Its Characteristic Analysis, a Case Study. *Landscape Architecture and Regional Planning*. Vol. 2, No. 3, 2017, pp. 72-77. doi: 10.11648/j.larp.20170203.11

Received: July 4, 2017; **Accepted**: July 24, 2017; **Published**: August 15, 2017

Abstract: Today when the amount of waste increases and its fractions vary, establishing the integrated waste management system based on recycling, reuse and re-circulation technologies in terms of stabilization, minimization and recycling of waste is a crucial issue to properly solve in the environmental protection in the case study city (Pyongyang), as urban poplluation, production and consumption increase. Therefore this paper conducted the analysis for the amount of waste generation per fraction, its trend and treatment in the case study city, which is one of the primary issue to rationally improve solid waste management and successfully perform strategic waste management planning. Based on the analysis for disposals of solid waste generated in the case city, 50.2% of total amount of waste is recycled and reused, 0.3% is incinerated and 49.5% is landfilled. Percentage of recycling and reuse of industrial waste is high with 76.3%, but for household waste is low with 26.5%.

Keywords: Solid Waste, Characteristic Analysis, Waste Management, Composition of Waste

1. Introduction

The world Municipal Solid Waste (MSW) production is approximately 1300 million tons per year and it is estimated that, in 2025, the production will rise to 2200 million tons per year [2]. MSW refers to waste generated in households and waste similar to household waste generated in commercial activities, office buildings, institutions etc. [8]. The MSW has special features depending on numerous factors such as the types of residential and non-residential buildings and coverage of service facilities [1]. In general, geographical and seasonal considerations also influence the quantity and type of waste generated in different countries [4].

The quantities of waste are mainly measured by weighing vehicles delivering the waste to landfills or to sorting and composting facilities [1].

Globally, MSW is usually managed in four major ways: recycling, composting, landfilling, and waste to energy [4].

Composting is an ancient strategy to recycle a variety of organic wastes. It can be considered a biotechnological aerobic process where during the first phase (active phase) microbial communities transform and partially mineralize the most easily biodegradable materials of organic matter present in the raw materials [9]. The treatment of biological waste by composting is a growing practice that enables the production of organic amendments rich in stabilized organic matter [6].

MSW treatment has become an increasingly intricate societal problem, because the conventional landfilling method has not only occupied precious land resources but also leads to serious contamination of soil and groundwater [10]. Landfills represent an active anaerobic ecosystem in which a portion of the organic biodegradable fraction of waste is converted to methane and carbon dioxide by anaerobic microorganisms. The major biodegradable components of MSW include paper, yard waste and food scraps. There is also growing interest in the acceptance of non-hazardous industrial waste in MSW landfills [7]. The space available for landfill is decreasing in major cities, and the methane produced by landfilled MSW, green waste and biosolids are now recognized as a significant, long-term source of greenhouse gas emissions. The waste management industry now recognise opportunities in converting the energy in urban waste streams to renewable energy products [4].

To achieve a sustainable waste management approach, the waste hierarchy has been proposed, which includes recycling or reuse and energy from waste [5].

Results of analysis for composition of MSW can be important starting point for decisions determining proper ways

of resolving problems in the field of waste management [1].

Accurate and reliable data on waste composition are crucial both for planning and environmental assessment of waste management as well as for improvement of resource recovery. To develop the waste system and improve technologies, detailed data for the material characteristics of the waste involved are needed [3].

Waste management planning needs reliable data concerning waste generation, influencing factors on waste generation and forecasts of waste quantities. MSW management systems are becoming more complex in many countries, and particularly waste management agencies need waste compositional information to plan, organize, develop, implement and observe waste management schemes [11].

This study aimed at conducting the analysis for the amount, its compositions and treatment methods of solid waste in Pyongyang.

In the case city, approximately 1560 t of industrial waste and 1680 t of household waste per day are generated from the industrial, commercial and household sectors.

Therefore in the case city, it is important to take measure that collection, transportation and treatment systems for household waste and industrial waste are reasonably set up and the waste is effectively used as materials by establishing a circular cycling system adding processes and facilities of recycling and reuse of solid waste.

2. Generating Amounts of Solid Waste

Economic and human activity in the case city have resulted in an increase in production of products as well as waste. Therefore, there is an urgent need to ensure safe disposal or treatment of waste and appropriate reuse and recycling.

Waste generated in the case city can be broken down into industrial, municipal and hazardous waste.

Industrial waste comes from mining, metal, machine, electric power, coal, chemical, rubber, plastics manufacturing, textile, paper and lumber, foodstuff and building materials industries, and agriculture. Hazardous waste includes toxic materials and biohazard waste from hospitals.

Municipal waste includes domestic waste, enterprise waste, and public waste. Domestic waste derives from daily-use activities, while enterprise waste comes from office-cleaning, fuel combustion, maintenance and repair and public service. Public waste is generated from cleaning yards, roads, land and public places. The amount and composition of waste vary regionally according to the population, season, social habits and dominant fuel use.

According to the investigated data in the period of 2009~2010, the the case study city generates 1 178 600 t of solid waste per year from residential areas and public agencies, which are namely 613 600 t of household waste and 564 000 t of industrial solid waste averagely (table 1). Generating proportions of household and industrial wastes per fraction are presented in figure 3 and 4 respectively.

Table 1. *generating amount of solid waste in the case city.*

Type	Household waste	Industrial waste	Total
Generating amount (10 thousands t/a)	61.37	56.49	117.86
Proportion (%)	52.07	47.93	100

Table 2 shows the composition of MSW in the case city. Most of the MSW is composed of coal ash and combustion residue because households use coal for heating and cooking. This generates a large quantity of coal ash and combustion residue, the volume of which increases substantially in the colder winter months (fig. 2). The rest of MSW is composed of fruits and grains, metal, paper, plastics, glass etc.

Table 2. *Generating amounts of solid waste per fraction.*

No.	fractions	Household proportion (%)	Industrial proportion (%)	Total proportion (%)
1	plastics	1.39	0.10	0.77
2	coal ash		54.96	26.34
3	sewage sludge		8.33	3.99
4	combustion residue	68.37	1.45	36.30
5	paper	3.39	0.07	1.80
6	wood	0.79	0.02	0.42
7	textile	1.13	0.12	0.65
8	glass, pottery	0.85	0.17	0.52
9	mixed organic waste	16.95	1.92	9.74
10	slag		4.32	2.07
11	rubber	0.91	0.01	0.48
12	metal	3.76	0.10	2.01
13	oil		0.03	0.01
14	construction residue		0.11	0.05
15	crop residue	2.46	22.62	12.12
16	stockbreeding waste		5.37	2.57
17	others		0.30	0.15
total		100.00	100.00	100.00

2.1. Household Waste

Most of household waste generated in the case city is being transported to waste landfill sites located in the suburb.

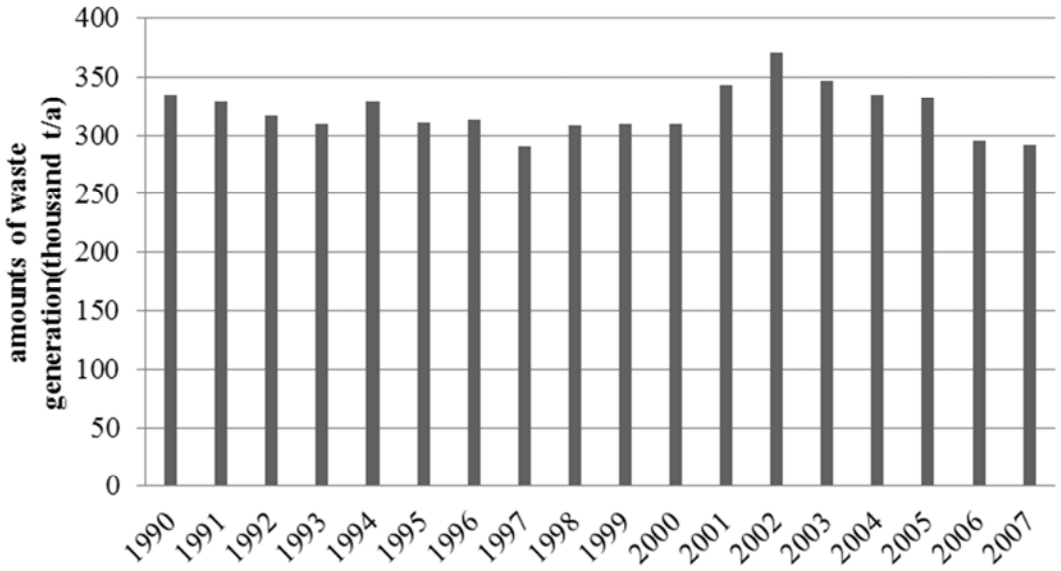

Figure 1. *Changing trend of generating amounts of household waste (annual).*

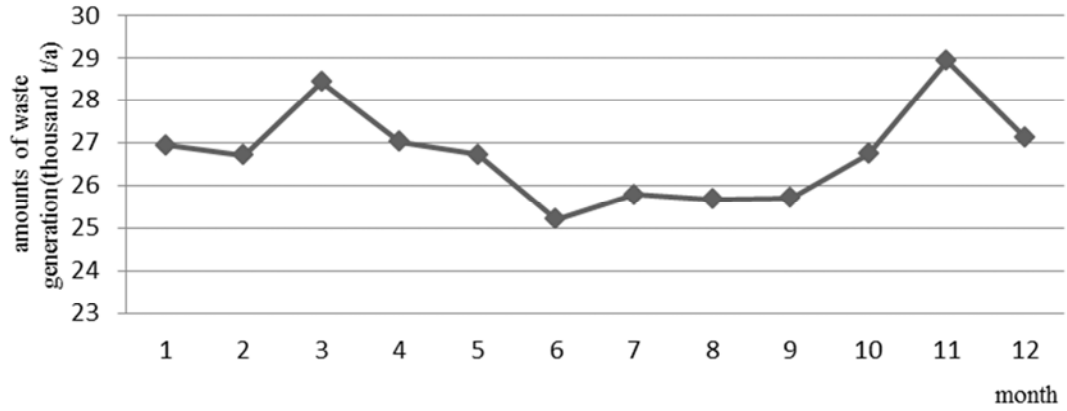

Figure 2. *Change of amounts of household waste generation (per month).*

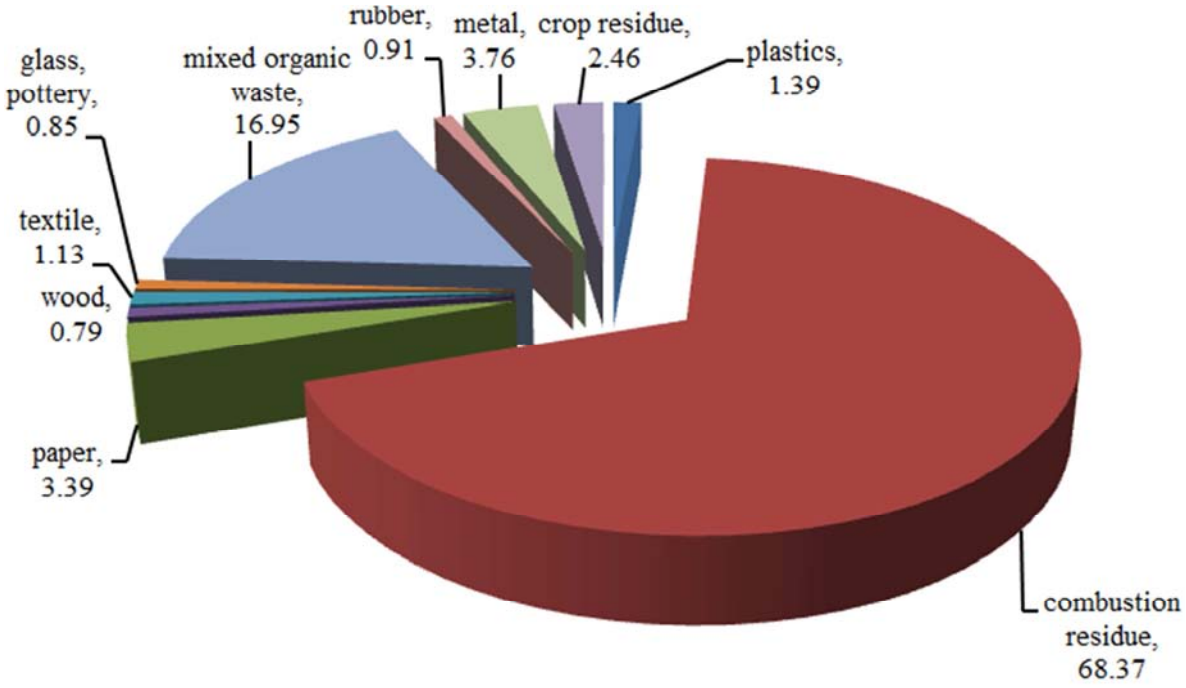

Figure 3. *Generating proportion of household waste per fraction (%).*

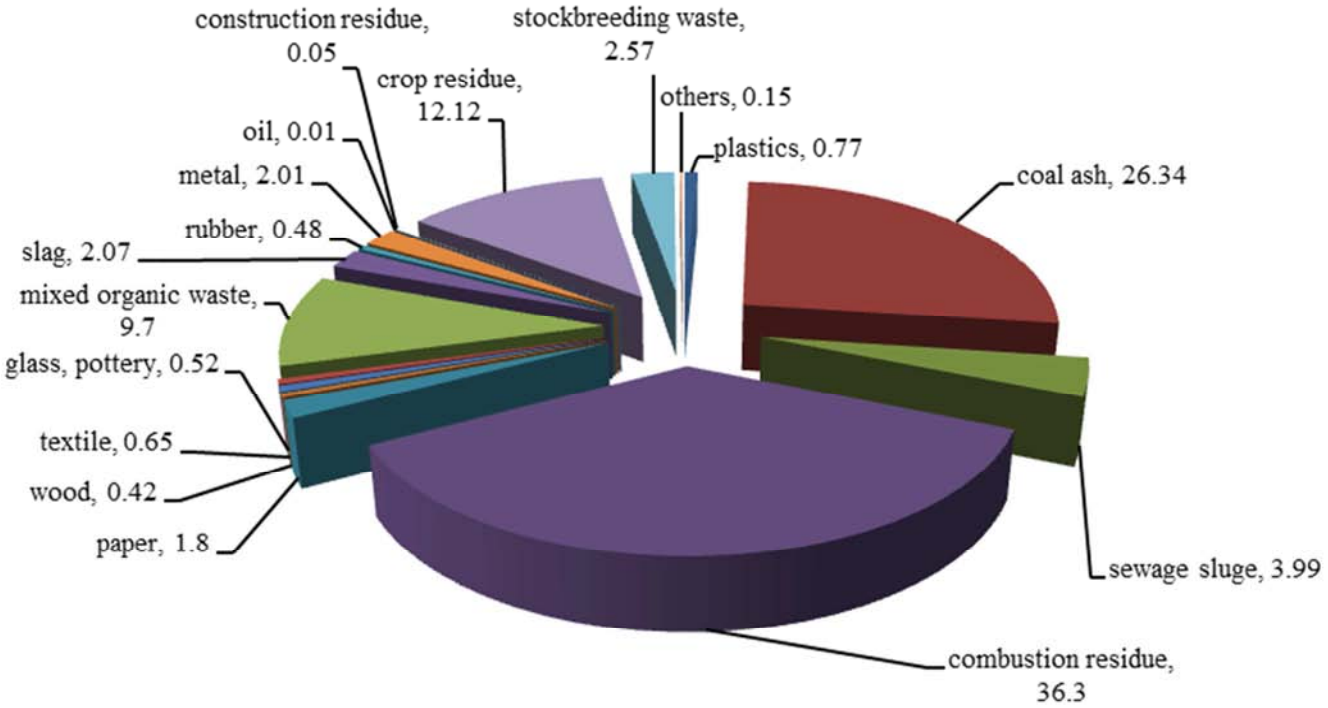

Figure 4. *Generating proportion of industrial solid waste per fraction (%).*

Figure 1 shows the change trend of generating amounts of household waste in the period of 18 years, 1990~2007. According to the figure, the amount of waste was high in the period of 2001~2005 and was decreased from 2006 and 2007.

Figure 2 shows the monthly change of amount of household waste generation. The amount of waste generation is high in the period of October~March because this period lead to a lot of coal ash. The generation of waste peaks in November due to the large amount of coal ash and by-products of vegetable use.

2.2. Industrial Waste

Most of industrial waste generated in the case city includes coal ash and slag from boilers and furnaces. The mainly generating sectors of industrial waste belong to electric, metal, machine, agriculture, stock-breeding sectors. Generating proportion of industrial solid waste per fraction is presented in table 2 and figure 4.

Industrial waste similar to household waste belongs to higher proportions of combustion residue (36.3%), coal ash (26.34%), crop residue (12.12%) and mixed organic waste (9.7%).

3. Treatment and Disposal of Solid Waste

Based on the analysis for the diposals of solid waste generated in the case city, 50.2% of total amount of waste is recycled and reused, 0.3% is incinerated and 49.5% is landfilled. Percentage of recycling and reuse of industrial waste is high with 76.3%, but for household waste is low with 26.5% (table 3).

Industrial, domestic and hazardous waste are treated, disposed of, or recycled according to regulated procedures and methods. Industrial waste is to be recycled or reused as a rule. Waste generated at production sites is collected and sorted for use in the manufacturing of recycled products or mixed with raw materials to produce other products. Hazardous waste, such as heavy metals, are strictly controlled by national level regulations (table 4). Hospital waste is collected and burnt in incinerators at hospitals to prevent contamination of other waste and the spread of infection.

Under an integrated system, MSW is collected and disposed of, or recycled, in landfill sites and fertilizer production plants. The collection and disposal system requires reusable waste to be sorted and sent to the appropriate processor for recycling or reuse.

Reusable materials include paper, glass, iron, rubber, cloth, plastics, bottles, and non-ferrous metals.

The recycling and reuse of waste are currently constrained by the lack of appropriate technologies. The recycling and reuse system reduces the burden on municipal waste disposal, which conserves scare natural resources, minimizes the expansion of landfill sites and lowers production input costs. The system is based on voluntary public participation.

Coal ash is used as an input in the production of new building materials but is also mixed into soils to reduce acidity and improve physical qualities of the soil.

Organic waste and sewage se are used to produce mulch, often without being treated. These practices have the potential to result in chemical and bacterial contamination of agricultural soils. Soils closer to industrial areas and those that receive higher amounts of ash and organic amendments from municipal and industrial waste streams have higher levels of contaminants. Direct use of organic waste gives rise to foul odors in addition to posing a risk of contamination of the soil and groundwater. Landfilling of solid waste is likely

to cause surface and groundwater pollution.

Table 3. *Disposal proportion of solid waste.*

type	Landfilling proportion (%)	Incineration proportion (%)	reuse and recycling proportion (%)	Total proportion (%)
household	72.90	0.60	26.50	52.07
industrial	23.66	0.04	76.30	47.93

Table 4. *Disposal proportion of industrial waste per fraction.*

No.	fractions	disposal methods		total	Proportion (%)
		reuse and recycling proportion (%)	Landfilling (dumping) proportion (%)	Incineration proportion (%)	
1	plastics	57.4	31.5	11.1	0.1
2	combustion residue	59.3	40.7		56.4
3	sewage sludge	95.6	4.4		8.3
4	paper	96.3	3.7		0.1
5	wood	66.7		33.3	0.02
6	textile	17.1	77.1	5.7	0.1
7	glass, pottery	88.8	11.2		0.2
8	mixed organic waste	99.5	0.5		1.9
9	rubber	80		20.0	0.01
10	metal	100			0.1
11	oil	31.3	18.8	50.0	0.03
12	slag	100			4.3
13	construction waste		100		0.1
14	crop residue	100			22.6
15	stockbreeding waste	100			5.4
16	others	70.8	29.2		0.3
	total	76.3	23.6	0.04	100

4. Conclusion

The environmental agencies to be responsible for MSW management have taken following measures to establish a waste management system and to promote the recycling and reuse of materials in the case city.

These measures include:

1) establishing a legal framework for waste management including the formulation of detailed regulations and standards for different types of waste,

2) creating an integrated management system for MSW,

3) developing and applying waste recycling technologies,

4) generating energy and fertiliser from waste,

5) establishing environment management systems in factories and enterprises to reduce resource consumption and waste and stimulate recycling,

6) conducting scientific research and development improving the system for collecting, sorting, transporting and disposing or treating domestic waste and encouraging environmentally safe landfill,

7) improving environmental monitoring of the disposal and treatment of waste,

8) disseminating information on appropriate waste management by means of mass media and public awareness activities.

5. Further Research

The investigated result for waste compostion in the case city is an essential source which leads to map out and perform a plan of waste management.

Based on the analysis result of waste composition, the further research is to focus on planning advanced waste management and conducting the comparative assessment of environmental impact potentials by environmental life cycle assessment between the existing waste management options and the planned options.

References

[1] Boer, E. D., 2010. A review of municipal solid waste composition and quantities in Poland. Waste Management. 30, 369–377.

[2] Campuzano, R., González-Martínez, S., 2016. Characteristics of the organic fraction of municipal solid waste and methane production: A review. Waste Management 54, 3-12.

[3] Edjabou, M. E., et al., 2015. Municipal solid waste composition: Sampling methodology, statistical analyses, and case study evaluation. Waste Management 36, 12-23.

[4] Hla, S. S., Roberts, D., 2015. Characterisation of chemical composition and energy content of green waste and municipal solid waste from Greater Brisbane, Australia. Waste Management 41, 12–19.

[5] Peddireddy, S., Longhurst, P. J., Wagland, S. T., 2015. Characterising the composition of waste-derived fuels using a novel image analysis tool. Waste Management. 40, 9–13.

[6] Peltre, C., Dignac, M. F., Derenne, S. Houot, S., 2010. Change of the chemical composition and biodegradability of the Van Soest soluble fraction during composting: A study using a novel extraction method. Waste Management 30, 2448–2460.

[7] Sadri, A., et al., 2010. Effect of an acidic and readily-biodegradable non-hazardous industrial process waste on refuse decomposition. Waste Management. 30, 389–395.

[8] Sahimaa, O., et al., 2015. Method for residual household waste composition studies. Waste Management. 46, 3–14.

[9] Silva, M. E. F., et al., 2016. Comparison of the bacterial composition of two commercial composts with different physicochemical, stability and maturity properties. Waste Management. 50, 20–30.

[10] Zhang, J., et al., 2015. TG-MS analysis and kinetic study for thermal decomposition of six representative components of municipal solid waste under steam atmosphere. Waste Management. 43, 152–161.

[11] Zorpas, A. A., et al., 2015. Household waste compositional analysis variation from insular communities in the framework of waste prevention strategy plans. Waste Management. 38, 3–11.