Abandoned Landfills in Indonesia and Their Problems

Marisa Mei Ling · Junboum Park*

Civil and Environmental Engineering, Seoul National University, Seoul 151-742, Republic of Korea.

ABSTRACT

This paper presents current condition of landfills in Indonesia and the problems exist. It also presents a review of study on abandoned landfill in Bandung, West Java where the actual problems can be seen and an insight to the solutions were developed.

Key words : landfills, solid waste, landslide wastes, Leuwigajah landfill

1. Introduction

With a population of more than 240 million people (growth rate at 1.3% per annum), Indonesia is the fourth most populous country in the world. Indonesia is also the largest archipelago with more than 17.000 islands of which 6.000 are inhabited. 60% of Indonesia's population resides in Java Island. Fig. 1 shows the map of Indonesia.

Indonesia's development has been led by the rapid growth of the manufacturing industry, particularly before the economic crisis in 1998 with more than 70% of the industries was located in Java. Hence, Java Island is a major generator of wastes. According to the survey by Indonesian State Ministry of Environment in 2006 (http://www.klh.go.id), the total amount of waste generation in Indonesia was estimated as 39 million ton/year (Table 1). The largest amount of waste was generated in Java Island where the population density is the highest of all.

In large cities in Java Island such as Jakarta (the capital city of Indonesia), Bandung (West Java Province), Semarang (Central Java Province), Surabaya (East Java Province), as well as in major tourists destination of Denpasar (Bali Island), the major sources of municipal solid waste are households, industrial, commercial, and market (traditional and modern shopping centers) areas. Fig. 2 shows the composition of solid waste in Java Island.

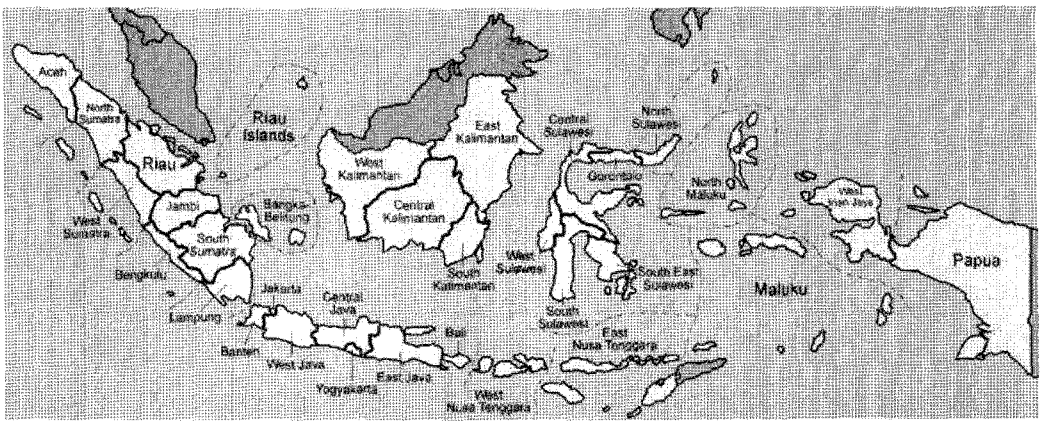

Fig. 1. Map of Indonesia (divided into provinces).

*Corresponding author : junbpark@snu.ac.kr

원고접수일 : 2009. 8. 1 심사일 : 2009. 8. 3 게재승인일 : 2009. 8. 26
질의 및 토의 : 2009. 10. 31 까지

Table 1. Estimation of waste generation in Indonesia

Group area	Population (million person)	Waste Generation (million t/year)
Sumatera	15.4	8.7
Jawa	64.6	21.2
Balinusra	4.1	1.3
Kalimantan	4.9	2.3
Sumapapua	4.9	5.0
Total	93.9	38.5

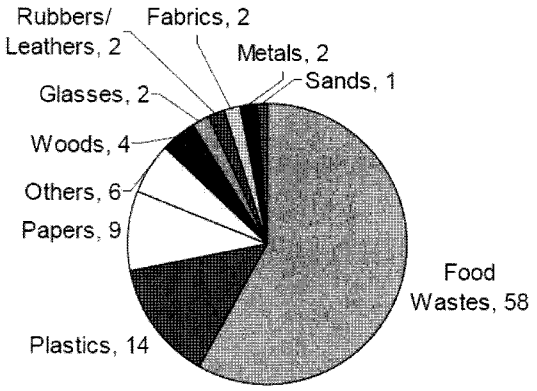

Fig. 2. Average composition of solid waste in Java Island.

Wastes need area to dispose of, therefore landfills sites were developed. However, the implementation and operation of landfills system has been a big problem in Indonesia. This paper aims to describe current condition of landfills in Indonesia, highlight their most salient problems, present a literature review of a study conducted in Leuwigajah landfill site in West Java Province where detail of existing problems at abandoned landfill can be seen and an insight to the rehabilitation plan is provided.

2. Overview of Landfills Sites Condition in Indonesia

Most of the time, in Indonesia, the wastes are just abandoned or if those are managed, they will finally dump at an open dumping site. Open dumping is a basic type of landfilling where waste is disposed of in open sites such as waste land, valleys, or marshland. The waste is not covered and waste water is not treated. Fig. 3 shows an example of open dumping practice in Surabaya (East Java Province).

Fig. 3. An Open dumping practice in Surabaya (Source: Hideo Azuma, 2007).

Fig. 4. Sanitary landfill in Jakarta, Indonesia (Source: Shoichi Hayami, 2007).

Open dumping poses a serious threat to the health of the people living near landfills and results in such problems as odors, breeding of rats and insects, water pollution, and fires. The methane released by decaying organic waste contributes to greenhouse gases that damage the ozone layer and create health risks for the human population.

Another landfill practice in Indonesia is sanitary landfill. This type of landfill covers wastes with soil (Fig. 4). A sanitary landfill is effective in controlling odors, insects and animals, and fire; however sanitary landfills have only been developed in large cities such as Jakarta (Johannessen et al. 2005).

According to the report of the Indonesian State Ministry of Environment in 2006, the total number of landfills (open dumping and sanitary landfill) in

Table 2. Number of landfills in Indonesia divided into group area

Group area	Number of landfills
Sumatera	57
Jawa	75
Balinusra	11
Kalimantan	19
Sumapapua	17
Total	179

Indonesia is 179 sites. Among them, 98% of all landfills are active. It is found that the number of landfill has a correlation with the total amount of waste generation. The number of landfills in Java, which is 75 sites, is the largest of all. Table 2 shows the number of landfills in Indonesia divided into group area. In many cases, active landfills cause a lot of problems for people who live around them. Rotting waste on landfills produce gases that are not only polluting the air and dangerous to the lungs but also is highly explosive. This had actually happened in a landfill in Bandung (West Java Province) around ten years ago. Toxic water out of the landfill flowed into the surrounding and poisoned the water. Hundreds of people died both from the explosion and from the water poisoning.

In Semarang (Central Java Province), previously five landfill sites were operated. Four have been closed because their capacity has been exceeded or were not being managed properly. The only landfill site being operated, covering an area of 45 ha, operated since March 1992, and reached its capacity in 2000. There were many problems at the landfill site because waste was being dumped directly over the edge of a very steep, almost vertical slope. Although compaction was taking place, the waste was not being covered with soil regularly. The area was breeding ground for rodents, flies, and other pathogenic microorganisms. A leachate treatment plant has also been in operation since August 1993, but its performance was poor resulting in public complaints over surface water contamination to a nearby stream in late 1994. During the dry season, fires often break out owing to the emission of methane gas (Supriadi et al. 2000).

Enormous quantities of generated municipal solid waste

Fig. 5. Active and abandoned landfills: steep, uncovered slope (Source : Shoichi Hayami, 2007).

have made it difficult to find sites for making new landfills. As a result, existing landfill sites are used beyond their capacity. Wastes may accumulate very high to cause geotechnical problems like slope stability. Fig. 5 shows abandoned landfill with steep and uncovered slope conditions that continues to use as dumping site.

In many developing countries around the world, communities exist in and around landfills. Migrants from rural areas in search of employment, they lived in an area adjacent to the landfill, a section that was used to sort recyclable materials for sale to the recycling industry. According to the World Bank Report in 2008, at Bantar Gebang landfill in Bekasi, West Java, approximately 640 waste pickers were officially registered by the landfill operator. Interfering with the operation of the landfill, the waste pickers set fires to recover metals and other non-combustible materials and waste truck traffic. The majority of waste pickers worked without proper protection, sometimes lacking basic protection such as shoes.

The government of Indonesia admits that it has been unable to solve the solid waste management crisis that the country faced. Inconsistency policy in handling municipal waste exists in Indonesia. Municipal solid waste is still not become an important priority in local government policy. Limited budget for handling municipal waste has caused the limitation of investment, operational, and maintenance of sanitary facilities and caused difficulty in increasing quality and quantity in sanitary services. Local government has not yet been

able to develop a proper final disposal sites that consider sanitary and environmental aspects. It is only very recently that landfills in Indonesia are being looked at by the government and also the private sector. This is because of the emerging carbon credit market in the global economy. By managing the landfills and capturing the gas coming out of the waste and polluting the air, emission from the landfills is reduced. The reduction can be sold as carbon credit. This carbon credit market is hopefully changing the face of landfills in Indonesia and also the quality of life of the people living surrounding them.

3. A Review of an Abandoned Landfill Site in Bandung, West Java

3.1. Background

Bandung city located in West Java Province is inhabited by 6 million populations in 2008. In Bandung, Leuwigajah landfill has been the biggest and the most important site for dumping wastes. It appears that all kinds of municipal waste of the city were simply dumped without incineration or separation. Hence, organic waste and plastics are mixed in the fill. The landfill was constructed since 1992 by simply dropping garbage from the top over the edge and poor compaction was made by crawlers. According to the data of Environmental Protection Agency of West Java in 2004, Leuwigajah landfill site of total area 25.1 hectare received more than 4,000 m^3/day of waste from three municipalities (Bandung City, Cimahi City, and Bandung Regency). Although the initial design was for sanitary landfill, Leuwigajah landfill is operated as open dumping. Consequently, operation of landfill did not consider environmental best practices into account, such as leachate treatment. Fig. 6 depicts untreated leachate from Leuwigajah landfill, polluting water and vegetation.

On 20th February 2005, after two days of heavy rain, a tremendous landslide occurred at Leuwigajah landfill. The quantity of collapsed waste was about 3.1 million m^3, the flow distance was maximum 950 m, and the area covered by the wastes was about 75 ha (Fig. 7). The disaster at Leuwigajah landfill claimed more than

Fig. 6. Untreated leachate from Leuwigajah landfill, polluting water and vegetation (Source: GBWMC, 2004).

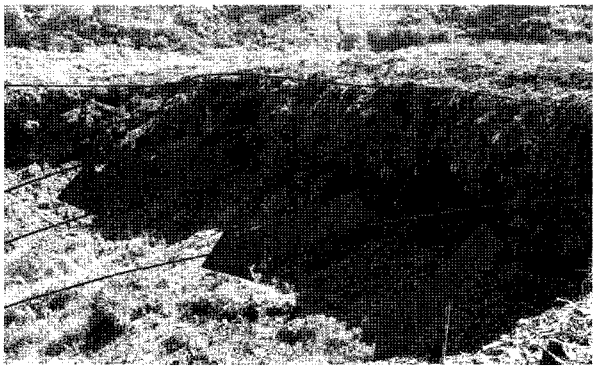

Fig. 7. Landfill sliding at Leuwigajah (Source: Azuma et al, 2007).

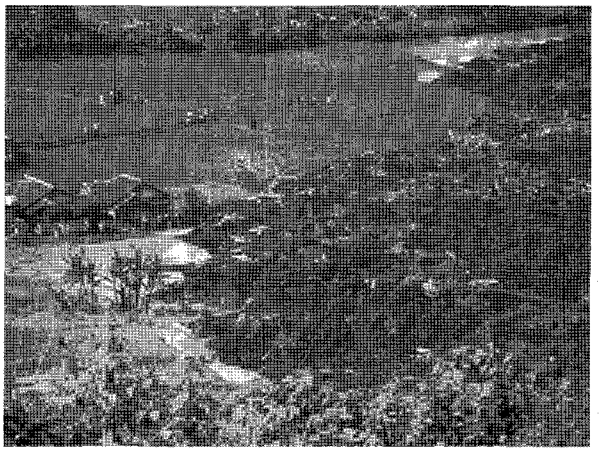

Fig. 8. Leuwigajah landfill landslide disaster (Source: Environmental Protection Agency of West Java, 2005).

140 lives, destroyed hundreds of houses and ruined acres of productive paddy fields (Fig. 8). After the landslide, the environmental impact from the landslide wastes was serious, such as odor, vermin, scattering

wastes, water pollution by leachate and the daily household wastes had no where to be disposed and piled up around the cities.

The Indonesian authorities had sought a new site, however, it was quite difficult to secure final disposal site. Consequently restoration and reuse of the collapsed Leuwigajah landfill for site disposal has been adopted. Within the construction of new landfill, the rehabilitation program of Leuwigajah landfill was finalized by Environmental Protection Agency of West Java Province in 2007.

3.2. Outline of site condition

3.2.1 Site location

Leuwigajah landfill situated in a narrow valley whose original gradient was 5-10% and its subsurface conditions consisted of bedrock covered by 1-m thick clay. The dumped landfill formed a waste deposit of 60 to 70 m in thickness. Leuwigajah landfill is located in Cimahi city, which is 12 km west of the center of Bandung City (Fig. 9). After the landslide in 2005, the landslide waste reached to an open (paddy) field at the foot of a mountain as long as 600 m. Even though, the thickness of the landslide can not be calculated because there were no boring data and maps before the landslide, the thickness of the landslide wastes can be estimated as 15 m to 20 m by visual checking. Topographic condition of Leuwigajah landfill is shown in Fig. 10.

3.2.2. Meteorological conditions.

The daily observation data of rainfall, temperature, sunshine duration and evaporation over 10 years (1998-2008) are collected in the observation point Bandung Meteorological Station which is nearest point from Leuwigajah landfill site. From the data, the average, maximum, and minimum of annual rainfall are recorded. The maximum monthly average of rainfall is also recorded. It is noted that in 2006, the monthly averages rainfall from November to April are more than 200 mm. On the contrary, monthly averages from June to September are less than 100 mm.

At the same time, the monthly average of temperature was recorded as around 23°C throughout a year. The

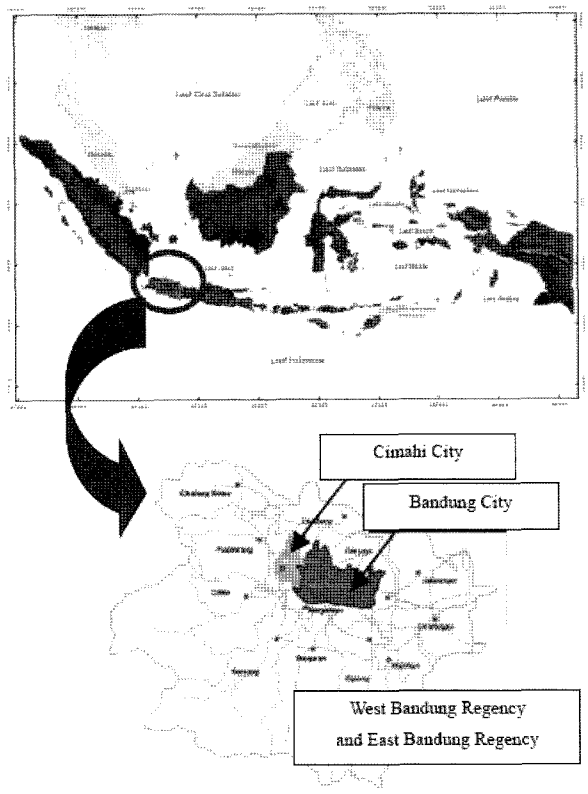

Fig. 9. Location of Leuwigajah landfill (Source: Yachiyo Engineering, 2009).

variation of temperatures is relatively small within mild climate. The annual average of sunshine duration is 1,725.6 hr. The maximum annual average is 1,962.3 hr recorded in 2006 and the minimum annual average is 1,603.4 hr recorded in 2003. The maximum monthly average is 190.7 in August and the secondary is 183.5 hr in July. The monthly averages during dry season (from June to September) are more than 160 hr. Conversely the monthly averages during rainy season (from October to May) are less than 160 hr. The annual average of evaporation is 1,182.6 mm. The maximum annual average is 1,397.0 mm recorded in 2006 and the minimum annual average is 1,032.0 mm recorded in 2001. The maximum monthly average is 119.2 mm in September and the secondary is 114.3 mm in August. The minimum monthly average is 88.6 in April and the secondary is 88.7 in June.

The comparison between each monthly average of rainfall and evaporation concludes that little leachate would probably generate during dry season because the

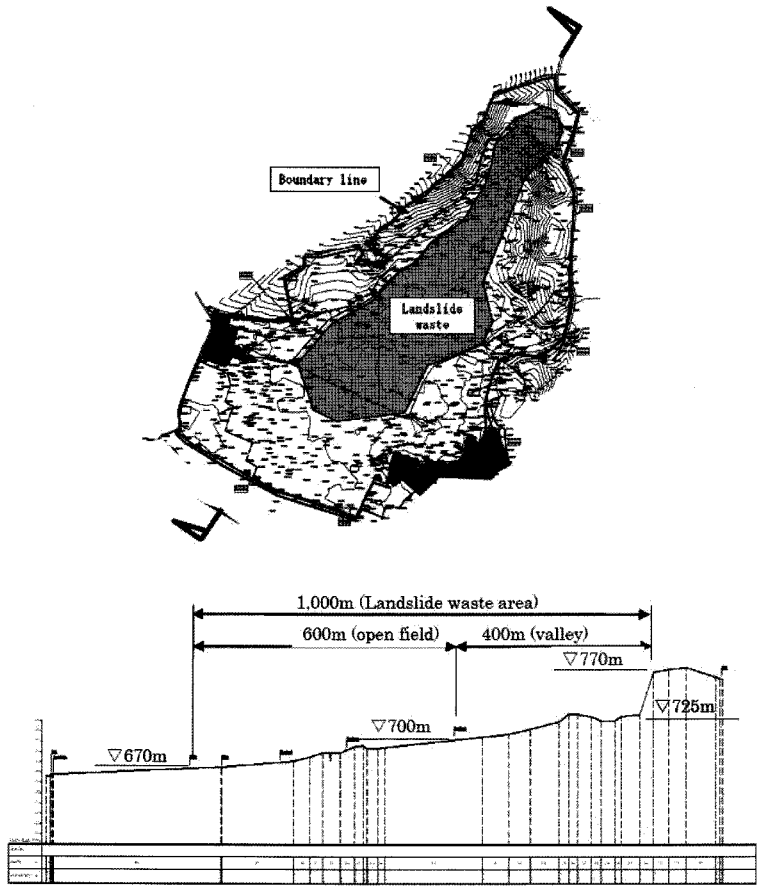

Fig. 10. Topographic condition of Leuwigajah landfill (Source: Yachiyo Engineering, 2009).

evaporation exceeds the rainfall. On the contrary, much more leachate would generate during rainy season because the rainfall is twice as large as evaporation.

3.2.3. Hydrological conditions.

There are 3 swamps around Leuwigajah landfill, namely Leuwigajah, Cireundeu Village, and Pojok village. From each swamp, rain water, spring water, miscellaneous waste water and leachate are mixed together and flow through channels to the open field of down stream. The channel from the swamp in Cirendeu Village extends from the south-east side of landslide wastes, turns to the down stream (south) side and meets the channel at the waste side of landslide wastes. After 1200m long heading to the down stream, it meets the swamp in Pojok Village and then those flows into Saguling Dam Lake after 1,500m long in distance. Saguling Dam Lake is utilized as water supplier for agriculture and factories as well as drinking water in Jakarta. The hydrological distribution around Leuwigajah landfill is shown in Fig. 11.

3.3. Effects of landslide wastes to the environment

3.3.1. Characteristics of landslide wastes

The landslide wastes mostly dominated by three components: soil and organic, stone, and plastics. As the following reasons, it is suitable for transportation and treatment of landslide wastes that landslide wastes would be segregated, and plastics, soil and organic wastes would be recycled: the ratio of plastics, soil and organic wastes is large, the compaction of plastic wastes is difficult, but recycling of plastic wastes is possible; it is possible to use soil and organic wastes as covering soil. Utilization of these wastes as covering soil will contribute to the reduction of cost for purchasing covering soil when sanitary landfill is constructed.

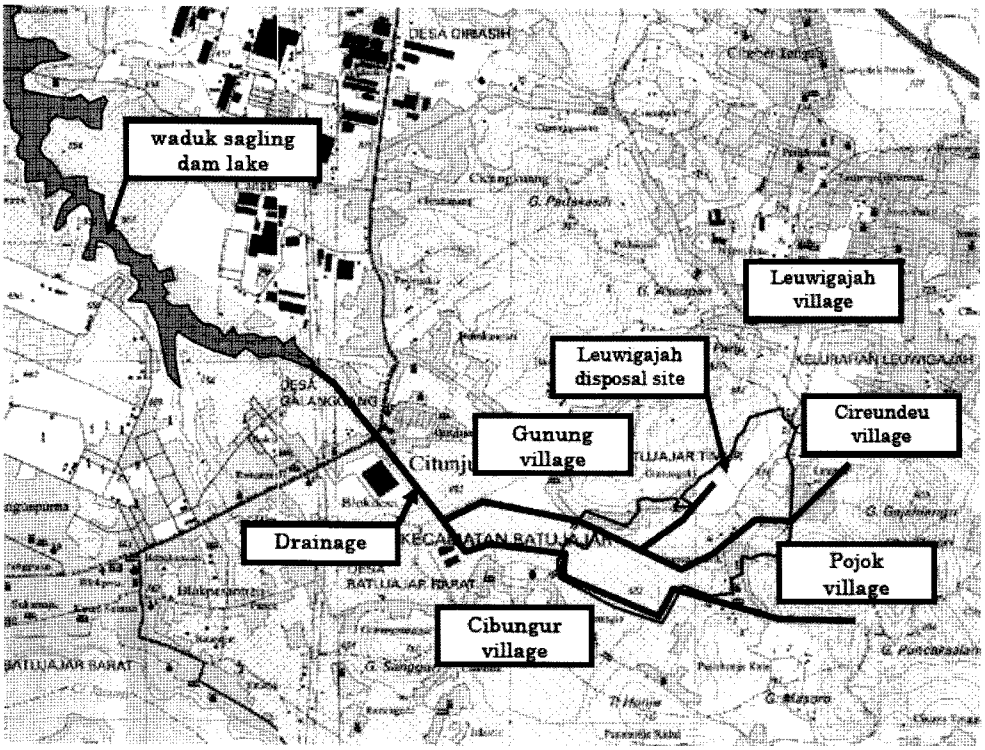

Fig. 11. Hydrological distribution around Leuwigajah landfill (Source: Yachiyo Engineering, 2009).

3.3.2. Water analysis

Two sampling points for leachate, four sampling points for groundwater (well) and four sampling points for canal water have been established. EC, pH, COD and NH_4 concentrations of each sample were then measured. It is found that the concentration of COD and NH_4 of samples were high. The samples show that the value of pH indicated as alkaline with deep gray color and high value of EC. The high concentration of COD effects aquatic living things and the high concentration of NH4 lead to eutropication. The leachate from Leuwigajah landfill has flown into canals surrounding the site meanwhile the water from these canals is utilized as source for agriculture and industry as well as drinking water.

Groundwater condition of every point samples shows variation in color, EC value, and pH. Further investigations are required to analyze the possibility of groundwater pollution. Presently, Institute Technology Bandung (ITB) investigates periodically water quality of wells surrounding Leuwigajah landfill and suggests the limitation of wells utilization which has low water quality.

The observation of canal water condition in some points sampling has indicated variation in color, EC value, and pH. In the points sampling where the concentration of COD, NH_4, and EC values were high, it can be predicted highly affected by leachate.

3.4. Strategy for rehabilitation and establishment of Leuwigajah landfill

The total amount of landslide wastes was estimated as 1,860,000 ton. Treatment of this landslide wastes is necessary for the stabilization of reusing Leuwigajah landfill. After landslide in February 2005, Environmental Protection Agency of West Java was in charge of implementation for rehabilitation program. The agency started this program in May 2006 and finalized it in 2007. The program included two components, construction of sanitary landfill and treatment of landslide wastes; and construction of intermediate treatment facilities. As part of the rehabilitation, West Java Province has implemented compensation, land acquisition, construction of canals and village roads. In construction of sanitary

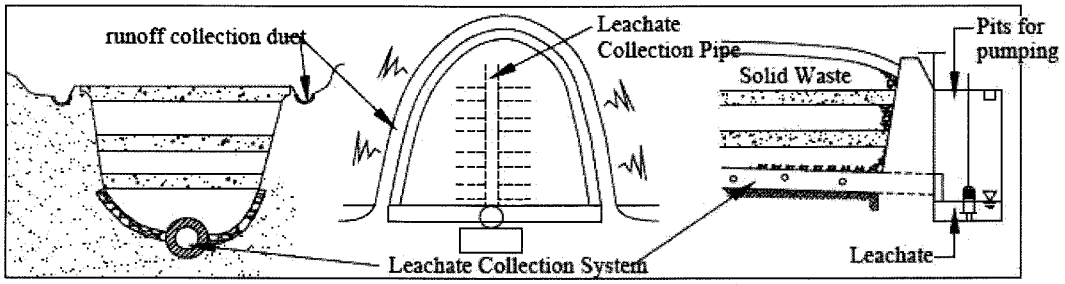

Fig. 12. Semi-aerobic landfill system.

landfill, semi-aerobic landfill system is adopted (Fig. 12). This system is considered appropriate for sanitary landfill with the control of input (i.e. incoming wastes) and of outputs (i.e. leachate and landfill gas). This system is expected to be appropriate for Indonesia context, as it is technically simple and cost effective. One of the main benefits of this system is to hasten biodegradation. And this system has the gas collection pipes through which rain water in the landfill runs out quickly. This specification is also appropriate for Leuwigajah landfill because the site has high rainfall.

4. Conclusions and Recommendations

One of the serious problems in developing countries is the management of municipal waste. Due to priority of economic development and insufficient attention to waste problems, wastes are simply dump in the field without provision for environmental and mechanical risks. An example of this type occurred in Bandung City of Indonesia in February, 2005, in which a large waste landfill collapsed after rain fall and killed more than one hundred people. After the landslide, landfill site became abandoned and the environmental impact from the landslide wastes was serious. The daily household wastes had no where to be disposed and piled up around the cities, therefore the Indonesian authorities sought for a new site, however, it was quite difficult to secure final disposal site. Consequently restoration and reuse of the collapsed Leuwigajah landfill for site disposal has been adopted. In addition, due to the recent problem of securing new landfill sites, the local government of West Java Province controls the overall system of the waste management and promotes 3R (Reduce, Reuse, Recycle) to minimize the amount of waste to be transported to the landfill sites.

References

Azuma, H. and Hayami, S., 2007, EDS Sourcebook Vol. 2, The report of Japan International Corporation Agency.

Erviani, N.K., 2008, Management warned over methods: Kuta, Bali, The Jakarta Post.

Environmental Protection Agency of West Java, 2004, Annual State of the Environment Report. Environmental Protection Agency of West Java, Bandung, Indonesia.

Environmental Protection Agency of West Java, 2005, Recovery of Leuwigajah Landfill Site and Improvement of Solid Waste Management in Metropolitan Bandung. Environmental Protection Agency of West Java, Bandung, Indonesia.

GBWMC, 2004, Technical Assistance for Greater Bandung West Management Corporation: Interim Report. Greater Bandung Waste Management Corporation, Under West Java Environmental Management Project (WJEMP), Bandung, Indonesia.

Hilman, M., Prospect of Municipal Waste Management through CDM Project in Indonesia, Ministry for Nature Conservation Enhancement and Environmental Destruction Control Republic of Indonesia.

Johannessen, L.M. and Boyer, G., 2005, Overview of solid waste landfills in developing countries: Africa, Asia, and Latin Amerika.

Kumar, A. and Kumar, A., 2001, Environmental Education, New Age International Limited.

Sembiring, E. and Nitivattananon, V., 2008, Integration of Social Welfare into Optimization Model of Solid Waste Systems, Proceedings of International Conference on Environmental Research and Technology.

Soma, S., Solid waste neighborhood Self-Management: A case

study in Bogor, Indonesia, PUSTRA Ministry of Public Works.

Supriadi, S., Kriwoken, L.K, and Birley, I., 2000, Solid waste management solutions for Semarang, Indonesia, Waste Management & Research, **18**, 557-566.

Yachiyo Engineering Consultant, 2009, Study for Integrated Environmental Improvement of Leuwigajah Disposal Site in West Java, Republic of Indonesia. Technical Report.

www.worldbank.org/urban/solid_wm

http://www.ambjakarta.um.dk/da/menu/Eksportraadgivning/Markedsmuligheder/Sektoranalyser/Milj%C3%B8/Miljoe.htm

http://www.thejakartapost.com/news/2005/08/06/good-solution-indonesia039s-waste-problems.html

http://www.indonesiatogo.com/2009/07/01/landfills-in-indonesia-open-dumping/

http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/uwp3.pdf

http://klh.go.id

http://www.jabar.go.id/jabar/public/77193/menu.htm

http://bplhdjabar.go.id