

SOLID WASTE TYPOLOGY AND MANAGEMENT IN HANOI



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Report presented during the kick-off meeting
of Blue Barrels project held in Hanoi
the 30th november 2015



Report funded by
GloFoods Metaprogram
« Transitions
for a global food security »
Year 2016



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Amongst environmental controversies, financial and technical considerations, waste management is a crucial issue in the development of the city of Hanoi. The Hanoi People's Committee must face the challenge of managing more than 6,400 tons of domestic waste per day (DONRE, 2014), despite the major expansion of the city in 2008. Hanoi has absorbed some surrounding urban areas thereby increasing its population from 3.4 million people to 6.5 million people.

In Vietnam, there is no central agency responsible for solid waste management as a whole: each Ministry and each Department of the Hanoi People's Committee are involved to the extent of their attributions to the waste processing mission. This is why waste management in Hanoi is subject to complex institutional governance. Many entities are involved, according to the missions they perform: regulations, transportation, processing, storage, treatment, etc.

This paper aims to shed light on the different actors in charge of waste management, the way they operate, and highlight the main challenges of the sector. The public service currently provided by the city of Hanoi, by semi-public and private stakeholders, will be analyzed in all their components, formal and informal.

To complete this introduction to waste management in Hanoi, the waste classification according to the Vietnamese nomenclature will be explained, as well as the volume and the corresponding features. This study will also focus on the methods of treatment and storage for each category of waste.

In order to perform this study, data collection on legislation, regulations and official reports was conducted as a first step. Secondly, a series of interviews was undertaken in order to establish an overview of the current status of municipal solid waste management in Hanoi. In methodological terms, we conducted qualitative interviews with public and private actors from different levels in Hanoi from September to November 2015. We were also able to count on the support of Hanoi Urban Environment Company (URENCO), the Department of Environment and Natural Resources of the Hanoi People's Committee and the Construction Department.

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INSTITUTIONAL FRAMEWORK GOVERNING SOLID WASTE MANAGEMENT IN HANOI

1.1 Public actors

a. Task partitioning at national level

Waste institutional governance in Vietnam is plural: each department handles waste issued from their activity field. At both national and local levels, there is no entity in charge of coordinating the waste management system. As part of its mission to protect the environment, the Ministry of Environment and Natural Resources (MONRE) is responsible for the management of hazardous waste. Similarly, the Ministry of Agriculture and Rural Development (MARD) takes care of waste from agriculture. The Ministry of Planning and Investment (MPI) and the Ministry of Finance (MF) are not directly involved in the waste management system, but they plan and elaborate strategies relating to waste treatment projects and control the public finances of the sector.

MONRE	MOC	MARD	MH	MPI	MF
<ul style="list-style-type: none"> - gives guidelines, plans, controls the waste management in the context of environmental policy. - provides reference standards - handles domestic waste with MOC - is responsible for hazardous waste - is responsible for health and industrial waste 	<ul style="list-style-type: none"> - gives directives in management, investment and construction of waste treatment sites. - manages the construction waste with the MONRE - handles domestic waste with MONRE - handles waste from the Craft villages 	<ul style="list-style-type: none"> - plans and manages waste from agriculture with the MONRE 	<ul style="list-style-type: none"> - manages waste from health facilities with MONRE - gives guidelines for healthy waste management, supervises their implementation. 	<ul style="list-style-type: none"> - plans investment projects - develops investment strategies - attracts domestic and foreign funding 	<ul style="list-style-type: none"> - implements and controls the budget for waste management projects

Figure 1 : Competence of each ministry in waste management

This division allows each ministry to ensure waste management in its sphere of influence, however this affects the coordination of waste treatment, in particular when different entities manage and operate on the same type of waste. Sometimes it is difficult to precisely define who the decision-maker is since each ministry may refer to the responsibility of another. Furthermore, several regulatory enactments relating to the same type of waste can be written by different ministries.

In fact, the organization is likely to cause overlapping of responsibilities between many ministries (MONRE 2011). For the same type of waste, such as healthcare waste, three ministries are competent: the Ministry of Health (MOF), which implements regulations on waste management in health facilities, the Ministry of Construction (MOC), which controls waste treatment facilities and the Ministry of Environment and Natural Resources (MONRE), which regulates and controls the management of hazardous hospital waste.

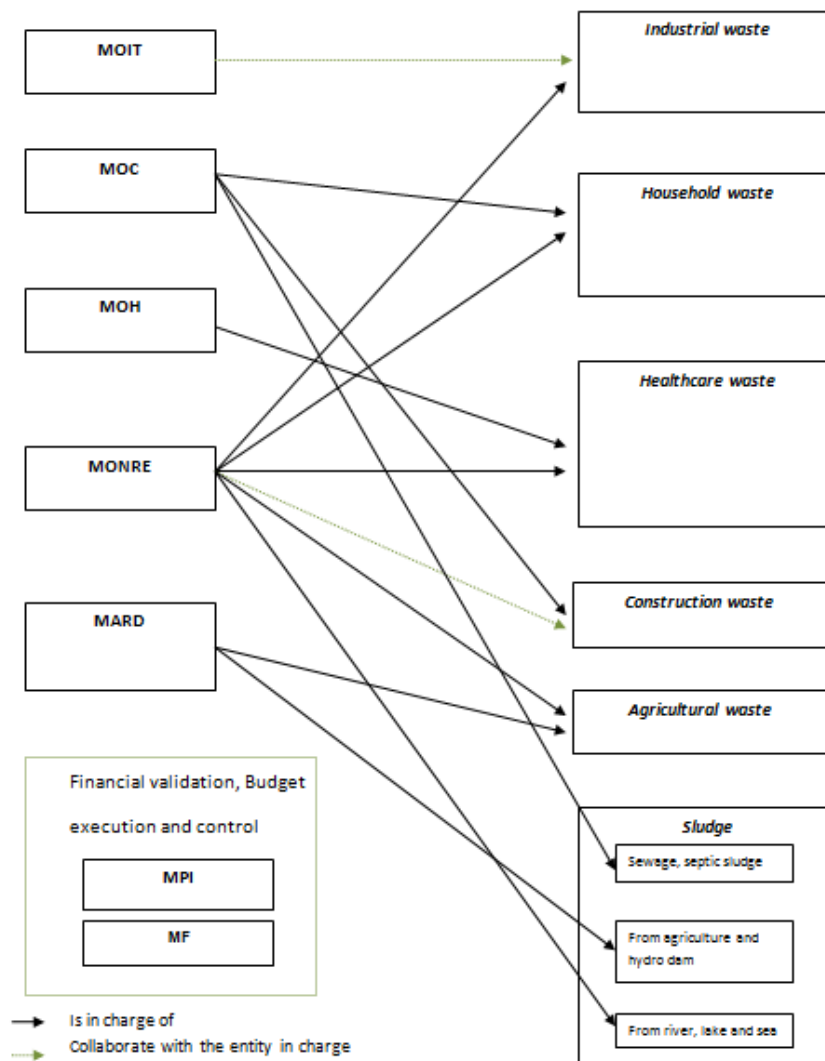


Figure 2 : Division of responsibilities between ministries

This figure illustrates the complexity of competence allocation between ministries. For example, the Ministry of Environment and Natural Resources manages industrial waste and hospital waste, but it also has in its indirect regulatory powers domestic waste management in collaboration with the Ministry of Construction, and the management of agricultural waste in rural areas shared with the Ministry of agriculture.

Regulatory laws remain quite vague on the forms of collaboration between various departments when they are in charge of the same type of waste. The legal framework on waste management states that the Ministry “guide,” “collaborate,” or “coordinates,” bringing all entities listed by the law to discuss and find a consensus. For example, the Decree n^o 38/2015/NĐ-CP issued by the Government in 2015 related to Waste and Scraps Management¹ provides that the MONRE “collaborates” with the MOC to regulate the construction waste sorting and collection, without precisely defining the task of the MONRE. Consequently, the task partitioning might be different between diverse administrative entities from central to local level.

Since all local levels are a replica of the central level, the problem arises in the same conditions as those at the state level. Indeed, in the Vietnamese institutional system, administration of the central level is available at the local level in its different components. The Ministry of Environment and Natural Resources at the state level becomes the Department of Environment and Natural Resources at the city level. At the district level, a unit with similar assignments exists and at the ward level, an official is in charge of environment issues. Thus, the division of powers, resources and responsibilities in the waste management area replicates itself from central to local levels.

b. The overlapping roles at the city level

The Hanoi People's Committee is the highest administrative body of the city and is responsible for implementing the legislation and regulations from the state level for the solid waste management. It specifies the adaptation modalities of the regulation issued at national level. Every year, The Hanoi People's Committee draws up a report for the Ministry of Environment and Natural Resources and the Ministry of Construction on waste treatment within the Hanoi territory. It is in charge of informing citizens and promoting best practices (MONRE 2011). Several departments within the People's Committee are responsible for waste management: some are directly in charge, such as the Department of the Environment and Natural Resources (DONRE), Department of Construction (DOC), Department of Agriculture and Rural Development (DARD) and the Department of health (DH). Others are indirectly in charge, such as the Department of Planning and investment (DPI) or the Department finance (DF).

¹ Government, 24/4/2015, Decree n^o 38/2015/NĐ-CP related to Waste and Scraps Management [*Quản lý chất thải và phế liệu*], 38 p.

Department of Construction	Department of Natural Resources and Environment	Department of Agriculture and Rural Development	Department of Health
<ul style="list-style-type: none"> - advises the People's Committee in order to apply state's directive management of solid waste in collaboration with other services - is responsible for the management of domestic waste in urban areas, construction waste and sludge. 	<ul style="list-style-type: none"> - runs state guidelines for environmental protection - advises the People's Committee in order to apply the state's directive management of solid waste in collaboration with other services - manages domestic waste in rural areas, hazardous solid waste (in collaboration with the DH and DOIT) and the Craft villages (in collaboration with DARD). 	<ul style="list-style-type: none"> - is in charge of agricultural waste in collaboration with DONRE. 	<ul style="list-style-type: none"> - dictates regulations and manages the waste collection and storage inside health facilities

The Department of Planning and Investment	The Department of Finance	The Office of Environmental Police
<ul style="list-style-type: none"> - plans the budget. - advises and assists the People's Committee concerning investment needs. - controls the implementation of state budget given to the city. - ensures the conformity of the budget implementation with regulations and guidelines issued on waste management. - Mobilizes national and foreign investors. 	<ul style="list-style-type: none"> - implements the budget. - works with the DPI to ensure a balanced budget in waste management. - works with the DOC and the DONRE to supervise and inspect the use of revenues from the waste management. 	<ul style="list-style-type: none"> - monitors compliance with laws and regulation on waste management. - identifies and prevents violations in the management of solid waste in accordance with regulations.

Figure 3 : Waste management at Hanoi People's Committee

Hanoi has a significant distinction in the waste management system. Indeed, the domestic waste of the 17 rural districts is managed by the Department of Environment and Natural Resources, whereas in the 12 urban districts and the commune-level town of Son Tay ² it is managed by the Department of Construction.

In 2008, when Hanoi absorbed some of the provinces in surrounding areas, including many rural areas, the volume of domestic waste ranged from 2,600 T to 6,500T daily. In reality, rural districts are sometimes left on their own. For those with public funds, they appeal to private companies. For those who do not, they set up an open air waste disposal site at the entrance of the village. When the smell becomes unbearable, funds are collected to buy land and fill in the waste site. Without any treatment process, waste and leachate generated from landfills pollute the local environment (air, soil, water resources) and affect community health. In recent years, Hanoi city has been actively implementing a new rural development program “*Chương trình xây dựng nông thôn mới*” to modernize rural areas. The city gives financial support for some communes to build communal or inter-communal landfills.

² *Son Tay belonged to Ha Tay Province. In 2008 Ha Tay Province was merged into Hanoi.*

	DONRE	DOC	DARD	DPI	DF	DOH
Domestic waste	<ul style="list-style-type: none"> - regulates the waste management of Hanoi according to environment policies. - DONRE is directly in charge of waste management in 17 rural districts of Hanoi 	<ul style="list-style-type: none"> - controls and manages waste treatment infrastructure at the city level - is directly in charge of waste management in the 12 urban districts of Hanoi and town of Son Tay. 		<ul style="list-style-type: none"> - plans, approves and monitors investments made by the city 	<ul style="list-style-type: none"> - implements the budget 	
Construction waste	<ul style="list-style-type: none"> collaborates with the DOC to develop a regulation on the construction waste management 	<ul style="list-style-type: none"> - manages constructions waste whether in rural and urban areas. - regulates sorting, collection and treatment, in collaboration with the Department of Environment and Natural Resources 		<ul style="list-style-type: none"> - plans, approves and monitors investments made by the city 	<ul style="list-style-type: none"> - implements the budget 	
Industrial waste	<ul style="list-style-type: none"> - manages and regulates the management of industrial waste. - ensures compliance with environmental protection standards in waste treatment facilities 			<ul style="list-style-type: none"> - plans, approves and monitors investments made by the city 	<ul style="list-style-type: none"> -implements the budget 	

Healthcare waste	- regulates and manages the transport and the processing of hospital waste			- plans, approves and monitors investments made by the city	- implements the budget	- regulates and manages the waste collection and storage inside health facilities, in collaboration with the DONRE
Agricultural waste	- regulates and gives the guidelines for the collection and storage of agricultural waste		- supports the agricultural waste management in connection with the DONRE. - is in charge of waste sorting and storage on site.	- plans, approve and monitor investments made by the city	- implements the budget	
Sludge	- manages sludge from ponds, rivers and water points	- manages sludge from septic tanks and sewage system	- manages sludge from agricultural areas, canals and hydro dams	- plans, approves and monitors investments made by the city	- implements the budget	

Figure 4 : Task partitioning for waste management in Hanoi people committee

c. At the district level

- The People's Committees of urban and rural districts are in charge of waste management at local level. They are responsible for environmental issues and their mission is to implement regulations issued at higher levels in their respective areas. There is an Environment and Natural Resources Office in each district.

- The Office of Environment and Natural Resources advises the People's Committees of districts for the implementation of the City's policies and regulations. It also has the mission to propose and relay citizen's opinions, addressing waste management and environment problems to the city. In connection with municipal departments such as the Planning and Investment Department and the Finance Department, it signs contracts with private operators with enough technical competence in waste processing.

d. At the ward level

People's Committees at ward level execute environmental protection tasks established by the city's regulation. It maintains and controls sanitary procedures, implements the orders of the district concerning solid waste management. This is the institutional level closest to the citizens. In each People's Committee at ward level, there is an official in charge of environmental issues. The ward level defines the collection sites and the waste pickup hours. The organization of the Fatherland Front is also responsible for promoting best practices, compliance with regulations and sorting at source. It's the reason why they work at this specific level, in order to be closer to the citizens.

The role played by neighborhood organizations cannot be neglected. In Hanoi, *tổ dân phố*, neighborhood organizations, gather 10 to 80 families, according to geographical divisions. The *tổ trưởng* is the head of the organization and is elected by the population he or she serves. The *tổ trưởng* is not employed by any public entity but assumes the role of representative and mediator in many aspects of the neighborhood life including waste management (deposits places, collection calendar, respect of best practice, etc.). Sometimes, the neighborhood organization may organize a large waste collection day, inviting people to improve their life environment. In several rural villages and communes, there are *Tổ vệ sinh môi trường tự quản*, self-organized community teams in charge of waste collection.

When public bodies in charge of the waste want to promote an action which needs the support of the population or to implement a new policy regarding waste, working with the *tổ dân phố* is an necessary step.

1.2 The privatization of the sector and its requirements

Since 1999, public entities responsible for management, collection and transportation of solid waste are slowly being privatized. Vietnam largely supports private investment in the sector. Decree No. 59/2007/NĐ-CP issued by the Government in 2007 related to solid waste management³ explicitly affirms the desire to encourage "socialization" of the waste sector, that is to say, to enable the private companies to enter an initially public sector.

Hanoi also encourages this trend, stating in its regulations that the "*Hanoi's People Committee promotes the participation of economic entities in socialization of collecting, sorting, transporting and proceeding solid waste.*"⁴ Hanoi city performs its public mission by passing tenders or placing an order to private companies specialized in this field. Currently, 24 companies are working in this area (DONRE, 2015).

In the capital, the waste treatment sector is shared between public and private companies. The main actor in the public sector is URENCO (Hanoi Urban Environment one-member state owned limited company). URENCO works on four urban district: Ba Dinh, Hoan Kiem, Dong Da, Hai Ba Trung. The company is also responsible for the management of waste treatment centers in Nam Son and the leachate treatment station in Xuan Son center.

Smaller structures, *Xí nghiệp môi trường đô thị* (Urban Environment Company), also exist at district scale. In Hanoi, they are located in 5 districts: Gia Lam, Soc Son, Dong Anh, Thanh Tri and Tu Liem. These public companies have the special status of *Đơn vị sự nghiệp có thu* (Public Service Agency with Revenue). These units are created by the state to respond to general interest needs when the private sector is not present. These companies are financially independent. In fact, in the waste sector, they need public subsidies granted by local authorities.

In urban areas, collection and transportation of domestic waste are mainly run by private companies and cooperatives, such as the Thang Long Joint Stock Company or the Thanh Cong Sanitation cooperative. These companies are involved in sanitation treatments for various districts in Hanoi. There are 24 operators involved in collection, transportation and disposal of solid waste in Hanoi (DONRE, 2015), among them, 17 are private companies and 7 are public entities.

The city undertakes contractual relations with private and public companies through three types of contracts: direct attribution, order and tender. As stipulated in Decree No 130/2013/ND-CP issued by the Government in related to production and supply of public products and services⁵,

³ Government, 2007: Decree n° 59/2007/NĐ-CP dated 9/4/2007 related to Solid Waste Management [*Quản lý chất thải rắn*], 25 p.

⁴ Hanoi People's Committee, 2013: Decision n° 16/2013/QĐ-UBND dated 3/6/2013 issuing the Regulation on Non-hazardous Solid Waste Management in Hanoi [*Quy định quản lý chất thải rắn thông thường trên địa bàn thành phố Hà Nội*], 17 p.

⁵ Government, 2013: Decree n° 130/2013/NĐ-CP dated 16/10/2013 related to production and supply of public products and services [*sản xuất và cung ứng sản phẩm, dịch vụ công ích*], 18 p.

solid waste collection and disposal service must be supplied by tender. Order can only be used as a last choice. In reality, order and direct attribution are preferred. Thus, Hanoi plans to apply tender from 2016 for waste collection and transport service. Bidding will be held by Hanoi People's Committee (for four ancient urban districts) and the Districts People's Committees (for other districts) for a service delivery contract of five-year period.

Type of contracts	Order	Direct-attribution	Tender
Duration	1 year	1 year	5 years
Characteristics	The remuneration is set by the city at a flat rate to achieve the mission.	The remuneration is fixed and regulated by the city. If the end of the year if the budget is not entirely spent, it will be reassigned to another mission.	Bidders are selected on the basis of price and quality of their service.

Figure 5 : Type of contracts in waste management

Aid policies to the companies such as taxes easing on land fee and various administrative facilitations are part of this desire to attract private operators in a sector stifled by lack of funding. Private companies thus have considerable power over technology choices, methods of processing and storage, which can sometimes lead to consistency problems in the service proposed, or cause a lack of long-term strategic vision. Hence, the private sector has the power to influence public decisions, making state actors more passive and reluctant to compel the private operators to adhere to environmental and social considerations. All the more so that the penalties are often not applied where the standards and regulations have been violated.

One factor is also taken into account: the maximum price. This price set by the MOC in order to fix the maximum that a public or private entity can be paid to process a ton of waste. Currently, it is approximately 20 dollars to incinerate a ton of waste. For the companies surveyed, it is quite difficult at this price to earn a return on investments while abiding by laws and regulations. Furthermore, it discourages new technologies implementation.

SOLID WASTE TYPOLOGY, QUANTITIES AND CHARACTERISTICS

2.1 Definition and classification of Solid Waste

a. Solid Waste Definition

According to Vietnamese Environmental Protection Law issued by National Assembly in 2014⁶, the term Waste is defined as “matters discharged from production, business, services, daily life activities or other activities.”

The Decree No. 38/2015/ND-CP on Waste and Scraps Management defines Solid Waste (SW) as “waste in solid or semi-solid (also called sludge) discharged from the production, business, services, daily life activities or other activities.”

b. Sources and types of solid waste

Currently in Vietnam, there is no law or regulation clearly guiding the classification of solid waste and fully defining each type of specific waste. However, solid waste is generally classified by source of generation or by toxicity.

⁶ National Assembly, 2014: *Environmental Protection Law n° 55/2014/QH13 [Luật bảo vệ môi trường]*, 67 p.

Way of classification	Component
By source of generation	Domestic solid waste
	Industrial solid waste
	Medical solid waste
	Agricultural solid waste
	Construction solid waste
	Sludge
By toxicity	Ordinary solid waste
	Hazardous solid waste

Figure 6: Classification of solid waste in Vietnam

2.2 Solid Waste Generation, Composition and Characteristics

As reported by the DONRE, from 2012 to 2014 the average total volume of solid waste generated in Hanoi was 10,200 tons (agricultural waste and sludge are not included), of which 6,400 tons is domestic waste.

No	Type of waste	Volume (tons/day)				
		2010	2012	2013	2014	2012-2014 (average)
1	Domestic waste	5,500.0	6,366.0	6,422.0	6,400.0	6,396.0
2	Construction waste	1,500.0	3,200.0	3,000.0	3,000.0	3,066.7
3	Industrial waste	850.0	750.0	750.0	750.0	750.0
4	Medical waste	-	9.5	9.6	9.8	9.6
	Total	7,850.0	10,325.5	10,181.6	10,159.8	10,222.3

Figure 7: Generation of solid waste in Hanoi (period 2012-2014)

(Source: DONRE, 2015)

This figure shows that the population growth, urbanization and the development of construction sector of Hanoi in the recent years has significantly affected the amount of generated waste.

As stated by the following chart, domestic and construction waste represent the biggest proportion of generated waste: approximately 62.6% for domestic waste and 30% for construction waste.

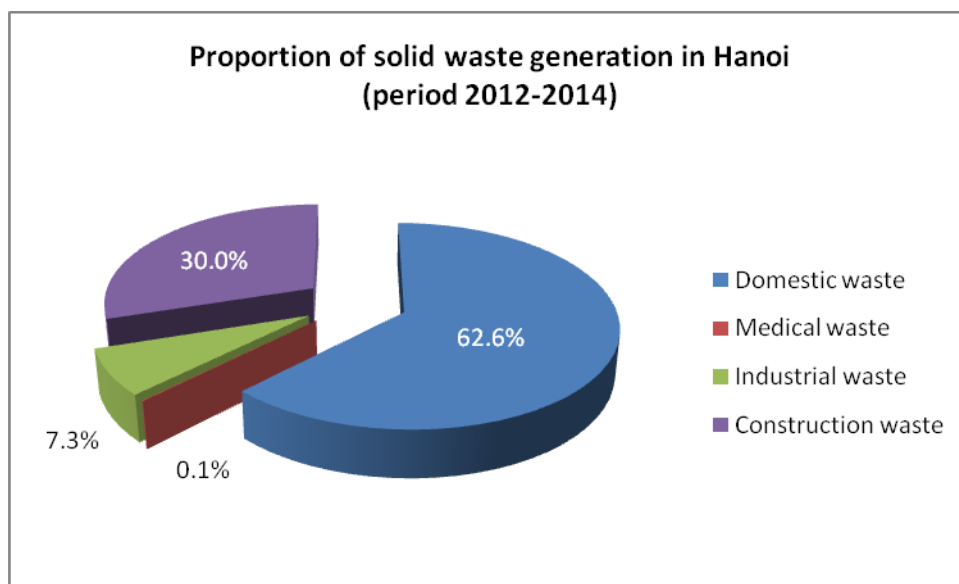


Figure 8: Solid waste generation by source in Hanoi (period 2012-2014)

(Source: IMV, 2015)

According to the Hanoi Master Plan for Solid Waste Disposal to 2030, with a vision to 2050 approved by the Prime Minister on 2014⁷, the city will be divided into three zones for solid waste collection and treatment. The total volume of waste generated is estimated at 14,150 tons/day in 2020 and 18,900 tons/day in 2030, an increase of respectively 40% and 86% over 2014. This significant increase will become a great challenge for Hanoi government authority.

No	Type of waste	Volume (tons/day)		
		2020	2030	2050
1	Domestic waste	8,500	11,300	15,900
2	Construction waste	2,100	3,400	4,800
3	Industrial waste	1,700	1,900	1,900
4	Medical waste	90	150	280
5	Septic sludge	1,500	1,800	2,100
6	Sludge dredged from drainage network	260	350	400
	Total	14,150	18,900	25,380

Figure 9: Estimated volume generated in Hanoi (period 2020-2050)

(Source: Decision No 609/QĐ-TTg dated 25/4/2014 of Prime Minister on approval of Hanoi Master Plan for Solid Waste Disposal to 2030, with a vision to 2050)

⁷ Prime Minister, 2014, Decision n° 609/2014/QĐ-TTg dated 25/4/2014 on approval of Hanoi Master Plan for Solid Waste Disposal to 2030, with a vision to 2050 [Quy hoạch xử lý chất thải rắn Thủ đô Hà Nội đến năm 2030, tầm nhìn đến năm 2050], 21 p.

Conforming to the Master Plan, the quantity of domestic and construction waste will always occupy a large proportion in the total volume generated (from 75% to 82%) and tend to increase gradually over the period 2020-2050. This fact once again confirms the important impact of the process of urbanization, population growth and development in construction field to waste generation in Hanoi.

Period	Average volume growth rate (%/year)	Proportion of domestic and construction waste in the total volume generated (%)
From 2014 to 2020	6.55	74.9
From 2020 to 2030	3.36	77.8
From 2030 to 2050	1.22	81.5

Figure 10: Forecast of waste volume growth rate in period 2014-2050

(Source: IMV, 2015)

- **Domestic solid waste:**

As reported by DONRE, domestic solid waste refers to waste produced from human daily-life activities in domestic settings, markets, commercial and services centers, institutions, industrial and medical establishments.

Domestic waste includes organics (food waste, leaves, dregs of coffee and tea...), paper, plastics, rubber, glass, metal, soil... of which organics account for 50%-60% in volume. With a share of over 60% of the total volume generation, domestic waste in Hanoi is a potential resource for composting.

Domestic waste in Hanoi has moisture ranging from 40% to 70% and density varying from 0.39 to 0.5 tons/m³ depending mainly on the season.

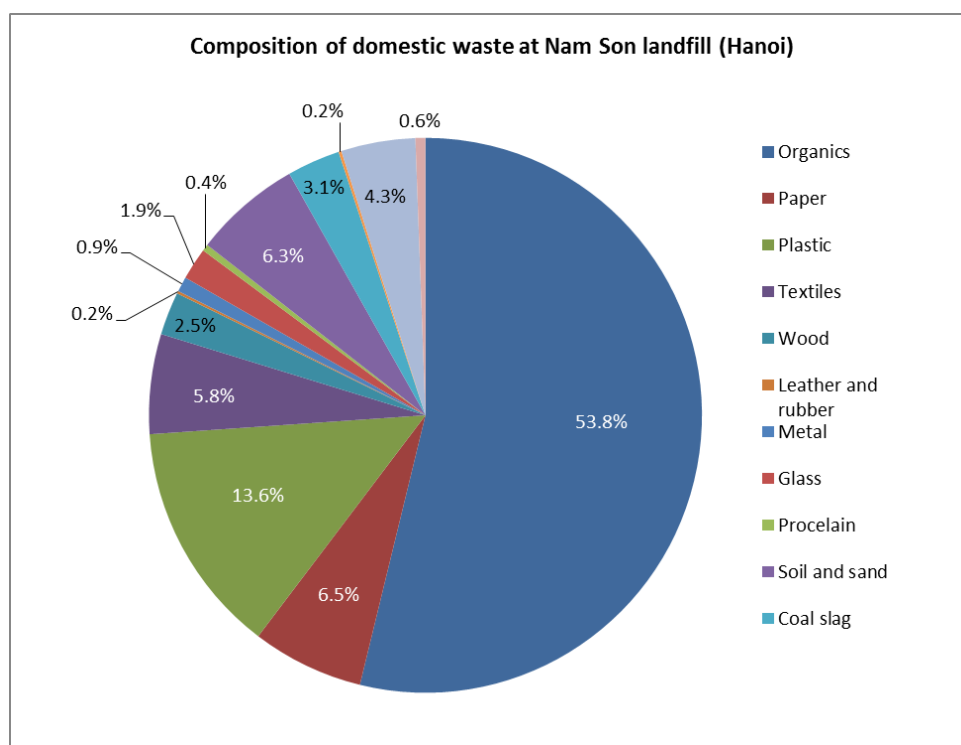


Figure 11: Composition of domestic solid waste at Nam Son landfill (Hanoi)

(Source: DONRE, 2015)

Currently, the amount of domestic waste generated in Hanoi is reported as being approximately 6,400 tons/day, of which 4,528 tons/day comes from urban areas (12 urban districts and Son Tay town) and 1,872 tons/day from suburban and rural areas (17 suburban and rural districts).

Urban areas represent only 12.6% of total area of Hanoi but account for 46.6% of the population and generate 70.8% of the total volume of domestic waste. With an average population growth rate of 2.3%/year in period 2010-2014 and current urbanization rate of approximately 3.8%/year (DONRE 2015), the increase in urban population in the coming years will create a great pressure on municipal waste disposal work of the city.

No	Zone	Area (km ²)	Population (habitant)	Waste volume (tons/day)	Percentage in volume (%)	Collection ratio (%)	Waste generation rate (kg/hab/day)
1	Urban areas (12 urban districts and Son Tay town)	417.46	3,408,000	4,528	70.8	98	1,33
2	Suburban and rural areas (17 suburban and rural districts)	2,907.06	3,911,000	1,872	29.3	89	0,48
	Total	3,324.52	7,319,000	6,400	100.0	94	0,87

Figure 12 : Generation of domestic waste in Hanoi in 2014

(Source: DONRE, 2015 & Hanoi Statistical Office, 2015)

The data in Table 2-5 shows that there is a remarkable difference in waste generation rate per capita between urban areas and suburban and rural areas. For the whole city, each inhabitant generates daily approximately 0.9 kg of domestic waste.

- **Industrial solid waste:**

Industrial waste comes from industrial manufacturing, craft villages' production, business and service activities in the city. Industrial waste is classified into two categories: hazardous waste and ordinary waste (non-hazardous waste).

At the moment, industrial production activities in Hanoi are diverse with different types of industries such as textiles manufacturing, leather manufacturing, food processing, appliances manufacturing, mechanical engineering, construction materials production, plastics processing... Each industrial sector produces specific kinds of waste, but in general industrial waste consists of fuel waste from production, materials waste from manufacturing processes, packages...

From 2012 to 2014, industrial waste generation in Hanoi was stable at 750 tons/day in which ordinary waste represented a large proportion, approximately 86.1% (equivalent to 646 tons/day). Hazardous components accounted for 13.7% of total volume (*DONRE, 2015*).

- **Medical waste:**

Medical waste arises from operation of medical facilities in the city such as hospitals, general medicine clinics, clinics, preventive medicine centers, private medical establishments... Medical waste is comprised of both ordinary waste and hazardous waste.

63 hospitals and 52 general medicine clinics are registered in Hanoi. The quantity of medical waste generated rose in the period 2012-2014 with an average volume of 9.6 tons per day in which hazardous waste accounts for 16% (*DONRE, 2015*).

- **Construction solid waste:**

Construction waste is generated during the construction, renovation and demolition of buildings and infrastructures (roads, bridges...). Construction waste, generally considered as non-hazardous waste, includes soil, sand, gravel, broken bricks, concrete, metal, wood, plastics... all of which is mostly reusable for daily-life activities, manufacturing or soil flattening.

The rapid urbanization and the implementation of a large number of construction projects (buildings, infrastructures, new urban areas...) over the past years have generated a considerable amount of construction waste. Compared to 2010, the volume of waste generated in 2014 was double, going from 1,500 tons/day to 3,000 tons /day (*DONRE, 2015*).

- **Agricultural solid waste:**

Presently, the total area of agricultural land in Hanoi is 187,151.5 ha, accounting for 56.3% of total natural area of the city (*Hanoi Statistical Office, 2015*). Agricultural waste originates from agricultural production activities (mainly from crop cultivation and livestock production) of farmers and production facilities in the suburban and rural areas of Hanoi.

Agricultural waste consists of many different components. 60-65% is biodegradable organic matter: crop residues (straw, leaves, etc.) and waste from animal husbandry, slaughter (cattle

manure and uneaten feed of cattle). There is also a significant amount of packaging which contains chemicals used in agriculture (plant protection products, pesticides, fertilizer....). There are no official statistics on the volume of agricultural waste produced in Hanoi, however, according to an individual research, every year the city could generate approximately 4.8 million tons of by-products from cultivation production of major crops (rice and corn) and waste from livestock production (*Nguyen Song Tung, 2015*).

- **Sludge**

Sludge consists of septic sludge, sludge dredged from drainage network and sewage sludge.

There are no official statistics on the volume of sludge generated in Hanoi, however, as reported by Hanoi Urban Planning Institute (HUPI), from 2012 to 2013 there was approximately 120,000 to 150,000 tons of sludge per year dredged from drainage network in some urban districts of Hanoi which were collected and disposed of in Yen So landfill. For septic sludge, it is estimated that an average amount of 500 tons is generated in Hanoi, of which approximately 300 tons comes from the urban areas (*Institute of Science and Environmental Engineering, 2015*).

2.3 Source separation, collection, transport and disposal

a. Waste sorting

According to Environmental Protection Law, the waste generators are responsible for sorting waste at source in order to facilitate its re-use, recycling, energy recovery and disposal. In fact, in Vietnam only industrial and medical wastes are required to be separated at source into two categories (ordinary waste and hazardous waste) to be collected and treated separately. For other types of waste, there is no mandatory regulation on sorting at source.

- **Industrial waste:**

In Hanoi, industrial waste is mostly sorted at source properly in large-scale factories or industrial zones. In some small production and business facilities in urban areas and craft villages in rural areas, waste from production activities is only partly sorted for re-use or recycling purposes, the rest is mixed and collected with domestic waste.

- **Healthcare waste:**

The sorting, handling and storage of medical waste at the healthcare facilities are implemented in compliance with the Regulation on medical waste management issued by the Ministry of Health. However, as reported by Hanoi Department of Health, only 90% of hospitals in the city sort waste at source and of them only 50% perform it properly in accordance with the regulation⁸.

⁸Vietnam Communism Party journal, 13/9/2015, Đỗ Thoa “Những bệnh viện ... rác” [The wasted hospitals] http://dangcongsan.vn/cpv/Modules/Preview/PrintPreview.aspx?co_id=30111&cn_id=733546

- Domestic waste:

The separation of domestic waste at source is not implemented widely, nor in Hanoi, nor throughout the country. The waste sorting is usually done spontaneously by some households, institutions or manufacturing facilities in order to keep reusable or recyclable objects (papers, plastics, cardboard, bottles, metal ...), or sell to informal scrap collectors.

Although the waste sorting at source is required in the National Strategy on Integrated Solid Waste Management to 2025 with a vision to 2050 issued by the Government in 2009 and in Hanoi Master Plan for Solid Waste Disposal, it was only implemented in some pilot projects financed by international sponsors such as:

- Project 3R-HN: implementation of waste separation at source in 4 center wards of Hanoi (Phan Chu Trinh, Nguyen Du, Thanh Cong and Lang Ha) from 2006 to 2009, funded by Japanese government and performed by URENCO and JICA (18,300 households involved)
- Project Improvement of capacity in solid waste management in Gia Lam district: implementation of waste sorting at source in six communes of Gia Lam, a suburban district of Hanoi, sponsored by Ile-de-France Region (France), carried out in the period 2009-2013 by IMV in collaboration with People's Committee of Gia Lam district and the Urban Environment Company of Gia Lam (18,000 households involved)

These pilot project initially achieved some positive results such as: reduction of waste volume sent to landfills (ex. approximately 30% for 3R-HN project), improvement of local conditions, reduction of disposal costs, enhancement of composting efficiency... nevertheless, when these projects ended, Hanoi authority did not maintain the implementation of waste sorting at source, nor were they able to multiply this action in other zones. Some difficulties were pointed out in the course of implementation of these pilot projects including: lack of community awareness on environmental protection and active participation of local authorities; difficulty in changing people's waste generation habits; incompatibility between the existent collection and treatment facilities with the processing separated waste; lack of fund for collection and disposal infrastructure investment.

- Participation of informal sector in waste separation in Hanoi:

In Hanoi there is an important informal sector including scrap collectors, scrap purchase stores and recycling facilities in and outside the city, actively involved in sorting and collecting solid waste.

Every day, a large number of scrap collectors travel around the city to collect plastics, rubbers, glass, papers, magazines or bottles from households, offices, production facilities, construction sites and especially landfills located in rural areas. According to statistics from 2013, there are more than 10,000 scrap collectors in Hanoi (among them, 700 people work every night at the Soc Son landfill). With an estimated daily collection rate of 5-20kg per person, approximately 50-200 tons of scrap are separated from the total waste volume generated in Hanoi every day. Scraps gathered by collectors are then sold to purchase stores

in Hanoi. These stores resell them to individuals or facilities to reuse or recycle (HUPI, 2013).



Photo 1: A scrap collector in Hanoi
(Source: IMV)



Photo 2: A scrap purchase store in Thanh Xuan District, Hanoi
(Source: IMV)

b. Waste Collection and Transport

Waste collection and transport in Hanoi, especially for urban areas, are now performed by public and private sanitation operators (see above).

- Domestic waste:

Garbage from households is collected every day. Citizens often gather waste in plastic bags and drop them at public collection points or pour them directly into public waste bins or waste handcarts at scheduled time (generally from 17h to 19h). Waste in handcarts is transported by collection workers of sanitation operators or self-organized community teams at communal level (for some rural communes) to temporary local gathering points. Afterwards, it is loaded into garbage trucks and then moved to disposal sites. Waste from commercial and industrial sources are collected daily or periodically depending on the amount generated and transported to disposal sites by sanitation companies. The collection and transport service is carried out under contract between the sanitation company and the waste generator. Waste from streets, markets and public places are also collected everyday by sanitation companies and moved to treatment facilities.



Photo 3: A local waste collection point in Long Bien District, Hanoi

(Source: IMV)



Photo 4: Domestic waste collection by garbage truck in Nguyen Du Street, Hanoi

(Source: IMV)

By the end of 2014, the collection rate in urban areas was nearly 98% (approximately 100% for four historical urban districts: Ba Dinh, Hoan Kiem, Dong Da and Hai Ba Trung). The entire amount collected is transferred to two municipal waste treatment centers (center of Nam Son and center of Xuan Son). For suburban and rural area, the average collection rate is reported to be approximately 89% but only 82% of the volume collected is taken to the municipal disposal centers or treatment sites at district level. The rest is dumped in an uncontrolled landfill. (*DONRE, 2015*)

Currently, Hanoi city lacks temporary waste gathering points in urban areas and has no large-scale waste transfer station in the suburbs to load waste from small garbage trucks to bigger and long-distance vehicles. In urban areas, especially in the center of city, the population and building density are very high. Thus, there is less spare place for building temporary waste gathering points that meet operational and environmental requirements. For this reason, sanitation operators often take advantage of empty space in the sidewalk, pavement or public space like parks, gardens or squares to gather waste handcarts.



Photo 5: A waste gathering point on pavement in city center

(Source: IMV)



Photo 6: A waste gathering point along the road in rural district of Gia Lam, Hanoi

(Source: IMV)

Currently, the municipal center of waste treatment of Nam Son receives daily 3800-4200 tons of waste from 12 urban districts and 7 suburban and rural districts accounting for 59-65% of the total volume of waste generated in Hanoi. The garbage trucks currently used by the sanitation companies in Hanoi with maximum load from 3 to 7 tons with rational shipping distance of less than 30km (Source: HUPI, 2013). Without any waste transfer station in suburban or rural areas, these small trucks have to travel approximately 50km to transport waste directly from inner districts to Nam Son treatment center. This operation increases the transportation expense and presents potential risk of polluting the environment during transfer.

- Industrial waste:

Industrial waste is sorted at source into ordinary waste and hazardous waste for separate collection and treatment.

According to the DONRE, approximately 646 tons of ordinary industrial waste is actually produced in Hanoi each day. 10 to 15% (65-97 tons) are kept by production facilities for reuse or recycling purposes. The remaining waste (549-581 tons) is collected by sanitation companies (under contract between waste generator and company) for disposal in waste treatment facilities of Hanoi such as Nam Son center, Xuan Son center and the landfill of Kieu Ky. However, statistics show that the processed volume by treatment facilities is only 382 to 405 tons per day. Then, what happens to the waste collected from industrial facilities but not transferred to the disposal sites handled?

For hazardous waste, collection rate is only about 60-70% of the volume generated (approximately 62-73 tons per day). The rest is still stored in some industrial production facilities. Waste generators sign a contract with a company authorized for industrial hazardous waste collection and transportation to collect waste from source to industrial waste disposal facility in Nam Son center or to some other treatment sites outside the city (DONRE, 2015). The fact that upwards of 30-40% of hazardous waste volume generated

is still being kept at its source (particularly facilities located in the city center with a high population density) shows that there is the likely risk of polluting the environment and affecting public health if these production facilities don't respect the regulations of hazardous waste storage and preservation at source.

According to the Environmental Protection Law, a sanitation company must be authorized by MONRE or DONRE when it handles hazardous waste. In fact, not all of them have authorization. As reported by DONRE, by the end of 2014, 34 companies are authorized, of which 22 are authorized for transportation and 12 for disposal.

- Medical waste:

As with industrial waste, medical solid waste is also required to be separated at source by medical facilities into hazardous and non-hazardous components.

The collection of ordinary medical waste generated from health care establishments such as hospitals, clinics... is carried out by different sanitation companies, among which URENCO is the most experienced operator. Non-hazardous medical waste is processed together with domestic waste in some municipal waste disposal facilities (Nam Son center, Xuan Son center or Kieu Ky landfill...)

Regarding hazardous waste, some of it is treated on-site at some medical facilities equipped with a medical waste disposal system. For the rest, according to the regulations on hazardous waste management, medical establishments without disposal facilities must have a contract with an authorized company to collect and transport waste to municipal medical waste disposal center in Cau Dien. This facility is under management of URENCO.

Not all health establishments fully respect these regulations. Some cases of illegal transportation, selling and destruction of hazardous medical waste performed by some public hospitals and private medical establishments were discovered in recent years. A private medical clinic in Truong Dinh quarter (Hoang Mai district) was caught by the Police of Environment of Hoang Mai while dumping hazardous waste from their operations into the toilet of examination room. Even major public hospitals like Bach Mai and Viet Duc had been caught by Police of Environment for the illegal selling of a number of tons of hazardous waste to some establishments specialized in waste recycling but not authorized for hazardous waste transportation and disposal⁹.

- Construction waste:

The collection and transportation of construction waste in Hanoi is mainly carried out by authorized sanitation operators like URENCO, Urban Environment Companies at district level and some private companies. There are also a number of individuals and private informal collectors.

⁹ Petro Times journal, 20/7/2014, Nguyễn Bách "Kinh hoàng rác thải y tế" [Horrible medical waste] <http://petrotimes.vn/kinh-hoang-rac-thai-y-te-194126.html>

Operators	Volume (tons/day)
URENCO	794
Urban Environment Companies at district level and private companies authorized	2,000
Others	200
Total	2,994

Figure 13: Generation of construction waste in Hanoi in 2014

(Source: DONRE, 2015)

According to the regulation on construction management in Hanoi, construction waste generated from construction sites must be collected and gathered in temporary construction waste dumps located in suburban or rural areas, then be transported by sanitation operators to municipal construction waste landfills. Illegal dumping usually happens along canals or roads in the suburbs. This situation shows that the volume of construction waste produced in reality is more than 3000 tons per day as reported by DONRE. Although Hanoi authorities have been making efforts to supervise, detect and handle illegal waste dumping the results remain limited. After its expansion in 2008, the area of Hanoi increased considerably and the suburban and rural zones represent a large proportion of the city. Due to a lack of personnel, municipal and local authorities find it difficult to properly control such an extensive area. Further, the supervision and handling of violations in this field has become increasingly complicated with the intervention of different authorities such as the Police of Environment, construction inspectors, traffic officers...



Photo 7: An illegal construction waste dumpsite in Hoang Mai District, Hanoi

(Source: IMV)

- Sludge:

Sludge dredged from urban drainage system of Hanoi is collected to sludge landfill in Yen So by Hanoi Sewage and Drainage Company. The volume collected to Yen So landfill is estimated about 120,000-150,000 tons per year. For the suburban and rural areas, this work is carried out by Urban Environment Companies at district level. Sludge collected is all buried in domestic waste landfills of district.

The collection of septic sludge in Hanoi is currently performed by URENCO, some Urban Environment Companies at district level and a number of private companies. As mentioned above, about 500 tons of septic sludge is produced daily. While the sludge treatment station at Cau Dien previously reached only a capacity of treatment for 50 tons per day, newly upgraded in May 2014, it can now process up to 300 tons per day. According to the statistics of URENCO, in the first 6 months of 2014, only 200 tons among the volume collected in the whole city were sent to Cau Dien treatment station by private companies. An amount not yet reported was buried in some landfills of districts by Urban Environment Companies at district level. The remainder was illegally dumped by some private companies in suburban or rural areas (lakes, ponds, canals, sewers...) to reduce transportation expenses and obtain money¹⁰. The illegal dumping is polluting the environment and affecting the sewerage system of these areas.

c. Solid waste disposal

- Domestic waste:

- *Treatment rate:* In Hanoi, by the end of 2014 among 6,400 tons of domestic waste generated every day, about 5,860 tons (accounting for 91% of volume) were collected and processed in municipal waste disposal centers and waste treatment sites of districts (DONRE, 2015).

- *Methods and technologies of waste disposal:*

Not only in Hanoi but also across Vietnam, landfill, composting and incineration are the most common methods used for solid waste disposal at the moment.

As reported by the Technical Infrastructures Department of the MOC, at the end of 2013, Vietnam has 458 landfills of more than 1ha, with total area of 1,813.5 ha. Among them, only 26.5% are sanitary landfills. 26 solid waste disposal plants with total designed capacity of treatment of 6,000 tons per year are operating in some provinces and cities such as Hanoi, Ho Chi Minh, Can Tho, Binh Duong, Ha Tinh, Thai Nguyen, Hai Phong...

¹⁰ Construction journal, 18/11/2014, Vũ Quang "Nóng xử lý bùn thải" [Sludge treatment is urgent] <http://www.baovaydung.com.vn/news/vn/xa-hoi/nong-xu-ly-bun-thai.html>

Method of waste disposal	Number of plants
Incineration	3
Incineration and composting	3
Composting and landfill	20
Total	26

Figure 14 : Waste disposal methods applied in waste disposal plants in Vietnam (2014)

(Source: Technical Infrastructures Department–Ministry of Construction, 2014)

✓ *Landfill:*

By the end of 2013, as reported by DONRE, over 90% of quantity domestic waste in Hanoi was treated by land filling mainly in 8 municipal waste disposal centers and waste treatment sites at district level (*see details in Annexe 1: List of waste disposal facilities in Hanoi*). Only Nam Son waste disposal Complex receives and processes daily approximately 3,800-4,200 tons (can be up to 4,500-4,700 tons per day during Tet Holiday) collected from 12 urban districts and 7 rural districts.

In large-scale facilities such as Nam Son Complex, Xuan Son and Kieu Ky centers, sanitary landfill processing is applied for waste disposal. Leachates generated from landfills are collected and treated. In other landfills, leachates are not handled or simply handled through natural lagoon that doesn't meet environmental requirements and causes pollution to the water resource. Furthermore, most of landfills in Hanoi don't have landfill gas capture and treatment system which is essential for environmental protection.



Photo 8: Landfill of Kieu Ky (Gia Lam District)
(Source: IMV)



Photo 9: Leachate treatment station in Nam Son Complex (Soc Son District)

(Source: IMV)

✓ *Incineration:*

In Hanoi, there are three incinerators with a treatment capacity of less than 1,000 tons/day. They are all operated by private companies (Thanh Cong Cooperative, Thang Long Urban Environment JSC and Thanh Quang Investment JSC). These incinerators, with mostly Chinese technologies, were manufactured in Vietnam or China with some technical improvement to adapt to Vietnamese waste specificities (composition, moisture, specific heat capacity).

The recovery of heat from the combustion process has also gradually been researched or planned in some plants (Phuong Dinh plant, Son Tay plant) for electrical generation or reusing for drying waste before incineration, but for the moment no result has been certified.

✓ *Composting:*

Composting is often used in Vietnam for waste treatment. In Hanoi, there are two compost/organic humus production plants: one in Cau Dien waste disposal center, the other in Kieu Ky treatment site.

- Designed with a processing capacity of 50,000 tons/year, Cau Dien composting plant treats less than 13,000 tons/year due to the lack of financial support from the city. Waste processed in the factory is mainly from market waste with high proportion in organics and mixed with septic sludge to produce compost. Japan International Cooperation Agency (JICA) plans to fund, by ODA, for upgrading capacity and improving quality of compost with Japanese technology (URENCO, 2014).

- In 2015, the waste disposal site in Kieu Ky received daily approximately 50-60 tons of domestic waste from Gia Lam District with a treatment rate in organic humus of approximately 35% in volume (*Gia Lam Urban Environment Company, 2015*). Most of waste collected is not separated at source but at the Kieu Ky site. Because of the lack of investment, this system now produces only organic humus and not real compost. A part of humus produced is used by real estate developers. Some farmers in Gia Lam District use a small quantity for leveling their gardens. The remains are stored at the plant.



Photo 10: Organic humus produced from Kieu Ky composting plant

(Source: IMV)



Photo 11: Chain of waste separation in Kieu Ky composting plant(Gia Lam District)

(Source: IMV)

✓ *Recycling:*

Recycling activities from recyclable materials in waste (paper, glass, plastic, metal ...) is carried out mainly in some craft villages inside or outside Hanoi. As reported by Hanoi Urban Planning Institute, in 2013 approximately 18-22% of waste in Hanoi was recycled, mainly in some villages of Hanoi such as Trieu Khuc, Da Hoi or Minh Khai. Trieu Khuc, located in the South of Hanoi, is specialized in plastic recycling.

Solid waste recycling activities in craft villages has significantly contributed in reducing waste volume. However, these activities are still spontaneous and use old recycling technologies, causing air, soil and water resource pollution in the region. Lack of close supervision and examination by local authorities, the pollution situation in some craft villages in Hanoi is now a challenge for the Hanoi government.



Photo 12: A family purchasing and cleaning plastic bottles in order to resell them to recycling facilities in Trieu Khuc village

(Source: IMV)



Photo 13: A private plastic recycling facility in Trieu Khuc village (Thanh Tri District)

(Source: IMV)

- Industrial waste:

- *Treatment rate:* As reported by DONRE, among 646 tons of ordinary industrial waste generated daily, approximately 85-90% is eliminated in the disposal facilities such as Nam Son, Xuan Son và Kieu Ky. The rest is kept by generators for reusing or recycling purpose. For hazardous waste, only about 62-73 tons (accounting for 60-70% of total volume produced) are collected and treated daily in Nam Son Complex which is equipped with an industrial waste treatment system with capacity of 48 tons/day. The rest is stored at sources.

- *Method of disposal:* In the Nam Son Complex, industrial waste is currently eliminated by incineration or storage in cellars or safety landfill (Source: HUPI, 2013).

Presently, an industrial waste incinerator with a capacity of 75 tons per day is under construction by URENCO within the Nam Son Complex. This project is funded by NEDO, a Japanese organization. As reported by URENCO, heat from combustion will be recovered for generating electricity. The system is expected to be in use in 2016.

- Medical waste :

According to DONRE, a part of ordinary medical waste generated is kept at medical establishments for reusing or recycling purpose. The remainder is treated by incineration or sanitary land filling in a domestic waste treatment center of the city.

Hazardous medical waste is eliminated either on-site at some medical establishments equipped with medical waste treatment system or off-site at the medical waste disposal center in Cau Dien under the management of URENCO. Designed with capacity of

processing of 35 tons per day, the incinerator in Cau Dien is now only working with 5-6 tons per day¹¹.

As reported by DONRE, at the end of 2014, among 41 medical establishments in the city, 18 are equipped with small scale treatment facility (incinerators for mostly). The small scale incinerators in the health facilities in the city might present a risk of pollution if smoke from the incinerator is not treated properly. Therefore, according to Hanoi Master Plan for solid waste disposal, these equipments will be gradually closed in accordance with the roadmap of investment of hazardous waste disposal center of the city.

- Construction waste:

In Hanoi, construction waste is mainly disposed of by land filling in pits generated from clay exploitation for brick manufacture or in some natural or artificial lake. It can also be reused for filling ground in construction works. As reported by DONRE, there are five construction waste landfills in Hanoi with a total area of 20ha. They can receive an average amount of 3,000 tons per day.

According to Hanoi Master Plan for solid waste disposal, in the years to come, landfill will still be used in priority for construction waste disposal. Several new landfills will be added in some rural districts. However, the study of new technologies for recycling construction waste (ex. production of brick for paving sidewalk or public space) will be taken in consideration in order to save land.

- Septic sludge:

In Hanoi, a septic sludge treatment station in Cau Dien with processing capacity of 50 tons per day is managed by URENCO. Although the station was upgraded in August 2014 to a processing capacity of 300 tons per day, it has not met the current need of treatment of about 500 tons/day.

At Cau Dien station, septic sludge is put into settling tanks and sludge compression tanks for thickening and dewatering. Dewatered sludge is mainly sent in landfill. Only a small amount is mixed with organic waste for composting. Wastewater separated from the sludge treatment process is treated before discharging into the receiving environment (*Institute of Science and Environmental Engineering, 2015*).

At some rural districts, septic sludge collected by Urban Environment Companies at district level is buried with domestic waste in landfills.

- Sludge dredged from drainage network:

Sludge dredged from drainage network collected by Hanoi Drainage and Sewage Company and some Urban Environment Companies at district level is buried in landfills either separately, as in the Yen So landfill, or together with domestic waste as in the Kieu Ky.

¹¹ Vietnam Communism Party journal, 13/9/2015, Đỗ Thoa “Những bệnh viện ... rác” [The wasted hospitals] http://dangcongsan.vn/cpv/Modules/Preview/PrintPreview.aspx?co_id=30111&cn_id=733546

Using sanitary land filling in Hanoi for sludge treatment should be considered a short-term solution. This technique requires large expanses of land and cannot remove all the toxic substances contained in sludge, presenting a potential risk of pollution to the environment.

2.4 Organic and food waste issues

- Generation and composition

Organic waste generates mainly from daily life activities in households, offices, factories, production and commerce related to food (restaurants, hotels, markets, commercial centers, food processing facilities...) and agricultural production.

Organic components in solid waste include:

- food loss and food waste (food lost from its production, processing, transportation and distribution, leftovers from food consumption);
- waste from agricultural production (straw, leaves, animal feces, dead livestock, leftover from animal feeds ...).

- Disposal of food waste

Because of the diversity of components and the origin of its production, organic waste is currently processed in different ways.

- **Municipal collection:** Food waste discharged from production, commerce facilities or households can be collected and processed with domestic waste in municipal disposal sites. In municipal disposal sites, domestic waste with a high proportion in organic and food waste is processed by different methods: landfilling, composting and incineration. For the moment, landfilling is the predominant treatment means because of its low cost. However, this solution presents many limitations such as high demand of land, pollution to environment, and the inability for resource recovery from waste. It is also necessary to specify that other (informal) methods such as burying or discharging directly into ponds or canals are widely practiced.

- **Animal feed:** feeding food scraps to animals is the common way of dealing with restaurant food waste. It is given to some farmers and farmsteads in Hanoi's suburb and neighboring provinces for livestock feeding (ex. pig or chicken feed). Food waste is disinfected by steaming and fed to pigs, chickens, either on private farms or in piggeries. For chickens, it can also be mixed with grains.

- **Agricultural use:** organic waste from agriculture can be used to favor agricultural production. Indeed, it can help to fertilize the soil, regulate the temperature, contribute to mushroom growth etc.

- **Composting:** Food waste can be biodegraded by composting, and reused as a good soil fertilizer. This method has always been evaluated by experts as a potential solution for Vietnam. Nevertheless, the application of this method remains very limited. The main reason is the poor quality of the product. Compost producers can't sell their production, even when it is given free. It contains a high percentage of plastic and metal components. Indeed, as there is no sorting at source, the organic waste mixed with other waste has to be sorted, manually most of the time, with the expected result. The compost produced doesn't meet the technical requirements given by the Ministry of Agriculture and Rural Development for using widely in agriculture. For this reason, it is mainly used for private gardens or to level the ground for construction sites.

- **The informal recycling market:** leftovers from restaurants, usually high standing restaurants or hotels with strict expiry date regulation, can be sold to other street food restaurants at the end of the day. Grease leftovers can also be used again and sold to other restaurants.

- Excerpt of an interview :

There are different kind of informal workers in organic waste processing: people collecting food for their own farms, people collecting organic waste for agricultural purposes, transporters who are paid by farms to collect food waste etc. During our study, small scale, qualitative research interviews were carried out, the one with Mme Tin is particularly interesting.

Mme Tin, 06/10/2015

She has a farm in the rural district of Thuong Tin, 15 km from Hanoi after Ecopark. She has 6 pigs, approximately 20 ducks and goose. Every day, she comes to the city center on her motorbike.

In the morning she sells ducks and goose at the market in the south of Hanoi. Then she goes to Ba Trieu Street to collect the leftovers. There is indeed a huge construction site on the street, a big real estate project you can see if you pass by. At approximately 2pm she collects for free burnt rice and leftovers from the lunch of the workers. Usually, she takes leftovers from a « pho » restaurant in Pho Hué and she prefers it because there is more meat. But the construction site gives her leftovers for free whereas the restaurant gives them to her for 300 000d or 400 000d per month. The construction project will last for at least 6 months, but when it is over, she will return to restaurants leftovers.

She explains that the restaurant is chosen by taking into consideration the percentage of water and meat.

Concerning food waste, there is no specific legislation, nor control. There seems to be a local consensus between public authorities, restaurants and informal collectors. Indeed, every actor seems to find some benefit: for restaurants, farmers, collectors and for public authorities who do not have to manage the huge amount of waste that food waste represents. Interviewed on that topic, Hanoi public authorities answered that they do not have the ability to control the whole process.

ANNEXE 1
List of solid waste disposal facilities in Hanoi (2014)

TT	Facility	Type of waste treated	Volume of treatment (tons/day)	Area (ha)	Service zone	Method of disposal
1	Waste disposal complex of Nam Son (Soc Son District)	DW, OMW and IW	- DW: 3,800-4,200 - IW: 48	Phase I: 83.5 (In expansion to 180)	Hanoi Region	- DW: sanitary landfill - IW: incineration
2	Waste disposal center of Xuan Son (town of Son Tay) - Landfill	DW and OMW	250	Phase I: 13 (In expansion to 26)	Inter-districts	sanitary landfill and incineration
	- Plants		850	N/A		
3	Waste disposal plant of Phuong Dinh (Dan Phuong District)	DW	200	N/A	Inter-districts	Incineration with energy recovery, recycle (plastic, paper, metal)
4	Waste disposal plant of Cau Dien (Tu Liem District)	DW, MW, SS	- DW: 13.000 tons/year - MW: design 35, operation 5-6 - SS: 300	3.9	Hanoi city	- DW : composting - MW : incineration - SS : composting and landfill
5	Waste disposal center of Kieu Ky (Gia Lam District) - Landfill	DW, OMW, SS & SD	33-39	6.3	Inter-districts	Landfill and composting
	- Plant		50-60	7.7		
6	Landfill of Nui Thoong (Chuong My District)	DW	40	2	Inter-districts	Landfill
7	Landfill of My Thanh (My Duc District)	DW	20	0.5	District	Landfill
8	Landfill of Van Dinh (Ung Hoa District)	DW	40	3.0	District	Landfill
9	Landfill of Van Noi (Dong Anh District)	CW	800 – 1000	7.5	Hanoi city	Landfill
10	Landfill of Nguyen Khue (Dong Anh District)	CW	1000	50	Hanoi city	landfill
11	Landfill of Vinh Quynh	CW	600	4.9	Hanoi city	landfill

TT	Facility	Type of waste treated	Volume of treatment (tons/day)	Area (ha)	Service zone	Method of disposal
	(Thanh Tri District)					
12	Landfill of Song Phuong (Hoai Duc District)	CW	300	3	Hanoi city	landfill
13	Landfill of Dan Phuong (Dan Phuong District)	CW	300	4.6	Hanoi city	landfill
14	Sludge landfill of Yen So (Hoang Mai District)	SD	120,000-150,000 tons/year	7.5	Hanoi city	landfill

(Source: IMV, 2015)

Notes:

- *Domestic Waste (DW)*
- *Medical Waste (MW)*
- *Ordinary Medical Waste (OMW)*
- *Industrial Waste (IW)*
- *Construction Waste (CW)*
- *Septic Sludge (SS)*
- *Sludge dredged from Drainage network (SD)*