Japan's Experiences on Waste Management: Overview

Contents

1 Introduction

This training material is intended to effectively utilize the knowledge, technology, and lessons accumulated in Japan's history of improving waste management and building a sound material-cycle society in developing countries facing various challenges related to waste management.

This section firstly provides an overview of waste management as targeted by the Sustainable Development Goals (SDGs) and Japan's experience, in light of Goals 11 and 12 of the SDGs, and then explains how this material can be used.

The next section reviews the history of waste management in Japan and outlines the various measures taken by Japan to establish its current waste management system from the perspectives of "planning", "legislation", "policy", and "technology" in Topics 1 through 4. Topics 5 through 7 introduce the themes and trends that are increasingly posing challenges to the waste management sector, the efforts of the Japanese municipalities to overcome these challenges, and case studies of international cooperation projects provided by Japan to developing countries.

Each Topic

Topic 1：Waste Management Facts and Plans
Topic 2：Legislation and Government Policy Pertaining to Waste
Topic 3：Administrative Organization and Finance
Topic 4：Waste Management Technologies
Topic 5：Modern Trend of Waste Management
Topic 6：Efforts of the Municipalities in Japan
Topic 7：Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects

2 Waste Management as Targeted by the SDGs and Japan's Experience

The Sustainable Development Goals (hereinafter “SDGs”) are international goals set forth in the “2030 Agenda for Sustainable Development” adopted at the United Nations Summit in September 2015. The SDGs consist of 17 goals and 169 targets to achieve a sustainable and better society by 2030. The SDGs are universal, regardless of whether they are being addressed in developing or developed countries, and the goal is to ensure that no one on earth is left behind in the process of implementation. The goals and targets of the SDGs aim to achieve integrated improvements in sustainable development in three dimensions: environmental, economic, and social.

Goal 11 of the SDGs is to “Make cities and human settlements inclusive, safe, resilient and sustainable” and Target 11.6 of that goal is set as: “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management”. In Japan, each local government is responsible for waste management in its area of jurisdiction as part of its administrative responsibilities to maintain a sanitary living environment. The financial resources for waste management are covered by taxes, waste services fees collected from waste generators, or subsidies from the central government.

Waste management in a region operates on the basis of the understanding of waste generators and residents on the importance of waste management. In particular, the waste collection service is a familiar point of contact between the administration and residents, and is provided to all residents living in the area of jurisdiction of the local government. Although many of these services are outsourced to the private sector, the local government manages the quality of the waste collection work and the collection and transport private companies. High quality waste collection services are provided to the residents by establishing a waste collection system based on consensus making and respect of the opinions of the individual residents and the community. In response, residents have established a relationship of trust by adhering to the prescribed waste separation methods, discharge times and locations, etc. Through such mutual efforts between the local government and residents, a sanitary living environment is maintained.

Regarding Goal 12 of SDGs “Ensure sustainable consumption and production patterns,” Target 12.4 of this goal is set as follows: “By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment”. In Japan, administrative efforts have been made to reduce environmental pollution and environmental impact throughout the product life cycle through Extended Producer Responsibility (EPR), and monitoring illegal dumping, mainly to ensure that industrial

waste-generating business operators are aware of their responsibilities and held accountable. In addition, through research and development of incineration and landfill technologies, treatment and disposal methods that reduce environmental burden have been actively introduced.

SDGs' Target 12.5 states that "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse". In connection with this target, Japan has been vigorously promoting efforts toward sustainable production and consumption.

In the process of achieving rapid economic growth, economic and social activities characterized by mass-production and mass-consumption a mass-waste society emerged, and the frequent occurrence of illegal dumping and the shortage of landfill sites became serious issues. In response to these issues, from the late 1990s to the early 2000s, various laws were enacted to promote the formation of a sound material-cycle society, the 3Rs (reduce, reuse, recycle), heat recovery, and development of appropriate treatment and disposal methods. As a result, the amount of waste generation per capita has decreased from 1.185 kg/person/day in FY[1]2000 to 0.918 kg/person/day in FY 2019. Additionally, the recycling rate reached approximately 20% in FY 2007, up from approximately 14% in FY 2000, and has remained at the same level since then.

Thus, the Japanese experience in waste management is considered to contain many useful suggestions for achieving the SDGs in developing countries.

[1] In Japan, Fiscal Year (FY) starts from April and ends in March. For example, FY 2019 means from April 2019 to March 2020.

3 Purpose and Utilization of the Training Material

(1) Purpose of the Training Material

Japan has a history of facing and overcoming various difficulties before establishing its current waste management system.

Waste management in Japan began as a public health measure, and has continued to evolve over a long period of time into the current waste management, while meeting the demands of each time period against the backdrop of the social conditions of that period, such as the preservation of the living environment and the establishment of a sound material-cycle society. In recent years, Japan has been working on waste management with the aim of making further progress toward the promotion of a sound material-cycle society and the establishment of a low-carbon society.

Furthermore, in order to achieve the goals of the SDGs, Japan is actively working on various issues both in the domestic and international arenas, including the 3R Initiative and the Osaka Blue Ocean Vision. In Africa, Japan is working to build proper waste management throughout the continent, including the establishment and operation of the “African Clean Cities Platform” in collaboration with relevant organizations to promote knowledge sharing for improved waste management.

This training material not only introduces the actual state of waste management in Japan, but also explains the history and experiences that Japan has accumulated. The training material will also present how Japan tried to solve the problems the waste management sector confronted in each period and what measures were taken.

For many developing countries currently facing problems similar to those experienced by Japan in the past, Japan's experience, knowledge, and lessons learned are expected to provide them with useful suggestions. Obviously as circumstances differ from country to country and region to region, the same measures taken in Japan may not necessarily be the best solution for other countries. The purpose of this training material is to be used as a guideline for developing countries to consider how to tackle and solve the waste problems in their countries, based on the lessons learned from Japan's experience.

(2) Utilization of this Training Material

In order to provide a comprehensive study of the history of waste management in Japan to serve as reference to developing countries, the seven Topics listed below are included in this training material.

Each Topic begins with an overview of relevant and important findings, technologies, lessons learned, etc., followed by an explanation of specific experiences and approaches, as well as basic information. Columns are also included to introduce case studies and technologies that may be useful to developing countries.

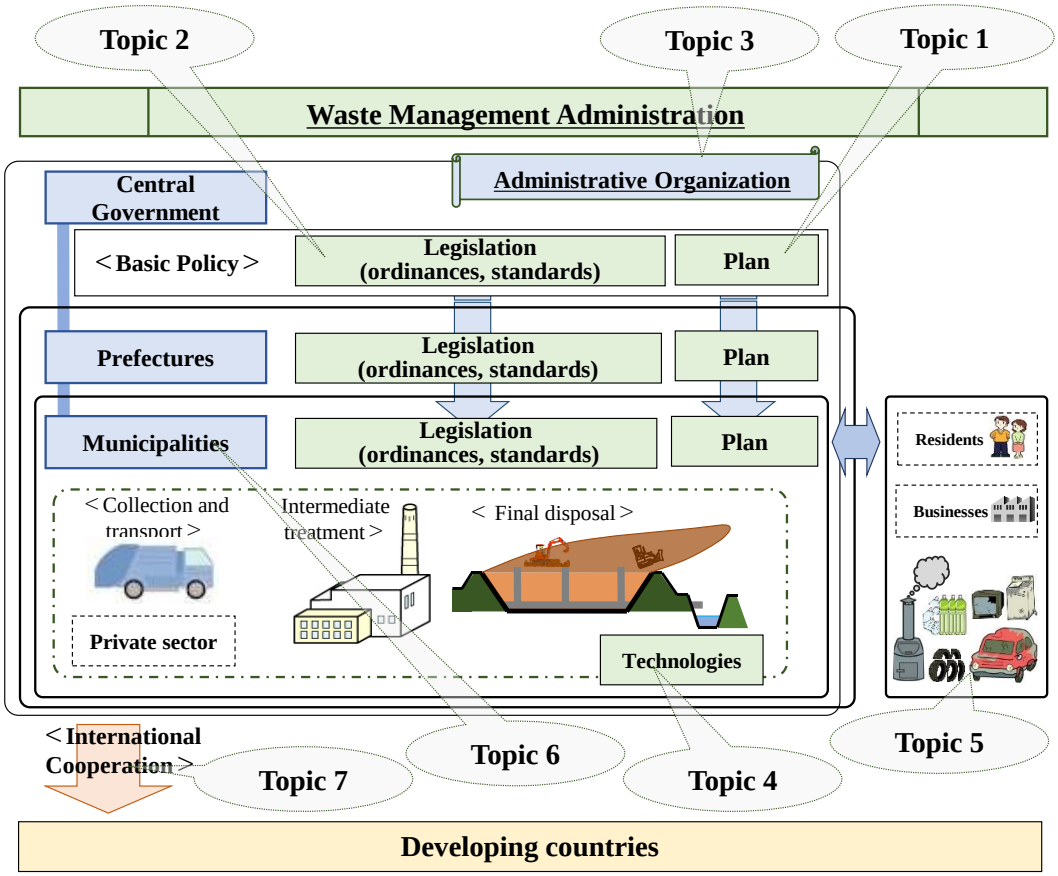


Figure 1 Schematic Diagram of Topics Introduced in the Training Material

Important Points for each Topic

Topic1：Waste Management Facts and Plans

To learn the importance of having an accurate understanding of the actual status of waste management and planning based on quantitative data

Topic 2：Legislation and Government Policy Pertaining to Waste

To learn approaches and efforts to improve the legal systems in developing countries

Topic 3：Administrative Organization and Finance

To learn about waste management systems and roles/ responsibilities, and measures that contribute to securing financial resources

Topic 4：Waste Management Technologies

To learn about the characteristics and utilization of various technologies related to waste collection and transport, intermediate treatment, and final disposal

Topic 5：Modern Trend of Waste Management

To learn the efforts, issues and important points regarding responses and measures for key waste management themes

Topic 6：Efforts of the Municipalities in Japan

To learn about the efforts and experiences of Japanese local governments

Topic 7：Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects

To learn about Japanese experiences and technologies applied in JICA projects and the lessons learned from each project

Items covered in the training videos are marked with the icon  .

4 Waste Management Facts and Plans (Topic 1)

This Topic introduces the actual status of waste management in Japan and the various plans that have been formulated, and teaches the importance of understanding the actual status of waste management and formulating plans based on quantitative data. In order to quantitatively grasp the actual status of waste management represented by the waste management flow from discharge to recycling and final disposal, the relevant data is collected and accumulated every year, and various plans are discussed based on the data analysis results. Numerical targets in the plans will be considered and set based on reliable data and with clear definitions.

(1) Present Status of Waste Management in Japan

1) Definition and Categorization of Waste

The *Waste Management and Public Cleansing Law* (*Waste Management Act*) of Japan defines waste, which is unwanted matter in a solid or liquid state (excluding gases), and earth and sand are outside the scope of the *Waste Management Act*. Categories of waste in Japan is shown in Figure 2.

Note that this text generally deals with municipal waste. Additionally, the term “waste” is used to mean municipal waste unless otherwise specified. However, the term may include industrial waste when policies, laws, hazardous waste, dioxin-related problems, and the like are discussed in the relevant text.

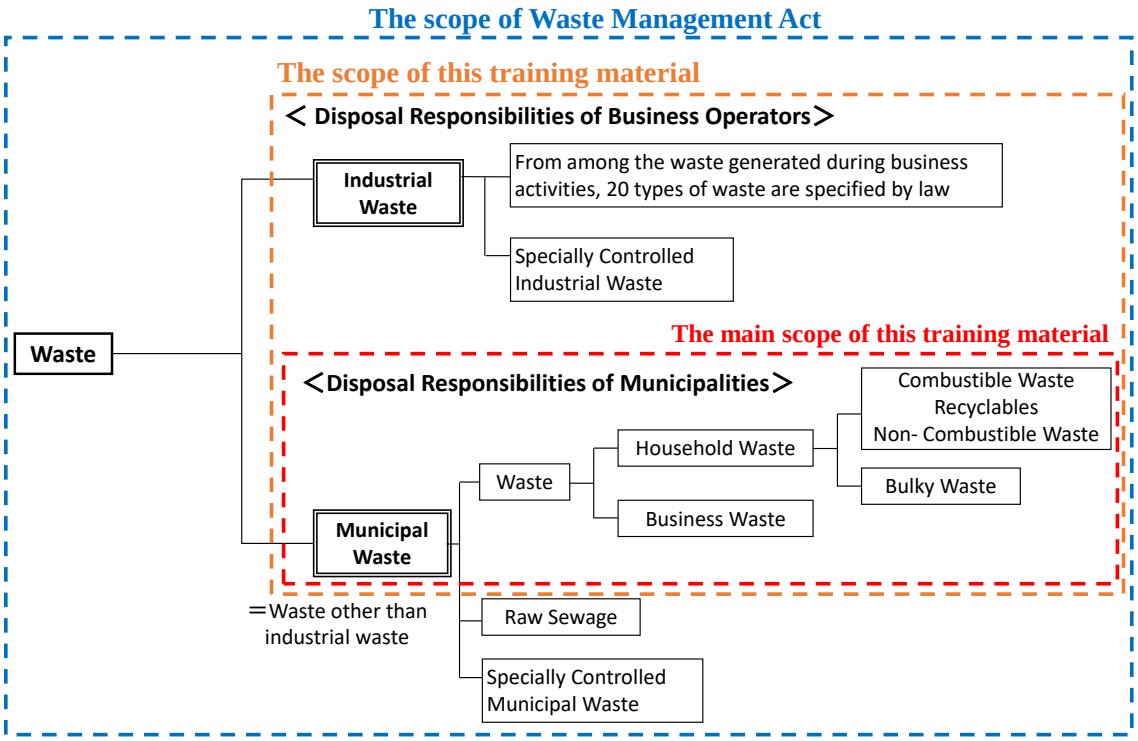


Figure 2 Categories of Waste in Japan

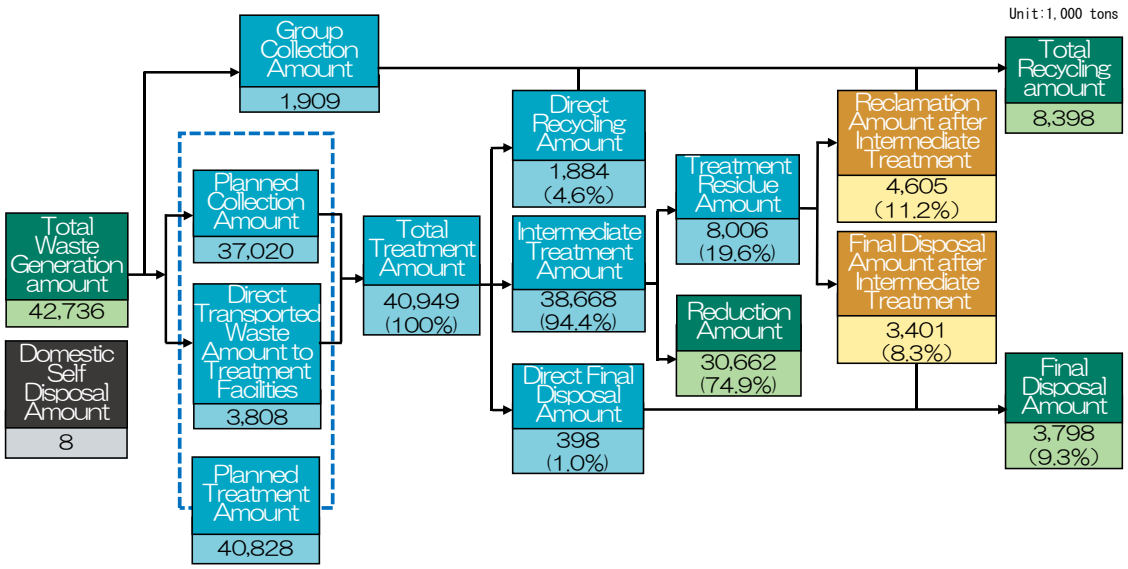
2) Waste Management Conditions

(a) Waste Generation Amount

During Japan's period of high economic growth (1960s and 1970s), factors such as rising incomes and changes in consumer behavior drove the development of an economic structure based on mass production and mass consumption, causing both municipal and industrial waste to rapidly increase and diversify. Later, during the bubble era[2] (late 1980s and early 1990s), the amount of waste increased swiftly as consumption and production activities expanded further. However, the total amount of waste generated and the unit generation rate per person per day have trended downward since 2000, in part due to the efforts to develop a sound material-cycle society. Accordingly, the total amount of waste generated is also changing in response to social and economic changes.

(b) Waste Management Flow

The Ministry of the Environment and municipalities regularly prepare waste management flows that visualize the path waste travels from discharge to recycling and final disposal. This waste management flow makes it possible to develop an appropriate understanding of the relationships between amounts of waste at the different stages of treatment, recycling, and disposal, which is useful for understanding the status of waste and formulating plans.



Source : Ministry of the Environment Website "Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2021" (2021)

Figure 3 Waste Management Flow in Japan (FY 2019)

[2]The bubble era refers to the economic boom in Japan, especially in the late 1980s and very early 1990s, when asset prices soared. The name is derived from the way asset prices expanded like a bubble and burst under certain circumstances.

(2) Waste Collection and Transport/ Intermediate Treatment/ Final Disposal

Discharged waste is collected using collection vehicles, which transport the waste to treatment plants or transfer facilities. Collection vehicles are commonly referred to as “packers” in Japan.

Collected waste is transported to intermediate treatment plants. There are many types of intermediate treatment plants for different wastes; examples include incineration plants, bulky waste treatment plants, and composting plants.

In FY 2019, the total treated waste amount[3] was 40.95 million tons, of which 32.94 million tons, or roughly 80%, underwent incineration treatment (direct incineration amount).

Recycling is the recapture and reuse of resources that have been discarded (here, recycling means material recycling, in which materials are reused as raw materials, and does not include thermal recycling[4], in which thermal energy is recovered and utilized). In Japan, the recycling rate is defined as the percentage the total recycled waste amount (Direct recycling amount + Group collection amount[5] + Recovery amount after intermediate treatment) of the total treated waste amount (Total treatment amount + Group collection amount).

Source: Ministry of the Environment “Solid Waste Management and Recycling Technology of Japan” (2013)

Photo 1 Waste Collection by Compactor

Source: Yachiyo Engineering Co., Ltd.

Photo 2 Funabashi North Incineration Plant

$$\text{Recycling Rate (\%)} = \frac{\text{Direct Recycling Amount} + \text{Group Collection Amount} + \text{Recovery Amount after Intermediate Treatment}}{\text{Total Treatment Amount} + \text{Group Collection Amount}} \times 100$$

[3] Total treatment amount = Intermediate treatment amount + Direct final disposal amount + Direct recycling amount

[4] In the EU, the concept of energy recovery is used to distinguish it from thermal recycling, and recovery of thermal energy is not included in recycling.

[5] All the Group collection waste is considered to be thoroughly sorted at source and composed only of recyclables.

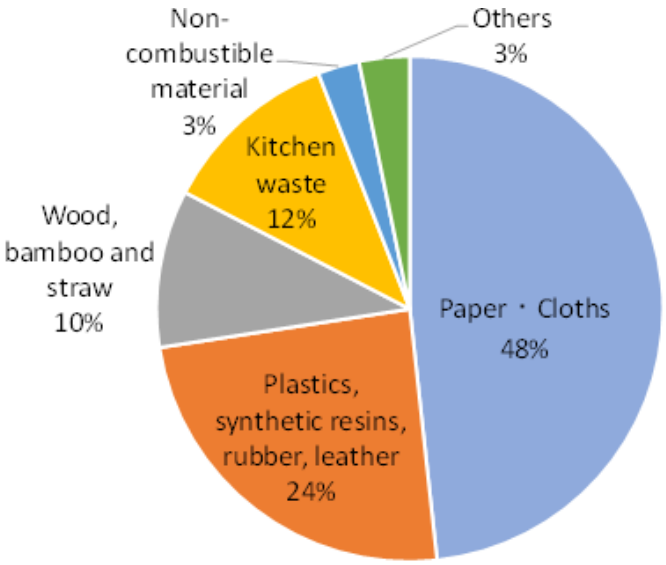
"Final disposal" means that waste is ultimately disposed into landfill sites at the last stage of the waste management flow. The final disposal amount is the sum of the amount of waste sent directly to final disposal without intermediate treatment (direct final disposal amount) and the amount of waste sent to final disposal after intermediate treatment (final disposal amount after intermediate treatment).

Source: Sagamihara City "Landfill site for municipal waste in Sagamihara City" (2019)

Photo 3 Landfill of Sagamihara City

(3) Waste Composition

Understanding the waste composition incoming to intermediate treatment facilities and final disposal facilities is essential for considering recycling methods and feasibility of introducing incineration facilities, as well as for determining of facility specifications. In particular, obtaining the values of moisture content, ash content, and combustible content (these are called the three components of waste) leads to knowing the combustibility of the waste. Knowing the unit volume capacity is also important for the remaining life of the landfill site and designing the waste pit of the facility.



Source: Ministry of the Environment Website "Results of the survey on municipal waste management (FY2019)" https://www.env.go.jp/recycle/waste_tech/ippan/ (accessed January 25, 2022)

Figure 4 Result of Waste Composition (Dry Weight Base) (2019)

(4) Waste Management Plans

1) Management of Waste-Related Data

In Japan, the Ministry of the Environment publishes the results of an annual survey on the state of municipal waste management. Since the 1970s the Ministry of the Environment has been conducting a survey in the form of a questionnaire to municipalities and associations for the purpose of obtaining basic data on municipal waste administration. The central government then collects and accumulates the data from municipalities to build a nationwide database, which is characteristic of data management in Japan.

The survey items are broadly divided between the conditions of facility operation and the conditions of treatment. The data obtained is aggregated by municipalities in each prefecture, and the statistical tables are available to the public. This data fulfills an important role in examining and setting specific priority targets, achievement indicators, and other criteria when formulating plans for waste management.

In the course of carrying out waste management, municipalities continuously collect a variety of data and use it to formulate policies and plans for the future.

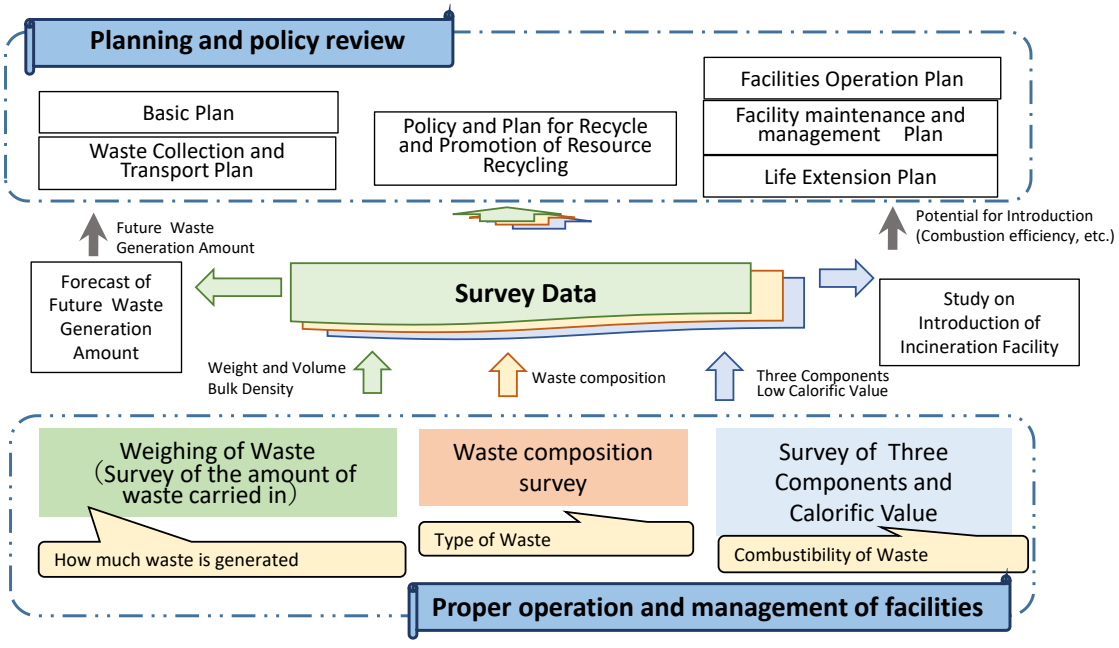


Figure 5 Examples of Utilization of Waste Survey Data

2) National-Level and Municipality Level Waste Management Plans

Plans and facility development for waste management at the national and municipal levels are shown in Table 1.

Table 1 Waste Management Plans

Level	Plan	Description
National-level waste management plans	Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society	The plan was established to comprehensively and systematically promote measures for forming a sound material-cycle society based on the *Basic Act on Establishing a Sound Material-Cycle Society*.
	Waste Management Facility Development Plan	The plan defines the targets and outline of the waste management facility development project for the planning period, based on the *Waste Management Act*.
Plan for waste management at the municipality level	Municipal Waste Management Plan	Based on the *Waste Management Act*, the municipality establishes a plan for municipal waste disposal in the area of the municipality in order to properly dispose of general waste while preserving the living environment and improving public health, which are the objectives of the Act.
	Municipal Separate Collection Plan	Set by municipalities for implementing separate collection of waste containers and packaging based on the *Containers and Packaging Recycling Act* and the *Plastic Resource Recycling Promotion Act*.
	Inter-Municipal Waste Treatment Plan	The prefecture and the municipalities in its jurisdiction collaborate to formulate an inter-municipal waste treatment and consolidation plan.
Plan for the development of waste-related facilities	Technical guidelines for environmental impact assessment	Based on the *Environmental Impact Assessment Act* and the *Waste Management Act*, technical guidelines for environmental impact assessment to ensure that environmental impact assessment and post-implementation studies of waste treatment facilities are properly conducted based on scientific knowledge.
	Comprehensive Plan for Extending the Service Life of Waste Treatment Facilities (Waste Incineration Facilities)	The purpose of this plan is to extend the service life of waste treatment facilities by introducing the concept of stock management, proper daily operation and management, appropriate annual inspections and maintenance, and plan for periodic renewal of major facilities and equipment.

5 Legislation and Government Policy pertaining to Waste (Topic 2)

This Topic introduces how legislation and policies have been developed to respond to various waste management issues - such as improvement of public health, preserving living environments, and establishing a sound material-cycle society - arising from economic growth, industrialization, urbanization, and changing lifestyles in the process of building a modern society.

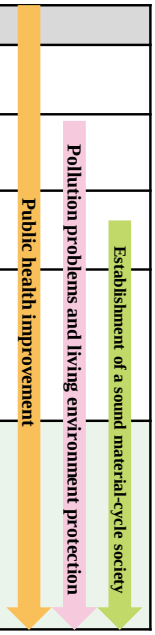
The efforts and approaches to systematically develop the basic laws, laws for individual issues and plans at the national and municipal levels in response to changes in social conditions, are introduced here. These can be useful as references for the development of legal systems in developing countries.

(1) History of Waste Management in Japan

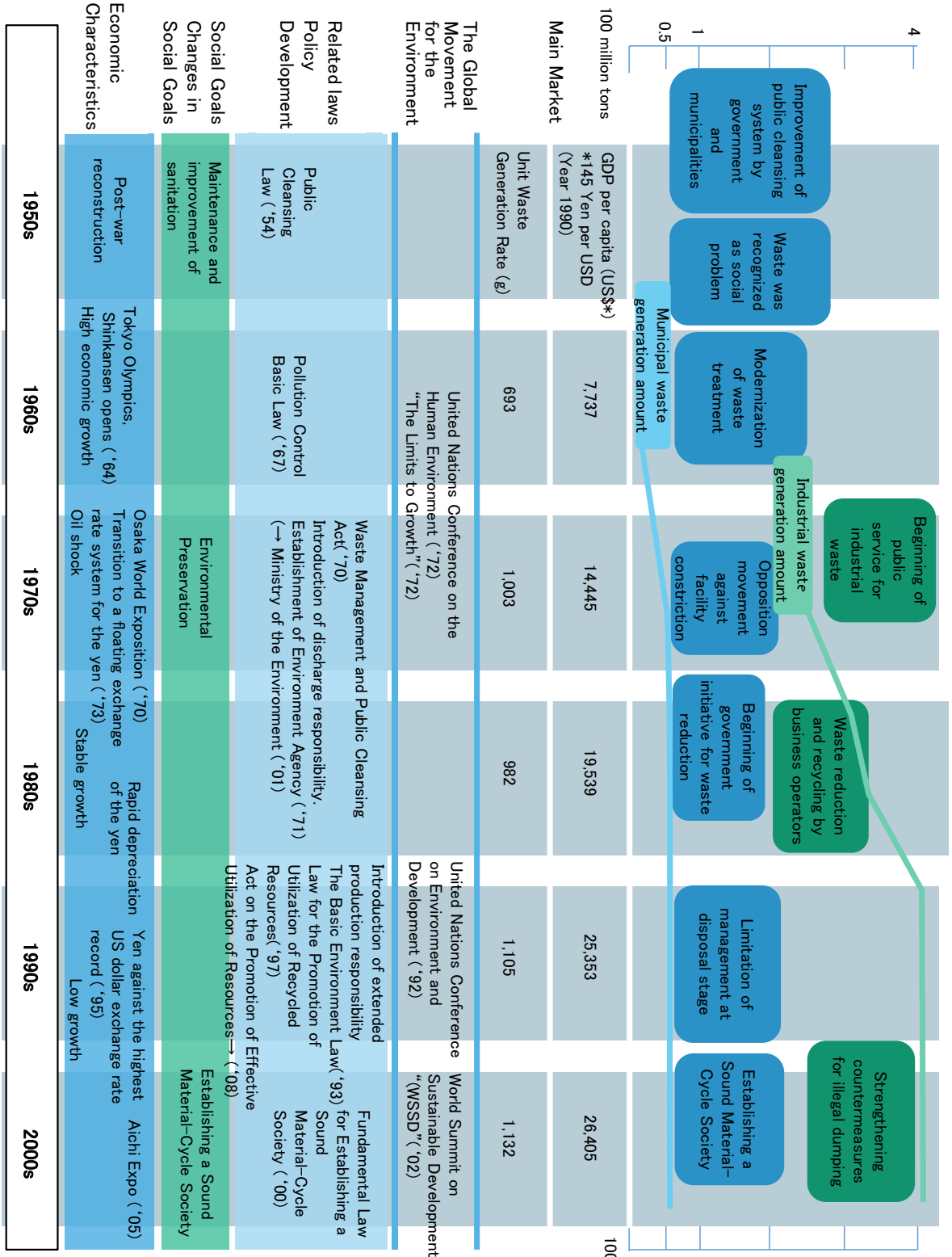
Since the late 19th century, the social environment in Japan has changed as modernization progresses, and residents' lifestyles and living environments have changed accordingly. Although Japan has successfully created a highly convenient society, it has also confronted many waste management-related issues from one era to the next. "Waste management" is also referred to as "waste treatment" in the law, and the two are synonymous.

Table 2 Changes in the Social Situation in Japan and Issues and Legislation related to Waste Management

Period	Major Issues	Laws Enacted
Post-war period to the 1950s	• Waste management for environmental sanitation • Maintenance of a healthy and comfortable living environment	• Public Cleansing Act (1954)
1960s to 1970s	• Increase in the amount of industrial waste and emergence of pollution problems as a result of rapid economic growth • Waste management for environmental protection	• Act on Emergency Measures concerning the Development of Living Environment Facilities (1963) • Waste Management Act (1970) • Revision of the Waste Management Act (1976)
1980s	• Promotion of the development of waste management facilities • Environmental protection required for waste management	• Wide-area Coastal Environment Development Center Act (1981) • Private Sewerage System Act (Johkasoh Law) (1983)
1990s	• Waste generation control and recycling • Establishment of various recycling systems • Management of hazardous substances (including dioxins) • Introduction of a proper waste management system to cope with diversification in the type and nature of waste	• Revision of the Waste Management Act (1991) • Act to Promote the Development of Specified Facilities for the Disposal of Industrial Waste (1992) • Japanese Basel Act (1992) • Basic Environment Law (1993) • Containers and Packaging Recycling Law (1995) • Revision of the Waste Management Act (1997) • Home Appliance Recycling Law (1998) • Law Concerning Special Measures against Dioxins (1999)
2000-	• Promotion of 3R measures aimed at the establishment of a sound material-cycle society • Enhancement of industrial waste management • Enhancement of illegal dumping regulations	• Basic Act for Establishing a Sound Material-Cycle Society (2000) • Construction Material Recycling Law (2000) • Food Waste Recycling Law (2000) • Revision of the Waste Management Act (2000) • Act on Special Measures concerning Promotion of Proper Treatment of PCB Wastes (2001) • End-of-life Vehicle Recycling Act (2002) • Act on Special Measures concerning Removal of Environmental Problems Caused by Specified Industrial Wastes (2003) • Revision of the Waste Management Act (2003 to 2006, 2010) • Small Home Appliance Recycling Act (2013) • Revision of the Waste Management Act (2015, 2017, 2020) • Plastic Resource Recycling Promotion Act (2022)



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2017)



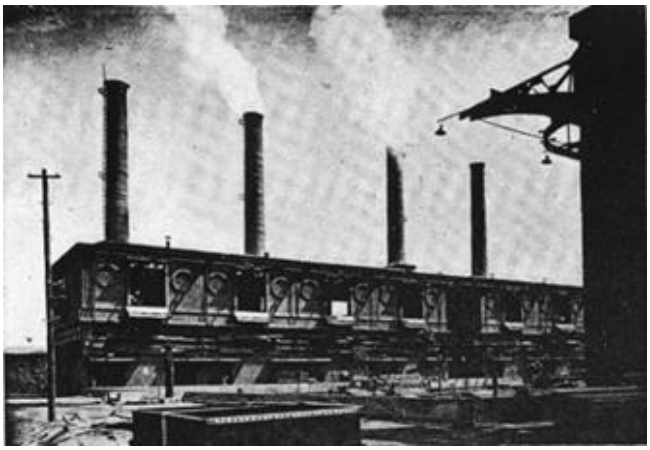
Source: Based on the Ministry of the Environment "Japan's Experience in Promotion of the 3Rs" (2005)

Figure 6 History of Waste Management in Japan

(2) Legislation Pertaining to Waste Management

1) Changes in Legislation Pertaining to Waste Management

The first law pertaining to waste was the *Waste Cleaning Act* (1900). In light of the subsequent worsening of public health problems caused by the rapid increase in municipal waste associated with postwar economic development and increasing urban population density, the *Public Cleansing Act* was enacted in 1954 for the purpose of improving public health, and the *Waste Cleaning Act* was repealed.



Source: Tokyo Metropolitan Archives

Photo 4 Fukagawa Incineration Plant – Technology of the Time did not Provide Adequate Exhaust Gas Treatment (Completed in 1933)

As Japan entered its period of high economic growth in the 1960s, the further increase and diversification of municipal waste, pollution caused by hazardous waste, and other social problems prompted the 1970 repeal of the *Public Cleansing Act* and concurrent enactment of the *Waste Management Act*. This concurrent act details requirements to conserve living environments in addition to improving public health as stated in the former *Public Cleansing Act*.

Source: Tokyo Metropolitan Government Bureau of Environment

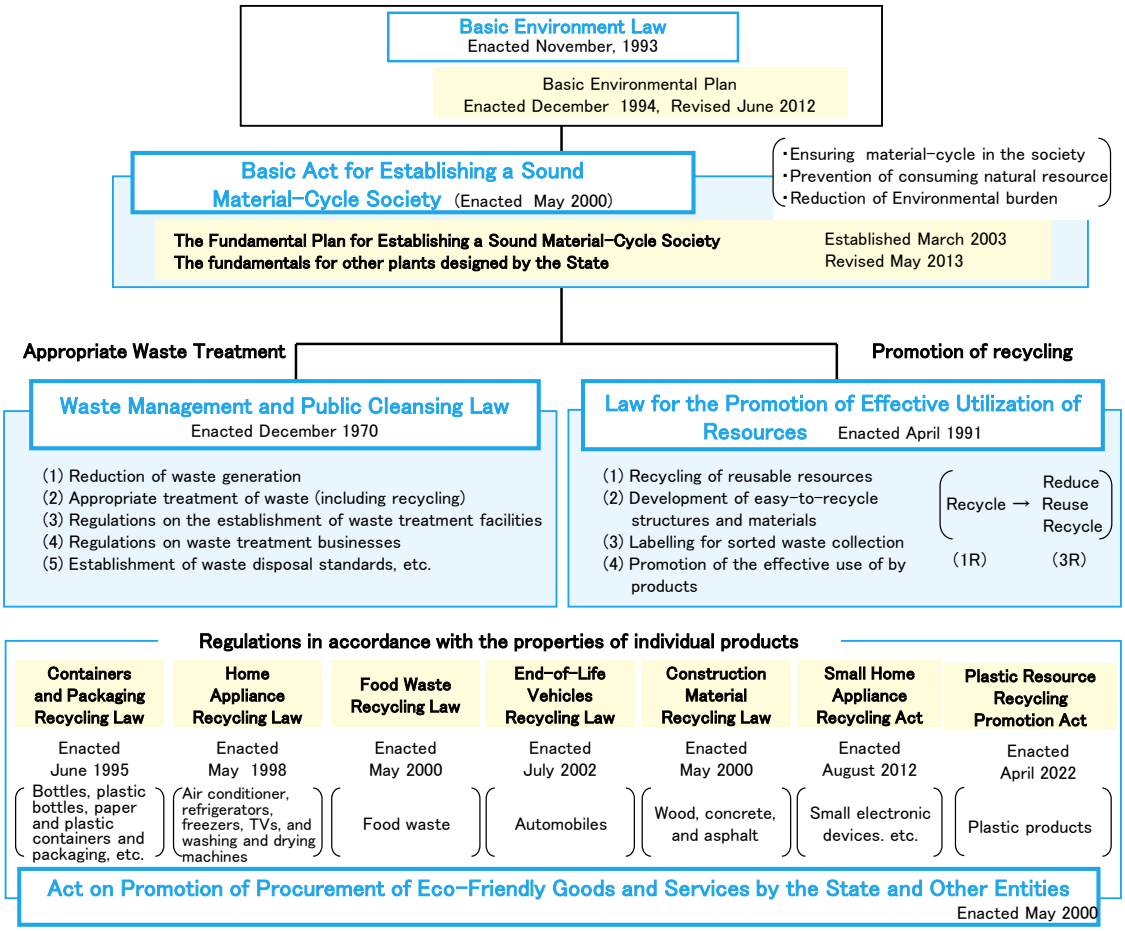
Photo 5 Transport Vehicle that were Often Used-circa 1961

In the 1970s, the social structure based on mass production, mass consumption, and mass disposal continued to progress as Japan sought greater material wealth. Consequently, the amount of waste generated continued to increase and the remaining capacity of landfill site was shortened. These and other problems made it necessary to concentrate efforts toward radical solutions. Given that the focus of policy had shifted to reducing amounts of waste generated and recycling, the *Waste Management Act* was amended. Furthermore, the *Basic Act for Establishing a Sound Material-Cycle Society* and other laws on recycling were enacted in due order, and a shift toward forming a sound material-cycle society was promoted.

2) Legal Structure to Waste Management

The legal laws and regulations pertaining to waste management was established to support the formation of a sound material-cycle society, and comprises the *Basic Act for Establishing a Sound Material-Cycle Society* - which sets out the basic philosophies and approaches to forming a sound material-cycle society based on the *Basic Environment Law*, which sets out the core elements of environmental policies - and the individual laws that embody the acts.

Many laws have been established toward the formulation of a sound material-cycle society. The *Waste Management Act* aims to preserve living environments and improve public health through efforts such as waste minimization and proper treatment of waste. The *Law for the Promotion of Effective Utilization of Resources* (the *Effective Resource Utilization Promotion Act*) aims to ensure the effective utilization of resources, reduce the generation of waste, and conserve the environment. The seven laws on recycling were enacted to correspond to the properties of individual items. The *Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities* (the *Act on Promoting Green Purchasing*) aims to establish a society capable of sustainable development by having public agencies take the lead in promoting the procurement of products and services that help reduce environmental impact.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 7 Legal Framework for a Sound Material-Cycle Society

(3) Policies Pertaining to Waste Management

In Japan, the Ministry of the Environment has taken the lead in adopting important measures to respond to issues such as proper waste treatment, pollution control and efficient waste management.

Table 3 Policies Pertaining to Waste Management

Policies	Description
Standards and Guidelines for Proper Waste Treatment	The Ministry of the Environment has established technical standards and guidelines for waste treatment plants, landfill sites, and other facilities in line with the related laws in order to respond to pollution problems, implement proper waste treatment, and achieve other goals. Japan has made efforts to resolve those problems using technical methods with technical and financial support from the Ministry of the Environment.
Thermal Recovery	The utilization of energy from incineration power generation is promoted because of the enhanced caloric content of waste associated with changes in lifestyles, and the improvement in power generation efficiency brought about by technical innovations.
Pollution Countermeasures (for Dioxins, etc.)	When pollution and other problem that threaten human life and health occur, the necessary laws are established and comprehensive countermeasures are implemented through technical and regulatory methods based on the results of the experts' investigations.
Inter-municipal Waste Disposal	Against a backdrop that includes the need to secure a certain scale of treatment capacity to promote efficient and proper waste treatment, dioxins countermeasures, and waste power generation, Japan has promoted inter-municipal waste disposal as a national policy, and has achieved a certain degree of success.
3R Promotion	In order to reduce consumption of natural resources and minimize waste, Japan has long engaged in efforts related to the 3Rs, including reducing waste, reusing unwanted articles, sorting recyclables, and group collection (voluntary resource collection systems run by local residents and others). Furthermore, amid a growing awareness of the importance of establishing a society capable of sustainable development, efforts toward establishing a sound material-cycle society have been promoted, namely through the enactment of the *Basic Act for Establishing a Sound Material-Cycle Society* in 2000.

6 Administrative Organization and Finance (Topic 3)

This Topic explains an overview of the administrative structure centered on the central government, the roles and responsibilities of each entity involved in waste management, including local governments, private companies, and residents, as well as the financial structure.

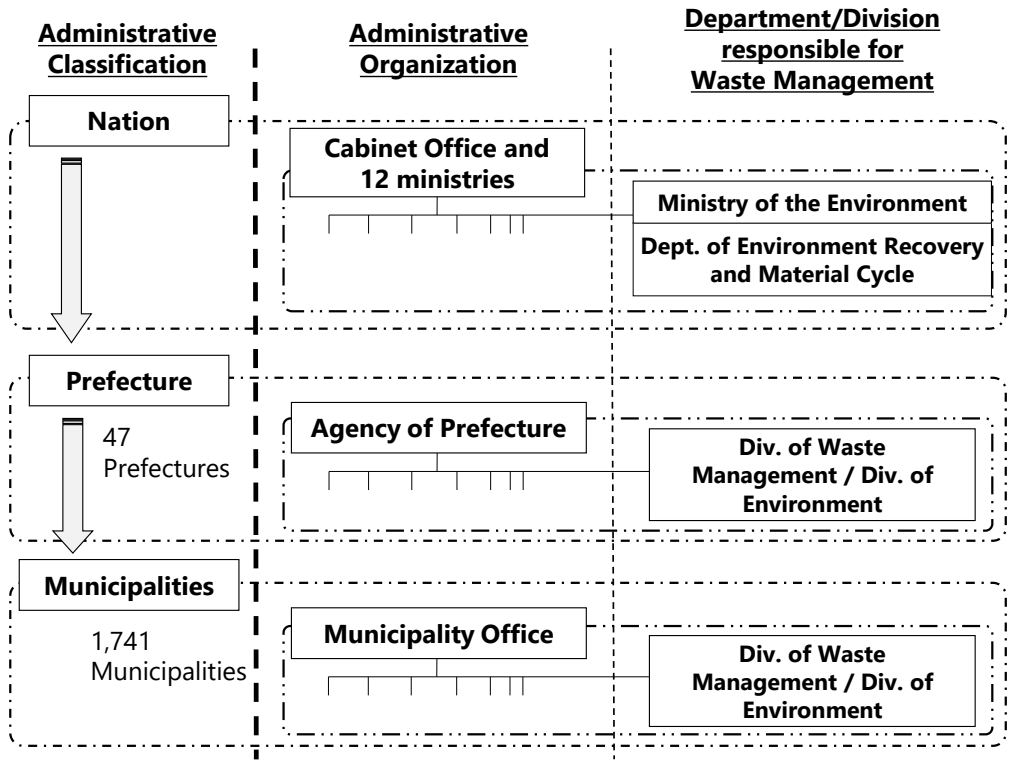
For proper waste management, it is important to establish a system that systematically covers the entire country based on administrative classifications such as central, prefectural, and municipal governments, and to ensure that each entity involved is aware of its roles and responsibilities. This Topic also provides an overview of the system of subsidies to local governments and fee collection based on the principle of responsibility of waste-generating business operators, and introduces measures which may be referred to by developing countries in their efforts to secure financial resources for their waste management.

(1) Government Organizations Involved in Waste Management

1) The Structure of Government Organizations

Under the central government of Japan there are 47 geographic administrative areas referred to as prefectures, major cities and districts. Within these prefectures there are different types of municipalities and special cities, and each of the prefectures, cities, towns, villages and special cities have their own administrative organization. These are the local governments responsible for administration within their administrative areas. (Special cities and municipalities number 1,741 (2020), of which 23 are special cities, 792 cities, 743 towns, and 183 villages).

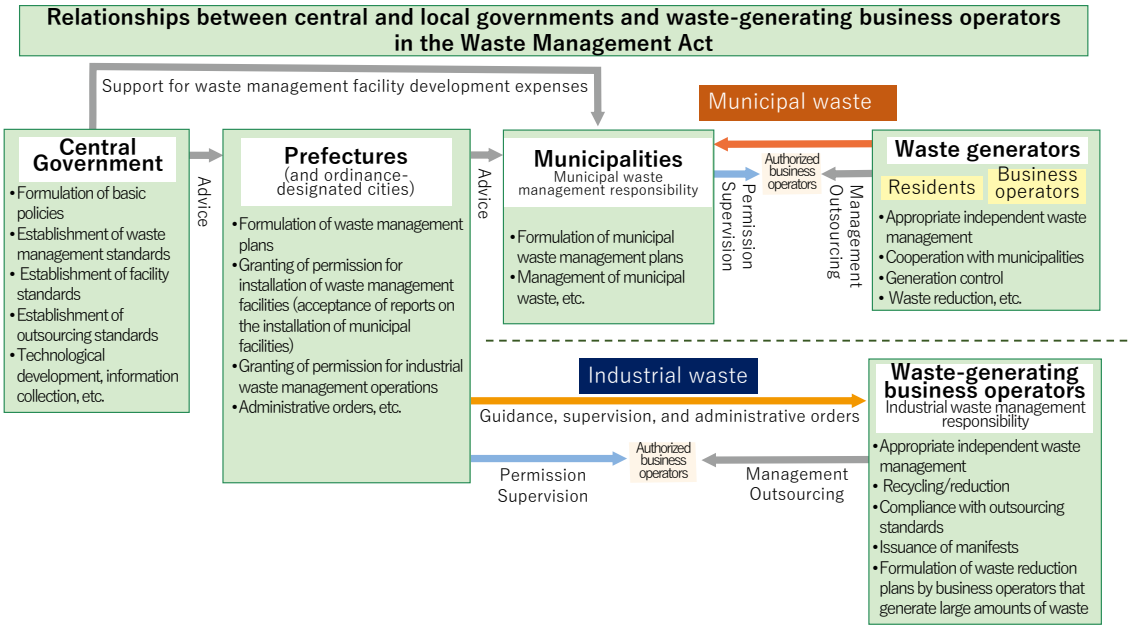
Japanese government agencies are made up of the Cabinet Office and 12 government ministries, of which the Ministry of the Environment is responsible for central management of the waste management system. Divisions have been set up in many prefectures and municipalities (in this text municipalities include special wards) to manage waste, and the respective responsibilities of the various levels of government agencies are determined by law.



Note: The 1,741 municipalities include cities designated by government ordinance that are at the prefectural level.

Figure 8 Waste Management System in Japan

The main waste management responsibilities of the central government, prefectures, and municipalities, together with the responsibilities of waste-generating business operators and individuals generating waste are shown in below. In addition to the responsible government agencies, both business operators and citizens generating waste also have roles to fulfill in waste management from their respective positions.



Source: Ministry of the Environment "History and Current State of Waste Management in Japan" (2014)

Figure 9 Division of Waste Management Responsibilities amongst Various Entities

2) Government Waste Management Services

Under the *Waste Management Act* municipalities are designated as the management entities for municipal waste operations. Thus, waste management is one of the important services municipalities must provide for citizens within the administrative area under their jurisdiction.

In addition to waste collection and the various work processes leading to final disposal, municipalities are also responsible for public awareness directed to citizens. Many municipalities have a specialized division dealing with waste management, but in the case of collection, transport and managing the operation of facilities, some municipalities do this work directly and some by outsourcing part of it to the private sector.

Also, some municipalities with relatively low populations join with other nearby municipalities and set up joint waste management (referred to hereafter as "Clean Association"). Thus, specialized associations are set up to provide government waste management services so that the municipalities can carry out their responsibility to provide waste management in an efficient way. These Clean Associations provide the government waste management services for all the administrative areas under the jurisdictions of the member municipalities. The parts of the work done directly by each municipality differs depending on each municipality's population size and area characteristics, however each municipality is responsible for the overall waste management under its jurisdiction.

3) Waste Management through Outsourcing and Collaboration with the Private Sector

In many municipalities in Japan, the government administrators outsource part of the waste management service to the private sector for which the government is responsible for, such as the collection and transport of waste or the operation of facilities.

Municipalities must set up fairly large organizations within their administrations to provide citizens directly with waste management government services, and they have to ensure the necessary personnel and budget to do the work. They also need to secure and implement budgets on an ongoing basis for the operation and maintenance of equipment and facilities. For these reasons, in order to supply services for waste collection and transport efficiently and economically, many municipalities outsource waste collection and transport services to private sector collection and transport businesses. Many municipalities outsource the operation and management of their own waste treatment facilities (incineration facilities, recycling facilities, etc.) and final disposal sites to the private sector in order to ensure stable operation and management by highly skilled engineers.

4) Residents Participation and Consensus Building

Proper waste treatment depends on the cooperation of residents in properly sorting and discharging waste. Each municipality clarifies the roles of residents, business operators, and the government in its ordinances and basic plans, and stipulates what each of them should respectively do.

When constructing waste treatment plants or landfill sites, it is essential to consider residents living near the planned locations of the plants and sites. Opposition from local residents or environmental groups could arise if sufficient consideration and explanation are not given to them, hindering the progress of projects. In order to establish proper waste management systems, it is important for residents, business operators, and governments to understand their respective roles, and for the three parties to work together as one.

(2) Waste Management Utilizing the Private Sector with Private Finance Initiative (PFI)

PFI (Private Finance Initiative) is one way of implementing public works, such as constructing facilities and their operation and management, using private sector finance and technical knowhow.

Special Purpose Companies (SPCs) are companies established to carry out one particular PFI project. SPCs use their earning power from the project as collateral to gain financing, using a funding method known as project finance, and they carry out the project by financing part of the construction and other costs by loans from financial organizations. Also, SPCs are compensated for the services they provide, being paid for construction funding and management costs by local governments.

(3) Finances Concerning Waste Management

In FY 2019, the total expenditure was JPY 2,319.4 billion, comprising waste management expenses of about JPY 2,088.5 billion and human waste management expenses of about JPY 230.8 billion.

Concerning the revenues breakdown for waste management in the municipalities of Japan in FY 2019, the costs of waste management were covered by revenue of about JPY 1,383.3 billion (about 66% of the total revenue) which came from general finances, with other sources contributing 5-15% each including fee income contributing JPY 272.5 billion (13%). Concerning the expenditure breakdown, the operation and maintenance costs for intermediate treatment was about JPY 680 billion , taking up the largest share (33%), followed by the operation and maintenance cost for collection and transport of about JPY 600 billion (29%) and the facilities construction and improvement cost of JPY 415 billion (20%).

The major portion of waste management costs, 66% is covered by general finances, and waste treatment facility improvement costs, which requires large funds, are financed by grants or subsidies and local government bonds

Grant Program for Establishing a Sound Material-Cycle Society

The Grant Program for Establishing a Sound Material-Cycle Society is essential to municipalities improving waste treatment facilities in their districts. Improvement of waste treatment facilities are large projects that municipalities implement only every few decades and temporarily pose a huge financial burden on them. As such projects are important for the formation of a sound material-cycle society, the central government has created this grant program to provide not only technological support but also financial support necessary for such facility development.

Fee Collection Methods by Local Governments and Fee Bearing by Residents and Business Operators

While water supply service adopts the independent accounting system of consumption as the principal financial revenue in the form of “water charges” collected from residents, in the case of municipal waste management service the expenses are covered by taxes (such as resident taxes) as principal financial revenues.

With the aim of promoting the reduction of waste generation and reuse, the government examined how waste should be managed by municipalities to create a sound material-cycle society. In 2010, The “Basic Policy for the Comprehensive and Systematic Promotion of Measures for the Reduction and Other Appropriate Disposal of Waste” was revised. This basic policy identified that the roles of municipalities should be to “promote charging fees for municipal waste management, in order to minimize waste and promote recycling by utilizing economic incentives, to advance fairness of burden sharing in proportion to generated-waste amounts, and to build residents’ awareness”. In response to

this basic policy, each municipality is either already charging fees for waste management services, or considering to do so.

In line with the principle of "extended producer responsibility", the *Containers and Packaging Recycling Law* has established a mechanism that obliges business operators to bear recycling-related expenses for waste containers and packaging. As it is difficult for municipalities to conduct proper treatment or to recycle large and heavy home appliances, the *Home Appliance Recycling Law* provides a mechanism by which waste-generators bear waste collection and transport fees as well as recycling fees when discharging their own home appliances. Regarding automobiles, the *End-of-Life Vehicle Recycling Law* provides a mechanism by which, in general, automobile owners should bear recycling fees when purchasing their own automobiles.

Table 4 shows laws and regulations providing for expense sharing mechanisms.

Table 4 Expense Sharing Mechanisms by Laws and Regulations and their Expected Impacts

Law and regulations / Targeted products	Financial revenues secured (Use of financial revenue)	Expense bearers	Expected impacts
Containers and Packaging Recycling Law / Containers and Packaging	Outsourcing Fees for collection, transport and recycling (recycling and merchandising) of containers and packaging	Designated business operators (retailers, manufacturers, etc.)	Reduction of waste, life extension of landfill site, promoting of recycling
Home Appliance Recycling Law / Four Items of Home appliances	Fees for collection, transport and recycling of Home Appliances	Waste-generators of used home appliances	Reduction of illegal dumping of used home appliances, reduction of waste, life extension of landfill site, promotion of recycling
End-of-Life Vehicle Recycling Law / End-of-life vehicles	Recycling fees for end-of-life vehicles	Vehicle owners	Reduction of illegal dumping of end-of-life vehicles, reduction of wastes, life extension of landfill site, promotion of recycling
Waste discharged from household	Forming part of financial revenue for waste management (used for public awareness building, etc.)	Residents	Reduction of wastes, life extension of landfill site, ensuring fairness of expense sharing, raising residents' awareness, building awareness and technology capacities of business operators, securing part of financial resource necessary for waste management

7 Waste Management Technologies (Topic 4)

This Topic provides an overview of the various technologies for collection and transport, intermediate treatment, and final disposal, as well as the evolution of these technologies. In developing countries it is important to select and appropriately apply technologies that meet the conditions of the target region, and satisfy the demands for efficient collection and transport, appropriate waste treatment, and sanitary landfill disposal. Therefore, in addition to introducing the characteristics of each technology, this Topic also discusses effective utilization methods and key points in operation and maintenance.

(1) Waste Discharge, Collection and Transport

1) Collection Methods

Storage and Discharge of Waste

Waste is generated every day from each household and it is important to collect the waste generated effectively and efficiently to secure the sanitary condition of each household and its surrounding area. For this reason, in principle, it is important for residents to collect the waste that is generated in each household, and store the waste inside the house until it is time to discharge it to the designated location at the specified time according to the predetermined collection plan.

Source: Yachiyo Engineering Co., Ltd.

Photo 6 Station Collection

Door-to-door Collection and Station Collection

Waste collection services that are provided by the municipality are mainly carried out by door-to-door collection or station collection methods. In the door-to-door collection method, waste is discharged in front of each household which is then collected. In the station collection method, a specific location is set as a waste discharge station and a number of households discharge their wastes there for collection.

Source: Yachiyo Engineering Co., Ltd.

Photo 7 PET Bottle Separated and Discharged by Residents in Tokyo

Source Separation and Separate Collection

It is extremely important to separate waste at the source of generation (source separation) in order to promote recycling. In each municipality, the categories for separation are determined according to the characteristics and actual condition of the region. On the other hand, since an increase of the number of categories for waste materials separation requires development of a system for sorting and increases the burden on the residents, further cooperation of residents becomes necessary.

Source: Yachiyo Engineering Co., Ltd.

Photo 8 Bins and Cans Separated and Discharged by Residents in Tokyo

Resource Recovery

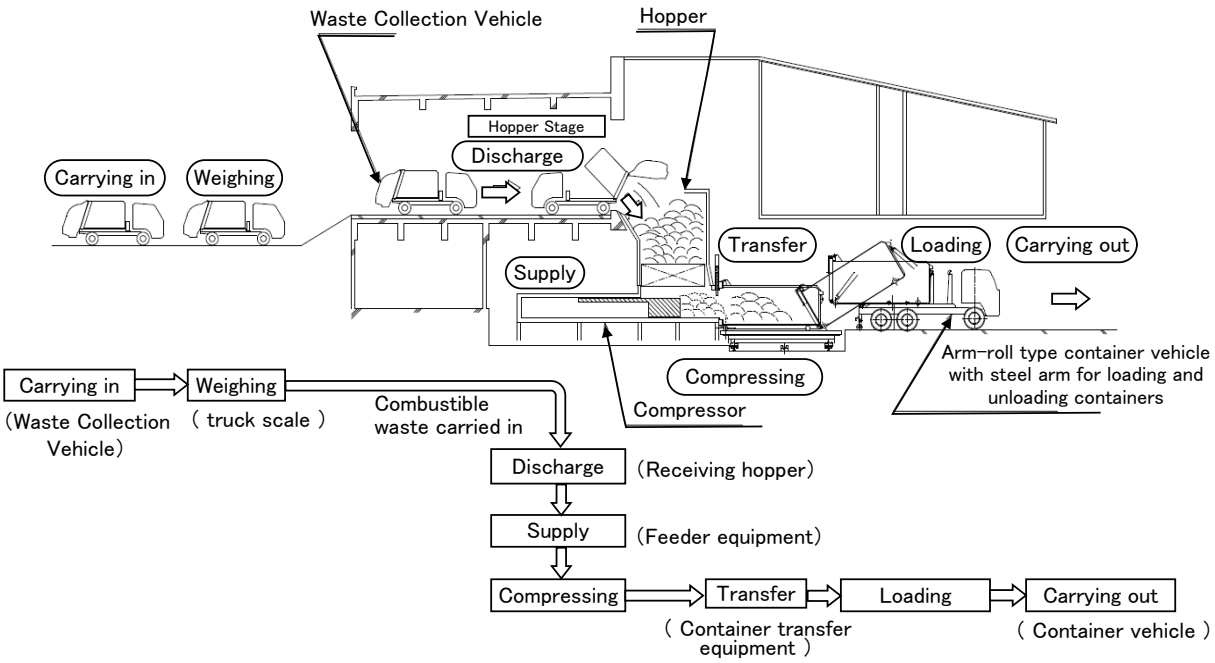
In addition to source separation and separate collection that are implemented by municipalities, community group collection is exercised as a recycling activity, where a voluntary association of community residents such as a neighborhood association and a children's group voluntarily collects recyclable waste and delivers it to a recycle business operator.

2) Maintenance Management of Waste Collection and Transport Vehicles

Collection vehicles must be constantly kept in good condition to operate them stably and continuously according to the collection plan. For this reason, regular and appropriate vehicle inspection and maintenance is very important. To maintain vehicles in good condition, it is desirable to apply the concept of preventive maintenance and inspection that prevents faults occurring during operation, and that not simply takes measures swiftly to rectify the faults that are detected as a result of inspection or occur during collection operation.

3) Transfer Station

A transfer station is a facility where waste is transferred from a small or a medium-size collection vehicle to a large transport vehicle, either with or without compression of the waste, in order to allow the collection truck to speedily return to its collection activities. The transfer station operation thereby enhances the efficiency of waste collection and transport for urban areas where waste is to be collected across wide areas. Figure 10 shows an example of a transfer station processing flow (compactor/container type).



Source: Ministry of the Environment "Guidance for application for subsidy for establishing a Sound Material-Cycle Society (For Facility)" (2021)

Figure 10 Example of Process at Compactor/Container Type Transfer Station

(2) Intermediate Treatment

1) Transition of the Intermediate Treatment Technologies

Since Japan has a small land and the usable land area is limited, reduction of waste amount is extremely important. Therefore, incineration has historically been considered an effective treatment method and was mandated under the amendment of the *Waste Cleaning Act*, in 1930. However, even with this mandate the burning of waste in open fields and the dumping of waste into rivers continued to be frequent occurrences, and in reality incineration technologies were not introduced as centralized intermediate treatment.

Source: Tokyo Metropolitan Government

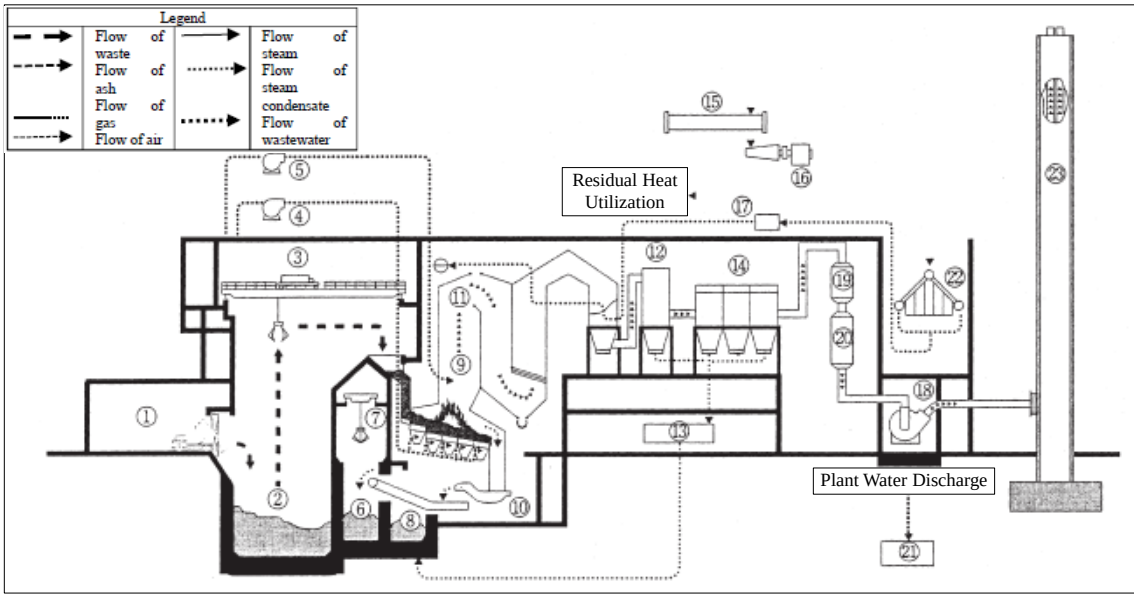
Photo 9 Shin-Koto Incineration Plant

From the period of the 1960s', the treatment of the increased waste amount that was associated with the rapid economic growth, the improvement of the living environment, and enhancement of public sanitation became serious issues. In order to resolve these issues and from the perspective that incineration of waste is very effective in sanitary treatment of waste and reduction of the waste amount, the development of intermediate treatment facilities using incineration technology was promoted.

Under this development policy, the introduction of a waste incineration facility was promoted in all urban areas through the provision of technical and financial support based on the laws and plans established by the central government, and promising results were achieved for sanitary treatment and amount reduction of waste. At the same time, in response to the pollution issues caused by waste incineration, the central government established the Facility Technical Standards Including Exhaust Gas Treatment (1971) for proper waste treatment by intermediate treatment facilities. Since then, the incineration technology has significantly progressed to become a highly reliable waste treatment method, through the process of responding to new and updated standards, regulations, and structural guidelines (1979) and performance guidelines (1998) which ensured the necessary countermeasures against dust, dioxins, organic pollutant, and mercury.

2) Incineration Technologies

Figure 11 shows an example of the structure of an intermediate treatment facility that utilizes stoker-type incineration technology.



(1) Platform	(9) Incinerator	(17) Steam condensate Tank
(2) Waste pit	(10) Ash extruder	(18) Induced draft fan (IDF)
(3) Waste crane	(11) Boiler	(19) Steam type gas re-heater
(4) Forced draft fan (FDF)	(12) Cooling tower	(20) Catalytic reaction tower
(5) Secondary positive blower	(13) Fly ash treatment device	(21) Wastewater treatment facility
(6) Ash pit	(14) Filter type dust collector	(22) Steam Condensers
(7) Ash crane	(15) Steam receiver	(23) Stack
(8) Induced fan at ash pit	(16) Turbine generator	

Source: JICA "Guideline for Promoting Waste to Energy Facility Projects" (2017)

Figure 11 Example of Waste Incineration Plant with a Stoker Furnace

Other Uses of Incineration Technology

Use of Waste Heat	The thermal energy that is generated by combustion in an incineration facility is used for heating, and hot water supply within the facility in the forms of air, steam, and hot water. The energy is stored and distributed to the local residents as an energy source for hot water for swimming pools in recreational centers, social welfare facilities, and community centers of the region, in addition to heating inside the incineration facility.
Incineration Power Generation	Steam is created by the waste heat that is generated during the incineration of waste. The steam is then utilized to turn a turbine, a device that converts thermal energy into kinetic energy and uses it as power to generate electricity

3) RDF/RPF Conversion Technology

RDF (Refuse Derived Fuel) is a solid fuel that is produced from combustible waste - kitchen waste, paper waste, plastic waste, and so on. The combustible waste is solidified through the processes of shredding, sorting, drying, and molding. RDF can be stored for a comparatively long period of time due to its low biodegradability and can be transported more easily than waste due to its reduced amount and molding into more usable shapes.

Stable combustion is another major feature of RDF because of its generally constant shape and heat value.

RPF (Refuse derived Paper and plastics densified Fuel) is a solid fuel that is manufactured mainly from paper and waste plastics discharged in industrial waste and specifically selected municipal waste, that are difficult to recycle as raw materials. RPF can be used as a fuel in the same way as RDF, however, since RPF is produced from selected waste, it is characterized by having less foreign matter content, lower moisture content, and higher heat value (5,000kcal/kg or more).

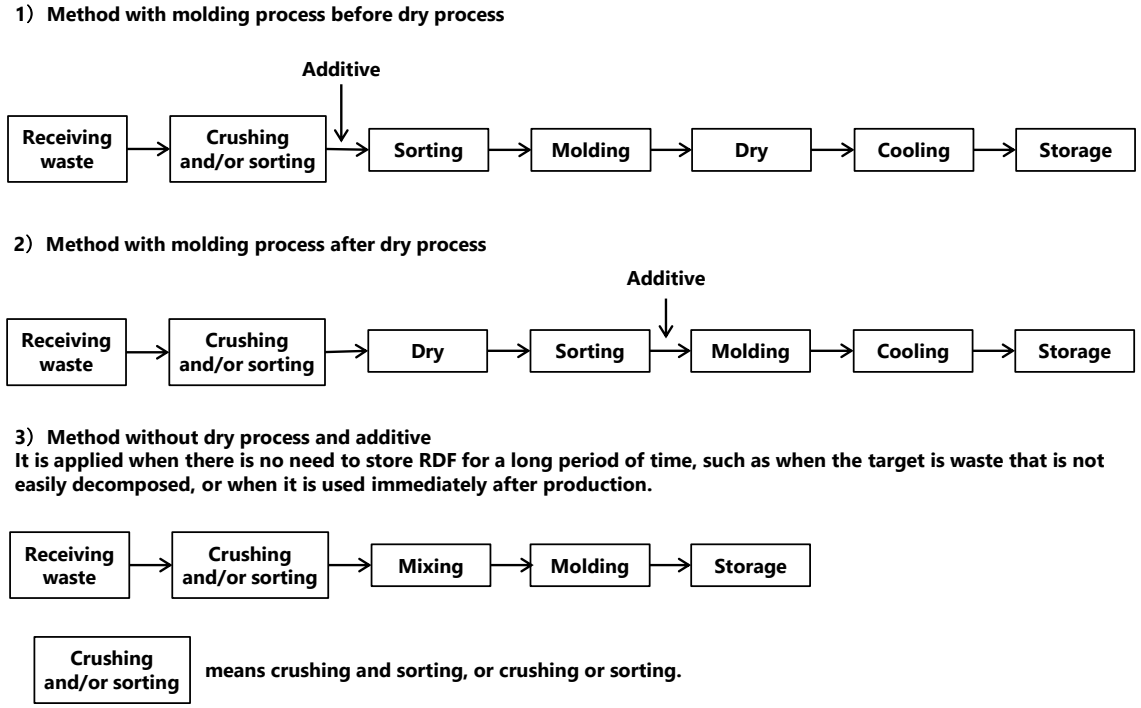
Photo 10 RDF

Photo 11 RPF

Source: Study Group on Appropriate Management of RDF "Report of Study Group on Appropriate Management of RDF (2003)" (RDF) (Photo 10)

Source: Japan RPF Association Website "What is RPF?" https://www.jrpf.gr.jp/rpf-1 (accessed January 10, 2022) (Photo 11)

Figure 12 shows the treatment methods at the intermediate treatment facility where RDF/RPF conversion technology is applied.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 12 Treatment Process of RDF Facility

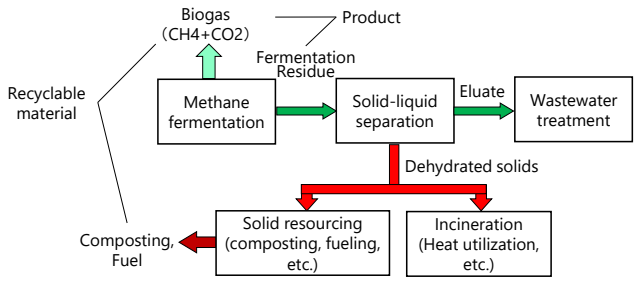
4) Organic Waste Recycling Technology

(a) Overview and Types of Technologies Related to Organic Waste Recycling

Biomass refers to organic resources from animals and plants, excluding fossil fuels. It is a sustainable and renewable resource that can be utilized as renewable energy and may be produced as long as there is life and solar energy. In Japan, utilization of biomass is being promoted according to the regional characteristics, and promoting the utilization of biomass included in organic waste is part of Japan's efforts to construct a sound material-cycle society.

(b) Overview of Methane Gasification Technology

Methane gas facilities ferment the organic waste that is acquired by separate collection and from mechanical sorting of collected mixed waste, and recover the biogas from the produced methane. Figure 13 shows the process.



1. Biogas and fermentation residue are produced from methane gasification.
2. Dehydrated solids are used as fertilizer, etc. Or, after drying into solids, they can be incinerated.
3. Fermentation residue is used as liquid fertilizer, after disinfection. Or, after dehydration, the eliminated liquid is treated as wastewater.

Source: Ministry of the Environment Website "Methane Gasification Technology"
https://www.env.go.jp/recycle/waste/biomass/technical.html (accessed January 20, 2022)

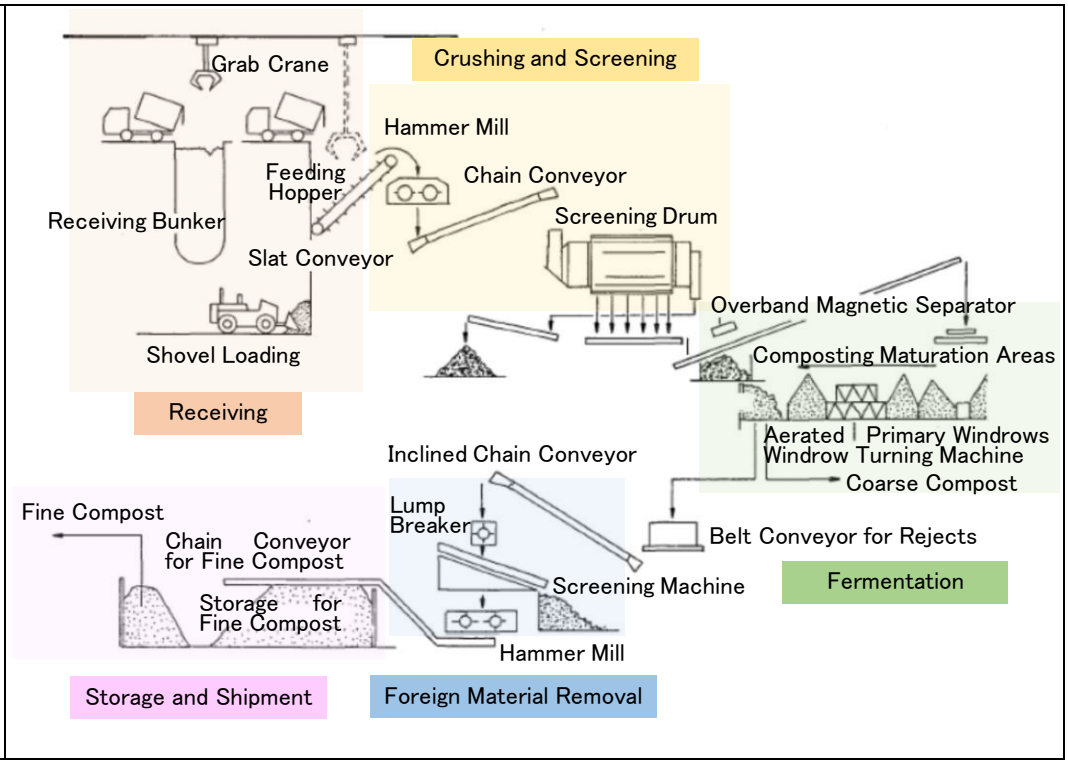
Figure 13 Process of Methane Fermentation

(c) Overview of Composting Technology

In composting, the organic waste in kitchen waste and the like is broken down and made into compost by microbes under aerobic conditions. This technology has been used for recycling kitchen waste in Japan for ages.

Composting

Flow



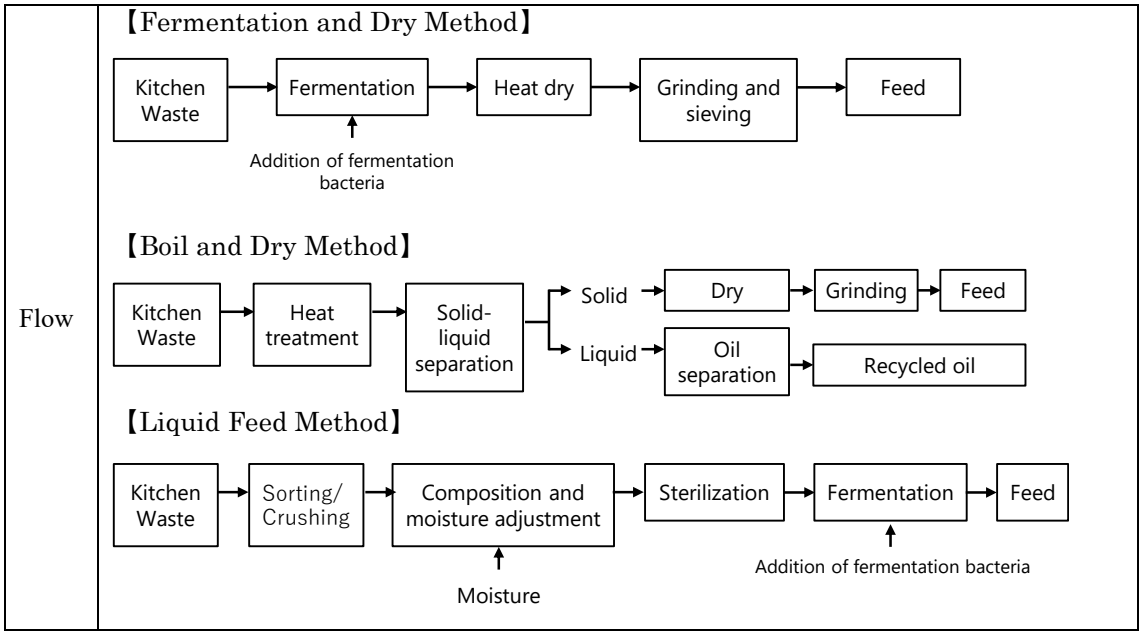
Source: JAPAN ENVIRONMENTAL SANITATION CENTER "Waste management technology in Japan (JICA training text)" (2017)

Figure 14 Flow of Composting

(d) Overview of Technology Related to Turning Waste into Livestock Feed

Under this technology livestock feed is produced from kitchen waste and other organic waste. As is the case with composting, this is a food recycling technology that has been used in Japan for ages. The main technologies involved in turning waste into livestock feed are reducing the water content through thermal treatment and drying, and adjusting the oil and fat content.

Livestock feed



Source: Ministry of the Environment Website "Types and uses of waste biomass"
http://www.env.go.jp/recycle/waste/biomass/biomass.html (accessed January 27, 2022)

Figure 15 Flow Chart of Recycling to Feed

5) Recycling Technology

In order to create a sound material-cycle society, the effective use of resources and recycling is very important. In Japan, various recycling laws have been enacted to promote recycling. It is necessary to economically and safely process waste using methods suitable for source separation and separate collection. The main technologies related to recycling are sorting, shredding, compression, drying, and solidifying.

Recycling technologies such as sorting, shredding, and compressing can also perform the following roles for promoting efficient recycling.

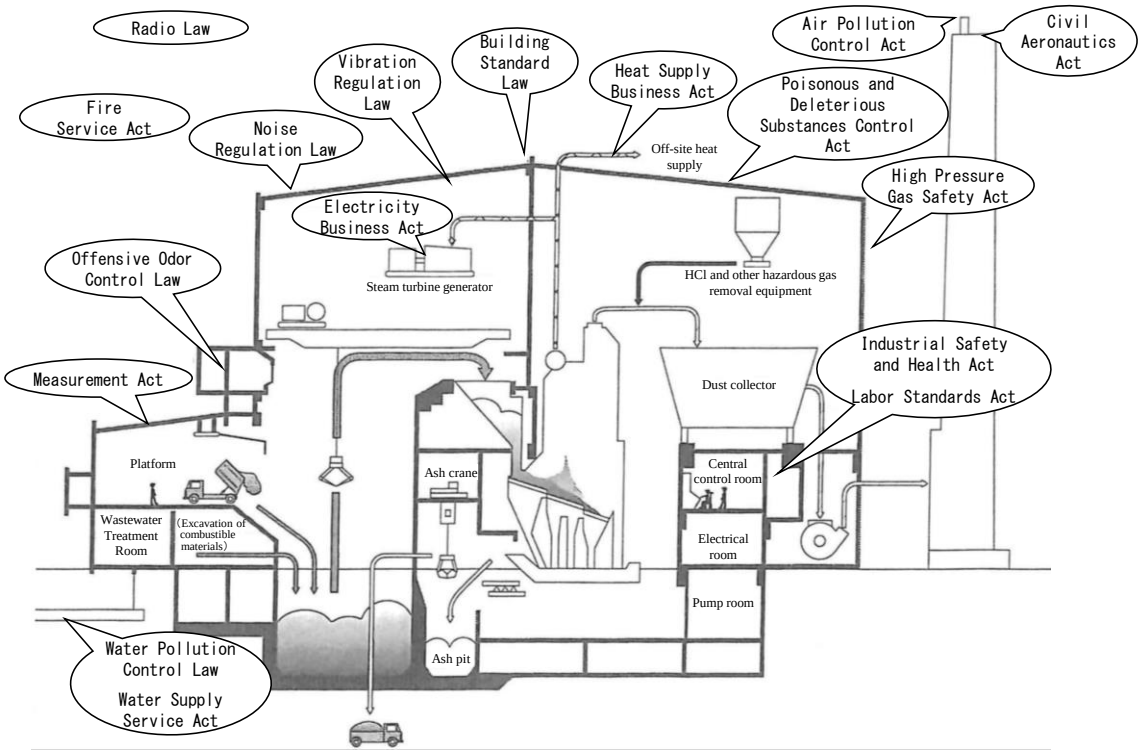
Roles of recycling technology

- Shredding combustible bulky waste into sizes that can be incinerated.
- Shredding organic waste into sizes suitable for intermediate treatment.

- Shredding and sorting incombustible waste and bulky waste to enable recovery of recyclable materials.
- Reducing waste disposal by shredding and compressing waste.
- Reducing final disposal amount by recovering recyclable materials.
- Reducing waste generation amount.
- Resources recovery.

6) Maintenance Related to Intermediate Treatment Facilities

The construction and operation of a waste treatment facility must consider the surrounding environment. The technical standards related to the operation and maintenance management of general waste treatment plants are regulated by the *Waste Management Act*. There are detailed standards that specifically regulate incineration plants which must be met. Waste treatment plants must be operated and maintained under the strictest control to satisfy the related standards.



Source: Japan Waste Management Association "Planning and Design Guidelines for Waste Treatment Facility Maintenance, 2017 Revised Version" (2017)

Figure 16 Relevant Laws and Regulations Pertaining to the Planning of Facilities

(3) Final Disposal

1) History of Disposal Sites

Before the introduction of intermediate treatment, kitchen waste and other types of waste were disposed of at designated locations. However, this caused problems for the surrounding environment such as the generation of odor, pests (mosquitos, flies, etc.), and spontaneous fires caused by gas produced from the disposed waste.

During the period of high economic growth in the 1960s, waste increased, the remaining capacity of landfill site was shortened and it became necessary to promote the reduction of waste disposal amount at landfills by incineration.

Source: Tokyo Metropolitan Government Bureau of Environment

Photo 12 A Landfill Site in Tokyo where Spontaneous Combustion was Occurring Because the Waste was Directly Disposed with no Intermediate Treatment and no Soil Cover Application – circa 1957

In the 1970s, the *Waste Management Act* was revised and technical standards for disposal sites covering construction, operation and maintenance, and decommissioning were established. Disposal sites were divided into three categories, namely inert landfill sites, controlled landfill sites, and isolated landfill sites and standards were established for each.

Then, the “Structural Guidelines for Final Waste Disposal Sites” were established in 1979 and the “Performance Guidelines for Final Waste Disposal Sites” were established in 2000. These guidelines dealt with the issues of suitable landfill control, and helped to alleviate the shortage on landfill sites and solved the problems related to the surrounding environment, such as the generation of hexavalent chromium and hydrogen sulfide.

The shortage of landfill sites furthered the need for more sites which was one problem, but on the other hand it was becoming more difficult to gain the understanding of surrounding residents to construct new sites. Therefore, local harmonized landfill sites were proposed, underpinned by the operation and maintenance being strictly controlled and implemented with the understanding of residents. As a result, closed system landfills were adopted as landfill sites for municipal waste. There were 1,620 municipal waste final disposal sites in FY2019, and 83 closed system landfill sites in FY2018.

2) Functions and Features of Landfill Site Facilities and Equipment

The main functions required of landfill sites are as follows: waste storage function to stably store the waste in the landfill; water sealing functions to prevent groundwater from entering the landfill site,

and prevent water from the waste in the landfill from being discharged outside the disposal area; and cleaning functions to facilitate the decomposition of organic waste and washing out contaminated matter. The main facilities are storage structures, waterproofing liner system construction, leachate treatment facilities, monitoring facilities, and generated gas treatment facilities.

3) Types of disposal sites

Landfill sites are facilities for disposing of wastes that are difficult to undergo intermediate treatment - such as incineration, recycling, etc., waste items that are difficult to reuse, and the residue from intermediate treatment. They are facilities where waste is appropriately stored without negatively impacting the surrounding environment.

Generally, landfill sites are constructed in mountainous terrain by adopting the topographical features there or by excavation in plains. In Japan due to limitations of finding sites for constructing landfills, the method of constructing a seawall in a coastal area and constructing a landfill at sea, i.e. land reclamation, is also implemented.

In Japan, learning from past experience that construction of landfills was difficult due to opposition from local residents, in recent years closed system landfill sites in which waste is disposed of in enclosed structures have been constructed as regional-friendly facilities that are accepted by the residents. Moreover, operation and maintenance of closed system landfill sites are not affected by the weather and has the advantage of being able to effectively minimize leachate generation as intake of rainwater can be controlled.

Source: Minami-Ashikaga City Website “Landfill” https://www.city.minamiashigara.kanagawa.jp/shisetsu/kankyou/saisyusyobunjyou.html (accessed March 1, 2022)

Photo 13 Landfill of Minami-Ashikaga City

Source: Tokachi Environmental Complex Office Association, "Municipal Waste Final Disposal Facility Ume-ru Center Mikato Pamphlet" (2021)

Photo 14 Outside View of the Landfill “Ume-ru Center Mikato” Landfill of Tokachi Environmental Complex Office Association

Landfill sites are categorized into landfill sites for municipal waste and landfill sites for industrial waste. Landfill sites for industrial waste are categorized into inert, controlled and isolated landfill sites. Landfill sites for municipal waste are almost identical to controlled landfill sites for industrial waste.

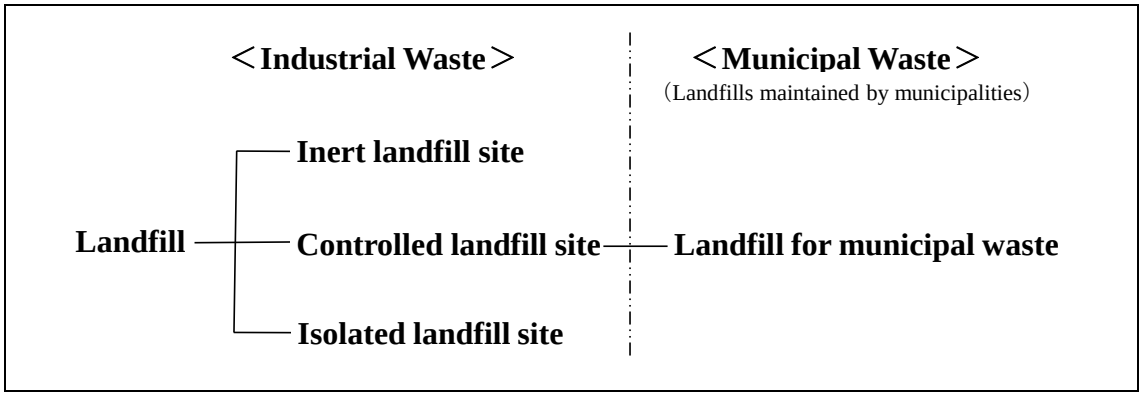
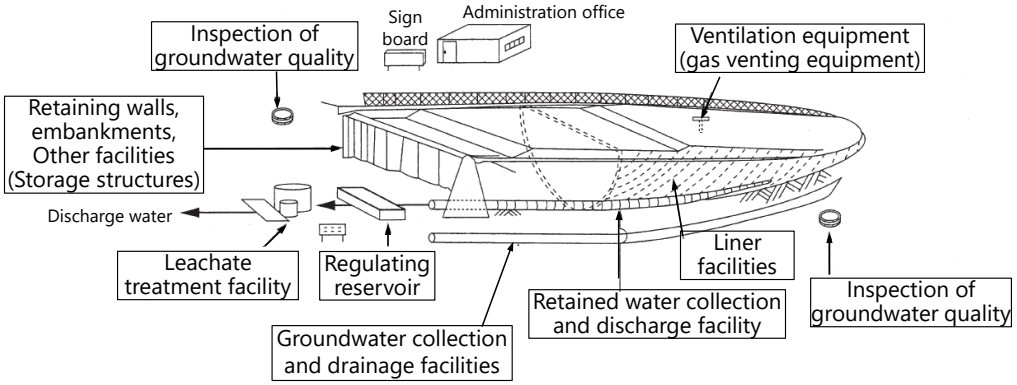


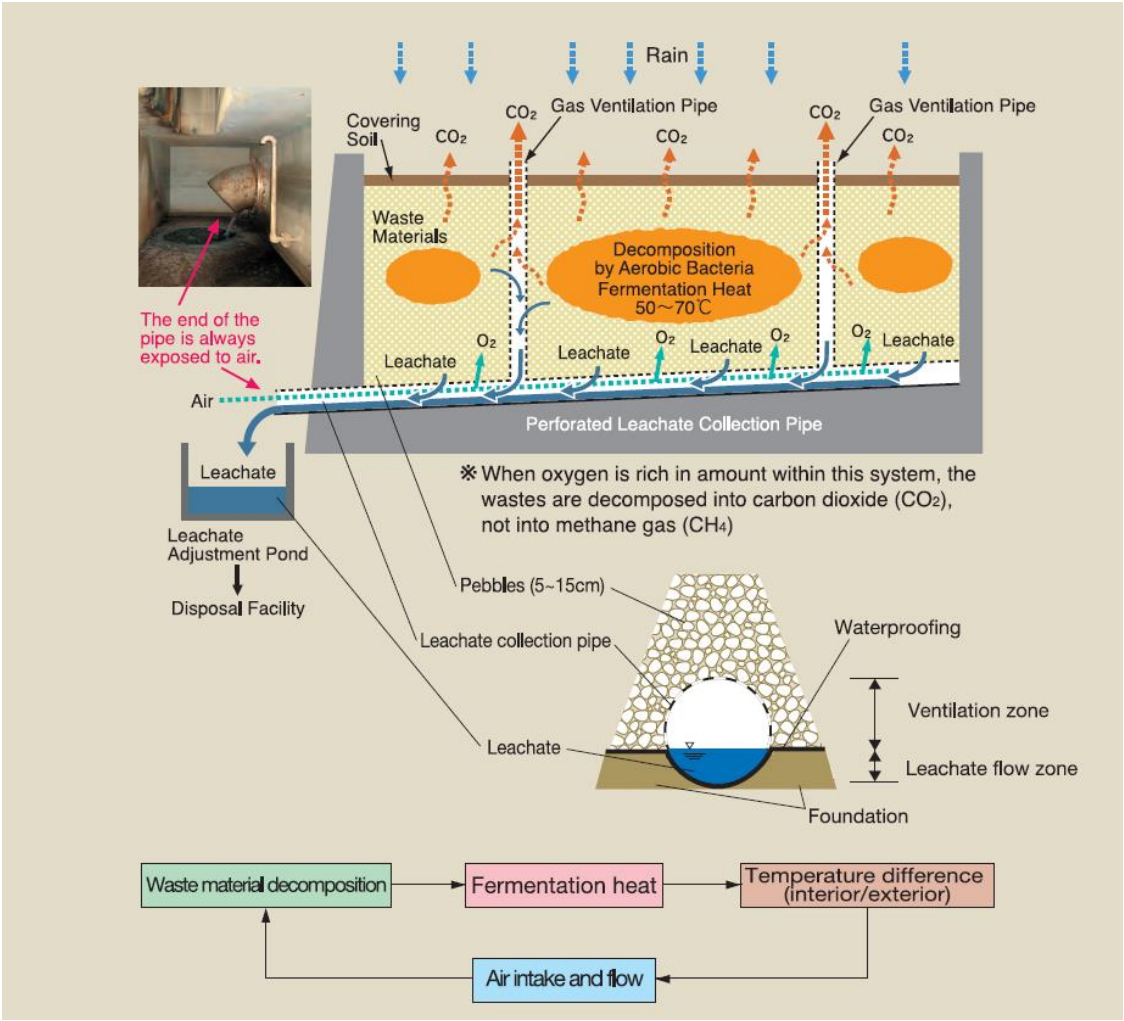
Figure 17　Types of Landfill



Source: Ministry of the Environment "Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007" (2007)

Figure 18　Example of Controlled Landfill Site Structure

The semi-aerobic landfill construction method was researched and developed by professor emeritus Hanashima of Fukuoka University with the cooperation of Fukuoka City. At the time, Fukuoka City was confronted with pollution issues from landfill sites used for kitchen waste that caused water pollution, odor, gas, and pests. Therefore, professor Hanashima and Fukuoka City jointly conducted a study for three years from 1973 to improve the leachate quality and in turn the landfill sites. As a result of these experiments, the basic concept of semi-aerobic landfill construction that uses leachate collection pipes to supply air to the interior of landfill sites was proposed. In 1975, the first semi-aerobic landfill site was constructed at the Shinkamata landfill site. Then, the semi-aerobic landfill construction method was adopted throughout Japan under the name of the Fukuoka Method.



Source: Fukuoka Prefecture "Guide to Introducing The Fukuoka Method" (2020)
English: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086159_misc.pdf
Vietnamese: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086163_misc.pdf
Thai: https://www.pref.fukuoka.lg.jp/uploaded/life/613855_61086164_misc.pdf

Figure 19 Conceptual Figure of Semi-Aerobic Landfill Construction

4) Operation and Maintenance Management of Landfill Sites

When local governments need to develop landfill sites, they must apply to their prefectural governments. Together with their application, they must submit an operation and maintenance management plan. The understanding and cooperation of local residents are extremely important to facilitate the operation and maintenance of the facility, and the prepared operation and maintenance plan should carefully consider local conditions and aspirations and the plan contents need to be thoroughly discussed with local residents. Once commissioned, the facility should be operated and maintained in accordance with the prepared plan.

Waste Delivery Control

In order to manage and operate a landfill site according to plans, it is important to understand the types, quantities, and characteristics of the waste that will be delivered to the landfill.

Landfill Work Management

Carrying out landfill work as planned is necessary not only for securing disposal capacity at the landfill site, but also for stabilizing landfill waste and managing leachate and landfill gas generated from the landfill. Information on the types and amounts of waste disposed in each landfill disposal cell is also necessary from the perspective of long-term landfill management, including the prevention of environmental pollution during the period after completion of disposal operations and abolition of the landfill and consideration of the land use after abolition.

Facility Operation and Maintenance Management

If the functions of each facility are not fully utilized, the disposal site will become unsanitary, causing problems such as environmental pollution to the surrounding area and negative impacts on the health of workers. In addition, since it takes a long time, in some cases several decades, from the completion of disposal operations to the abolition of the landfill, it is necessary to keep in mind that each facility will be operated for a long period of time.

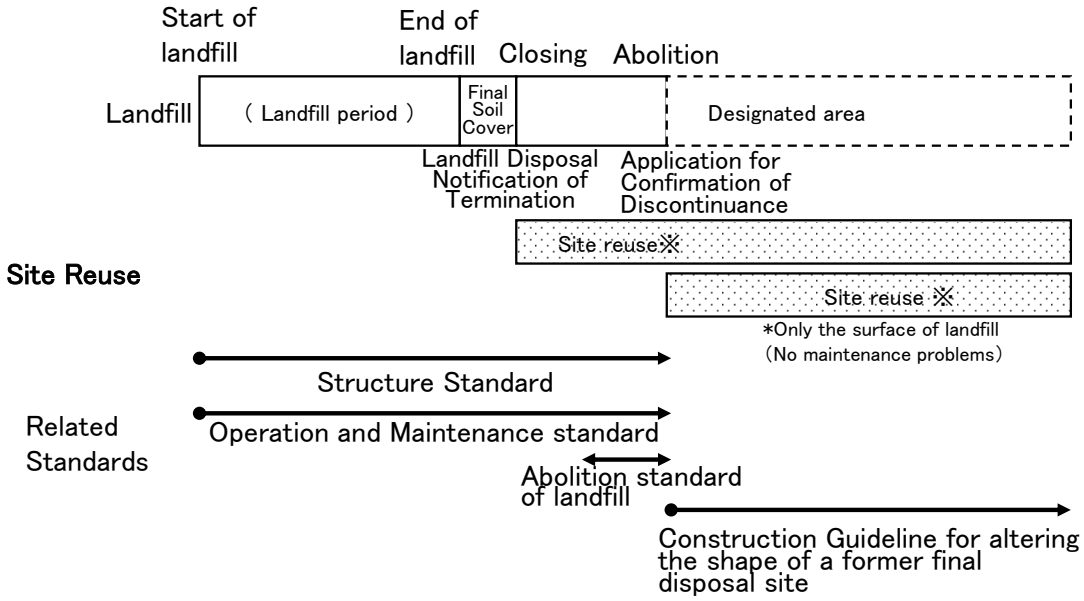
5) Appropriate Closing and Use of the Site

(a) Appropriate Closing

In Japan, when waste is no longer received at a landfill site and landfilling work is terminated, facility services are ended by taking actions, such as the final covering with soil to close it appropriately. When a facility is closed, although there is no new delivery of waste, the disposed waste has not completely decomposed, so the water quality of leachate and gas from the landfill must continue to be controlled according to the facility standards, and operation and maintenance standard. Once a landfill site is closed, entrance to the site is limited and managed so that landfill waste is not agitated.

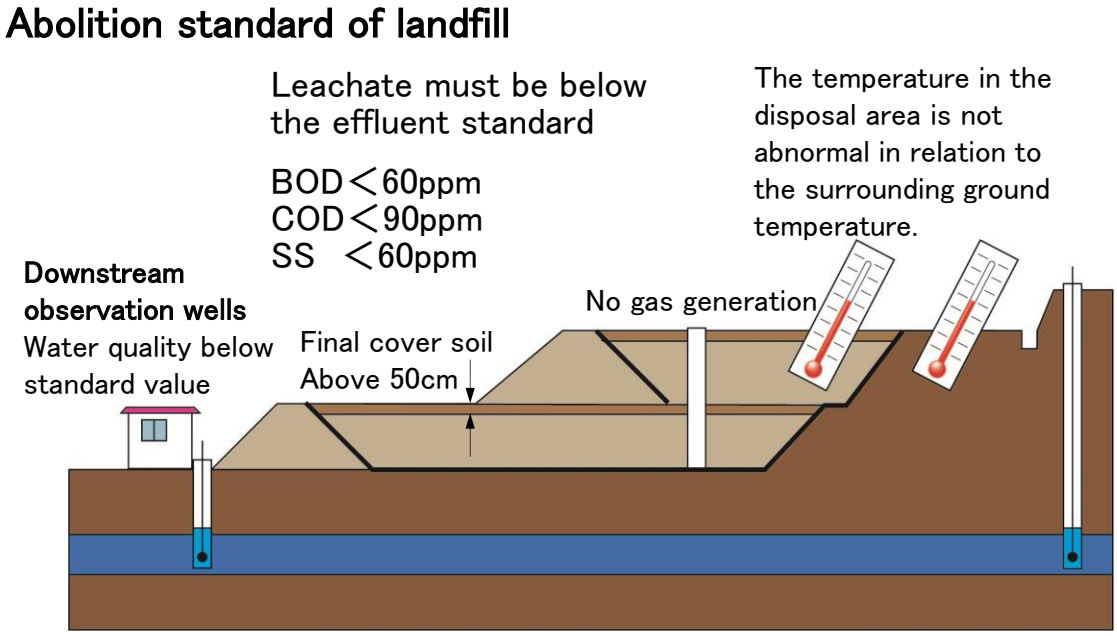
After a monitoring period during which the decomposition of the landfill waste has stabilized, the water quality of leachate, landfill gas emissions, and landfill waste temperature are confirmed to make sure that they comply with the standards. If the abolition standards are met, a new project may be commenced at the site according to the guidelines related to site usage of landfill sites.

Figure 20 shows the flow from the start of a landfill site until the site is reused for another purpose.



Source: Japan Waste Management Association "Planning, Design, and Management Procedures for Preparing Waste Landfill Sites, Revised 2010 Edition" (2010).

Figure 20 Final Disposal Site Utilization and Related Standards



*: BOD : Biochemical Oxygen Demand
COD : Chemical Oxygen Demand
SS : Suspended Solids

Figure 21 Abolition Standard of Landfill

(b) Site Reuse

After landfilling at landfill sites has been terminated, the site will be relatively large and flat and similar to a vacant lot very much like the condition just before the development of the landfill. It is therefore possible, after a site has been used as a landfill site, to reuse it effectively to help develop or revitalize the area. The site reuse is expected to deepen residents' awareness and understanding of the construction of landfill sites and promote the locating of new landfill sites.

8 Modern Trend of Waste Management (Topic 5)

This Topic introduces Japan's domestic and international cooperation efforts to manage the issues of illegal dumping, dioxins, hazardous waste, disaster waste, and marine plastics waste as social issues and global trends related to waste management.

In order to deal with these issues, cooperation and consensus building not only within administrative institutions but also with residents, local communities, and industry are indispensable. This Topic covers economic and regulatory measures taken in actual cases in Japan, as well as specific lessons learned and considerations regarding responses and countermeasures that can be used as reference for developing countries.

(1) Illegal Dumping

1) Cases in the Past

In managing waste, illegal dumping is strictly forbidden in Japan and the law prescribes penalties as will be described in this section. However, in the process of industrial development, illegal dumping occurs repeatedly, and it is extremely difficult to discover and control it in a timely manner.

2) Illegal Industrial Waste Dumping Case in Teshima, Kagawa Prefecture

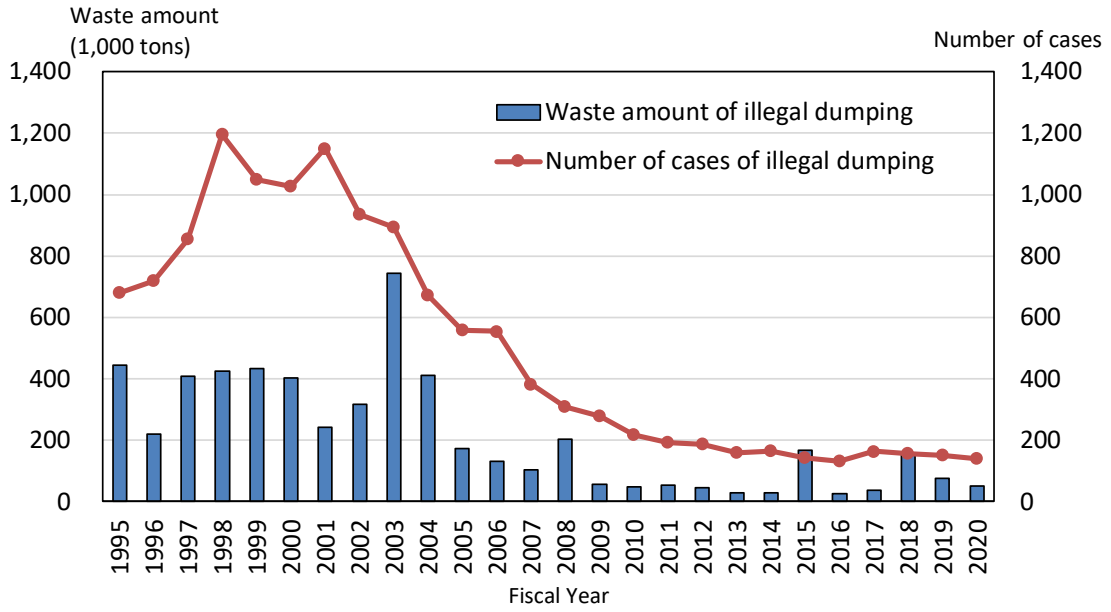
The illegal dumping of industrial waste in Teshima, Kagawa Prefecture in the 1990s is one of the largest cases of illegal dumping that occurred in Japan. Triggered by this case, responses to illegal dumping in Japan became stricter and government officials and citizens have since been cooperating to establish a system to prevent illegal dumping.

Photo 15 Polluted Situation in Teshima

Photo 16 Campaign by the Residents

Source: Material for Teshima Residents' Council of Countermeasure for Waste Treatment (Photo 15 taken in 1990, Photo 16 taken in 1996)

Various measures have been taken against illegal dumping, such as enactment of necessary laws, strengthening cooperation between the central government and municipalities, strengthening the surveillance system, improving the reporting system, and others and, as a result, the number of newly detected illegal dumping sites has greatly decreased compared with the respective numbers during the peak period of the late 1990s.



Source: Ministry of the Environment "Survey results of illegal dumping, etc. (FY2020)" (2022)

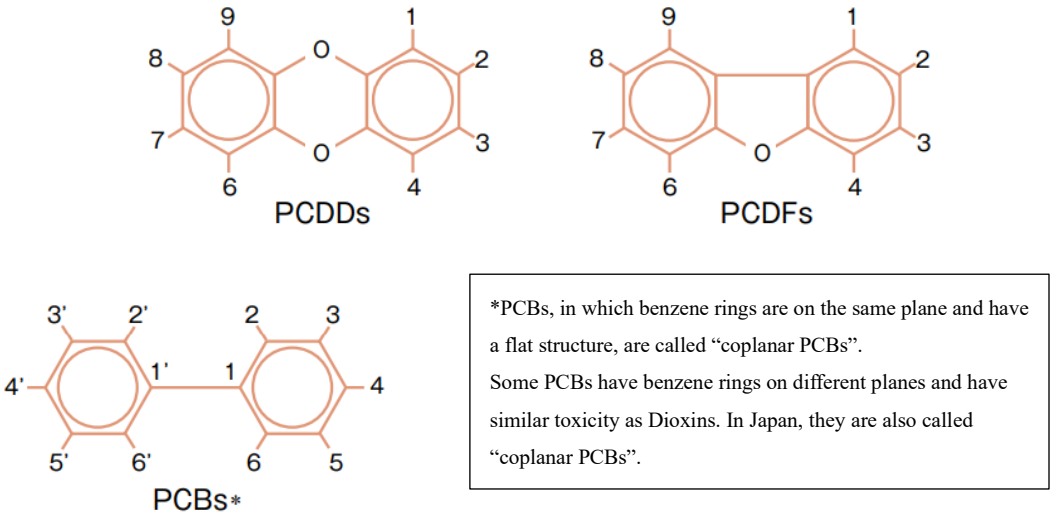
Figure 22 Transition of Number and Amount of Newly Discovered Cases of Illegal Dumping

(2) Dioxins Problem

1) What are Dioxins

Dioxins are a generic term for Polychlorinated dibenzo-p-dioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs). Although the substances that show toxicity like dioxins such as coplanar-polychlorinated biphenyl (coplanar PCB) are called dioxin-like compounds, dioxins in this document refer not only to PCDDs and PCDFs but also coplanar PCB in accordance with the definition in *Act on Special Measures concerning Countermeasures against Dioxins* enacted in 1999.

Dioxins have basically a structure where two benzene rings are combined with oxygen and chlorine is attached there. There are 75 types of PCDD, 135 types of PCDF, and dozens of types of coplanar PCB since the shape varies depending on the number of attached chlorine and where they are attached, and only 29 types of them are regarded as toxic.



Source: Brochure shared with related ministries “Dioxins” (2012)

Figure 23 Molecular Structure of Dioxins

2) Measures Taken Against Dioxins in Japan

Based on the Dioxins Measures Promotion Basic Policy and the *Act on Special Measures concerning Countermeasures against Dioxins* formulated in 1999 with the aim of preventing environmental pollution caused by dioxins, the central government, municipalities, business operators, and citizens worked to implement various pollution prevention measures. As a result, the total amount of emission of dioxins to the environment was reduced by 90% at the end of 2002 compared with 1997.

(3) Hazardous Waste

Waste generated by industries, businesses, and our daily life contains hazardous waste that is difficult to treat. Mercury, PCB, and asbestos have been selected as major hazardous wastes to be discussed; an overview of their properties and toxicity is presented, together with current countermeasures in Japan, and past cases of pollution caused by these wastes. Through the description of actual cases, the necessary measures and the challenges for their implementation are also introduced.

Table 5 Summary of Hazardous Waste

Hazardous Waste	Summary
Mercury	Mercury has an effect on living organisms, which is a disorder due to “corrosive action of inorganic mercury compounds” and “uptake of methyl mercury”. Minamata disease is widely known as the most famous disorder that has occurred in Japan from mercury pollution. Globally, research was conducted by the United Nations in 2000s and the Minamata Convention went into effect in 2017. Japan ratified this convention and is engaged in developing and applying the countermeasures.
PCB	Although PCB was used for various uses in the past, at present orders were issued for discontinuing production, collection, and prohibition of importation. Collected PCB is treated by the Japan Environmental Storage & Safety Corporation (JESCO).
Asbestos	Asbestos that is taken into the human body and remains there causes diseases such as lung fibrosis, lung cancer, and malignant mesothelioma. Its use is regulated in Japan and at present is not imported into the country.  Source: Environmental Restoration and Conservation Agency (ERCA) Website https://www.erca.go.jp/asbestos/what/whats/whatAsbestos.html (accessed February 1, 2022)

(4) Disaster Waste

Due to its location, geography, geology, climate, and other natural conditions, Japan frequently experiences typhoons, severe rainstorms, earthquakes, and other natural disasters. The percentage of global disasters that Japan accounts for is 20.8% of earthquakes with a magnitude over 6, and the percentage of disaster damage costs is 18.3%. As Japan accounts for only 0.25% of the world's land area, these figures are very high. When a disaster occurs, vast quantities of waste are immediately generated and they must be speedily disposed of to help the residents recover.

1) Changes in the System

Based on the lessons learned from the Ise Bay Typhoon of 1959, the *Disaster Countermeasure Basic Act* was enacted in the same year and has been revised several times since then. The purpose of the act is to protect the lives, health, and property of the citizens from disasters and thereby contribute to maintaining social order and assuring public welfare.

In 2011 Japan was struck by the Great East Japan Earthquake, and once more the lessons learned in that disaster led to the establishment of the *Basic Act to Strengthen National Resilience to Contribute to Disaster Prevention and Alleviation to Achieve Strong and Flexible Citizens' Lives* (hereinafter referred to as the *Basic Act to Strengthen National Resilience*) established in 2013, and activities have since been carried out based on the concepts of this act.

Based on these laws, the Basic Plan to Strengthen National Resilience was established in June 2014, and "situations to be avoided" was defined as "situations in which recovery and reconstruction are delayed due to stagnation in the treatment of the vast quantities of waste produced by disasters". Therefore, countermeasures for disaster waste were included as part of the policies to strengthen national resilience.

2) Current Situation of Disaster Waste Management

The Ministry of the Environment's Disaster Waste Countermeasure Guidelines (Revised Edition) describes the basic flow of disaster waste management after a disaster has occurred. In principle, disaster waste is managed according to the descriptions in the guidelines.

The Ministry of the Environment is at the center of national level disaster waste countermeasures in Japan. Specifically, the ministry formulates legislation, basic plans, and guidelines as described earlier in this section. The ministry also monitors the efforts by the various local governments, makes suggestions as necessary, and at the same time, it archives information about waste from past disasters and makes it available to the public through its "Disaster Waste Countermeasures Site".

The Ministry of the Environment also operates the Disaster Waste Treatment Assistance Network (D.Waste-Net) as a secretariat to support disaster waste management implemented by local governments. Numerous research and specialized organizations, as well as municipal waste related organizations, are members of D.Waste-Net.

3) Japan's International Cooperation

As an example of Japan's international cooperation related to disaster waste, the debris treatment support provided to Nepal after the major earthquake that struck that country in 2015 and the creation of the "Asia-Pacific Disaster Waste Management Guidelines" are introduced in this section.

From April to May 2015, earthquakes of a maximum magnitude of 7.8 struck the municipality of

Gorkha which is about 77 km northwest of the capital city of Kathmandu. Over 50,000 homes were destroyed and there were over 8,000 casualties. In response, the Japanese government, through the Japan International Cooperation Agency (JICA) dispatched an international emergency relief team and provided about JPY 25 million of emergency relief supplies (tents, blankets, etc.) as humanitarian support for the victims. In addition, based on requests from the government of Nepal and the United Nations Environment Programme (UNEP), the Ministry of the Environment provided technical support for formulating disaster waste treatment plans centered on the recycling of the bricks from the buildings destroyed in Nepal.

At the G7 Toyama Environment Ministers' Summit in May 2016, the "Toyama Material Cycle Framework" was adopted for the field of disaster waste management. The G7 countries agreed to provide support for nations and regions in the Asia-Pacific region that experienced natural disasters.

Based on this agreement, from fiscal 2017, the Ministry of the Environment examined the natural disasters occurring around the world, centering on the Asia-Pacific region, and the treatment of disaster waste, then it organized the issues and lessons learned.

Based on the Japanese know-how on disaster waste countermeasures and the needs of other countries that were identified through the aforementioned study, in October 2018 the Ministry of the Environment created the "Asia-Pacific Disaster Waste Management Guidelines" to describe the points necessary to accurately, smoothly, and quickly process disaster waste.

(5) Marine Plastic Waste Issue

1) Global Situation

Since the introduction of plastic products around the 1950s, their applications have expanded due to the ease of processing and stable non-corrosive characteristics, and the gross production amount so far is said to exceed 8.3 billion tons. Of this, 6.3 billion tons are disposed of as waste, much of which is landfilled or dumped in the ocean. Recently, large amounts of plastics were found from the stomachs of dead seabirds and whales in various regions around the world. A video showing a scene in which a plastic straw was removed from the nose of a turtle was aired in the media and this image galvanized global attention to the marine plastic waste issue. The issue of marine plastic waste is now being addressed as a global scale.

Photo 17 Plastic Waste on the Beach

Photo 18 Sea Turtle and Plastics

Source: DigArt “Plastic bottles and waste washed up on a beach by the incoming tide, covering the entire beach at Umkomaas in KZN, South Africa” (Photo 17), Willyam Bradberry “Water Environmental Pollution Problem Underwater animal Sea turtle eating Plastic” (Photo 18）

2) Current Situation in Japan

Strongly encouraged by this international momentum, Japan is also promoting countermeasures to combat plastic pollution.

At the G20 Osaka Summit that was held in Osaka on June 28, 2019, as the chair country Japan promoted “Osaka Blue Ocean Vision” to each country as a universal global vision. The aim is to completely eliminate extra pollution caused by marine plastic waste by 2050 through the comprehensive approach to life cycle including the reduction of the outflow of plastic waste caused by poor management. This is to be achieved by the improvement of waste management and innovative solutions that are achieved while recognizing the important role of plastics in the society.

In this Summit, Japan also announced the country’s intention to support capacity building and infrastructure development relating to waste management in developing countries. To achieve this objective, the Japanese Government established the “Marine Initiative” to support effective global countermeasures for marine plastic waste, by focusing on (1) waste management, (2) recovery of marine waste, (3) innovation, and (4) capacity enhancement. The Japanese Government supports capacity enhancement of developing countries to promote waste management, recovery of marine waste, and innovation through the following specific policies under this initiative.

3) Japan’s International Cooperation

In terms of countermeasures to prevent marine plastic waste, it is important for the world as a whole, including developing countries, to promote efforts to curb the outflow of plastic waste into the ocean. Accordingly, the Japanese Government is promoting effective support for developing countries through the "MARINE Initiative" and other programs mentioned earlier.

9 Efforts of the Municipalities in Japan (Topic 6)

In discharging their responsibilities for waste management practices, the challenges the municipalities face and the countermeasures they adopt, differ depending on the size of the city, its geography, and economic and social conditions. Based on the history and case studies of waste management in Tokyo (large-scale and capital city), Fujisawa City (medium-scale city), and Shibushi City (small-scale city), this Topic aims to provide experiences and lessons learned that will be useful references for local governments in developing countries to handle similar issues, such as responding to increasing waste amount and waste diversification associated with economic growth, pioneering efforts in intermediate treatment and recycling, and building public consensus for source separation and waste reduction.

Topic 6 introduces the waste management practices of the following three municipalities, selected based on their size and characteristics: the 23 special cities of Tokyo representing a large municipality, Fujisawa City a medium-sized municipality, and Shibushi City a small municipality.

The 23 special cities of Tokyo (hereinafter refer to as Tokyo 23 Cities), the capital of Japan, located at the center of Tokyo, have experienced the challenges of waste management while Tokyo was developing into the large-scale metropolitan capital city of today, and have finally established their current waste management system. Tokyo 23 Cities have also led Japan's waste management program and assisted other municipalities. Local governments in developing countries, especially in capitals and large cities with similar conditions as that of Tokyo, can benefit from the lessons learnt from Tokyo 23 Cities and their experiences.

Fujisawa City is a medium-scale municipality with a population of 430,000. Medium-scale municipalities are suitable for helping to understand the comprehensive system adopted by Japan’s municipalities to manage waste. Fujisawa City has from early on actively engaged the private sector in waste recycling and facilities improvement activities. Thus, Fujisawa City was selected as a representative of medium-scale municipalities. Furthermore, Fujisawa city has maintained records of their waste management efforts for many years, and there are many lessons that can be gleaned from the city’s experiences by municipalities in developing countries aiming to build a comprehensive waste management system including intermediate treatment in the future.

The third municipality selected here, Shibushi City does not have incineration plants and is known for its high recycling rate. Although it has a short history of waste treatment, the city has reduced the amount of waste disposal at landfill by implementing multi-item sorted waste discharge and separate collection to support recycling, and thereby the life of landfill sites has been successfully extended. The case in Shibushi City may be thought-provoking for municipalities of developing countries that are either planning to promote, or are already engaged in recycling. The Shibushi case study demonstrates how the city reached an agreement with its residents and obtained their cooperation

during the development process of their multi-item waste recycling system as well as overcoming other issues.

(1) Waste Management Efforts Made by the 23 Special Cities of Tokyo

1) History of Waste Management in Tokyo

From 1900 to the present, the 23 special cities of Tokyo have overcome various waste management problems in changing historical backgrounds. The waste management measures taken in each time period are introduced in this section.

(a) Dawn of the Waste Problem, 1900 - 1955

In the latter half of the 19th century, cholera and plague pandemics were spreading globally and taking measures to protect public health became an issue in Japan as well. The Tokyo Metropolitan Government (TMG) had identified unsanitary conditions as one of the causes of the spread of these infectious diseases, and recognized that prompt and proper disposal of waste and human waste was essential to improve the situation. In 1900 the government of Japan enacted the *Waste Cleaning Act* and municipalities assumed responsibility for waste management. In response, Tokyo introduced a waste collection system and started to contract out collection services to business operators. However, in 1908 problems of unreliable waste collection by business operators arose and TMG reversed its decision of contracting out collection and returned to directly-managing waste collection. Furthermore, to cope with the rapidly increasing amount of waste associated with urbanization, Tokyo constructed the first waste incineration plant in Osaki in 1924 and a municipal waste treatment plant in Fukagawa in 1929.

(b) Period of High Economic Growth - Escalation of the Waste Problem, 1955 - 1973

Tokyo's population grew due to the return of evacuees and military personnel, and sanitary conditions worsened, underlining the urgent need to implement drastic waste management countermeasures. In response, Tokyo improved the related ordinances and organization. During this period, the mechanization of waste collection progressed. Furthermore, in 1963, a subsidy system was introduced to support the development of the increasingly required larger waste treatment facilities. The *Waste Management Act* was enacted in 1970, and Tokyo revised the waste ordinances to clearly specify the responsibility of business operators who generate business waste and the importance of obtaining the understanding of residents on the waste management system. Under these circumstances, in 1971, the Governor of Tokyo declared a "war on waste" at the Tokyo Metropolitan Assembly and promoted the development of incineration technology and treatment.

(c) Period of Stable Economic Growth - Addressing the Environmental Problem, 1973 - 1985

Following the enactment of the *Waste Management Act* by the central government in 1970, Tokyo revised the ordinance to clearly specify the responsibility of business operators who generated business waste. As the necessity for reuse and recycling of waste increased, recycling activities and group waste collection were promoted, and thorough discussions were conducted with local residents through explanatory and consultative meetings. In 1985, incineration plants were in operation at only 13 locations and in order to ensure that the combined incineration capacity was sufficient, source separation and separate collection of combustible and incombustible waste were started.

(d) Significant Increase of the Amount of Waste, 1985 - 1990

Rapid economic growth led to redevelopment in Tokyo and a rush to construct new buildings and condominiums. People's lifestyles also changed resulting in generation and disposal of large amounts of waste and increased variation in waste compositions. TMG reacted by calling for waste reduction and recycling.

(e) Introduction of a Sound Material-Cycle Society, 1990 - Present Day

With the revision of the *Waste Management Act* in 1991, promotion of waste reduction and recycling heightened. After the central government enacted the *Act on the Promotion of Effective Utilization of Resources* in 1991, Tokyo started to fully charge for bulky waste collection in the same year and for business waste collection in 1996. Tokyo also established a new ordinance that strictly promoted the reduction of waste generation and reuse of waste in 1992. In 1997, TMG started resource recovery and collection of PET bottles from stores.

More efforts were needed to achieve waste reduction and coming closer to developing a sound material-cycle society, and these included the expansion of waste treatment plants. In the 1990s, dioxins generated from incineration plants by the incomplete combustion of waste became a major social problem in Japan. Tokyo was under pressure to respond to the dioxins problem. Incineration plants were reconstructed, upgraded or altered and new technologies were introduced. During the period from 2002 to 2008 gasification fusion furnaces and ash melting facilities were improved, by 2009 all waste plastics that were not recycled were fully incinerated accompanied by heat recovery, and by 2015 all the ash produced in the incineration plants were reformed into raw material for use in the cement production industry.

Photo 19 Itabashi Incineration Plant (Completed in 1961)

Photo 20 Separate Discharge of Recyclables in Omorideragou Town (1977)

Source: TMG Bureau of Environment

2) Noteworthy Experience: War on Waste

"War on Waste" refers to disputes over the treatment and disposal of waste in the Tokyo 23 Cities, particularly those between Koto City and Suginami City from the late 1950s through the 1970s, which erupted into protests and court battles involving local residents over the construction of an incineration plant. In response to the rapid increase in waste amount, TMG continued to landfill waste in the bay area, and attempted to promote the construction of an incineration plant without the full understanding of local residents. In this background, this was an opportunity to reaffirm the importance of dialogue and cooperation between the local governments and residents regarding the operation of waste management, a common practice today, and the "Principle of waste treatment within the administrative boundary where the waste was generated".

(a) Rapidly Increasing Amount of Waste Generation and Waste Management Dependent on Landfill during the Period of High Economic Growth

The period of high economic growth ushered in changes in the lifestyle of the people towards mass production of products and goods, their increased consumption and early disposal. As a consequence, the waste generated by the citizens of Tokyo increased. In addition, the composition of the generated waste became much more diverse. The increase in waste plastics, bulky waste, and hazardous industrial waste was making the waste management significantly difficult. TMG planned to construct an incineration plant in response to this situation, but the project was promoted without sufficient explanation to the local residents which showed a lack of consideration for their feelings.

(b) Opposition Movement against Construction and Principle of In-City Treatment

The principle of waste treatment within the administrative boundary where the waste was generated was born during the "War on Waste". This principle remains a basic policy of waste management in Tokyo 23 Cities even at present. In some instances a treatment facility in one special city accepts waste

from a neighboring special cities. In such instances adjustments are made to distribute the burden of nuisance impartially amongst the 23 cities.

(c) Path toward Reconciliation and the Terms of Settlement

The Suginami incineration plant construction problem was resolved after a long process spanning eight years since the Takaido district was first announced as the planned site in November 1966. The basic determining factors of the settlement were the acknowledgement of the need for reliable pollution control and the importance of residents' participation from the planning phase. Since then, when facilities are to be developed, resident participation is ensured from the planning phase.

(d) Lessons Learned - Changes in Tokyo Residents' Awareness of Waste Treatment

The background of the movements against the construction of incineration plants that took place in various regions during the era of the "War on Waste", was local residents' concerns about pollution and that the importance and seriousness of municipal waste management were not fully shared with the local residents. Since the declaration of the "War on Waste", the awareness of Tokyo residents regarding the waste problem changed dramatically through the blocking of waste coming into Koto City and the problem of constructing Suginami Waste incineration plant. Although waste management is one of the most fundamental urban issues, along with urban planning and water and sewerage systems, the people of Tokyo did not necessarily have such awareness. Rather, they were more conscious of avoiding waste. The declaration of the "War on waste" greatly changed such conception and raised awareness that waste is a very serious problem. It also led to the realization that it is important for project implementers to repeatedly communicate the necessity and safety of the facility and promote the understanding of local residents. Since the "War on waste", the construction of waste treatment facilities has been conducted with the participation of local residents, including careful explanation and incorporation of their requests from the planning stage. In addition, agreements were signed with representatives of residents' groups to operate the facility in compliance with laws and regulations and self-imposed limits, disclose various data on the facility's operations and provide tours of the facilities.

(2) Waste Management Efforts Made by Fujisawa City

1) History of Waste Management in Fujisawa City

Fujisawa City has developed its waste management along with the times, from the improvement of waste collection to the full-scale introduction of 3Rs, and the period from the 1945s to the present is divided into four periods.

(a) Period of Seeking a Better Waste Collection Method, 1945 - 1964

The history of waste management in Fujisawa City began in this period. Waste collection carried out by private sector operators started in 1947 and three years later, the collection operation was changed to direct management by the city. Late in this period, the amount of generated waste significantly increased due to the expansion of the urban district, increase in population, and enhanced standards of living. Accordingly, door-to-door collection was changed to station collection, and use of mechanized collection vehicles was promoted.

(b) Period of Seeking Proper Waste Treatment for Bulky Waste, 1965 - 1974

Accompanied by the high economic growth, consumption styles diversified and discharging of bottles, cans, and home appliances in the waste increased. Both the quantity and quality of waste significantly changed. In addition, the central government thoroughly revised its former *Public Cleansing Act* and enacted the *Waste Management Act* with the aim to secure and preserve appropriate living environment, and regulate waste management from a broad perspective, thereby fundamentally addressing waste management issues throughout the entire municipality.

(c) Dawn of 3Rs and Period for Development of Intermediate Treatment Facilities, 1975 - 1994

The amount of waste continued to increase and the contents of waste were diversified as well. Consequently, it became difficult to conduct proper treatment and disposal of waste collected based on only two categories: municipal waste and bulky waste. To find an effective means for waste reduction, the “Fujisawa City Waste Reduction Promotion Office” was established in April, 1977, and waste reduction and recycling measures were regularly discussed. Fujisawa City invited citizens to participate in the discussions at the early design phase of the waste management system instead of asking citizens for their cooperation after the system had been designed. As a result, a waste separation system was successfully established. It was favorably accepted by the citizens. In October 1990, Fujisawa City established the “Fujisawa City Waste Control Conference” with the participation of four parties: citizens, business operators, academic experts, and municipal administration officials. The Conference proposed measures to reduce the amount of waste by 20% by the year 2000, to the mayor of Fujisawa City in October 1991.

(d) Period of Full-Scale 3Rs Introduction, after 1995

The amount of generated waste nationwide began to increase in the 1980s. Municipalities hastened to improve landfill sites, and started to seriously engage in waste management based on the 3Rs policies, and increased source separation and separate collection activities for some recyclables. In 1999, the collection of PET bottles was initiated citywide, followed by source separation and separate collection of miscellaneous waste paper resources in 2001. In the same year, with the implementation

of the *Small Home Appliance Recycling Act*, four home appliance items were excluded from the general collection, and the separate collection of plastic containers and packaging was introduced in 2002.

In 2014, the Recycle Plaza Fujisawa was completed. The Recycle Plaza incorporated a recycling facility and a public educational facility, thereby greatly contributing to public awareness of waste management. This type of recycle plaza has been constructed nationwide since 1990.

2) Noteworthy Experience: Recycling of Recyclables - Fujisawa Method

In the 1970s Japan's major municipalities became involved in separated waste collection. At the time the objective behind separate waste collection was to support the proper treatment of waste, and was not for the promotion of recycling. In those days, incineration was the main method of waste treatment and therefore, incombustible waste and bulky waste that could interfere with the incineration process were separately collected and not taken to incinerators. Many municipalities started to separate recyclables for the purpose of recycling in the 1990s. However, Fujisawa City was engaged in recycling of recyclables earlier, in the 1970s through the joint activities of citizens, municipal administration, and collection operators. This method was referred to as the "Fujisawa method" which attracted countrywide attention.

3) Experience of Construction and Renovation of Incineration Facilities

Construction of waste incineration facilities requires the understanding and agreement of local neighborhood residents through having a dialogue with them. When the new plant, Ishinazaka Environment Center was constructed at the site of the old Ishinazaka incineration plant in Fujisawa City, the neighboring areas were crowded residential areas and strict environmental measures were required. Furthermore, as the service life of incineration facilities is long, ranging from 30 to 35 years, it was necessary to respond to changes both in waste quality, as well as in laws and regulations during the long operation period. Fujisawa City also took countermeasures against high-calorie heat generation and dioxins.

(3) Waste Management Efforts made by Shibushi City

1) History of Waste Management - Waste Recycling Project around the Time Shibushi City was Established

The former towns of Shibushi, Ariake, and Matsuyama did not have any incineration plants and the collected waste was discarded in a landfill located in a depressed area surrounded by mountains. However, with the rising concern for environmental problems, it became impossible to continue discarding waste in this location. Accordingly, in 1990, the South Soo Welfare Association, consisting of the former towns of Shibushi, Ariake, and Osaki, constructed a controlled-type landfill

site with a landfill capacity of 720,000 m^3 to directly receive waste generated from those three towns without separating waste items. Since waste was simply dumped in the landfill site, the site became a breeding ground for flies, mosquitos, rats, and crows, causing an offensive odor, and as a consequence a large number of complaints from neighboring residents were lodged with the South Soo Welfare Association. Furthermore, estimates showed that the landfill site would become full in 1998 if direct landfill continued without separating waste items. Thus, waste reduction became an urgent issue. From that time, Shibushi City started to actively work on the recycling.

Table 6 Shibushi City's Efforts in Waste Management from the Inauguration of the City to the Present Date

Start year	Event and project
1990	The former towns of Shibushi, Ariake, and Osaki (South Soo Welfare Association) constructed a controlled-type landfill site with a landfill capacity of 720,000 m^3.
1998	Source separation of cans, bottles, and PET bottles started using designated bags.
1999	Started the sorting process of the above at the Soo Recycle Center, which was completed in 1999.
1999	Collection of 19 items of resources was started at 500 stations in the city.
2003	Started the source separation of 24 items.
2004	The source separation of kitchen waste started three times a week at 600 stations in the former town of Shibushi and Ariake. Composting started in the Soo Recycle Center.
2006	Shibushi City was established through the merger of 3 towns. The source separation of kitchen waste started at the former town of Matsuyama.
2007	The door-to-door collection of bulky waste started.
2011	JICA Partnership program (Grass-roots technical cooperation) project (Fiji)
2013	Collection of small home appliances started. The number of items to be separated became 27.
2018	The source separation of disposable diapers started in model districts.
2019	The model districts for the sorted collection of disposable diapers were expanded.

Source: by interview to Shibushi City

Photo 21 Collected Recyclables at Collection Area

Source: Yachiyo Engineering Co., Ltd.

Photo 22 Waste Discharge by Resident

2) Noteworthy Experience: History of Separation of 27 Waste Items - Shibushi Model

The three former towns of Shibushi, Ariake, and Osaki constructed a full-scale final disposal facility in 1990. However, as the amount of waste brought in increased year by year, it was estimated that the facility would become full by 2004, even with the introduction of separate collection of cans, bottles, and PET bottles. Although construction of full-scale incineration facilities was discussed, there was concern that costs for construction, maintenance, and management of incineration facilities would become a huge burden on the city in the future. As a result, Shibushi City decided to carry out a thoroughgoing recycling for the purpose of waste reduction so as to extend the life of the landfill site.

In contrast to the previous stance of "It is OK to put anything in a black bag", municipal personnel in charge visited neighborhoods to explain to residents to "Write your name on the waste bag and discharge it responsibly". The black plastic bags with no names on them were not designed to raise awareness that the person putting out the waste should be responsible for separating it properly, as long as it was impossible to tell who put out what and what was put out.

The city actively promoted public awareness activities. Briefing sessions with residents were frequently held to provide an opportunity for each resident to express an opinion. In briefing sessions, the current conditions of the landfill site and the necessity of recycling were explained in detail. Some residents objected on the grounds that it was troublesome to separate waste, but administrators visited them and respectfully explained the reasons for change. In addition, environmental education programs were implemented 76 times in 2016 and altogether 1,868 people participated in the programs.

The city's painstaking efforts changed residents' consciousness about waste management. It seemed that the attitude of sorting waste being "troublesome" changed into an attitude of "gratitude". This was because residents do not need to store the kitchen waste at home.

The city successfully reduced waste to be disposed of in the landfill by 80% in 2008 and the recycling rate remained very high in comparison with the national average. The landfill site significantly changed because kitchen waste was not being landfilled there anymore. The offensive odor, flies, crows, and rats disappeared. The reduction of the amount of waste being deposited into the landfill made it possible to extend the life of the landfill site.

10 Waste Management Challenges in Developing Countries and Lessons Learned from JICA Projects (Topic 7)

This topic introduces examples of JICA projects that were implemented in developing countries to support their waste management systems and tackle specific issues related to improvement of collection and transport, introduction of inter-municipal treatment, appropriate disposal site management, and promotion of 3R activities.

In order to solve these issues, this topic provides Japan's past experience in addressing similar issues and the technologies applied, as well as the lessons learned from the implementation of the project, as a reference, that can be used by developing countries to address similar issues.

An overview of Japanese experiences, technologies, and lessons learned from international cooperation projects in Sudan, Palestine, El Salvador, Bangladesh, Malaysia, and Vietnam are summarized hereafter.

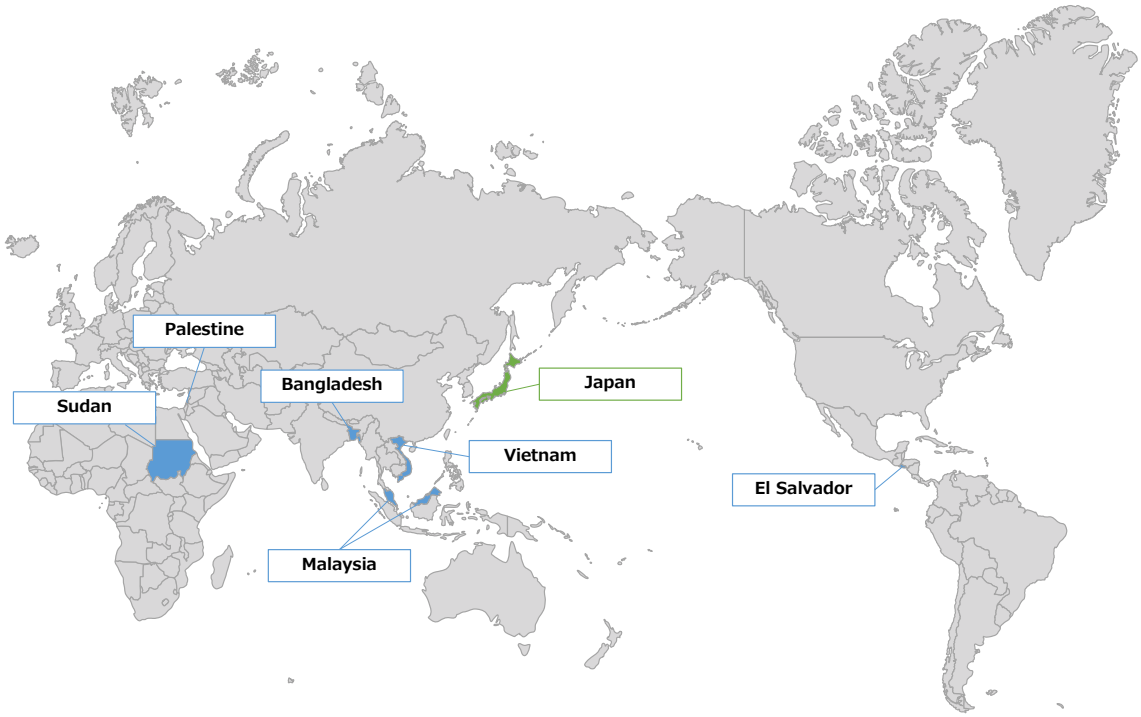


Figure 24 Locations of Countries Covered in Topic 7

(1) Republic of the Sudan ～ Introduction of "Fixed-Time Fixed-Place (FTFP) Collection"～

1) Background

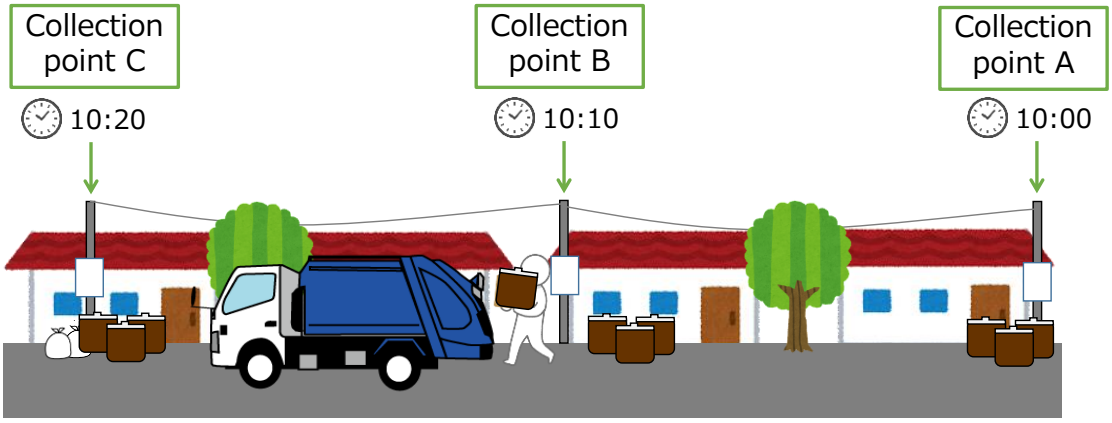
In Khartoum, the capital of the Republic of Sudan (hereinafter referred to as "Sudan"), waste was collected and transported by aging and inadequately maintained collection vehicles due to deterioration of the security situation and financial constraints. As a result, uncollected waste was scattered around the city, degrading the sanitary environment, especially in low-income neighborhoods. Residents were not sure when the waste they discharged would be collected. Residents also had very little interest in waste management because adequate waste collection services were not provided, and waste management were implemented without their cooperation or involvement.

Figure 25 Sudan Location Map

2) Application of Japan's Experiences and Technologies

(a) Introduction of Fixed-Time Fixed-Place (FTFP) Collection

A decision was made to introduce FTFP collection - which has become a mainstream system in Japan - in Khartoum to improve waste collection. FTFP collection is a method of collecting waste discharged at designated collection times and locations. There are a number of advantages in introducing FTFP collection, which include maintaining the cleanliness of communities by prohibiting the discharge of waste outside of designated collection times, reducing time period collection that vehicles spend on routes, and increasing collection efficiency. However, FTFP collection also comes with its own set of challenges: residents may feel burdened because they need to bring waste to specific places at designated times, the sense of individual responsibility may be diminished because it is impossible to identify the generators of the waste discharged, and it can sometimes be difficult to select and coordinate collection sites.



Source: Yachiyo Engineering Co., Ltd.

Figure 26 Image of FTFP Collection

Pilot Project

In Khartoum, pilot projects (PP) were carried out in several areas to examine the possibility of full-scale introduction of FTFP collection. A PP is the process of implementing a system that is being considered for full-scale implementation, together with collecting data to test the system and determine whether it is suitable and achieves the objectives set out. Collecting, analyzing, and verifying data before and after PP implementation makes it possible to measure the effectiveness of PP. The implementation of PP will provide decision-making materials necessary for examining the future direction of the project and knowledge on matters to be considered during the full-scale introduction.

Public Awareness

A public awareness campaign was conducted in Khartoum to promote FTFP collection. FTFP collection places comparatively high burden on residents, which poses a challenge, and the system will not be successful without their cooperation. Therefore, government staff in Khartoum implemented public awareness building activities for the project team (consisting of government officials, community representatives, and other concerned parties) and residents. Through these activities, it was possible to provide residents with opportunities to realize the benefits of FTFP collection and recognize that waste is their own problem.

Photo 23 During PP Implementation

Photo 24 Study Tour

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Evaluation of Feasibility through PP Implementation, Identification of Ongoing Challenges and Improvements, and Reflection in Collection Plans

By implementing PP for collecting and analyzing data before and after the introduction of FTFP collection, it is possible to quantitatively evaluate FTFP effectiveness. The issues identified in Khartoum at the time of the introduction of the FTFP collection were also found in projects in other countries, and lessons learned can be utilized to other cases. In the planning stage, information necessary for FTFP collection - type and number of collection vehicles, characteristics of the area to be collected (road conditions, etc.), collection routes, number of households to be collected, location of collection sites, etc. - should be shared in advance among the heads of administrative agencies in charge of waste management, officials in charge of collection planning (personnel and vehicle allocation planning), collection staffs, resident representatives, and other relevant parties. It is important to discuss solutions to possible problems through a series of collection and transportation processes. It is equally important to identify issues and points for improvement through periodic monitoring after the introduction of the FTFP collection, and to continuously review the collection plan.

(b) Need for Continuous Awareness Building Activities

While cooperative at the start of a project, residents can become less motivated with the passage of time. In order for the administration and residents to jointly work together continuously while recognizing their respective responsibilities, administration officials must promote understanding by local residents on waste management through regular meetings and awareness building activities, including public awareness programs and environmental education, and reflect the ideas and opinions collected from residents in waste management services. Regarding awareness-raising, it is important

to combine various activities, such as holding community meetings and study tours as well as to maintain the continuity of these activities. There also needs to be a mechanism to involve key persons in the community in the activities and to encourage residents to change their behavior and ways of thinking. On the other hand, residents are also expected to be aware of their own responsibilities for the waste they generate and be actively involved in waste management services provided by the government.

(2) Palestinian Interim Self-Government Authority, PA

～ Improving Waste Management through the Introduction of Inter-Municipal Waste Management ～

1) Background

The Palestinian Interim Self-Government Authority (hereinafter referred to as "Palestine") is divided into the West Bank bordering Jordan to the east and the Gaza Strip bordering the Mediterranean Sea to the west and Egypt to the south. The municipalities that make up Palestine are small and each municipality is responsible to collect and dispose of its waste. The waste collection rates were extremely low due to a lack of collection vehicles because of the short supply of financial resources in the municipalities providing the cleaning services. The collected waste was not disposed of properly, and instead was openly burned or dumped, and sanitary conditions were poor. With population growth and transportation barriers, Palestine faced challenges centered around a lack of access to disposal sites, waste management businesses that were not economically viable due to increasing operation and maintenance costs, and improper disposal practices, such as open burning, which created health hazards for residents and environmental pollution problems.[6]

Figure 27 Palestinian Location Map

2) Application of Japan's Experiences and Technologies

(a) Creating a Foundation for the Introduction of Inter-Municipal Waste Management

Waste management in Palestine, which had been carried out by smaller municipalities, is to be implemented by a regional association called the Joint Service Council (hereinafter referred to as "JSC"), under a collaborative initiative by several municipalities. The JSC aims to create an inter-municipal waste management system that will place a small burden on each municipality and provide stable waste management services throughout the entire region. In addition to reducing the budgetary burden on each municipality through the efficient operation and maintenance of collection vehicles and sharing the final disposal site, the inter-municipal system will allow for an increase in the size of the disposal sites and improve the efficiency of construction and operation.

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[6] Due to the long-standing conflict with Israel over land, Palestine has become an enclave, and its land area continues to shrink due to repeated Israeli settlement activities. In order to travel between Palestinian areas, one must pass through "checkpoints" set up by Israel on the border. Palestinians are not allowed to enter without an Israeli permit.

(b) Activities to Build Public Awareness on Waste Fee Collection

Costs related to inter-municipal waste disposal in Palestine are covered by waste disposal fees collected from residents. In general, compared to other public services (e.g., electricity and water), waste management is often not a top priority for residents, and it is difficult to enforce fee collection systems without their understanding of the importance of collecting fees. While Palestinian residents tend to be less environmentally conscious, some are not aware of the JSC's activities or may be concerned whether the introduction of inter-municipal waste management will actually improve waste management conditions. Therefore, a variety of activities were implemented to help residents understand the need to collect fees, such as the organization of information sessions for residents, and production of newsletters, leaflets and posters, documentary films, and TV advertisements.

Photo 25 Waste Collection (Ramallah - Al Bireh JSC)

Photo 26 Workshop with Residents

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Improvement of Efficiency of Waste Management through Inter-Municipal Waste Management

Smaller municipalities, where resources are in chronically short, have difficulty continuing to implement quality waste management. One proposed solution is the introduction of a system called "inter-municipal waste management", in which surrounding municipalities come together to jointly implement waste management. When introducing inter-municipal waste management, an inter-municipal association that will function as a secretariat must be established that will be run through the cooperation of participating municipalities.

In order to reduce the burden on each municipality during the organization creation phase, it is important to first investigate the existing equipment, human resources, capabilities, systems, financial resources, mechanisms, and facilities possessed by the municipalities comprising the JSC, and combine them for effective utilization, rather than purchasing new equipment or hiring new personnel

at the outset. Reducing the burden in the initial stages will lead to the smooth establishment of the JSC and the continuation of its subsequent operations.

(b) Introduction of Waste Collection Fees

When starting the collection of waste disposal fees, it is important to set an amount that the residents can afford and accept. In the Jericho and Jordan Valley areas, as a result of discussions within JSC, a waste disposal fee was set at an amount that would cover the JSC operating costs and that would not be a burden on the residents. After repeated explanations and discussions with the local residents through explanatory meetings and other means, the residents finally agreed that the waste disposal fee was appropriate.

On the other hand, the actual collection of fees is difficult, and in order to continue the waste management, it is necessary to consider measures such as increasing the fees. In order to improve the rate of fee collection, not only the quality of waste disposal service needs to be improved, but also various measures such as continuous dialogue with residents, suspension and resumption of service, and fee collection together with other public services (electricity, water, etc.) are required.

(3) Republic of El Salvador ～ Path to Proper Management of Sanitary Landfill Sites ～

1) Background

El Salvador did not have a waste management system in place, and waste was usually disposed in open dumps. The resulting increase in disposed waste caused groundwater pollution and contaminated the soil, creating adverse effects on people's health and ecosystems. To improve conditions, El Salvador enacted an *Environmental Law* in 1998 requiring all municipalities to close open dumping sites and build sanitary landfills by September 2007. There was an urgent need for the systematic and phased development of sanitary landfill sites and to reduce the volume of waste, leading the government of El Salvador to decide that it was necessary to bolster the waste management capacities of municipalities.

Figure 28 El Salvador Location Map

2) Application of Japan's Experiences and Technologies

(a) Construction and Proper Maintenance, Management and Expansion of Sanitary Landfill Sites Using the Fukuoka Method

ASINORLU is an inter-municipal association, which was responsible for operation and maintenance of the final disposal site. In 2006 the Santa Rosa de Lima Landfill, managed by ASINORLU was being operated as an open dump site. During the project improvement works were constructed at the site to transform the open dump into a semi-aerobic landfill, applying the Fukuoka method [7] developed in Japan. As a result of the improvement project, waste is no longer scattered around the sanitary landfill site as it was with open dumping, which indicates a dramatic improvement in environmental conditions as well. The reasons behind the site's proper maintenance as a sanitary landfill is the application of daily soil cover over the freshly disposed waste, thorough cleaning of storm water drains and site roads, and preventive maintenance of heavy equipment.

(b) Introduction and Expansion of Regional Waste Treatment through Inter-Municipal Cooperation

ASINORLU is composed of nine cities. It is necessary to reach agreements with each of the nine cities on setting disposal (tipping) fees to be paid to ASINORLU in order for waste to be accepted at

[7] In the semi-aerobic landfill system, gas venting pipes and leachate collection and drainage pipes are installed to allow air to flow naturally into the interior waste layers. The supply of oxygen to the interior of the disposed waste layers increases the speed of waste decomposition, decreases the concentration of pollutants in the leachate, and suppresses odors and methane gas emissions. As a result, the stabilization period of the landfill site is shortened. The Fukuoka method is becoming popular in developing countries because inexpensive local materials such as waste tires, drums, bamboo, and rubble can be substituted as materials for pipes and paving stones.

the landfill site. Since waste management is not always a high priority for mayors, ASINORLU provided detailed explanations to each mayor and obtained their consent to increase the cost for disposal. In addition to that, the citizens' understanding of waste management was promoted through environmental education and 3R activities at schools and government offices, and tours of disposal sites.

Source: Yachiyo Engineering Co., Ltd.

Photo 27 Newly Constructed Sanitary Landfill (Phase 2)

Photo 28 Briefing to the Mayor

Photo 29 Site Visit at the Regional and National Seminar

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) Political - Examining the Impacts of Changes in Government Administration

In El Salvador, the term of office for the President is five years, while the term of office for mayors is three years. A change in government, including political party, can result in significant changes in policy. In some cases, waste management falls in priority, budgets are reduced and, the introduction of inter-municipal waste management by associations has been postponed for reasons such as these. Every time the mayor of a city in the association changes, it is important for staff from the association to visit the city and provide a detailed explanation of the situation to the new mayor and city council.

(b) Financial - Securing Funding

It is important for the central government to establish a budgetary framework for the development

of inter-municipal waste management facilities. Only with this framework can inter-municipal cooperation be promoted in detail, and it will be easier to obtain the commitment of each municipality. The role of the central government should be to raise funds from donors and promote the allocation of the country's budget.

(c) Public Participation - Importance of Disclosing Information

An important factor in promoting inter-municipal waste management is the fair disclosure of information about project plans and outlines, and impacts on areas around facilities from the early stages of the planning process. As a first step, it is important to provide examples of proper development and operation and maintenance of landfill sites to avoid NIMBY-related problems.

Participation by residents and communities is an essential part of the waste management process, and incorporating their opinions, including opposing views, into project plans from an early stage and solving problems that arise will put the project on a fast track to implementation. There have been several cases where projects did not make it to the implementation phase due to failures to disclose information. Encouraging residents to actually visit sites through field trips to landfill sites and treatment facilities will also help them see waste issues as something that concerns them and will dispel causes for concern.

(d) Organizational - Securing Human Resources

As counterparts of projects move on, the experience and knowledge from the project and results of training in Japan may leave with them. However, in ASINORLU, counterparts are still directly involved in waste management, and significant developments have been observed even after the project ended. When staff are replaced within an organization, it is necessary to devise ways to retain the skills and methods developed through the project within the organization.

(e) Organizational - Improvement of Staff Motivation

In order to continuously maintain and manage a facility, it is important to motivate and maintain the staff involved in operation and maintenance management. In addition to a good working environment and a stable salary, visualization of work results, appropriate evaluation of work, and attention from others can also effectively motivate employees.

(f) Country Differences - Challenges in Expanding Systems to Other Countries

El Salvador is working on expanding lessons learned to other countries in Latin America based on ASINORLU's experience. However, it is not always possible to be applied successfully due to differences in laws and political systems in target countries. Conditions in other countries must be taken into account, and cooperation is needed to develop countermeasures to address this.

(4) People's Republic of Bangladesh ～ Community Participation in Waste Management～

1) Background

The population of Dhaka, the capital of Bangladesh[8], is estimated to be over 20 million. With rapid urbanization, the city is facing growing urban environmental problems, such as waste, air and water pollution. In Dhaka, waste management was being collectively implemented by the city government, but in such a large city it was difficult for an individual organization to be consistent in managing the discharge, collection and transport, intermediate treatment, and final disposal of waste. In addition, waste management in Dhaka City had been stagnating due to weak organizational structures, lack of equipment, and low sanitary awareness among the population.

Figure 29 Bangladesh Location Map

2) Application of Japan's Experiences and Technologies

(a) Ward Based Approach (WBA)

The Ward Based Approach (WBA), a management method for stable and continuous implementation of field-led waste management in wards[9], which are the smallest administrative units in Dhaka City, was introduced. Through WBA, for each ward, various activities such as staff training and awareness raising, improvement of organizational functions, improvement of equipment, and improvement of collection systems are combined in a synergistic manner to improve waste management. WBA consists of four activities: (1) Construction of ward cleaning offices and strengthening field management, (2) Improvement of working environment for cleaner, (3) Promotion of public participation, and (4) Improvement of collection and transportation.

<u>WBA1 - Construction of Ward Cleaning Offices and Strengthening Field Management</u>

In order to create a base in each ward to help wards improve waste management on their own, ward cleaning offices were constructed, and their functions strengthened. The offices were built to serve a

[8] The term "Dhaka City" refers to the former Dhaka City before the partition of the city into North and South Dhaka in 2011, which is now the combined area of Dhaka North City and Dhaka South City. In this material, "Dhaka City" is used for the sake of convenience.

[9] The smallest administrative unit of a city area. Multiple wards make up a single zone. As of 2022, there are approximately 130 wards in Dhaka City (Dhaka North City: 54 wards in 10 zones; Dhaka South City: 75 wards in 10 zones). The population per ward consists of tens to hundreds of thousands of people.

number of functions, including; as a point of contact for residents to reach out with complaints, a base for labor management and guidance for cleaner, a place for cleaner to take breaks, and a storage space for cleaning tools.

WBA2 - Improvement of the Working Environment for Cleaner

In Dhaka City, a safety and health committee was established to raise safety and health awareness and improve work efficiency, thereby providing a foundation for ensuring the occupational safety of the cleaner. A manual with diagrams was prepared for cleaner so that even those who couldn't read were able to understand the contents, and points to be kept in mind relating their work were made known to them. In addition, safety gear such as masks and gloves were distributed to cleaner to protect their health and safety, and information on how to use first aid kits and nearby hospitals were provided. Furthermore, a workshop was held to share with the cleaner the aims of waste management in Dhaka and to encourage their awareness that they, as city employees, are involved in the waste management.

WBA3：Promotion of Public Participation

In order to implement community-based participatory waste management, it was necessary to attract the attention of many residents and encourage them to change their behavior, and the participation of influential figures in the community was essential. Therefore, a survey was conducted to identify representatives and influential figures of local residents' organizations in each ward and new residents' organizations for waste management were established, with the identified individuals as key persons. Activities were mainly carried out through these community organizations to encourage the participation and cooperation of local residents in waste management. Activities included a march by local residents calling for city beautification projects, campaigns to raise awareness of the environment through plays and musical events, and clean-up campaigns organized together with cleaner.

WBA4：Improvement of Collection and Transportation

In order to remove large dustbins and containers causing unsanitary conditions in the city and traffic congestion, Dhaka City introduced compactor trucks for secondary collection. In parallel, the city introduced fixed-point collection, in which waste is discharged at a designated time and place. Unlike dustbins and containers, the time that waste was kept in the city was reduced, contributing to improved sanitation.

Photo 30 Meeting with Cleaners in Ward Cleaning Office

Photos 31 Part of the Cleaner Work Manual

Photo 32 Residents Cleanup Activities

Photo 33 Waste Collection by Compactor (Fixed-Place Collection at Regular Intervals)

Source: Yachiyo Engineering Co., Ltd.

3) Lessons

(a) To Improve Integrated Waste Management

WBA is an effective method for developing site-driven participatory waste management in the community. The construction of the ward cleaning 0ffice provides administrative work space for the cleaning supervisors and a place for the cleaner to rest and store their safety gear. It also serves as a point of contact for residents to casually discuss waste management issues, helping to build a relationship between the government and residents.

Protecting the occupational safety of cleaner is also important to avoid the sudden absence of cleaner due to injury or illness, especially if weakness in occupational safety interferes with collection work. Collection services can be improved by selecting appropriate collection methods, allowing services to be provided that not only consider the sanitation of local residents and the surrounding environment, but also the health and safety of the cleaner who perform collection work.

In order to encourage the participation of residents, who play an essential role in promoting proper

waste management, it is important to identify local representatives and influential people in the community and establish a resident's organization led by these individuals. The existence of such an organization will establish a foundation for local residents to work together and contribute to the implementation of activities to improve the sanitation environment in the community.

(5) Malaysia ～ Data Management Systems, Dissemination of 3R Activities and Environmental Education ～

1) Background

In Malaysia, prior to the transfer of waste management and recycling administration to the central government (National Solid Waste Management Department) in 2011, waste management was a local government task and the Ministry of Housing and Local Government (MHLG) was in charge of waste administration. Since the mid-1980s, Malaysia has experienced an increase in the amount of waste generated due to urbanization and diversification of lifestyles in line with economic development, as well as problems with disposal costs and securing landfill sites. Therefore, the National Development Policy has emphasized the concepts of reduce, reuse, recovery, and recycling, and made recommendations on the use of environmentally friendly products. In addition, the Ministry of Housing and Local Governments (MHLG) has been promoting recycling and raising awareness with citizens on the 3Rs at the national level, while local governments have promoted recycling activities. However, these efforts were limited to only a few local governments that had an advanced level of environmental awareness, and recycling rate was only 2% to 5%.

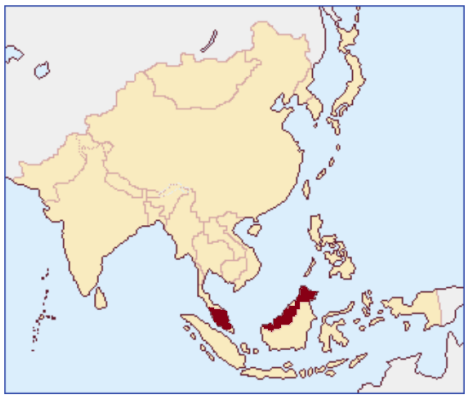

Figure 30 Malaysia Location Map

2) Application of Japan's Experiences and Technologies

(a) Development of a Data and Information Management System

One of the Japanese technologies that has been applied under the project in Malaysia is for creating databases on waste. A database was created in an information management system using data on the collection of recyclable materials digitally submitted by local governments and key information related to recycling shown below.

- General information about the local government: address, contact information of officer(s) in charge, website URL, etc.
- Collection centers, collection container locations, administrators
- Types of recyclable materials collected
- List of related organizations submitted by the local government

This database has made it possible to access and search key data, as well as create tables and graphs for purposes of research, analysis, and publication.

(b) Source Separation

Five target groups were selected in this project to verify source separation under different conditions: (1) general households (single-family houses), (2) general households (apartment complexes), (3) office buildings, (4) mega-marts, and (5) hotels. After targets were selected, waste was separated at source through the establishment of separation methods and collection routes for resources, and the organization of workshops and briefings to obtain stakeholders' understanding and cooperation. Finally, source separation guidelines were developed to promote separation at source. For each business operator, it took time to coordinate with the pilot project for introduction of source separation, because they were required to bear the costs of labor for sorting the waste, costs to purchase containers for the sorted recyclables, as well as to allocate personnel and consider a location for placing the containers.

(c) 3R Activities and Environmental Education

Prior to the start of activities, guidelines were developed for promoting the 3Rs in schools in collaboration with the ministries in charge of waste management, Ministry of Education, local governments, and school teachers. Based on these guidelines the schools were classified into levels according to the extent existing waste reduction programs were already being implemented. The guidelines also indicated the need to incorporate PDCA (Plan, Do, Check, Act) cycles to review and improve 3R activities that have been planned and implemented. It was important to initially provide appropriate guidance to school teachers so that guidelines could be properly implemented in educational settings, and therefore 3R workshops were also organized for teaching staff. Based on these activities, 3R programs were implemented in schools in Miri City, Johor State and other areas.

Photo 34 Briefing on Source Separation Activities to Residents

Photos 35 Awareness Survey on 3Rs in Schools

Source: JICA, Yachiyo Engineering Co., Ltd., EX Research Institute Ltd. "The Study on National Waste Minimization in Malaysia Final Report" (2006)

3) Lessons

(a) Training and Securing Competent and Appropriate Human Resources

Data management, updates to networks, and monitoring are essential aspects of waste management operations. Therefore, in order to maintain data management systems, it is necessary to educate not only the central ministries and agencies that manage the databases, but also the local government administrators who collect and submit data, and to appoint competent, appropriate, and trained personnel to maintain the systems.

(b) Coordination between Stakeholders on Source Separation

It took time to coordinate with the parties concerned, as they were required to bear the costs of labor and sorting containers for the introduction of source separation, as well as to allocate personnel and secure an installation site. Source separation programs for commercial facilities, such as supermarkets and hotels, faced various problems such as informing customers and gaining their understanding of cost burdens, etc. in terms of coordinating and negotiating with stakeholders. These problems lay beyond the control of local governments and the project team, and caused significant delays in the implementation of the program. For separation at source, it is necessary to coordinate with households and commercial facilities separately, and pay particular attention to the interests of stakeholders of commercial facilities.

(c) Strategic Implementation of Educational and Dissemination Programs through Inter-Agency Collaboration

In order to introduce sustainable waste reduction practices, it is necessary to teach the philosophy of the 3Rs to the younger generation through practical school education and extracurricular activities. Collaborative activities between ministries responsible for waste management (in this case, the Ministry of Housing and Local Government) and the Ministry of Education are essential for the introduction of sustainable and strategic educational and awareness programs suitable to students. The Ministry of Education and teachers were involved from the initial stage in developing guidelines to promote 3R activities in schools, which made the guidelines even more applicable in educational settings. It is important for multiple ministries and agencies to collaborate in order to efficiently implement educational and awareness programs.

(6) Socialist Republic of Vietnam ～ 3R Activities Involving Multiple Stakeholders～

1) Background

Environmental pollution in Hanoi, the capital of Vietnam, was worsening due to un-collected solid waste scattered on public roads and illegal waste dumping in lakes. Under the nation's environmental strategy to recycle 30% of waste by 2020, the government had been trying to promote a recycling movement for solid waste, but the collection of recyclables remained mainly limited to informal waste collectors.

Figure 31 Vietnam Location Map

The 3R Initiative, which combines the Reduce, Reuse and Recycle of waste, was positioned as a key component in the country's environmental strategy. The Ministry of Natural Resources and Environment was established in 2002 to work with local governments on environmental measures related to water and air quality and solid waste management.

2) Application of Japan's Experiences and Technologies

(a) Public Participation Initiatives Involving Various Stakeholders

This was an attempt to apply Japan's experience and knowledge of public participation as a key factor in the sustainable implementation of waste management and the 3Rs. Hanoi's 3R project involved a diverse range of stakeholders, including residents, local communities, government, media, students, experts, the private sector, and NGOs, attempted to position local residents at the center of the project and turn the focus on them. Many groups as described below, were formed to engage in 3R activities, and a wide variety of activities were implemented.

3R Stars; 85 organizations and individuals, including representatives from government agencies, universities, the media, private companies, and model districts, came together to form it.

3R Volunteers Club; These activities included instruction on sorting waste on the streets and in parks, participation in environmental events and other 3R publicity activities, and extracurricular 3R classes at elementary schools.

3R Supporters; The groups focused on 3R awareness-raising activities, such as providing guidance on sorting in the community and preparing and distributing leaflets on sorting methods.

(b) Separate Collection and Composting

As a result of the model project implemented in the four districts (total of four districts: about 18,300 households, population of 72,820) there have been improvements in the separate collection of the

recyclables, collection of the food waste, as well as composting. The introduction of fixed time fixed place collection (FTFP) using containers and collection vehicles (trucks and hand-pushed waste carts) for use on narrow roads has made it possible to collect separated waste regularly even in densely populated residential areas. This has improved the rate of separate collection of food waste. The quality of compost improved with upgrades to the composting process. A better understanding of the demand for compost was formed and then market expansion was attempted.

Photo 36 Publicity Activities on the Street by 3R Volunteers

Photo 37 Containers for Designated Wastes in the Park

Source: JICA "Project for Implementation Support for 3R INITIATIVE in Hanoi City to Contribute to the Development of a Sound Material-Cycle Society Final Report" (2009)

3) Lessons

(a) Mobilize and Promote Public Participation of a Wide Range of Stakeholders to Effectively Implement the 3Rs Initiative

The creation of the 3R volunteer program was an opportunity for young people to become interested in the 3Rs and environmental issues and led to independent activities involving residents. In addition, a wide range of stakeholders were invited to take part in discussions at the 3Rs Stars Meeting and to propose their ideas to policy-making organizations.

These activities encouraged public participation and increased the effectiveness and impacts of the project. The greater the interest and louder the voices of the residents, the harder it is for policymakers to ignore them. In today's world, it is necessary to find ways to engage the public that are appropriate to local conditions, such as the use of social networks.

(b) Need for Innovation when Introducing Source Separation

Public participation and behavioral changes are essential when introducing source separation. Even if rules for source separation are established, they will generally not be followed or sustained. Furthermore, consistency between source separation and collection systems and securing a place to pick up separated waste are also essential conditions. In order to introduce source separation and

establish relating rules, the introduction of incentives for residents and pick-up locations is considered a challenge, but with the city's budget constraints, no solution has been found.

As with Hanoi's 3R initiatives, one solution may be to motivate residents by involving all stakeholders and guide the momentum of society as a whole in the same direction. However, since it is difficult to ensure sustainability only with the participation of local residents, synergistic effects from multifaceted efforts, such as technological and operational improvements at recycling facilities and the widespread use of reusable containers, are desired. In addition, in a large city such as Hanoi, the challenges of rapid urban expansion continue, and in the waste agenda as well, there is a need to review collection methods along with the development of transfer stations and incineration facilities, and to position source separation and 3Rs in consideration of this background.