THEME 4 WATER POLLUTION AND ENVIRONMENTAL MANAGEMENT: PREVENTING DAMAGE TO HUMAN HEALTH AND LIVES AND CREATING SUSTAINABLE ENVIRONMENT

ABSTRACT

If the large amounts of sewage and wastewater generated by economic activities are not properly treated, they can harm both human health and ecosystems. In many developing countries, sewerage systems are developed in only a limited area, resulting in the direct discharge of factory effluents and domestic wastewater into rivers, lakes, and marshes; thus, the natural environment is degraded due to developmental activities.

In Japan, approximately 40,000 people[1] were affected by pollution-related diseases caused by factory wastewater during high economic growth. Laws and regulations involving monitoring and penalties improved water quality, and pollutant loads from factories dropped to less than one-tenth in 20 years. Factories improved their production and wastewater treatment processes. Currently, over 90% of the population uses sewage treated via sewerage connections and on-site systems in their houses.

In closed water bodies[2], water quality is difficult to improve, once deteriorated. Improvement measures involve controlling the inflow of upstream pollutants, handling point source loads where pollution sources can be identified, and managing non-point source loads where pollution discharge points can be specified. In Japan, only 50% lakes have achieved environmental standards of water quality. Thus, the government has formulated long-term plans for water quality conservation, involving action plans to implement projects.

During high economic growth, the river environment deteriorated, and Japanese residents were reluctant to approach and enjoy rivers. As people became more environmentally conscious, the government undertook the restoration of ecosystems and nature. In 1997, the River Law was revised by adding the maintenance and conservation of the river environment, in addition to conventional flood protection and water use. Various initiatives, such as river water purification projects, river development in harmony with the natural environment, and, more recently, green infrastructure development, were launched. The government managed illegal garbage dumping into rivers via early detection and actions through river patrols and "garbage pickup" in cooperation with civil society organizations and local communities.

[1] Number based on people eligible for support.
[2] Closed water bodies include lakes, marshes, or land-locked seas, with low water exchange with other sources.

CHAPTER 1 INTRODUCTION

> If economic development is prioritized and water pollution is left unattended, this could lead to environmental destruction and severe pollution. Thus, a legal system and institutions must be established to regulate discharge and to improve the water environment with nature-based solutions.

The water quality and environment of rivers, lakes, seas, and groundwater deteriorate because of the rising population of cities and increasing economic activities. Unless properly treated, sewage can harm both human health and ecosystems. The lack of sewerage systems and regulation results in the direct discharge of industrial and domestic wastewater into rivers, lakes, and marshes, and the natural environment is degraded with further development.

In Japan, water pollution was exacerbated due to prioritized economic development, particularly in urban areas. Factory effluents caused pollution-related diseases, such as Minamata and Itai-itai disease, compromising the health of people and causing severe pollution-related problems. In 2010, over 36,000 people[3] were deemed eligible for Minamata disease relief. In addition, water pollution damaged the ecosystem and deters residents from rivers, considerably impacting the water environment.

In response to the water pollution problems, the government regulated wastewater discharge into water bodies and employed measures to improve water quality, as explained in the "Water Pollution" chapter. The chapter "River Environmental Management" describes efforts to conserve the river environment. The government has been working with civil society organizations and local communities to improve the quality of river water and preserve riverine ecological habitats and landscapes that were once deteriorated. As a result, many rivers have become places of leisure for both residents and tourists.

[3] Number of people eligible for relief under the Minamata Disease Special Measures Law in Kumamoto and Kagoshima Prefectures in 2010

Water resources management is closely related to the Sustainable Development Goals (SDGs), and the relationships between water pollution and environmental management measures and the SDGs are shown in the following box.

Relationships between Water Pollution and Environmental Management and the SDGs:

(1) Water quality will be improved through measures against water pollution.
SDG 3: "Good Health and Well-being"; 3.3: "Address water-borne diseases"
SDG 6: "Clean Water and Sanitation"; 6.2: "Access to adequate and equitable sanitation and hygiene for all"
SDG 14: "Life below Water"; 14.1:"Prevent and significantly reduce marine pollution due to land-based activities"
SDG 15: "Life on Land"; 15.1: "Ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems, particularly forests, wetlands, mountains, and drylands"

(2) The natural environment of rivers is conserved and restored through environmental management measures.
SDG 17: "Partnerships for the Goals"; 17.17: "Encourage and promote effective public, public–private, and civil society partnerships"

CHAPTER 2 WATER POLLUTION

2.1 Legal System for Water Pollution-related Diseases in Japan

A legal system should be established for the conservation of water quality, through which effluent standards can be enacted to reduce the impacts of degraded water on human health, living environment, and ecosystem and effluents can be monitored and regulated. In Japan, government policies prioritizing economic growth resulted in disastrous pollution problems, such as diseases.

Initially, Japan lacked an efficient legal system for protection against water pollution, as industrial development was the priority. With the emergence and spread of pollution-related diseases, a legal system was introduced. Table 2.1 presets the timeline of pollution and enactment of laws related.

Table 2.1 Timeline of Water Pollution Diseases and Related Laws Enacted

Around 1910	Outbreak of Itai-Itai disease due to water pollution
1953	Outbreak of Minamata disease due to water pollution
1958	Edogawa River pollution Incident
1958	Water Quality Protection Act & Industrial Wastewater Act (Old Two Acts)
Around 1959	Outbreak of Yokkaichi asthma due to air pollution
1965	Outbreak of Second Minamata disease due to water pollution
1967	Basic Act for Pollution Prevention Measures
1970	The Pollution Diet was convened to drastically improve pollution-related laws and regulations
1970	Water Pollution Control Act
1972	Nature Conservation Act
1993	Basic Environment Act

Source: Toward the Conservation and Sound Use of Groundwater, Advisory Group on Future Groundwater Use, March 2007, MLIT

(1) History of Water Pollution

1) Development of "Polluting Industry" during the Post-World War II Reconstruction Period

After World War II, the public and private sectors collaborated to place the economy on a high-growth trajectory and achieve economic independence from the reconstruction stage. During this process, the impact of industrial activities on the environment increased. Heavy industrialization was promoted, creating a "polluting industry" with high pollutant emissions. Large-scale industrial complexes were built in coastal areas, and pollution intensified and spread spatially. The rising consumption demands of people and increasing production in response led to further environmental destruction. During high economic growth, four major pollution-related diseases emerged because of wastewater from factories and air pollution, and three of them, except Yokkaichi asthma, were caused by water pollution (Table 2.2).

The government developed infrastructure to improve the industrial base; however, the budget for living environment facilities remained small. In 1970, at the end of high economic growth, the project cost for the construction of living environment facilities constituted only 5.3% of the total public works expenditure[3].

[3] Water Environment Conservation Technology Training Manual General Remarks, Overseas Environmental Cooperation Center, March 1998

Table 2.2 Four Major Pollution-related Diseases

Disease	Minamata Disease	Second Minamata Disease	Itai-itai Disease	Yokkaichi Asthma
Region of Emergence	Shiranui Coast, Minamata, Kumamoto Prefecture	Agano River Basin, Niigata Prefecture	Jinzu River Basin, Toyama Prefecture	Yokkaichi City, Mie Prefecture
Responsible Company	New Japan Nitrogenous Fertilizer Company, Acetaldehyde Factory	Showa Denko Kanose Plant	Mitsui Mining & Smelting Company Kamioka	Ishihara Sangyo, Chubu Electric Power Company, Showa Yokkaichi Sekiyu, Mitsubishi Yuka, Mitsubishi Kasei Kogyo, Mitsubishi Moncent Kasei
Substance	Methyl mercury compound		Cadmium	Sulfur oxides
Symptoms	Hand and foot tremors, sensory disturbance, hearing impairment, neurological disturbance, ataxia, visual field narrowing, equilibrium dysfunction, speech impairment		Osteomalacia, renal dysfunction	Bronchitis, bronchial asthma, pharyngitis and other respiratory diseases, emphysema
Outbreak Year	Occurred in 1953 and recognized in 1956	1965	Around 1910	Around 1959
Number of Certified Patients[4]	2,283 (as of March 2020)	704 (As of December 2015)	200 (As of March 2018)	

Notes: In addition to certified patients, the number of people who received compensation from the government is tens of thousands.
Source: Materials added on the Environmental Science reference website by the project research team

2) Local Government's Initiatives

With the emergence of environmental issues, local governments faced a brunt of criticism from the resident population and had to solve the issues on their own before the national government could act. Around 1949, local governments began enacting ordinances for pollution prevention (see Reference). Many ordinances set out procedures for permitting the establishment of factories that might cause pollution but did not regulate emissions. Actions of the National Government

Regulations on water pollution did not proceed easily because of opposition from the industrial sector. In 1951, the Natural Resources Research Council of the Economic Stabilization Agency (now the Cabinet Office) submitted a "Recommendation on the Prevention of Water Pollution" to the President of the Economic Stabilization Agency and presented the outline of a bill. However, opposition from the industry, particularly the mining sector, which was considered the most severely affected by the

[4] Patients certified by the Law Concerning Pollution-Related Health Damage Compensation and Other Measures. This system was enacted in 1973 to promptly and fairly protect pollution victims, taking into account the special nature of pollution damage and civil liability for pollution causes.

regulation, was so intense that the act was considered premature and not enacted. Subsequently, from 1953 to 1957, the Ministry of Health and Welfare held 20 conferences among various ministries and agencies to prepare for the law. The ministries of health, industry, and fisheries drafted various bills, but none succeeded.

(2) Legal Systems

1) Two Water Quality Laws

The Water Quality Protection Act in 1958 was the first act in Japan to prevent water pollution. It designated water bodies and set effluent standards for factories and workplaces. Subsequently, the Industrial Wastewater Act was designed to ensure compliance with water quality standards.

However, the two water quality acts did not function enough in preventing pollution for the following reasons: (1) the purpose of the acts included harmonization with the economy; (2) the regulated water areas were limited; (3) measures to enforce compliance with the effluent standards were specified in multiple acts and the regulatory contents were inconsistent among the acts; (4) there were no sanctions (direct punishment system) for violating the standards, and facilities subject to regulation were for the manufacturing industry alone, with few and limited pollutants subject to regulation; (5) the regulations addressed only the concentration of pollutants; (6) the effluent standards were moderate enough to retain the current status; and (7) the water quality monitoring system was inadequate.

2) Water Pollution Prevention Act

In 1970, the Headquarters for Pollution Prevention was established, headed by the Prime Minister. The national diet on pollution, called the "Pollution Diet," was also convened, aiming to overhaul pollution-related laws and regulations. Finally, fourteen pollution-related laws were enacted to establish an effective system.

The 1970 Water Pollution Prevention Act aims to prevent water pollution in water bodies and groundwater, protect public health, and preserve the living environment. The "harmony clause" concerning harmonization with economic development was deleted. Regulations were strengthened by expanding the regulatory region from designated areas nationwide and increasing the number of substances to be regulated. The act protects victims by providing liability for damage to human health caused by factory effluents.

3) Basic Environment Act

Economic development entailed socioeconomic activities, such as mass production, consumption, and disposal. It also led to the concentration of economies in cities, where domestic wastewater caused pollution problems in urban life, such as nitrogen oxide pollution and water pollution. Increased waste burdened the environment to an ever-greater extent, and the natural environment continued to deteriorate.

Many issues, such as air and water pollution, occur in multiple environmental elements rather than individual ones, and measures against individual environmental elements cannot solve such complex issues. Acid rains and deforestation affect natural ecosystems. Forests absorb greenhouse gases. Measures addressing pollution prevention and natural environment conservation are required to mitigate the global environmental issues.

In 1993, in response to the growing demand for comprehensive measures to protect the environment, the Basic Environment Act was enacted with the following principles: "enjoy and inherit the benefits from the environment," "build a society that enables sustainable development with less environmental impacts," and "actively promote global environment conservation through international cooperation."

(3) Institutional Development

In 1967, the Central Council for Pollution Prevention Measures was established as a government system in the Prime Minister's Office. The national government consulted pollution prevention measures with the council. In 1993, the council became the Central Environment Council, which dealt with environmental policy. In 1971, the Environmental Agency was established to integrally control the existing pollution regulations under the jurisdiction of 13 ministries.

Under the 1967 Basic Act for Pollution Prevention Measures, local governments were responsible for promoting, monitoring, regulating, and guiding measures against water and other forms of pollution as well as handling complaints and disputes. The budget increased from 370 billion yen in 1970 to 5.5 trillion yen in 2000. The number of staff members, including environmental specialists, increased from approximately 3,000 nationwide in 1970 to approximately 16,000 in 2001. Laboratories were established for monitoring, research, and analysis.

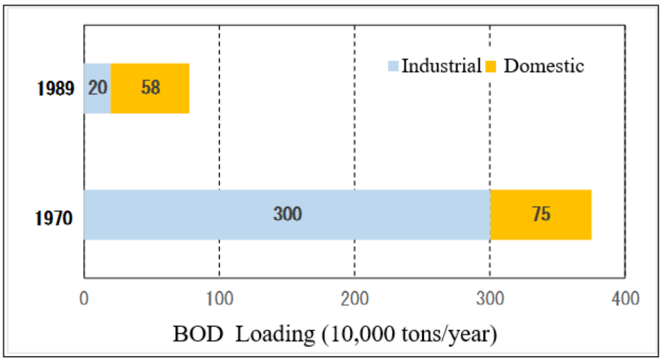
2.2 Wastewater Regulation

> To improve water quality, wastewater is regulated through acts and ordinances and monitoring is conducted.

(1) Factory Effluents

Factory effluents are regulated based on water quality standards and total volume regulations in Japan. Factories are required to record the water quality of the effluent and take emergency actions. Some factories have their own treatment facilities, while others are connected to sewage systems.

Figure 2.1 shows the Biochemical Oxygen Demand (BOD) loads[5] for 1970 and 1989. Over the past 20 years, the total BOD load decreased to approximately 20% of the level in 1970. The BOD load from the industrial sources decreased to approximately 7%. Factories reduced loads by improving production and wastewater treatment processes.

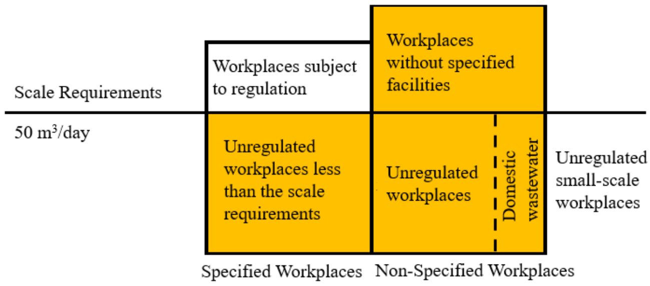


Source: Environmental Strategy of Water, Nakanishi Junko, Iwanami Publications

Figure 2.1 BOD Loading

[5] It is used as one of the indicators of water pollution.

In 1970, the Water Pollution Prevention Act was enacted, and ordinances were introduced by local governments to regulate the discharge of factory effluents into water bodies. Specified facilities with an average wastewater volume of 50 m³/day or more are subject to regulations under the Act (Figure 2.2). Specified workplaces include facilities that discharge (1) substances that may harm human health or the living environment or (2) sewage or liquid waste containing dioxins. The effluent standards and regulations for specified facilities are classified into the following categories:



Source: Project Research Team

Figure 2.2 Specified Factories Subject to the Water Pollution Prevention Act

- National minimum effluent standards: Nationwide uniform standards set by the national government
- Additional stricter standards by prefecture: In areas where national standards are insufficient to prevent water pollution, prefectural governments additionally establish more stringent standards in terms of the amount of effluent or expand the target of specified facilities[6].
- Standards for additional scope: For substances and industries that are not regulated by the Water Pollution Prevention Act, local governments establish ordinances setting standards for these substances and industries.
- Standards for total pollutant load: In areas where regulations are ordinarily not sufficient to achieve environmental standards, such as closed water bodies, standards for total pollutant load (Chemical Oxygen Demand (COD), nitrogen, and phosphorus) are applied to facilities. The regulation is executed based on the amount of load (concentration × water volume) and not the concentration.

The agreement for pollution prevention with companies became an important measure that complements regulation through acts and ordinance. In 1964, Yokohama City signed an agreement for pollution prevention with a company when the city sold reclaimed land in the coastal area. In 1969, 436 agreements were signed, and as of 2006, the number of effective agreements exceeded 32,000.

Factories discharging wastewater are required to measure their pollutant loads and record the measurement results. Local governments conduct on-site inspections several times per year in each factory. The purpose is to reaffirm that the workplaces were operated properly, complying with the regulations. Advance notice of on-site inspections is not issued.

After on-site inspection, the results are examined promptly. When a factory is at risk of not meeting the effluent standards, the local government instructs improvement measures. The local government repeats the on-site inspections to confirm whether the status has improved. Only a few improvement instructions

[6] When a prefecture, by ordinance, extends the applicable scope of facilities subject to regulation by the national government to smaller facilities (lowering the scale requirement presented in Figure 2.2).

are issued annually. When effluents do not satisfy the standards, the local government provides penalties regardless of whether the effluents are intentional or negligent.

In the case of a risk due to the discharge of hazardous substances from a specified factory, immediate emergency preventative measures are warranted and the prefectural governor must be promptly notified of the accident and measures. In the case of an accident, the following measures are required:

1. Emergency measures: To stop the outflow of the hazardous substance
2. Notification and communication: To notify the status of the accident and damage to and communicate with the relevant agencies
3. Investigation of environmental damage: To investigate damages, including downstream water bodies, and take the required measures
4. Post-accident measures: After emergency measures, investigations of the impact on downstream areas continue and permanent measures are prepared to prevent the recurrence of the accident

When pollution in water bodies intensifies due to abnormal droughts, the prefectural governor may take the necessary measures to reduce the volume of wastewater flowing into the water bodies.

Effluents from specified factories as well as those from factories connected to the sewerage system should satisfy the effluent standards. If the effluents from a factory exceed the standards, a facility must be installed to reduce pollutants within the limits.

(2) Agricultural Wastewater

When wastewater from rural areas flows into channels, water quality declines. Water quality can be improved by domestic wastewater treatment using rural sewerage systems and on-site wastewater treatment systems called Johkasou, which treats both black and gray water at household level. In addition, agricultural chemicals used on farmlands return to rivers and groundwater. Rainfall during flooding also causes pesticide run off. To ensure safety, only those pesticides registered under the act can be manufactured, imported, and sold. To prevent harm to humans, livestock, aquatic animals, and plants due to crop residues, soil residues, and water pollution, each pesticide is only registered after confirming that it does not exceed the relevant standards. Because indiscriminate and improper pesticide use can adversely affect living organisms and the environment, usage standards, such as the type of crops applicable, time of use, and use amount, are set. With regard to water pollution caused by pesticides, regulations based on legislation have set environmental standards and items requiring monitoring as well as criteria for withholding registration[7].

(3) Monitoring

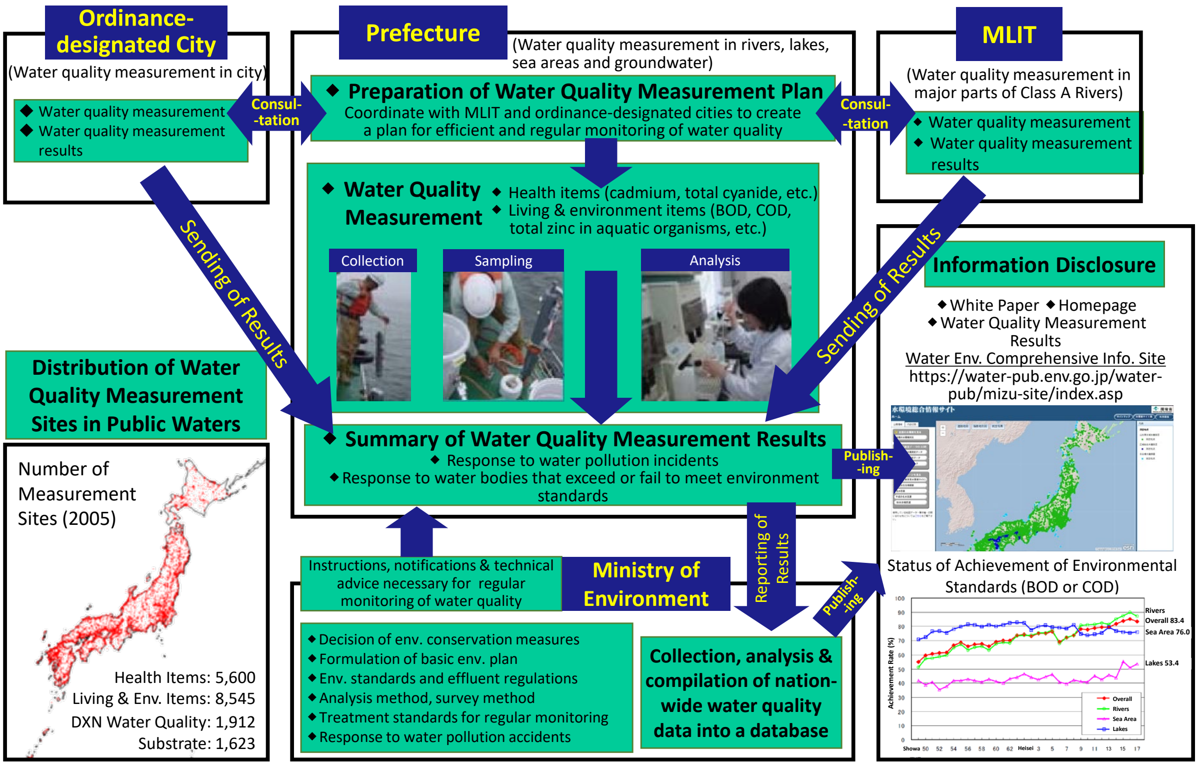
Water quality is monitored to ensure that effluents from sewerage treatment plants and factories comply with the standards. Monitoring the water environment is crucial for gathering data for planning and formulating policies, plans, and programs related to the water environment. The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) and the local governments monitor the water quality in

[7] Registration shall be withheld if the pesticide, when used by the general public in accordance with the description in the application form, causes water pollution in the public water bodies that is thought to be linked to the use of pesticides, and there is a risk of harming humans and livestock due to the use of this water (Criteria for withholding registration due to water pollution).

rivers and lakes. Guidelines were developed for monitoring rivers, dam reservoirs, and weirs. Prefectural governors can implement programs for flexible monitoring based on local conditions (Figure 2.3).

Rural sewerage systems report the amount and quality of wastewater to clarify the impact of agricultural activities on the environment. The National Institute for Agro-Environmental Sciences issued the "Agro-Environmental Monitoring Manual for the Conservation of Aquatic Environments." The agricultural sector has improved agricultural land management to address water pollution issues[8].

In 1971, the Act on the Improvement of Pollution Prevention Systems in Specific Factories was enacted. Companies with specified facilities under the act, including small- and medium-sized companies, must have the following staff: pollution prevention supervisors[9], pollution prevention managers, and chief pollution prevention managers. These companies have created a system to voluntarily engage in pollution prevention. Pollution prevention managers and chief pollution prevention managers should be qualified to pass national examinations.



Source: Japan's water environment Administration, September 2012, Ministry of the Environment

Figure 2.3 Regular Monitoring System

[8] The Ministry of Agriculture, Forestry and Fisheries (MAFF) has been implementing measures to help conserve agricultural land, water, and the environment since 2007.

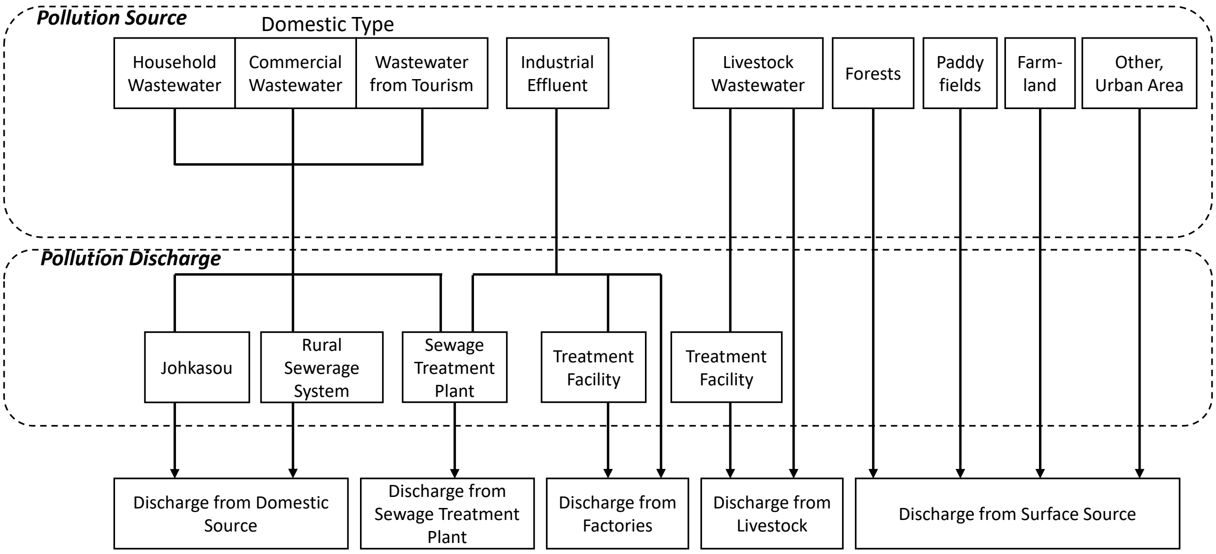
[9] The person who supervises and manages the business (plant manager, etc.). A person must be appointed if the company has 21 or more regular employees.

CHAPTER 3 SECURING CLEAN SURFACE WATER

3.1 Improving the Quality of Discharged Water

The quality of water discharged into water bodies must be improved. A combination of sewerage facilities and on-site facilities (e.g., Johkasou) can improve the quality for domestic wastewater.

Wastewater entering water bodies comprises domestic wastewater, factory effluents, and agricultural wastewater. The quality each type of wastewater must be improved. Figure 3.1 shows the sources of pollution and discharge points. Factory effluents and agricultural wastewater are explained in section 2.2, while domestic wastewater is explained in this section.



Source: Prepared based on Guidelines and Commentary on the Comprehensive Basin-wide Planning of Sewerage Systems, MLIT, 2015

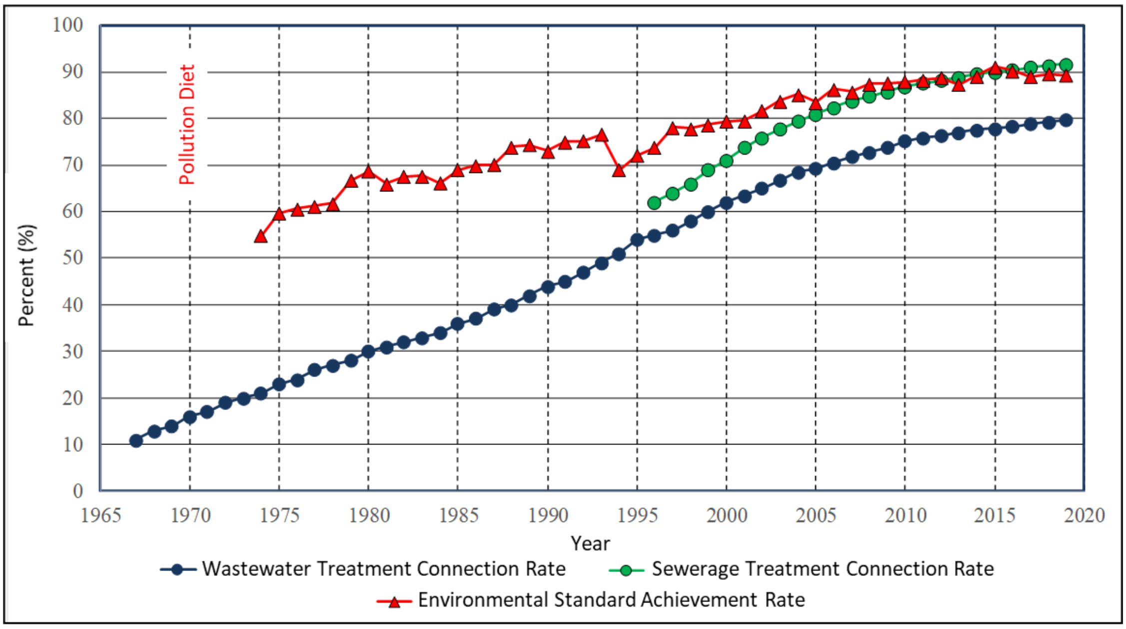
Figure 3.1 Sources of Pollution and Discharge Points

Domestic wastewater comprises black water from human waste and gray water from kitchens, baths, and laundry sources. Gray water comprises 70% domestic wastewater in the loading ratio and is one of the major causes of water pollution. As the BOD load of untreated and discharged gray water is considerable, a combination of Johkasou and sewerage systems is used for the conservation of water bodies.

(1) Treatment Methods for Domestic Wastewater in Japan

In Japan, sanitation facilities are under the jurisdiction of multiple authorities, resulting in complicated administration. Sewerage facilities are under the jurisdiction of the MLIT, rural sewerage systems for agriculture, forestry and fisheries communities are under the jurisdiction of MAFF, and Johkasou is under the jurisdiction of the Ministry of the Environment (MOE). The wastewater treatment coverage ratio[10] was 90.9% in 2017 (Figure 3.2). The following methods are used to treat domestic wastewater: (1) vault toilets (for black water); (2) Johkasou; (3) public sewerage systems; and (4) rural sewerage systems.

[10] An indicator of the prevalence of wastewater treatment facilities. It is calculated as the number of people who have access to sewerage and rural sewerage systems etc., plus the number of people who use Johkasou etc., divided by the total population.



Note: The wastewater treatment connection rate and sewerage treatment connection rate are from the MLIT's sewerage department, while the environmental standard achievement rate is from the MOE.
Municipalities that could not be surveyed due to the Great East Japan Earthquake were not included in the survey (2011: Iwate, Miyagi, and Fukushima prefectures; 2012: Iwate and Fukushima prefectures; 2013 and 2014: Fukushima Prefecture; 2015: 11 municipalities in Fukushima Prefecture; 2016: 10 municipalities in Fukushima Prefecture; 2017: 8 towns in Fukushima Prefecture; 2018: 7 towns in Fukushima Prefecture; 2019: 3 towns in Fukushima Prefecture.
Source: Promotion of Sewerage Development, MLIT, with additions and corrections

Figure 3.2 Changes in Wastewater Treatment Coverage Rate, Sewerage Treatment Coverage Rate, and Environmental Standard Achievement Rate

(2) Selection of Treatment Method

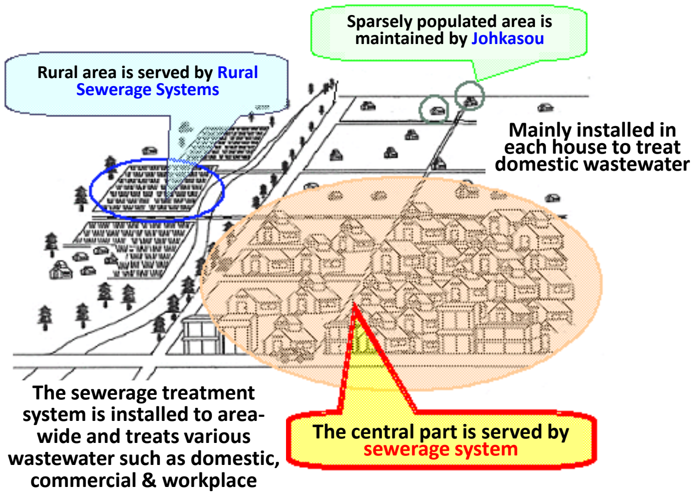
1) Comprehensive Basin-wide Plan of Sewerage Systems

Sewerage development is the most basic measure for water quality protection in water bodies. The Sewerage Act requires the formulation of a basic plan, the Comprehensive Basin-wide Plan of Sewerage Systems, which serves as an upper-level plan. Individual public and basin sewerage plans are formulated based on this plan. The Plan defines (1) the basic development policy; (2) the areas treated by sewerage systems; (3) the layout, structure, and capacity of facilities; (4) the priority of projects; and (5) the target amount and method of reducing nitrogen and phosphorus discharged from sewerage treatment plants in closed water bodies.

2) Selection of Treatment Method

Treatment methods are selected from an economic viewpoint. In urban areas, where the population is concentrated, collective treatment is more economical because the per-capita cost (total construction and maintenance costs) is lower. On-site treatment is more economical in sparsely populated areas (Figure 3.3).

Local governments formulate a development plan by zoning for each treatment method and estimate construction costs. The features of typical treatment facilities are listed in Table 3.1.



Source: MLIT Website

Figure 3.3 Treatment Facility Development

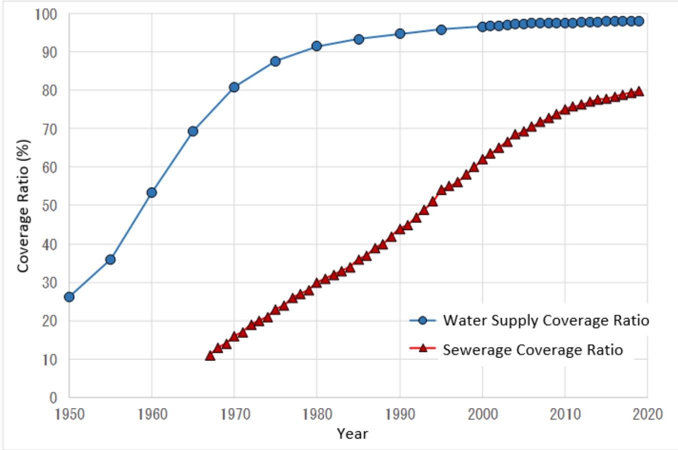
Table 3.1 Features of Typical Treatment Facilities

Item	Sewerage system	Rural sewerage system	Johkasou
1. Characteristic	Large-scale centralized collective treatment system Sewage is collected through a pipe and treated at the treatment plant	Small-scale decentralized treatment system ➢ Sewage is collected through a pipe culvert and treated	On-site treatment Wastewater is treated separately by installing treatment facility at each household site
2. Targeted wastewater	Wastewater from various citywide sources (domestic, school, business, and industrial sources)	Mainly domestic wastewater from agricultural communities	Mainly domestic wastewater from each household
3. Water quality protection effect	Stable treated water is maintained (by the local government)	Stable treated water is maintained (by the local government)	Installed and maintained by the local government or individual households
4. Economic efficiency	Economic in densely populated areas (i.e., urban areas), efficient due to economies of scale Long service life	Economic in densely populated villages, economics of scale work, resulting in high economic efficiency Long service life	More efficient than sewerage system, which require the installation of long pipe culverts in villages for scattered houses Short service life
5. Required period for development	Usually, ~5–20 years Due to the large scale of the project, the start of service is delayed	Usually, ~5–6 years It can be put into service relatively early	Usually, 1 week to 10 days Immediate effect of sewage treatment can be expected
6. Population treated	100,740,000	3,370,000	11,760,000

Notes: Population treated is data as of the end of 2008
Source: (1)–(5) obtained from the Ibaraki Prefecture website; (6) obtained from the MLIT website

(3) Sewerage System

In Japan, the sewerage treatment coverage ratio has increased by 70% over the 50 years since 1965 (Figure 3.4). In 2019, the coverage ratio was 79.7% (Figure 3.2). In the 1960s, while the water supply coverage ratio was approximately 70%, the sewage coverage ratio remained below 10%. Because river water quality deteriorated during high economic growth and the population was concentrated in urban areas, a large number of sewerage systems were constructed. Sewerage facilities include (1) pipelines to collect sewage and convey it to treatment plants; (2) treatment plants to process sewage; and (3) pumping station facilities to supplement pipelines and treatment facilities. Sewerage systems are also classified into public, river basin-wide, and urban sewerage systems.



Source: MLIT Website

Figure 3.4 Changes in Water Supply and Sewerage Treatment Coverage Ratio

- Public sewerage system: managed by the local governments of cities, towns, and villages to treat sewage in urban areas
- River basin-wide sewerage system: Managed by the prefectural government to receive and treat sewage from systems managed by multiple local governments
- Urban sewerage system: Sewerage systems managed by the local governments to drain sewage, mainly from rainwater.

(4) Johkasou

Johkasou is a unique system in Japan. The septic tanks used in developing countries only black water, whereas the Johkasou treats both black and gray water. They are used in rural areas, where houses are scattered sparsely. The coverage ratio of Johkasou was 9.3%[12] in 2018. Local governments or individual households install these systems. The anaerobic filter floor contact aeration method[13] is commonly adopted (Figure 3.5). Under the Johkasou Act, Johkasou must be maintained, cleaned, and inspected by contractors licensed by the local governments.

[12] MLIT Press Release Documents (August 23, 2019)

[13] After entering the anaerobic filter tank, the solids are removed and the organic matter is decomposed by anaerobic microorganisms on the surface of the filter media. The same process is repeated through another anaerobic filter layer, whereupon the water enters the contact aerobic tank. Here, the water is further treated by aerobic microorganisms while being agitated by air.

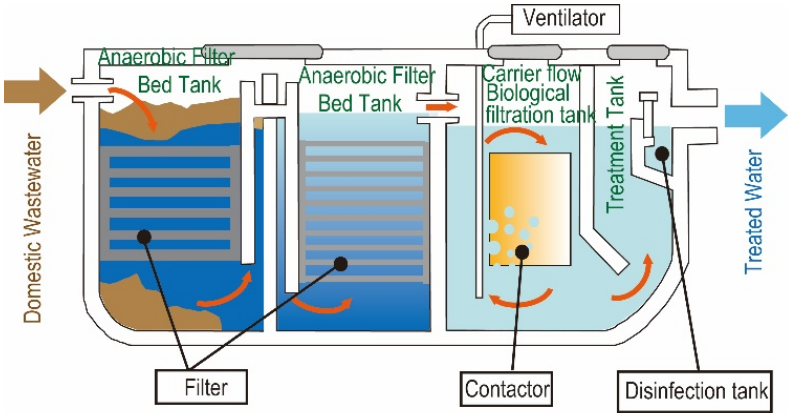
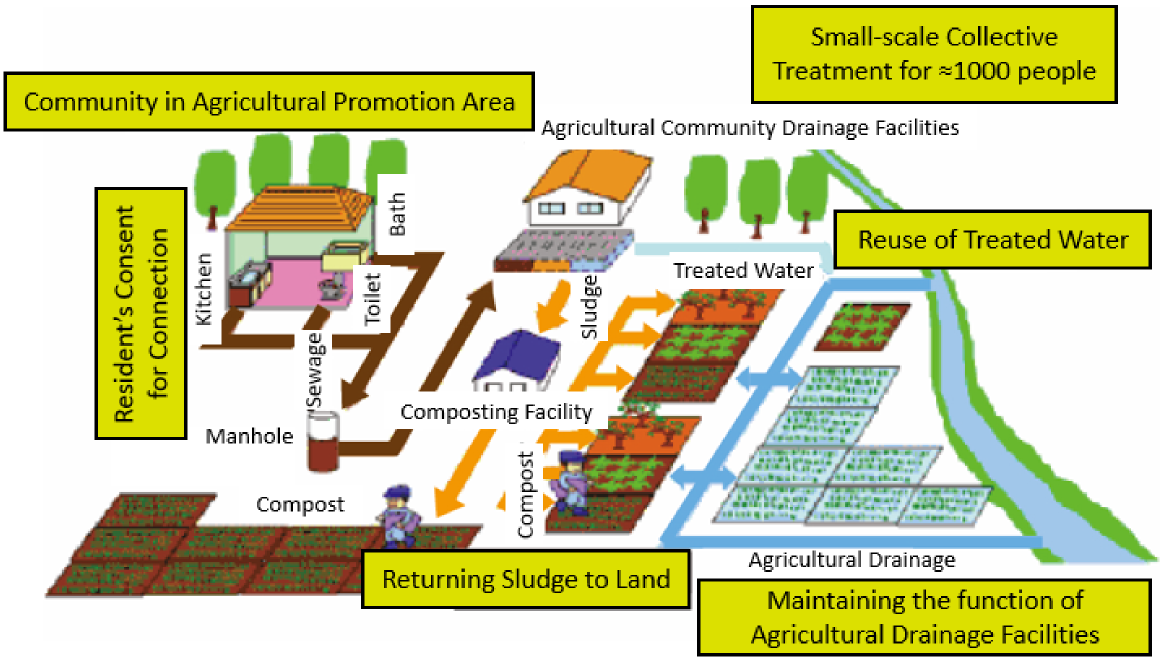


Figure 3.5 General Treatment Method in Johkasou

Note: Filter: Large chunks and water-soluble dirt are separated, and anaerobic microorganisms attached to the filter material decompose organic matter.
Contactor: Aerobic microorganisms attached to the contact material further decompose the organic matter in sewage.
Disinfection tank: *Escherichia coli* and other pathogens are eliminated with chemicals and treated with safe water.
Source: Website of Cleanup Federation in Wakayama Prefecture

(5) Rural Sewerage System

It is a small-scale decentralized treatment facility in rural areas (Figure 3.6). The target number of households is approximately 20 or more, and the capacity is approximately 1,000 people. Rural sewerage system prevent water pollution, allow for the reuse treated water for agricultural purposes, and enable the return of sludge to farmlands. Prefectures, municipalities, and agricultural irrigation area improvement and management associations (farmers' associations)[14] operate these facilities.



Source: Ministry of Agriculture, Forestry and Fisheries website

Figure 3.6 Rural Sewerage and Drainage Facilities

[14] For more information on agricultural irrigation area improvement and management association, Theme 1-2: Water Rights.

(6) Water Quality Monitoring

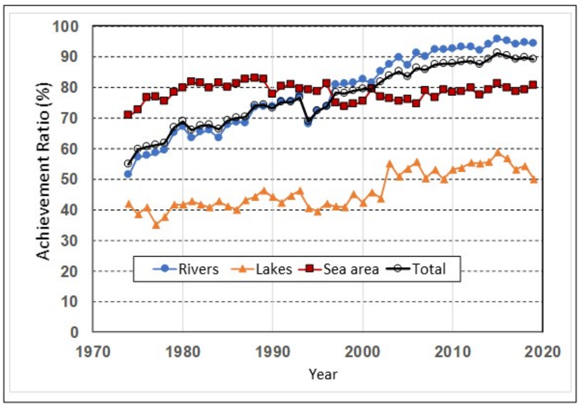
The Water Pollution Prevention Act requires sewage treatment plants to measure discharged water and record the results. For privately installed Johkasou, a designated inspection agency examines water quality once a year. The inspector gives the owner of the tank the inspection results with the classification of "appropriate," "acceptable," or "inappropriate"[15]. If the result is deemed "inappropriate," the owner takes actions for improvement with the guidance of specialists from public health centers. For Johkasou managed by the local governments, periodic inspections are conducted by designated agencies in accordance with the Johkasou Act.

3.2 Improvement of Water Quality in Closed Water Bodies

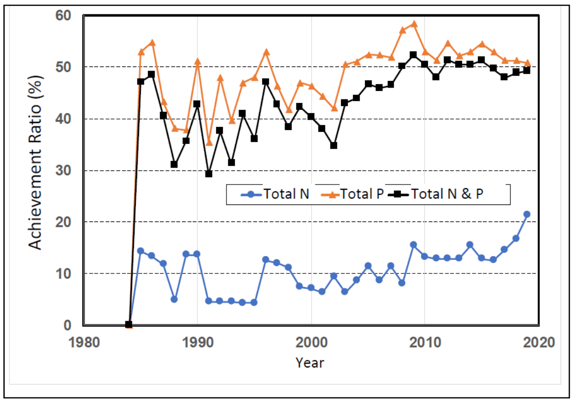
> It is difficult to improve the quality of closed water bodies, such as lakes, once it deteriorates. A long-term system should be established to regulate and improve the quality of inflowing water.

Lakes, marshes, inland bays, and land-locked seas are closed water bodies, with little exchange of water with open water areas. In these water bodies, inflowing pollutants can easily accumulate, hampering efforts to improve water quality. Population and industry are concentrated in areas of the Tokyo Bay, Ise Bay, and Seto Inland Sea, resulting in significant pollutant emissions. During high economic growth, the pollution load flowing into lakes increased with increased socioeconomic activities, resulting in eutrophic lakes, red tides, and other forms of water pollution. Water pollution further triggered various issues affecting the use of water bodies, such as water supply problems (malodor and bad taste), damage to fisheries, and decreased tourism value. Many lakes and marshes were found to be considerably more polluted than the water quality environmental standards.

In 1984, the Act on Special Measures Concerning Conservation of Lake Water Quality (the Lakes and Marshes Act) was enacted, which contributed to the improvement of water quality in closed water bodies. However, the rate of achievement of environmental standards (COD, nitrogen, and phosphorus) for closed water bodies remained lower than that for rivers (Figure 3.7).



Trends of the achievement rate of environmental standards (BOD or COD)



Trends of the achievement rate of environmental standards (total nitrogen and total phosphorus) for lakes

Source: 2019 Water Quality Measurements of Public Waters, Ministry of the Environment

Figure 3.7 Status of Environmental Standard Achievement

[15] When making a judgement, the results of visual inspection, water quality inspection, and document inspection are comprehensively evaluated.

The Act on Special Measures Concerning Conservation of Lake Water Quality was enacted to improve the water quality of lakes and marshes. Eleven lakes and marshes were specifically designated, whereupon prefectures formulated lake and marsh water quality conservation plans and runoff water improvement promotion plans (5-year plans). The plans indicated a long-term vision and goals to be achieved, providing a period for achieving the goals and quantitative indicators. These plans are shared among stakeholders. Thus, local communities should be involved in the implementation process. Based on these plans, projects to conserve water quality were implemented, and regulations were enforced to reduce the pollution load. The measures cover (a) projects to reduce pollution load, such as sewerage systems and Johkasou, and (b) dredging of sediment, aeration, diversion of water.
There are two types of pollution sources: (a) point source loads, such as wastewater from households, factories, and offices, for which the point and amount of discharge can be identified, and (b) non-point source loads, such as wastewater from paved roads in urban areas and agricultural fields, for which the point of discharge is difficult to identify. In the data for Kasumigaura and Lake Inba, the ratio of point source load to non-point (area) source load was 1:1 (in 2000).

Landowners (farmers, road managers, and sewerage managers) in agricultural and urban areas have implemented measures to improve water pollution. Measures to improve point source loads include the construction of sewage systems and Johkasou. Measures to improve non-point source loads included the following (Table 3.2):

(a) Measures for load sources: to handle loads generated by human activities in urban areas, farmlands, and forests.

(b) Measures for discharged load: to reduce the generated load by controlling rainwater runoff and purifying discharged water.

(c) Measures at the water area to be conserved: to prevent effluent loads from reaching the target water bodies (designated lakes and marshes) through rivers.

Table 3.2 Non-point Source Improvement Countermeasures

<table>
<tr><th>Classification</th><th>Measures for load sources</th><th>Measures for discharged load</th><th>Measures for water areas to be conserved</th></tr>
<tr><td>Urban areas</td><td>• Rainwater pit
• Pipe cleaning
• Road surface cleaning
• Prevention of garbage dumping
• Tree management</td><td>• Rainwater infiltration pit
• Underground infiltration of rainwater through trenches
• Rainwater storage ponds
• Storage facilities in each house
• Water purification plants
• Reduction of overflow water in sewerage</td><td rowspan="3">Measures for rivers
• Installation of water purification plants
• Installation of gravel-contained basin for water purification
• Installation of thin-gravel-layer in the channels for water purification
• Establishment of retarding basins
• Dredging of river channels
• Maintenance of riparian forests
• Conservation and regeneration of wetlands/lagoons
• Use of ponds</td></tr>
<tr><td>Agricultural land</td><td>• Proper application amount of fertilizer
• Improvement of fertilizer application methods
• Fertilizers and related materials
• Crop rotation for vegetables
• No-till farming
• Rice planting</td><td>• Reuse of irrigation water
• Water treatment using irrigation ponds
• Dredging of agricultural drainage channels
• Improvement of agricultural drainage channels (water purification plants)
• Prevention of water leakage from rice fields
• Improvement of irrigation water management
• Soil surface covering
• Windbreak measures
• Use of adsorption characteristics for denitrification and dephosphorization, etc.</td></tr>
<tr><td>Forests</td><td>• Prevention of illegal garbage dumping</td><td>• Sand settling ponds, turbidity control works, slit type dams, etc.
• Driftwood prevention and removal facilities
• Management of forests (promotion of thinning,)
• Maintenance of riparian forests</td></tr>
<tr><td>Others</td><td colspan="3">• Appropriate use of land
• Appropriate use of livestock manure
• Measures against load on golf courses and in tourist facilities
• Promotion of initiatives by residents</td></tr>
</table>

Source: Basic concept of measures in the basin for lake water quality: Measures for loading from non-specific pollution sources; MLIT, MAFF, and MOE, March 2006.

CHAPTER 4 FINANCIAL RESOURCES FOR MEASURES AGAINST WATER POLLUTION

Local governments use subsidies of the national government and private funds to operate sewerage systems. Polluters should bear their cost share for measures against water pollution based on the polluter-pays principle.

4.1 Financial Resources

(1) Cost-sharing

Public sewerage works are considered financially independent, publicly owned companies. Sewerage usage fees cover expenses. As a general rule, expenses are divided into rainwater drainage expenses borne by the public and sewage treatment expenses borne by the users.

Table 4.1 summarizes the allocation of construction costs for sewerage systems. Part of the construction cost is covered by local government bonds, which are repaid during the operation period. The users pay principle is adopted because sewerage improves the user's living condition environmentally, is convenient, and increases the asset values of the land. The sewerage uses pay a certain amount, such as the pipe construction cost. National and local governments subsidize the installation of Johkasou. Factories construct wastewater treatment facilities. Some local governments provide subsidies.

Table 4.1 Allocation of Construction Costs

Type	Construction costs
Public sewerage	Government funds (grants: 1/2 rate for major pipes and 1/2 or 5.5/10 rate for treatment plants) Local Funds: Local government bonds (appropriation rate = 100%) : Contribution from users : Prefectural subsidies
River basin sewerage	Government funds (grants: ½ rate for major pipes and 1/2 or 2/3 rate for treatment plants) Local funds: Local government bonds (for subsidies, appropriation rate = 60%; for local government finance, appropriation rate = 90%) : Local government cost: Local government bonds (for subsidies, appropriation rate = 60%; for local government finance, appropriation rate = 90%) General account transfers (cities, towns, villages) General account transfers (prefectures)

Source: Overview of Sewerage System Finances, MLIT

In accordance with the principle of public expenditure on rainwater drainage and user expenditure on sewerage treatment, public funds (general account transfers) cover the costs of draining and treating rainwater and private funds (sewerage use fees) cover the costs of sewerage. Sewerage usage fees account for approximately 50% of the ordinary revenue of public sewerage services, with a cost recovery rate[17] of approximately 90%. For public sewerage systems in areas with a low population density, this rate is as low as 77%. The fees are revised at intervals of 9 years on average, most often with a revision rate of 5–10%, followed by 10–15% and <5%[18].

[17] The cost recovery rate is the percentage of necessary sewage treatment cost covered by the user fee revenue.
[18] Ordinary revenues are based on 2008 financial results, and the cost recovery rate and revision rate of user fees are based on the 2008 Survey on the Status of Settlement of Accounts of Local Public Corporations.

Many local governments collect sewerage fees using water supply fees. They comprise a basic use fee as a fixed amount and a metered use fee commensurate with the amount of sewage discharged into the sewer. The amount of sewage used for the metered use fee is equivalent to the amount of tap water used. This system is advantageous for the residents because of a single point of contact for payment and a single procedure for starting and stopping the use of the system. Local governments can also save the cost of administration by consolidating procedures.

The financial situation is severe in the sewerage sector due to reduced revenue from users caused by the shrinking population and increased investment cost for renewal required due to aging facilities. Publicly owned companies for sewerage services should improve their financial management ability by introducing accounting standards for private companies, accurately determining the status of assets, and implementing flexible management.

(2) Efforts to Connect Each House to the Sewerage System

Some households are not connected to the system, even though the act requires households to be connected to the public sewerage system within 3 years. In rural areas, the coverage rate remains unchanged, mainly for economic reasons and due to the lack of environmental awareness. Various efforts are underway, including the following:

(a) Subsidies, grants, and other programs by the local governments
(b) Dissemination activities through the sewerage service support staff
(c) Raising awareness of residents through door-to-door visits
(d) Promotion of flush toilets through publicity campaigns
(e) Sewerage saving with incentives

4.2 Polluter Pays Principle

Countries where the government bears the cost of prevention of environmental pollution may be at a competitive advantage for business compared with those where the cost of pollution prevention is borne by businesses. In May 1972, the Organization for Economic Co-operation and Development (OECD) Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies was introduced to prevent such inequities in international business competition.

In Japan, the Basic Environment Act stipulates those polluters appropriately bear the relevant costs. The polluter pays principle is the basis of the compensation method for health damage and cost-sharing for pollution prevention projects. The private sector must invest in water pollution prevention measures. Almost all such facilities were constructed between the 1970s and the early 1980s, thanks to loans from governmental financial institutions.

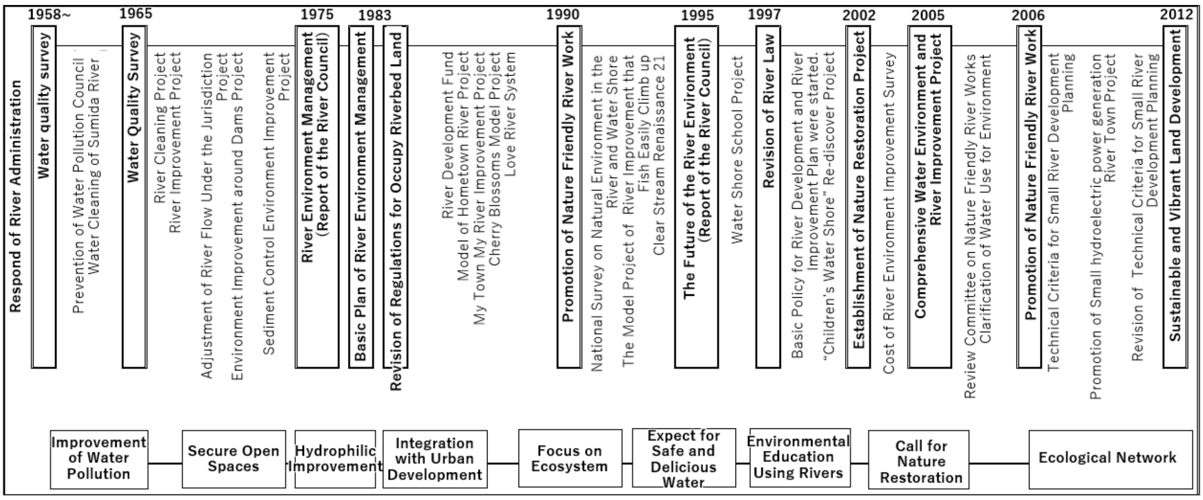
CHAPTER 5 RIVER ENVIRONMENTAL MANAGEMENT

5.1 Trends of River Environment Improvement

> River improvement projects should be in harmony with the nature by minimizing negative environmental impacts and creating rich environment.

In the 1990s, as a reaction to conventional river improvement using concrete, the government promoted "nature-friendly river work" to preserve and create a habitat for the growth and breeding of aquatic organisms and diverse landscapes inherent to rivers, taking into account the natural processes of the entire river and harmony with the lifestyle of local people and their history and culture (Figure 5.1). In 1997, the River Law was revised to include the objectives of river improvement and management (Figure 5.2) (Theme 1-1: Legislation and Organization). It responds to public needs by improving and conserving the river environment.

To gain a comprehensive understanding of the river environment, river management offices (RMOs) survey water and terrestrial ecosystems, conditions of diverse river flows, nature of riparian areas, and people's utilization of the river space. The surveyed data are used for river improvement, including the formulation of relevant plans. Since 1990, dams and rivers managed by the MLIT and Japan Water Agency have regularly been surveyed for the river environment once every 5 years as part of the National Survey on Natural Environment in the River and Water Shore. Eight items are investigated, including six biological surveys (fish and shellfish, benthic animals, plants, birds, amphibians, reptiles, mammals, and terrestrial insects), a river environment base map survey (condition of the river flow type, such as rapids, pools, and riparian channels), and a river space utilization survey (users of the river space). The survey results are compiled in a database (Figure 5.3).

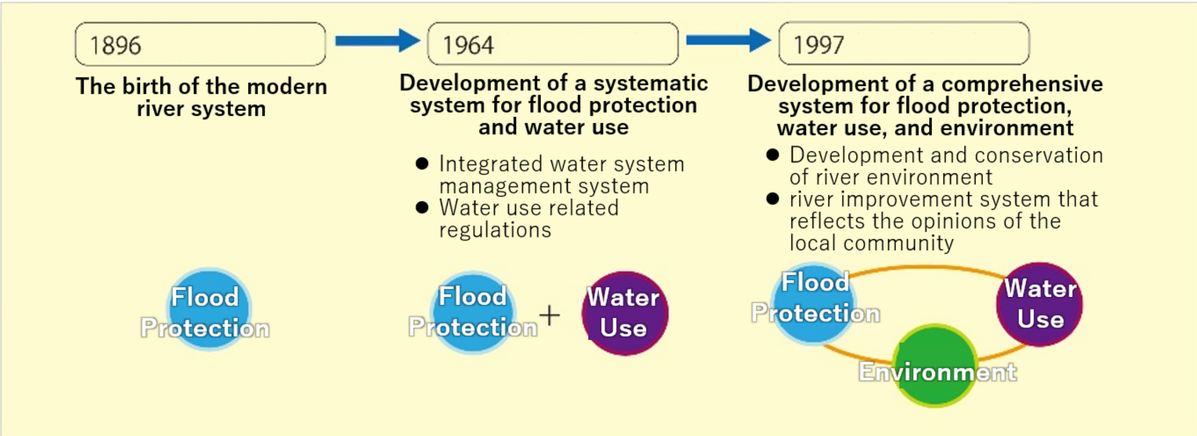


Source: Current status of efforts to develop and preserve the river environment, MLIT, April 13, 2007

Figure 5.1 History of Effort to Improve the River Environment

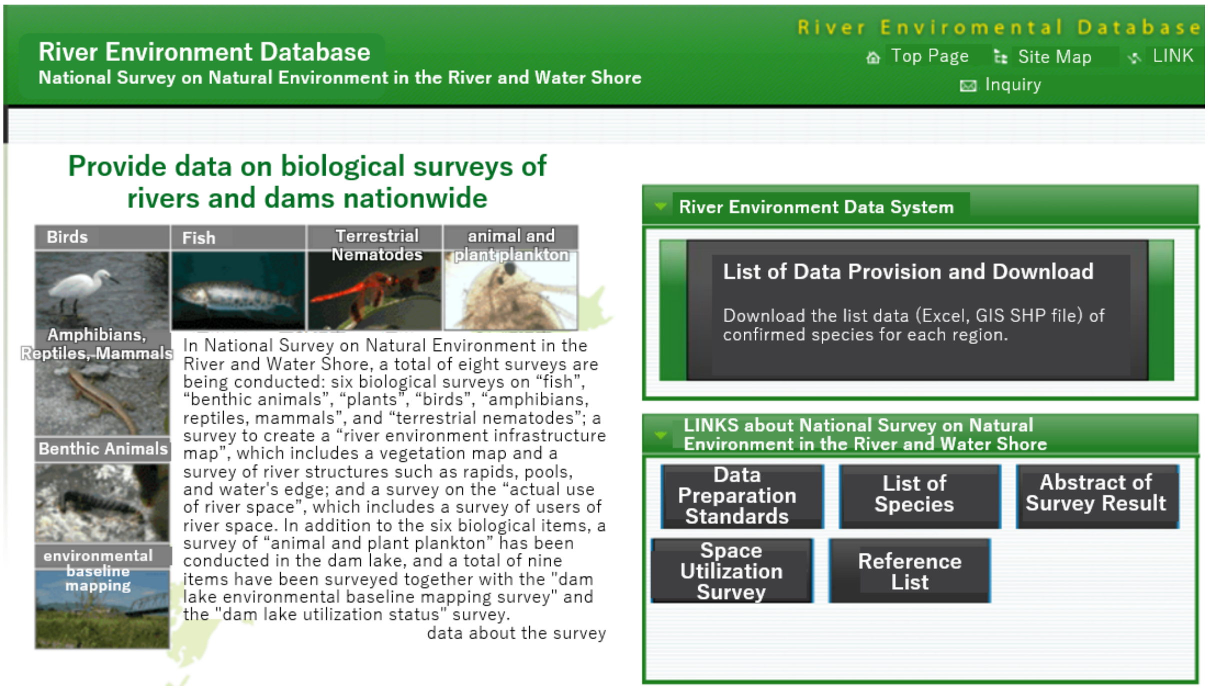
According to the 2002 Act for the Promotion of Nature Restoration, nature restoration involves the conservation, regeneration, creation, or maintenance of the natural environment through the participation of various local actors, including administrative agencies, local governments, non-profit organizations (NPOs), and experts, aiming to actively restore natural damage.

Regarding people's participation in river management, in 2013, the River Law was amended to establish the "River Cooperation Organization System" for supporting NPOs and other civil society organizations engaged in river maintenance and river environment conservation. These civil society organizations clean up rivers, conduct surveys, and disseminate information. Such efforts taking the environment into account have led to recent activities related to green infrastructure development.



Source: New developments in river environment administration, MLIT

Figure 5.2 History of the River Law Amendment



Source: MLIT National Institute for Land and Infrastructure Management website

Figure 5.3 River Environment Database

5.2 Plan to Manage the River Environment

> The river environment is maintained following a management plan prepared with the involvement of local residents, experts, and related organizations.

To implement comprehensive measures to conserve and create river environments, the Basic Plan of River Environment Management (now renamed the River Environment Management Plan) has been formulated since 1983. Although this plan is not legally enforceable, it has been applied to many rivers and systems. The plan mainly stipulates the following: basic concept, monitoring, river facility management, and implementation plan of projects.

As a case study, the Tama River Environmental Management Plan is described here. The conservation plan for the Tama River was incorporated in the River Improvement Plan. The plan is built upon two pillars—"space management" and "water surface management plan"—to promote people engagement in various activities and preservation of the nature.

(1) Space Management: Within the river area, each part of the high water channel is categorized into eight functional space designations using five types of zones as follows (Figure 5.4):

A. Development Improvement Zone
Developments such as sports facilities and recreational facilities will be actively provided.
B. Facility Utilization Zone
A zone primarily for development, but also for educational facilities.
C. Improvement and Nature Zone
A zone used half for development and half for nature-oriented purposes.
D. Nature Utilization Zone
A zone primarily for nature-oriented facilities, but with some development also included.
E. Nature Preservation Zone
A zone for preserving natural ecosystems. Facilities for active use by humans will not, in principle, be constructed.

Source: Guidebook to the Plan to Manage the Natural Environment of the Tama River, MLIT, March 2002

Figure 5.4 Five Zones and Eight Functional Space Designations for the Tama River

(2) Water Surface Management plan: The downstream area is used for wide-ranging purposes, such as boat and water recreation (e.g., rowing and fishing). Guidelines for harmonious and well-organized use are established. The river area is divided into water surface and waterside

zones considering the functional space designated in the management plan to show desirable water surface use (Figure 5.5).

Source: Guidebook to the Plan to Manage the Natural Environment of the Tama River, MLIT, March 2002

Figure 5.5 Waterside Spaces

5.3 Management of River Water Quality

To maintain the normal function of a river, the water quality must be improved and the river environment must be restored and maintained.

RMOs work with the environmental and sewerage sections to realize water quality management. One of the objectives of the River Law (enacted in 1964) is to maintain the "normal function of river water," which has the following four main meanings:

- Maintaining and improving water quality by diluting or purifying wastewater and preventing saltwater intrusion
- Maintaining river channels and preventing the blockage of the river mouth
- Maintaining the water level for water intake and navigation
- Maintaining the growth and breeding of aquatic animals and plants

The following water purification methods are used:

1) Purification using gravel: Gravel (stones) is used as a contact material in the septic tank. When polluted water is slowly poured onto the gravel layer, microorganisms on the surface of the gravel absorb pollutants and decompose them, resulting in water purification.

2) Purification using rapids and pools: This reproduces the "rapids" and "pools" of the river's inherent "self-cleaning" functions. The river flow is slow in pools, wherein pollutants are settled and decomposed. The rapids provide oxygen and filtration through sand and gravel.

3) Thin laminar flow purification method: The riverbed is lined with gravel as the contact material, and water is spread widely and thinly for greater exposure to the contact material. The turbulence of water flow caused by the contact of water with gravel and the supply of oxygen at the water

drop in the weir located upstream are also important for purification. Microorganisms on the gravel surface adsorb and decompose pollutants.

4) Vegetation purification method: Reed beds produce a natural purification effect. The reeds serve as a habitat and a rich environment for the growth of aquatic organisms and plants.

Under the River Law, activities that may affect the cleanliness of water are regulated, such as the following:

- Sewage discharge exceeding the volume of 50 m^3/day,
- Actions should be taken in the case of emergencies when the river becomes extremely polluted due to abnormal droughts.

Sumida River Water Quality Improvement

Sumida is a 23.5-km-long river with the basin area of 690.3 km^2, which splits off from the Arakawa River in Iwabuchi (Kita Ward, Tokyo) and joins the Shingashi, Shakujii, and Kanda rivers and many other tributaries to flow north–south through the eastern lowlands of Tokyo. Previously, the Sumida River was clean, in which Japanese icefish inhabited and people could play. In 1940, chemical plants and dyeing factories began to populate the river, with BOD dropping to as low as 10 mg/L[21] at the Senju Bridge and 5 mg/L at the Ryogoku Bridge. By 1952, the river became so polluted that fish could no longer thrive. Toxic gases and malodors were generated and people living nearby constantly experienced mild coughing, red eyes, loss of appetite, and headaches.

Efforts based on legislation and sewerage system improved water quality. In response to an extreme drought in 1964, a pipeline was constructed from the Tone River via the Arakawa River for water supply. This surplus water was used for dilution to purify the Sumida River. Due to accumulated pollutants at the river bottom, flood protection and navigation were hindered; thus, dredging was started in 1958 and continues to this day.

Source: Ministry of the Environment Chapter 21: Sumida River
Arakawa River System Sumida River Basin River Improvement Plan, Tokyo Metropolitan Government, June 2016

5.4 Efforts to Improve Water Quality in Urban Rivers

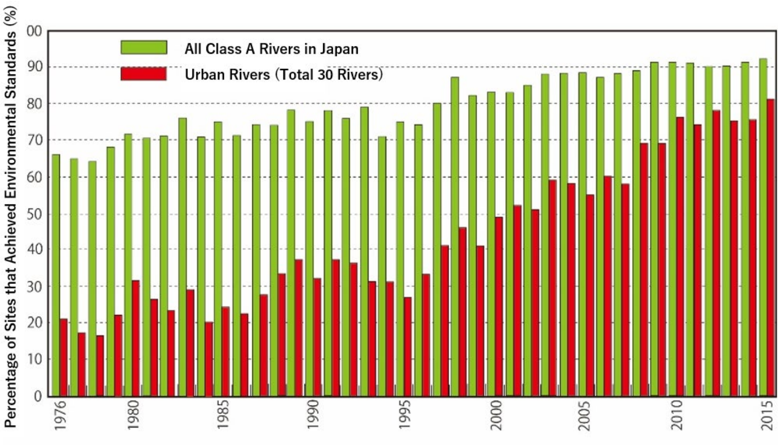
Various stakeholders and residents should be involved in improving the water environment.

In 2015, nearly 90% of Class A rivers and 80% of urban rivers in Japan satisfied the environmental standards (BOD), compared with only around 30% in 1995. As an action plan to improve the water quality of urban rivers, the "Clear Stream Renaissance 21" has been implemented since 1993, followed by the "Clear Stream Renaissance 2" in 2001. As a result, water quality improved (Figure 5.6).

Under the Clean Stream Renaissance 21 and 2, local governments, RMOs, sewerage offices, and related organizations formed a council to set water quality improvement goals and implement environment

[21] At a BOD of 10 mg/L or higher, the oxygen in the river is consumed and disorders associated with anaerobic decomposition, such as malodors, begin to emerge. In a source of water supply, when the BOD exceeds 3 mg/L, it is said to be difficult to treat with general water purification methods.

improvement projects with the agreement of all parties involved. Water quality improvement targets were set according to the conditions of each river. For instance, in the case of the Kimotsuki River in Kagoshima Prefecture, targets were set to "create an environment where children can play safely and happily and where they can easily become familiar with the river."



Source: MLIT Website

Figure 5.6 Percentage of Sites that Achieved Environmental Standards for Class A and Urban Rivers Nationwide

Water Quality Improvement in Ayase River (Tokyo, Saitama)

Until the latter half of the 1950s, the Ayase River had a clear flow where people could play in the water. However, with the development of the riparian areas, it gradually became dirtier, and since 1980, it was the dirtiest river in Japan for 15 consecutive years. To restore the river, mayors of cities along the river, the Tokyo Metropolitan Government, Saitama Prefecture, and the MLIT worked to improve the sewerage systems and purification facilities, involving the local community in the activities. The water quality of the Ayase River gradually improved. In 2000, the river was no longer the dirtiest in Japan (Figure 5.7).

Note: Provided by the Soka City Environment Division to the Edogawa River Construction Office website [foaming water believed to be domestic wastewater (laundry water) from a waterway flowing into the Ayase River]

Ayase River in 1973

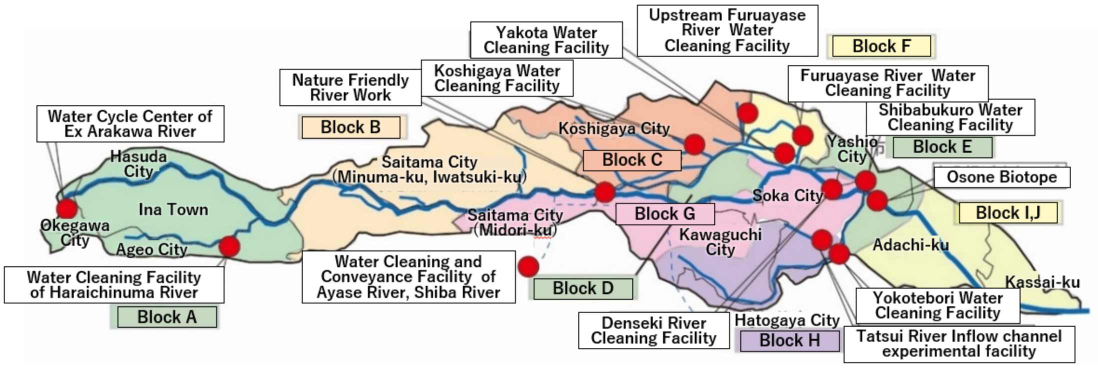
CCTV Camera Image
Yanaginomiya Area, Yashio City, Saitama

Ayase River in 2021

Source: MLIT Edogawa River Office website

Figure 5.7 Past and Present Condition of the Ayase River

The local community set a standard called the Citizen's Environmental Standard to demonstrate the efforts (Figure 5.9) put in by the residents for improving water quality. It includes "transparency," "odor and water color," "garbage," "habitat and growth of organisms (fish, benthic animals, aquatic plants, etc.)," "use of the waterfront," and "waterfront scenery." The local council decided to use an evaluation method, which involves local peoples as the "Water Environment Surveyors" and a questionnaire survey. The basin was divided into 10 blocks to improve water quality. Figure 5.8 presents the blocks and examples of the measures employed.



Sources: Based on MLIT Edogawa River Office Website, Ayase River Seiryu Renaissance II Annual Report 2011, Ayase River Seiryu Renaissance II Regional Council, November 2011

Figure 5.8 Examples of Countermeasures by Blocks in the Ayase River Basin

Junior high school students conducting water quality surveys (Ina Town)

Cleanup of the Ayase River basin by residents and government (Saitama City)

A lecture on what you can do for the river (Yashio City)

Ayase River Water Quality Survey by everyone (a simplified water quality survey) (Adachi Ward)

Source: Edogawa River Office website

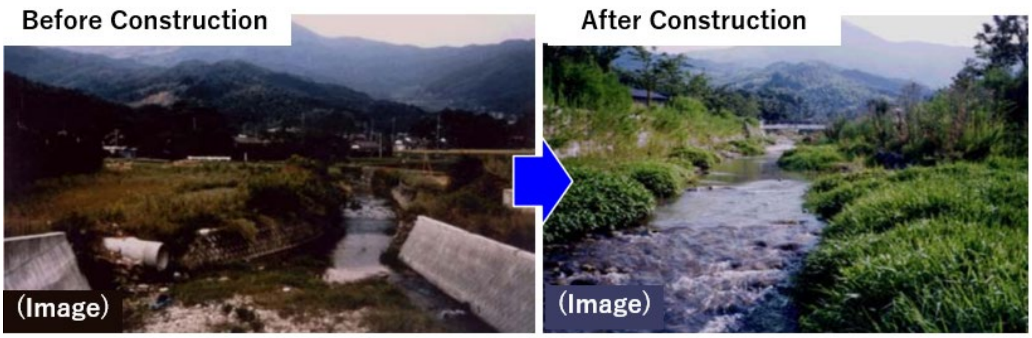
Figure 5.9 Examples of Collaboration and Education with Local Residents Along the Ayase River

5.5 Nature-friendly River Works

The extensive use of concrete in river improvement results in the loss of the river environment. Improvement measures must allow the geomorphological processes of river, such as erosion and sedimentation.

In Japan, nature-friendly river improvements create rivers in harmony with the natural environment. The main objective is to allow natural processes, such as erosion and sedimentation, and natural changes in the river form. Many flood protection and water management facilities were constructed with gray materials of iron and concrete during the post-war reconstruction and high economic growth. However, opinions on the need to preserve and restore the natural environments have been increasing.

The Ministry of Construction (now MLIT) launched the "Nature-Friendly River Works" Initiative in 1990. At that time, the measures preserved and restored the waterfront area, such as riverbank protection using natural materials, such as stones, trees, and porous concrete, on which plants could grow. After nearly 15 years of trial, the "nature-friendly river works" became a common and inevitable method of river improvement (Figure 5.10). The MLIT formulated the "Basic Guidelines for Creating Nature-friendly Rivers" in 2006 and the "Technical Standards for River Channel Planning for Small and Medium Rivers" in 2008.



Source: MLIT Website

Figure 5.10 Nature-friendly River Works (Before and After Construction)

Conventional construction methods that use local materials are recognized as nature-friendly. These techniques blend in with the surrounding natural conditions and are highly adaptable to the waterfront topography. The methods include (1) water control works, such as "Seigyu" to control water flow,; (2) submerged fascine mattresses to protect river banks; (3) riparian forests to mitigate flooding; and (4) weirs used for irrigation water intake (Figures 5.11 and 5.12). Submerged fascine mattresses have been used in the Shinano, Abukuma, and Agano rivers in Japan and in the Mekong River in Laos. Moreover, in Afghanistan, Dr. Nakamura constructed an irrigation intake weir using stones modeled on the Yamada weir in Kyushu (Figure 5.12).

Source: Kofu Rivers and National Highways Office website

Seigyu (Water control works): A pyramidal structure of pile-like members installed in places where driving piles into the riverbed is difficult due to gravel or stones. To prevent the works from flowing away, a gabion is used as a weight.

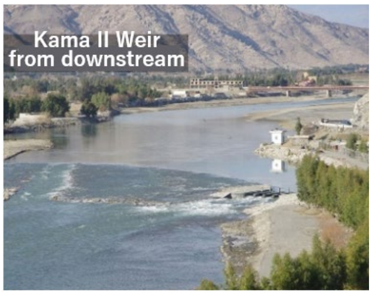
Source: Shinano River Downstream Office website

Fascine mattress (riverbed and riverbank erosion control):
Bunches of fascine are arranged in a grid pattern to form a large mat, which is then filled with stones and gravels, and sunk to the riverbed.

Source: Hokkaido Development Bureau website

Riparian forest: Forests reduce the force of floodwater flow and inundation currents, prevent embankment breaches, and mitigate flood damage.

Figure 5.11 Conventional Construction Methods



Kama II Weir (Afghanistan)

Yamada Weir (Japan)

Note: Weirs are designed to take water and have been constructed since ancient times. Some are made of wood, while others of masonry.
A weir was constructed in Afghanistan based on the Yamada weir, which has been used as an irrigation weir in Japan since the Edo period.
Source: Peshawar Association website, Asakura City website

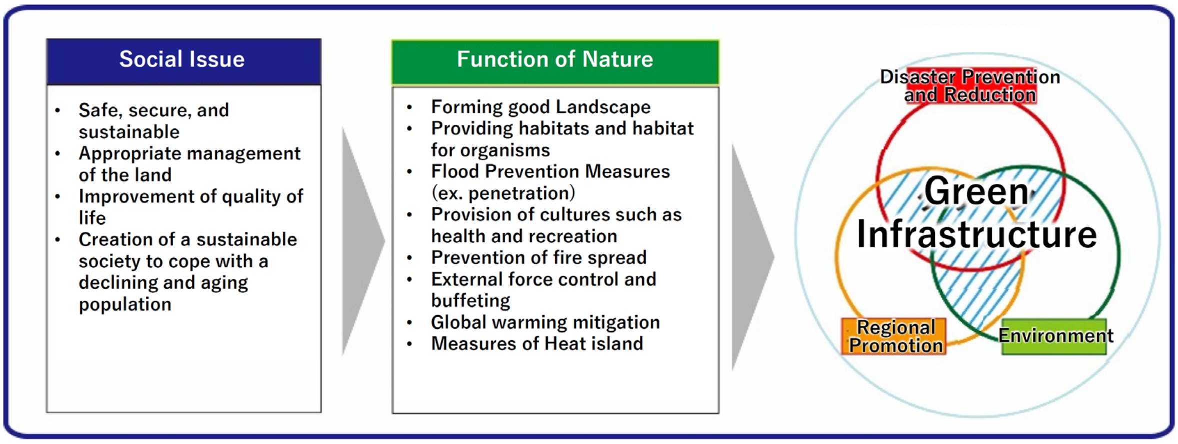
Figure 5.12 Conventional Weir

5.6 Green Infrastructure Initiatives

> Green infrastructure is expected to produce various effects, such as disaster management, environmental improvement, and regions' attractiveness.

Japan used green infrastructure to protect tsunamis as recovery works from the Great East Japan Earthquake in 2011. The government organizations developed tsunami barriers with an afforestation program. The term "green infrastructure" was used in the National Land Formation Plan in 2015, which utilizes the diverse functions of the natural environment (Figure 5.13). To promote green infrastructure initiatives, a platform has been established with members of relevant government ministries and agencies, local governments, the private sector, and academic parties. These initiatives contribute to building a carbon-neutral society while simultaneously solving various issues.

In the Maruyama River, an ecological network was formed in cooperation with the local community by restoring wetlands, which were used by storks as feeding grounds. The related activities included the production of brand-name rice (named "storks harvest"), environmental education at elementary schools, and other local developmental activities (Figure 5.14). The efforts in the Maruyama River are in line with the sustainable development goal (SDG) targets 2, 4, 6, 11, 13, 15, and 17. There are also examples of local governments using crowdfunding and hometown tax payment systems to promote green infrastructure. Additionally, ESG investments and green bonds have been used (Theme 5: Urban Water Management).



Source: Green Infrastructure Portal Site, MLIT

Figure 5.13 Green Infrastructure

Wetlands revived in the Kayo area

Ecological survey with children in Kayo District

Storks feeding in the wetlands of Hinoso Island

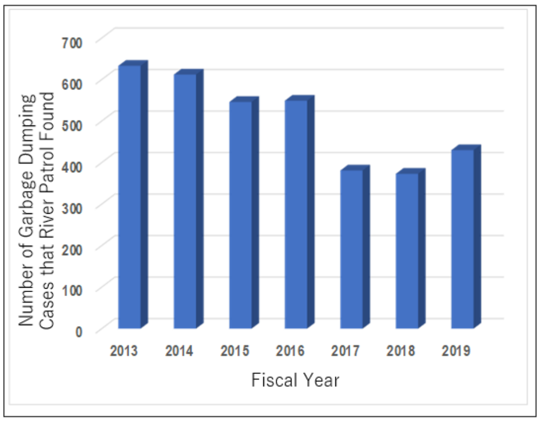
Source: MLIT Kinki Regional Development Bureau Toyooka River National Highway Office Website

Figure 5.14 Efforts in the Maruyama River

5.7 Measures Against Illegal Waste Dumping

Illegal dumping of garbage degrades the river environment. Thus, countries should employ appropriate measures to stop illegal dumping. In Japan, penalties for illegal dumping were enacted.

In developing countries, there are many cases of illegal dumping, not only in riverine areas but also in rivers. One cause of illegal dumping is the lack of a well-functioning waste collection and disposal system.



Source: Created based on the Arakawa-Karyu River Office website

Figure 5.15 Trends of the Number of Garbage Dumping Cases in the Lower Reaches of the Arakawa River

In Japan, garbage collection and disposal work as a system; however, there are cases of illegal garbage dumping into rivers. Under the River Law, the penalty for illegal dumping is "imprisonment not exceeding 3 months or a fine not exceeding 200,000 yen" and under the Waste Management and Public Cleansing Act, "imprisonment not exceeding 5 years or a fine not exceeding 10 million yen." RMOs work with NPOs and local communities to conduct "trash pickup" activities, detect trash early, and respond to illegal trash dumping during daily river patrols. These efforts include reporting illegal dumping to the police and public relations. According to the Arakawa-Karyu River Office (Figure 5.15), there are approximately 400 dumping cases per year. As for the types of garbage, household garbage, oversized garbage, and vehicle dumping, such as bicycles and motorcycles, account for 80% of the total.

CHAPTER 6 LESSONS LEARNED

(1) **Establishing a legal system and enforcement mechanisms can regulate adverse environmental effects.** Water pollution affects human health and lives and may destroy ecosystems and the environment. In Japan, government policies prioritizing economic growth resulted in the emergence and spread of disastrous pollution-related diseases. During the high economic growth, water pollution caused by effluents from factories led to the outbreak of pollution-related diseases, such as Minamata and Itai-itai, affecting tens of thousands of people. The legal systems and local government ordinances cover water quality standards, monitoring, and penalties. Local governments can conduct on-site inspections of factories and impose on penalty for illegal actions.

(2) **Pesticide use should be regulated as they deteriorate the quality of river water and groundwater.** In Japan, various standards have been established to regulate pesticide use. The permissible pesticides should also be registered, and crops for which the pesticides can be used, the time when they can be used, and the permissible amount for use are specified.

(3) **Domestic wastewater should be treated to achieve quality that meets the standard values.** In Japan, local governments have formulated basic plans to develop basin-wide sewage systems. Treatment methods can be optimized by the conventional sewerage system and Johksou, on-site treatment facility at the household level, taking into account the population density, topographic conditions, and economic efficiency.

(4) **For closed water bodies such as lakes and marshes, more stringent measures are essential for preserving water quality.** In lakes, marshes, inland bays, land-locked seas, and other closed water areas, improving water quality is difficult once deteriorated. There are two types of pollution loads: point and non-point sources. For the latter, improvement measures are required over large areas because the discharge points of pollutants are difficult to be identified. The act was enacted, followed by the setting of long-term targets, formulation of short-term plans, and implementation of water quality improvement for lakes and marshes in Japan.

(5) **Green infrastructure can contribute to the creation of a carbon-neutral society and resolution of various social issues.** Green Infrastructure or nature-based solutions, which utilize the diverse environmental functions, highlight the region's attractiveness based on the river's characteristics, local nature, and culture as well as mitigating disaster damage. In Japan, the River Law was revised to make the environment an internal objective for river improvement projects.

REFERENCES

Prefectures and Cities Enacting Pollution Prevention Ordinances

Organization	Year of establishment	Organization	Year of establishment	Organization	Year of establishment
Tokyo Metropolitan Government	1949	Aichi Prefecture	1964	Okayama Prefecture	1965
Kanagawa Prefecture	1951	Hyogo Prefecture	1964	Kumamoto Prefecture	1965
Osaka Prefecture	1954	Nagano Prefecture	1964	Kawasaki City	1960
Fukuoka Prefecture	1955	Miyagi Prefecture	1964	Sapporo City	1962
Niigata Prefecture	1960	Fukushima Prefecture	1965	(Smoke and Soot Prevention Ordinance)	
Shizuoka Prefecture	1961	Ibaraki Prefecture	1965		
Saitama Prefecture	1962	Tochigi Prefecture	1965	Soja City	1962
Chiba Prefecture	1963	Wakayama Prefecture	1965	Kumamoto City	1965

Source: Modern Capitalism and Pollution, Tsuru Shigeto, Iwanami Shoten 1968